Energy Vision

2020

7

Volume 2, Technical Document

# Customer Service Options

Volume 2, Technical Document 7

# Customer Service Options

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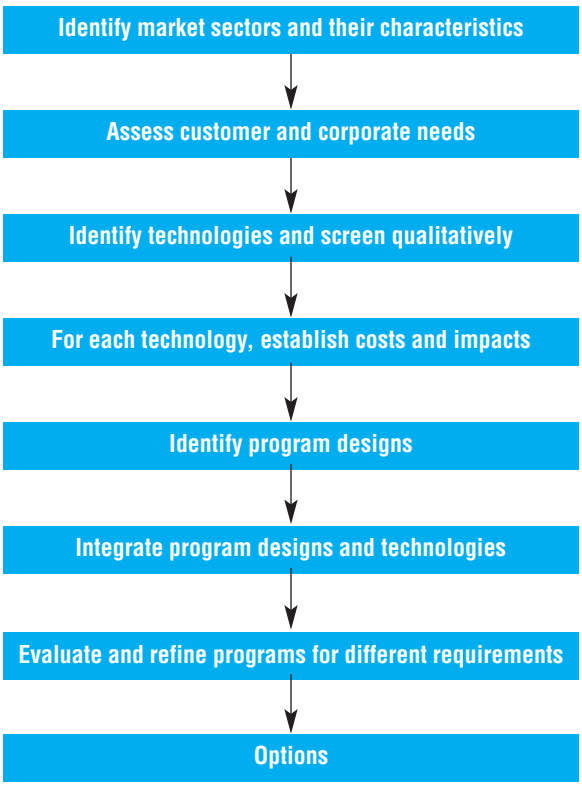
# Customer Service Options

## INTRODUCTION

TVA has developed more than 60 customer service options for consideration in Energy Vision 2020. Options were developed for all of the sectors and many of the end uses in the Valley economy. TVA developed options that impact the system load shape in a variety of ways, including energy efficiency, load management, self-generation, beneficial electrification, and rate options. The options include many different technologies that can be used to achieve a significant improvement in the efficiency of electricity use and deliver value to the residences and businesses throughout the Valley.

Technical Document 7, Customer Service Options, describes the methodology and data used for development of the options. This technical document contains a description of how customer service options were evaluated both at the program level and in the resource integration process. The criteria for ranking the technologies for inclusion in the options and prioritizing the options for inclusion in the different resource strategies are also discussed. Descriptions of all the customer service options are provided and include detailed impact and cost information. The last section of this technical document records the development of the technology data base and the technology screening process.

*FIGURE T7-1.* **Process for Development of Customer Service Options**




## Methodology for Option Development

A seven-step process was used to develop and evaluate the initial set of customer service options. *Figure T7-1* illustrates the process used to develop customer service options, including energy efficiency, load management, self-generation, beneficial electrification, and to a limited extent, rate options.

### IDENTIFICATION OF MARKET SECTORS AND ASSESSMENT OF CUSTOMER NEEDS

TVA identified different market sectors and their characteristics to assess customer needs and to better understand the kinds of technologies and programs that would be most beneficial. TVA also met with distributors of its power to obtain their input for promoting energy-efficient technologies to end-use customers.

### IDENTIFICATION AND QUALITATIVE SCREEN OF THE TECHNOLOGIES

To ensure that a wide range of options was developed for analysis in Energy Vision 2020, TVA identified a wide variety of efficient technologies. TVA received assistance in developing technology data from several organizations that are particularly qualified to provide technology information: E-Source, Tellus Institute, the National Renewable Energy Laboratory, Barakat & Chamberlin, Inc., Synergic Resources Incorporated, and Unimar, as well as TVA sources and the Energy Vision 2020 Review Group.

Technologies were qualitatively screened to ensure their appropriateness and applicability for the region. For example, evaporative air conditioners were dismissed because they are not compatible with the Valley's humid climate. An emerging technology could be discarded if adequate data to assess its costs and impacts were unavailable or could not be estimated. Considerable care was taken not to eliminate technologies prematurely and to carry forward as many technologies as possible to the next stage of the analysis.

### ESTABLISH AND RANK TECHNOLOGY COSTS AND IMPACTS

For all selected technologies, TVA gathered information on costs, energy requirements, and impacts on its capacity. This information was stored in a detailed database. Engineering simulations, as well as data from other utilities, technology vendors, and TVA field tests all contributed information to the database. Once the database was developed, it was reviewed by a number of technology experts, including the companies and agencies identified above.

For each market segment, TVA ranked energy efficiency technologies from a total resource cost perspective. To ensure that TVA would have a comprehensive set of options, some technologies with benefits less than the costs of the technology were included in one or more program options. Beneficial electrification measures were ranked according to their impact on electricity prices. This ranking identified the technologies to be included in one or more of the beneficial electrification options.

### IDENTIFICATION OF PROGRAM DESIGNS

A critical step in the option development process was the design of programs that would encourage customer acceptance, meet economic and financial objectives, and provide options for all customer classes. TVA reviewed other programs to identify good strategies that would meet TVA, distributor, and customer objectives. Past and present TVA programs, other integrated resource plans, and other utility programs were examined to find best practices and program characteristics providing the greatest chance for success. Programs included in TVA's customer service options were designed to:

- Increase energy efficiency by overcoming obstacles to the adoption of a new technology
- Provide customer value
- Promote market changes

Programs providing customer value, such as microwave heating or laser cutting options, address environmental concerns and increase productivity. These factors often have a greater impact on business profits than do energy costs.

### INTEGRATION OF PROGRAM DESIGNS AND TECHNOLOGIES

For customer service options, TVA combined technologies with delivery strategies to provide economical and efficient services to customers. Technologies were integrated with program designs based on likely distribution channels, customer needs, and the characteristics and economics of the different technologies.

### EVALUATION AND REFINEMENT OF OPTIONS TO MEET DIFFERENT REQUIREMENTS

The customer service options were checked for completeness and correctness, and to ensure a sufficient number of options were available for the construction of a wide range of strategies. TVA looked for a wide variety of different options to ensure diversity and comprehensiveness. TVA evaluated each option to determine its likely impact on the utility, its customers, and society. Delivery of technologies through a variety of program designs ensures that different customer needs are met.

## Program Designs Used to Deliver Technologies and Meet Customer Objective Needs

*Figure T7-2* lists the program designs or delivery mechanisms that were used to develop the customer service options and shows the customer objectives that can be satisfied by these program designs. Some program designs are more technology-specific, while others are designed to assist customers in identifying efficiency opportunities unique to their homes or businesses. These program designs provide value to the customer by making technologies more accessible to them and by overcoming obstacles that prevent customers from adopting energy efficiency measures on their own.

The obstacles to adopting energy-efficient technologies, often referred to as market barriers, can be classified into five types:

- Inadequate information
- Inconvenience and hassle
- Excessive risk
- Financial barriers
- Equipment availability

*Figure T7-3* shows how different program designs can overcome the market barriers identified above. Some program designs are more technology-specific than others.

Programs such as the following can be used to overcome these market barriers:

**Financing/Leasing.** Financing is offered to utility customers or the utility owns the technology itself and leases it to customers.

**Technical Assistance.** Architectural and engineering firms, utility personnel, equipment vendors, or manufacturers assist customers with the new technologies.

**Operating and Maintenance Assistance.** Customers receive ongoing assistance in operating and maintaining equipment.

**Rebates.** Customers, equipment installers, or manufacturers receive monetary incentives for high-efficiency energy systems.

**Direct Install.** Customers receive high-efficiency equipment and direct installation at no charge or at reduced charge.

*FIGURE T7-2.* **Objectives Satisfied by Program Designs**

| | PROGRAM OBJECTIVES | | | | | |
|---|---|---|---|---|---|---|
| Program Concepts | Minimum Rates | Low Cost | Large Impact | Diversity | Customer Service | Social Equity |
| Financing/Leasing | ● | | | ● | ● | |
| Technical Assistance | | | | | ● | |
| Assistance with O & M | | | | | ● | |
| Rebates | | | ● | ● | | ● |
| Direct Install | | | ● | | ● | ● |
| Audit | ● | ● | | ● | ● | |
| Mail Order | | ● | ● | | | ● |
| Rates | ● | ● | | ● | | |
| Custom Programs | | | ● | ● | ● | |
| Shared Savings | ● | ● | | ● | ● | |
| Market Transformation | | | ● | | | |

**Audit.** Customers are offered help to determine the most cost-effective energy efficiency options for their homes or businesses. Tools and information also may be given to facilitate a self-audit.

**Mail Order.** Catalogs are promoted as a source of appliances that are not widely available, in order to discount cost and provide information for customers. Catalogs are most appropriate for smaller, easily installed items. This program is particularly attractive for people in rural or remote areas and for the elderly.

**Rates.** Customers get a special electricity rate that encourages use of various equipment or influences energy use patterns.

**Custom Programs.** Customers receive site-specific assistance to identify and install energy efficiency measures or make changes that will save energy.

**Shared Savings.** Utilities provide financing and assistance in implementing an efficiency program and share the savings with the customer.

**Market Transformation.** Programs designed to increase the supply and demand of efficient technologies through manufacturer alliances, customer education, and establishment of new standards and building codes.

## Option Evaluation

### DSMANAGER & MIDAS

All of the customer service options developed for consideration in Energy Vision 2020 have been evaluated to determine option benefits and costs. DSManager, Version 2.5, was used to develop and evaluate all the customer service options. DSManager is software developed by the Electric Power Research Institute (EPRI) to analyze demand-side management (DSM) programs. The information from DSManager was then fed into MIDAS (Multiobjective Integrated Decision Analysis System, software devel-

*FIGURE T7-3.* **Market Barriers Overcome by Program Designs**

| | MARKET BARRIERS | | | | |
|---|---|---|---|---|---|
| Program Designs | Information | Inconvenience & Hassle | Risk | Financial | Availability |
| Financing/Leasing | | ● | ● | ● | |
| Technical Assistance | ● | | ● | | |
| O & M Assistance | ● | ● | ● | | |
| Rebates | | | ● | ● | |
| Direct Install | ● | ● | ● | ● | ● |
| Audit | ● | | | | |
| Mail Order | ● | ● | ● | ● | ● |
| Rates | | | | ● | |
| Custom Programs | ● | | ● | ● | |
| Shared Savings | | | ● | ● | |
| Market Transformation | ● | ● | | | ● |

oped by EPRI) to integrate and evaluate both demand-side (customer service) and supply-side options.

Customer service options change the way that customers use energy. DSManager traces these changes to quantify the change in electricity used by the customer over time. DSManager calculates the monetary impact of customer service options using data that describe how these changes in electricity use affect customer costs, as well as detailed descriptions of the production costs and rates (prices) for energy. DSManager calculates the costs and benefits of the customer service options for end-use customers, distributors, and the TVA system.

Once the customer service options had been defined and evaluated using DSManager, their impact and cost data were transferred to MIDAS. MIDAS was used to study and compare the system load impacts and rate impacts of different resource options. MIDAS performs a variety of calculations, including load analysis, capacity planning, production costing, financial projections, and rate calculations. Although available from DSManager, the demand and energy impacts shown in this technical document are from MIDAS. MIDAS provides a more dynamic description of the power system and takes into account the interactions between options and other resources in determining option impacts. Also, the supply costs avoided by implementing customer service options are determined in MIDAS, based on the alternative resource options considered.

## CUSTOMER SERVICE OPTION BLOCKS

The customer service options were grouped into four blocks to be combined with supply-side options to create resource strategies. Each block is approximately the size of a generating unit, between 1,000 megawatts and 1,500 megawatts. The different resource strategies were then analyzed at the integration level using MIDAS. The options were divided into the blocks shown below based on the following criteria: (1) option cost; (2) impact on rates; (3) customer value and competitiveness (e.g., long-term customer relationships); and (4) equity (i.e., whether customers have opportunities to participate in programs).

Options in Block 1 provide energy savings at the lowest average total resource cost (described in the next section) of any block, or 2.7 cents per kilowatt-hour. Block 1 also has a minimal impact on average rates or does not cause rates to increase. The average total resource cost of Block 2 options is 2.8 cents per kilowatt-hour, but Block 2 options have a greater impact on average rates than the Block 1 options. The average total resource cost of the options in Block 3 is 3.9 cents per kilowatt-hour and in Block 4 is 5.2 cents per kilowatt-hour. The peak demand savings potential in year 2010 from Blocks 1 and 2 represents 8.7 percent of the forecast summer peak demand, and energy savings constitute 6.3 percent of the total projected system sales in the same year. *Figure T7-4* shows how the customer service options are divided into the four blocks considered in Energy Vision 2020.

## BENEFIT/COST TESTS

The outputs from DSManager and MIDAS can be expressed in the terms of the cost-effectiveness tests used to examine the relative benefits and costs of the customer service options from several perspectives. The standard cost-effectiveness tests (Participant Test, Rate Impact Measure Test, and Total Resource Cost Test) measure whether particular customer service options achieve their intended goals.

The Participant Test examines the benefits and costs of the options from the perspective of end-use customers participating in a customer service option. The Rate Impact Measure (RIM) Test takes the perspective of non-participants and quantifies the change in rates due to options. Thus, a program that passes the RIM Test will cause overall system rates to decrease. The Total Resource Cost (TRC) Test looks at options from the perspective of both participants and non-participants and measures the achievement of a goal of providing energy services at the lowest resource cost.

TVA also evaluated the customer service options using the Customer Value Test. This test combines both the RIM Test and the TRC Test, as well as other factors, such as external benefits, quality gains, and long-run rate impacts resulting from customer service options. The Customer Value Test allows comparison of both energy efficiency programs and programs designed to promote new beneficial uses of electricity with supply-side resource options. The results of all the cost-effectiveness tests were considered when options were placed in the blocks to be included in the different resource strategies in Energy Vision 2020.

# Option Descriptions

For each of the customer service options, information documenting the program costs and impacts has been provided. There is a written description of each option, typically discussing the applicable target market, implementation strategy, incentive strategy, and the monitoring and evaluation approach to be used to verify program benefits and costs.

The descriptions are intended to give a feel for how an option would be implemented if it were chosen as a viable resource option in the Energy Vision 2020. The option descriptions are intended to identify the appropriate delivery mechanisms for the measures involved and also to quantify the costs and impacts of these measures. Once an option has been selected, a detailed

*FIGURE T7-4.* **Customer Service Option Blocks**

**Block 1**

Commercial Cool Storage
Rooftop Cool Storage
Commercial Group Load Curtailment
Residential Load Management—Air Conditioning
Residential Existing Load Management—Air Conditioning
Residential Existing Load Management—Water Heaters
Residential Heat Pump Leasing/Financing Program
Residential Efficiency Products Catalog
Industrial Technology Rebates—High-Efficiency Motors
Residential Lighting Products—Retail Component
Comprehensive Measure Financing
Residential Ground-Source Heat Pump Leasing

**Block 2**

Residential Self-Audit
Residential New Homes
Commercial Lighting Technology Rebates
Residential Low Income Program
Residential Load Management—Water Heaters
Commercial New Construction
Commercial Technology Rebates—Other
Refrigerator Turn-In
Residential Student Self-Audit
Small Commercial Retrofit

**Block 3**

Residential Load Management—SCADA
Comprehensive Measure Rebates
Industrial Process Energy Efficiency—Distributor Served
Industrial Process Energy Efficiency—Direct Served
Industrial Technology Rebates—Adjustable Speed Drives
"Opt-Out" or Energy-Efficient Rates
Residential Heat Pump Water Heating Leasing
Residential Direct Install
Commercial HVAC Technology Rebates
Residential Manufactured Housing Program

**Block 4**

Residential Load Management—New Technology
Commercial HVAC Maintenance Program
Residential Heat Pump Loans
Residential Efficient Air Conditioning
Residential Heat Pump Rebates
Residential Load Management—Storage Water Heaters
Industrial Technology Rebates—Compressed Air Efficiency
Residential Appliance Rebates Program
Residential Low Income Weatherization Program
Residential Solar Water Heater Program
Commercial New Construction—Renewables

program implementation plan must be developed before the program can commence. The detailed development of all DSM programs is done in cooperation with the power distributors, as is their implementation.

## PROGRAM ASSUMPTIONS

The option descriptions are followed by the Program assumptions data. This data is divided into three sections. The top section provides some important facts about each option. The second section or table shows option participation by year. Finally, the third section shows program cost data. Each of the sections and variables contained within are discussed in more detail below.

### Program Constants

**Package Measure Life.** This is the average life of the measures installed in a program. For programs with multiple measures, the life is a weighted average of the life of the constituent measures.

**Free-Rider Rate.** The percentage of customers who would have adopted recommended program actions even without its existence, but who also participate directly in the program (e.g., they do claim rebates).

**Free-Driver Rate.** The percentage of customers who take program recommended actions because of the program, but who do not participate directly in the program (e.g., they do not claim rebates).

**Dropouts.** The percentage of program participants who drop out before the equipment or measure in a particular program reaches the end of its life.

**Take-Back Percentage.** The percentage of a measure's energy savings taken back by the program participant. Energy savings in some end-use technologies will affect a participant's bill significantly enough to influence the participant's energy usage. For example, a weatherization program may lower homeowners' heating bills such that they adjust their thermostat to achieve a more comfortable temperature, thereby "taking back" some of the energy savings to increase comfort. This variable is used only for calculations involving the Customer Value Test.

**Free-Rider Market Barrier Costs Eliminated.** The percentage of transaction costs, hidden costs, or other market barrier costs eliminated from free riders in the program. This variable is used in Customer Value Test calculations.

**Non-Free-Rider Market Barrier Costs Eliminated.** The percentage of transaction costs, hidden costs, or other market barrier costs eliminated from program participants who are not free riders in the program. This variable is used in Customer Value Test calculations.

**Annual Energy Impact (kWh).** The change in average annual energy usage resulting from the measures installed in the program. For programs with multiple measures, the energy impact is a weighted average of all program measures. This value is utilized to scale overall program impacts. Load management programs may not have significant energy impacts relative to their demand impacts. For program analysis, an appropriate load shape (a unitized hourly electrical demand profile) was used to determine the hourly demand impacts corresponding to the annual energy impact.

### Participation Data

**Year.** The option start date is flexible for the Energy Vision 2020 analysis so actual dates are not shown. Participation and costs are shown for the year of the program life. Up to 12 years of program data is shown regardless of the actual length of the program.

**Annual Eligible Population.** The number of eligible participants determined by the program target market (all customers or annual equipment failures), market segmentation (end use, building type, SIC code), and other factors including the percentage of distributors expected to participate in the program.

**New Participants.** The estimated number of new program participants by year. For different program sectors, the definition of participant varies. For the residential sector, one participant refers to one unit or one home. In the commercial sector, participation is measured by each thousand square-foot area. In the industrial sector, participation is measured in terms of each one million kilowatt-hours of electric usage.

**Total Participants.** The cumulative participation in the program from its first year, not accounting for free riders, free drivers, or dropouts.

**Cumulative Participation Rate.** The ratio of total program participants to cumulative eligible participation.

### Cost Data

**Fixed Administrative Cost.** The program costs not directly proportional to the number of participants are shown in this column. Typical items would include some staff or contract labor costs, training costs, database or software development costs, program design costs, marketing and advertising costs, and monitoring and evaluation costs.

**Variable Administrative Cost.** The single value indicates the per participant variable administrative cost per participant, and the table shows the annual total for these costs for all participants. Typical items included are inspection fees, program paperwork costs, survey costs, technical assistance costs, billing fees, and financing initiation fees.

**Participant Measure Cost.** The incremental installed cost of the program measures. This cost is the incremental cost above the base or equivalent technology. The single value shows the cost per participant, and the table shows the annual totals for all participants in a given year. In many cases a portion of this cost will be offset by participant incentives, which are shown separately.

**Participant Incentives.** Any incentive provided to the participant is indicated here. The single value shows the incentive per participant, and the table shows the annual totals for all participants in a given year. Incentives include one-time rebates, equipment maintenance, price buy-downs arranged with wholesale equipment dealers, or installation of equipment free of charge for some programs.

## OPTION-SPECIFIC CALCULATIONS

Following the basic program assumptions in the case of most options, there is an additional table of calculations or details pertinent to the option's costs or impacts. Most options promote more than one technology or measure. A mix of these measures is utilized to determine the average weighted impacts and costs for the measures. For the beneficial electrification options, the determination of the estimated quality gain is also provided.

Many of the values shown in the detailed option descriptions have been calculated. Due to rounding, some values may not be exactly reproduced using the numbers shown.

# RESIDENTIAL ENERGY EFFICIENCY OPTIONS

## SUMMARY OF PROJECTED IMPACTS IN YEAR 2010

| Residential Energy Efficiency | Winter MW | Summer MW | Million kWh | Thousands of Units | TRC ¢/kWh |
|---|---|---|---|---|---|
| Heat Pump Loans | 433 | 469 | 1,347 | 254 | 5.0 |
| Heat Pump Leasing | 581 | 518 | 1,688 | 266 | 1.6 |
| Heat Pump Rebates | 627 | 527 | 1,787 | 375 | 3.3 |
| Ground-Source Heat Pump Leasing | 58 | 62 | 179 | 26 | 8.1 |
| Efficient Air Conditioning | 0 | 133 | 233 | 124 | 7.6 |
| New Homes | 402 | 184 | 1,142 | 118 | 3.0 |
| Manufactured Housing | 164 | 53 | 358 | 131 | 4.4 |
| Direct Install | 845 | 386 | 2,399 | 1,163 | 2.3 |
| Low Income | 165 | 75 | 467 | 251 | 2.8 |
| Low Income Weatherization | 12 | 6 | 36 | 10 | 12.9 |
| Heat Pump Water Heater Leasing | 262 | 103 | 995 | 452 | 3.2 |
| Solar Water Heater | 11 | 4 | 41 | 15 | 22.1 |
| Efficiency Products Catalog | 234 | 107 | 665 | 714 | 1.4 |
| Lighting Products Retail Component | 225 | 103 | 639 | 687 | 2.5 |
| Appliance Rebates | 39 | 41 | 304 | 1,518 | 9.1 |
| Refrigerator Turn-In & Recycling | 10 | 13 | 93 | 91 | 3.5 |
| Student Self-Audit | 53 | 23 | 150 | 1,235 | 4.3 |
| Self-Audit | 42 | 19 | 120 | 102 | 2.6 |
| **Residential Load Management** | | | | | **$/kW** |
| Load Management—Air Conditioners | 0 | 53 | 21 | 39 | 58 |
| Load Management—Water Heaters | 212 | 84 | 0 | 158 | 55 |
| Load Management—Storage Water Heaters | 100 | 39 | 0 | 75 | 934 |
| Load Management w/SCADA | 0 | 0 | 0 | 67 | 140 |
| Load Management—New Technology | 0 | 0 | 0 | 276 | 2,039 |

Values are the impacts occuring only in the year 2010 for the cumulative participation in the program to that date.

TVA developed 23 residential options for evaluation in Energy Vision 2020 with applications for all major end uses of electricity and for all types of housing.

## HEAT PUMP LOANS PROGRAM

### Overview

The Heat Pump Loans Program promotes quality installations of higher efficiency heat pumps. The program provides financing for units that meet the minimum performance criteria. Incentives are provided for higher efficiency heat pumps. Weatherization measures can also be financed, if needed to meet minimum insulation and infiltration standards.

### Target Market

All residential customers in participating power distributor areas

### Implementation Strategy

The Heat Pump Loans Program is designed to promote quality installations of higher efficiency heat pumps. The program will continue the long-term financing effort already in place for heat pumps that meet a minimum SEER 12 performance criterion. In addition, cash or other financial incentives are proposed for dealers or consumers installing heat pumps that have SEERs higher than 12 and HSPFs higher than 7.5. Several levels of incentives will be offered, with greater incentives provided for units with greater performance efficiencies. To ensure optimal performance, a minimum attic insulation level of R-19 and infiltration reduction through weather-stripping and caulking are also included.

The program emphasizes the responsibility of the dealer to provide a quality installation. The Quality Contractor Network provides training for dealers, execution of post-inspection checklists, and awards for maintaining high installation standards. Standards will be established for all program installations to ensure the satisfaction of the consumer and the efficient operation of the system.

### Incentives

- Financing of the heat pump and installation costs
- Financing of needed weatherization measures
- Rebates for high-efficiency heat pumps

### Program Assumptions

| | |
|---|---|
| Package Measure Life (Years) | 15 |
| Free-Rider Rate | 15% |
| Free-Driver Rate | 0% |
| Dropouts | 2% |
| Take-Back Percentage | 5% |
| Free-Rider Market Barrier Costs Eliminated | 60% |
| Non-Free-Rider Market Barrier Costs Eliminated | 75% |
| Annual Energy Impact (kWh) | 4,630 |

| Year | Annual Eligible Population | New Participants | Total Participants | Cumulative Participation Rate |
|---|---|---|---|---|
| 1 | 57,300 | 11,200 | 11,200 | 20% |
| 2 | 58,200 | 12,600 | 23,800 | 21% |
| 3 | 59,100 | 13,500 | 37,300 | 21% |
| 4 | 60,100 | 14,500 | 51,800 | 22% |
| 5 | 61,000 | 15,500 | 67,300 | 23% |
| 6 | 62,000 | 16,600 | 83,900 | 23% |
| 7 | 62,900 | 17,000 | 100,900 | 24% |
| 8 | 63,800 | 17,200 | 118,100 | 24% |
| 9 | 64,800 | 17,500 | 135,600 | 25% |
| 10 | 65,700 | 17,700 | 153,300 | 25% |
| 11 | 66,700 | 17,000 | 171,300 | 25% |
| 12 | 67,600 | 18,300 | 189,600 | 25% |

| Year | Fixed Administrative Cost | Per Participant Variable Administrative Costs<br>$324<br>Total Variable Admin. Cost | Per Participant Measure Cost<br>$1,048<br>Total Part. Measure Cost | Per Participant Incentive<br>$0<br>Total Part. Incentive |
|---|---|---|---|---|
| 1 | $1,286,000 | $3,628,800 | $11,737,600 | $0 |
| 2 | $1,286,000 | $4,082,400 | $13,204,800 | $0 |
| 3 | $1,286,000 | $4,374,000 | $14,148,000 | $0 |
| 4 | $1,286,000 | $4,689,000 | $15,196,000 | $0 |
| 5 | $1,286,000 | $5,022,000 | $16,224,000 | $0 |
| 6 | $1,286,000 | $5,378,400 | $17,396,800 | $0 |
| 7 | $1,286,000 | $5,508,000 | $17,816,000 | $0 |
| 8 | $1,286,000 | $5,572,800 | $18,025,600 | $0 |
| 9 | $1,286,000 | $5,670,000 | $18,340,000 | $0 |
| 10 | $1,286,000 | $5,734,800 | $18,549,600 | $0 |
| 11 | $1,286,000 | $5,832,000 | $18,864,000 | $0 |
| 12 | $1,286,000 | $5,929,200 | $19,178,400 | $0 |

## Monitoring and Evaluation

Program impacts will be evaluated through pre- and post-billing analysis of homes that have not changed their level of insulation. Adjustment factors will be calculated for homes that have upgraded insulation as part of the program. Quality assurance inspections are performed for 100 percent of program installations. Inspections will verify appropriate equipment sizing, air flow and balance, and duct insulation and sealing.

| Measure | Incremental Energy (kWh/yr) | Incremental Cost ($) | # /home | Weighted Energy (kWh/yr) | Weighted Cost ($) |
|---|---|---|---|---|---|
| Base ASHP10 to ASHP12 | 3,489 | 590 | 0.78 | 2,721 | 460 |
| Base ASHP10 to ASHP14 | 6,989 | 708 | 0.14 | 978 | 99 |
| Base ASHP10 to GSHP | 5,035 | 2,250 | 0.08 | 403 | 180 |
| Attic Insulation | 683 | 650 | 0.40 | 273 | 260 |
| Programmable Thermostat | 637 | 122 | 0.40 | 255 | 49 |
| | | | **Total** | **4,630** | **1,048** |

*#/home: Based on current program experience*

## HEAT PUMP LEASING/FINANCING PROGRAM

### Overview

The Heat Pump Leasing Program allows for certain technologies to be selected by a customer and installed by the utility, with the customer paying a monthly "service charge" or loan payment on their electric bill. This program is designed to promote efficient electrical products where first cost is a significant barrier to customer participation. Additionally, this program simplifies maintenance and service of complicated equipment by moving the risk to the utility.

### Target Market

This program targets residential customers who own or are purchasing their dwelling.

### Implementation Strategy

The program works in conjunction with local equipment retailers as a financing program. The customer selects the contractor, eligible equipment, and contacts the utility for an installation inspection and to complete the necessary paperwork. Two payment options are offered. The first is a continual monthly charge with the utility maintaining ownership of the equipment and providing all necessary maintenance and repair of the equipment for as long as the customer is in the program. Early termination (before the customer has repaid his/her debt) requires the customer to settle for the remaining debt.

The second option is a larger monthly payment designed to pay back the debt. During the repayment period, the utility maintains and repairs the equipment free of charge. At the end of the repayment period, the customer can change to a maintenance/replacement contract payment if so desired.

The specified lease equipment must meet applicable SEER and HSPF efficiency levels. The heat pump installation will include an adaptive recovery programmable thermostat and must meet specific installation requirements.

Repair and replacement work will be performed by local contractors. A local phone number with answering service will be available 24 hours per day, 365 days per year. The customer is guaranteed replacement or repair within 48 hours of the call.

### Incentives

A service contract will be provided for each heat pump.

### Program Assumptions

| | |
|---|---|
| Package Measure Life (Years) | 15 |
| Free-Rider Rate | 15% |
| Free-Driver Rate | 0% |
| Dropouts | 2% |
| Take-Back Percentage | 5% |
| Free-Rider Market Barrier Costs Eliminated | 60% |
| Non-Free-Rider Market Barrier Costs Eliminated | 75% |
| Annual Energy Impact (kWh) | 5,478 |

| Year | Annual Eligible Population | New Participants | Total Participants | Cumulative Participation Rate |
|---|---|---|---|---|
| 1 | 57,300 | 11,220 | 11,220 | 20% |
| 2 | 58,200 | 12,600 | 23,820 | 21% |
| 3 | 59,100 | 13,500 | 37,320 | 21% |
| 4 | 60,100 | 14,500 | 51,800 | 22% |
| 5 | 61,000 | 15,500 | 67,300 | 23% |
| 6 | 62,000 | 16,600 | 83,900 | 23% |
| 7 | 62,900 | 17,000 | 100,900 | 24% |
| 8 | 63,800 | 17,200 | 118,100 | 24% |
| 9 | 64,800 | 17,500 | 135,600 | 25% |
| 10 | 65,700 | 17,700 | 153,300 | 25% |
| 11 | 66,700 | 18,000 | 171,300 | 25% |
| 12 | 67,600 | 18,300 | 189,600 | 25% |

| Year | Fixed Administrative Cost | Per Participant Variable Administrative Costs<br>$125<br>Total Variable Admin. Cost | Per Participant Measure Cost<br>$848<br>Total Part. Measure Cost | Per Participant Incentive<br>$242<br>Total Part. Incentive |
|---|---|---|---|---|
| 1 | $750,000 | $1,400,000 | $9,497,600 | $2,710,400 |
| 2 | $700,000 | $1,575,000 | $10,684,800 | $3,049,200 |
| 3 | $700,000 | $1,687,500 | $11,448,000 | $3,267,000 |
| 4 | $700,000 | $1,812,500 | $12,296,000 | $3,509,000 |
| 5 | $700,000 | $1,937,500 | $13,114,000 | $3,751,000 |
| 6 | $700,000 | $2,075,000 | $14,076,800 | $4,017,200 |
| 7 | $700,000 | $2,125,000 | $14,416,000 | $4,114,000 |
| 8 | $700,000 | $2,150,000 | $14,585,600 | $4,162,400 |
| 9 | $700,000 | $2,187,500 | $14,840,000 | $4,235,000 |
| 10 | $700,000 | $2,212,500 | $15,009,600 | $4,283,400 |
| 11 | $700,000 | $2,250,000 | $15,264,000 | $4,356,000 |
| 12 | $700,000 | $2,287,500 | $15,518,400 | $4,428,600 |

## Monitoring and Evaluation

Some equipment monitoring is required for program analysis purposes. Inspections will be performed on 100 percent of program installations for QA purposes. HVAC inspections will verify appropriate equipment sizing, equipment charge, airflow and balance, and duct insulation and sealing. A complaint phone number also listed on the appliance will provide significant feedback on the equipment and its timely repair.

| Measure | Incremental Energy (kWh/yr) | Incremental Cost ($) | # /home | Weighted Energy (kWh/yr) | Weighted Cost ($) |
|---|---|---|---|---|---|
| Base ASHP 10 to ASHP 12 | 3,489 | 590 | 0.75 | 2,617 | 443 |
| Base ASHP 10 to ASHP 14 | 6,989 | 708 | 0.25 | 1,747 | 177 |
| Programmable Thermostat | 637 | 122 | 1.00 | 637 | 122 |
| Maintain ASHP | 477 | 106 | 1.00 | 477 | 106 |
| | | | **Total** | **5,478** | **848** |

## HEAT PUMP REBATES PROGRAM

### Overview

The Heat Pump Rebates Program will promote efficient heat pumps using rebates and point-of-sale displays. The rebate structure is tiered corresponding to equipment efficiency levels and is designed to offset the majority of the incremental cost of the more efficient heat pumps. This program would be implemented in cooperation with heat pump manufacturers, distributors, dealers, and installers to promote the rebates to all applicable customers. Contractor/dealer training would be provided to increase understanding of the benefits and fuel cost savings for the more efficient equipment, as well as proper installation and maintenance practices.

### Target Market

The program targets the two-thirds of residential heat pumps that are not installed through the TVA Heat Pump Loan Program.

### Implementation Strategy

Rebate coupons, point-of-sale displays, and appliance labeling are utilized to promote efficient appliances. Utility representatives will work with manufacturers, dealers, and contractors to distribute displays and coupons. Additionally, coupons will be distributed through other compatible DSM programs, power distributor offices, and upon phone request.

### Incentives

Rebate coupons will be provided.

### Monitoring and Evaluation

Rebate coupons will provide initial information on replacement and usage patterns. A database will be completed from returned rebate coupons. Follow-up surveys of equipment installed and usage patterns will be conducted.

### Program Assumptions

| | |
|---|---|
| Package Measure Life (Years) | 15 |
| Free-Rider Rate | 25% |
| Free-Driver Rate | 0% |
| Dropouts | 0% |
| Take-Back Percentage | 20% |
| Free-Rider Market Barrier Costs Eliminated | 50% |
| Non-Free-Rider Market Barrier Costs Eliminated | 30% |
| Annual Energy Impact (kWh) | 4,103 |

| Year | Annual Eligible Population | New Participants | Total Participants | Cumulative Participation Rate |
|---|---|---|---|---|
| 1 | 36,600 | 5,500 | 5,500 | 15% |
| 2 | 38,400 | 7,700 | 13,200 | 18% |
| 3 | 40,400 | 10,100 | 23,300 | 20% |
| 4 | 42,400 | 14,800 | 38,100 | 24% |
| 5 | 44,500 | 20,000 | 58,100 | 29% |
| 6 | 46,700 | 23,400 | 81,500 | 33% |
| 7 | 49,100 | 24,500 | 106,000 | 36% |
| 8 | 51,500 | 25,800 | 131,800 | 38% |
| 9 | 54,100 | 27,000 | 158,800 | 39% |
| 10 | 56,800 | 28,400 | 187,200 | 41% |
| 11 | 59,600 | 29,800 | 217,000 | 42% |
| 12 | 62,600 | 31,300 | 248,300 | 43% |

| Year | Fixed Administrative Cost | Per Participant Variable Administrative Costs<br>$25<br>Total Variable Admin. Cost | Per Participant Measure Cost<br>$739<br>Total Part. Measure Cost | Per Participant Incentive<br>$568<br>Total Part. Incentive |
|---|---|---|---|---|
| 1 | $1,500,000 | $137,500 | $4,064,500 | $3,124,000 |
| 2 | $1,200,000 | $192,500 | $5,690,300 | $4,373,600 |
| 3 | $1,200,000 | $252,500 | $7,463,900 | $5,736,800 |
| 4 | $1,200,000 | $370,000 | $10,937,200 | $8,406,400 |
| 5 | $1,200,000 | $500,000 | $14,780,000 | $11,360,000 |
| 6 | $1,200,000 | $585,000 | $17,292,600 | $13,291,200 |
| 7 | $1,200,000 | $612,500 | $18,105,500 | $13,916,000 |
| 8 | $1,200,000 | $645,000 | $19,066,200 | $14,654,400 |
| 9 | $1,200,000 | $675,000 | $19,953,000 | $15,336,000 |
| 10 | $1,200,000 | $710,000 | $20,987,600 | $16,131,200 |
| 11 | $1,200,000 | $745,000 | $22,022,200 | $16,926,400 |
| 12 | $1,200,000 | $782,500 | $23,130,700 | $17,778,400 |

## GROUND SOURCE HEAT PUMP LEASING PROGRAM

### Overview

The Ground Source Heat Pump Leasing Program allows for certain technologies to be selected by a customer and installed by the utility, with the customer paying a monthly "service charge" on his/her electric bill. This program is designed to promote ground source heat pumps, for which initial cost is a significant barrier to customer participation. Additionally, this program simplifies maintenance and service of complicated equipment by moving the risk to the utility.

### Target Market

This program targets residential customers who own or are purchasing their dwelling.

### Implementation Strategy

The program works in conjunction with local equipment retailers similar to a financing program. The customer selects the contractor, eligible equipment, and contacts the utility for an installation inspection and to complete the necessary paperwork. Two payment options are offered. The first is a continual monthly charge with the utility maintaining ownership of the equipment and providing all necessary maintenance and repair of the equipment for as long as the customer is in the program. Early termination (before the customer has repaid his/her debt) requires the customer to settle for the remaining debt.

The second option is a larger monthly payment designed to pay back the debt. Once the debt has been fully repaid, ownership of the equipment is transferred to the homeowner. During the repayment period, the utility maintains and repairs the equipment free of charge. At the end of the repayment period, the customer can change to a maintenance/replacement contract payment if so desired.

The specified lease equipment must meet applicable SEER and HSPF efficiency levels. The heat pump installation will include an adaptive recovery programmable thermostat, and must meet specific installation requirements.

Repair and replacement work will be performed by local contractors. A local phone number with answering service will be available 24 hours per day, 365 days per year. The customer is guaranteed replacement or repair within 48 hours of the call.

### Incentives

A service contract will be provided for each ground source heat pump.

### Monitoring and Evaluation

Some equipment monitoring is required for program analysis purposes. Inspections will be performed for 100 percent of program installations for QA purposes. The heat pump inspection will verify appropriate equipment sizing, equipment charge, air flow and balance, and duct insulation and sealing. A complaint phone number also listed on the appliance will provide significant feedback on the equipment and its timely repair.

### Program Assumptions

| | |
|---|---|
| Package Measure Life (Years) | 15 |
| Free-Rider Rate | 1% |
| Free-Driver Rate | 0% |
| Dropouts | 2% |
| Take-Back Percentage | 5% |
| Free-Rider Market Barrier Costs Eliminated | 40% |
| Non-Free-Rider Market Barrier Costs Eliminated | 50% |
| Annual Energy Impact (kWh) | 6,046 |

| Year | Annual Eligible Population | New Participants | Total Participants | Cumulative Participation Rate |
|---|---|---|---|---|
| 1 | 79,700 | 100 | 100 | 0% |
| 2 | 79,700 | 200 | 300 | 0% |
| 3 | 79,700 | 300 | 600 | 0% |
| 4 | 79,700 | 400 | 1,000 | 0% |
| 5 | 79,700 | 500 | 1,500 | 0% |
| 6 | 79,700 | 700 | 2,200 | 0% |
| 7 | 79,700 | 800 | 3,000 | 1% |
| 8 | 79,700 | 1,000 | 4,000 | 1% |
| 9 | 79,700 | 1,200 | 5,200 | 1% |
| 10 | 79,700 | 1,400 | 6,600 | 1% |
| 11 | 79,700 | 1,500 | 8,100 | 1% |
| 12 | 79,700 | 1,700 | 9,800 | 1% |

| Year | Fixed Administrative Cost | Per Participant Variable Administrative Costs<br>$75 Total Variable Admin. Cost | Per Participant Measure Cost<br>$2,250 Total Part. Measure Cost | Per Participant Incentive<br>$242 Total Part. Incentive |
|---|---|---|---|---|
| 1 | $300,000 | $7,500 | $225,000 | $24,200 |
| 2 | $200,000 | $15,000 | $450,000 | $48,400 |
| 3 | $150,000 | $22,500 | $675,000 | $72,600 |
| 4 | $150,000 | $30,000 | $900,000 | $96,800 |
| 5 | $150,000 | $37,500 | $1,125,000 | $121,000 |
| 6 | $150,000 | $52,500 | $1,575,000 | $169,400 |
| 7 | $150,000 | $60,000 | $1,800,000 | $193,600 |
| 8 | $150,000 | $75,000 | $2,250,000 | $242,000 |
| 9 | $150,000 | $90,000 | $2,700,000 | $290,400 |
| 10 | $150,000 | $105,000 | $3,150,000 | $338,800 |
| 11 | $150,000 | $112,500 | $3,375,000 | $363,000 |
| 12 | $150,000 | $127,500 | $3,825,000 | $411,400 |

## EFFICIENT AIR CONDITIONING PROGRAM

### Overview

This program will promote efficient central air conditioners using rebates. Utility representatives will work with HVAC contractors, HVAC distributors, and trade associations to promote applicable appliances and to distribute displays and coupons.

### Target Market

All residential customers with central air conditioning in participating power distributor areas are targeted.

### Implementation Strategy

Rebate coupons, point-of-sale displays, and appliance labeling are utilized to promote efficient appliances. Utility representatives will work with HVAC contractors, HVAC distributors, and trade associations to promote applicable appliances and to distribute displays and coupons. Additionally, coupons will be distributed through other compatible DSM programs, power distributor offices, and upon phone request.

### Incentives

Rebate coupons will be provided.

### Monitoring and Evaluation

Program impacts will be evaluated through pre- and post-billing analysis. Quality assurance inspections are performed for approximately 10 percent of program installations, with emphasis on new dealers and problem dealers. Inspections will verify appropriate equipment sizing, air flow and balance, and duct insulation and sealing.

Rebate coupons will provide initial information on replacement and usage patterns. A database will be completed from returned rebate coupons. Follow-up surveys of equipment installed and usage patterns will be conducted.

### Program Assumptions

| | |
|---|---|
| Package Measure Life (Years) | 15 |
| Free-Rider Rate | 15% |
| Free-Driver Rate | 0% |
| Dropouts | 0% |
| Take-Back Percentage | 20% |
| Free-Rider Market Barrier Costs Eliminated | 50% |
| Non-Free-Rider Market Barrier Costs Eliminated | 30% |
| Annual Energy Impact (kWh) | 1,632 |

| Year | Annual Eligible Population | New Participants | Total Participants | Cumulative Participation Rate |
|---|---|---|---|---|
| 1 | 19,300 | 2,900 | 2,900 | 15% |
| 2 | 19,300 | 3,900 | 6,800 | 18% |
| 3 | 19,300 | 4,800 | 11,600 | 20% |
| 4 | 19,300 | 5,800 | 17,400 | 23% |
| 5 | 19,300 | 6,700 | 24,100 | 25% |
| 6 | 19,300 | 7,700 | 31,800 | 28% |
| 7 | 19,300 | 8,700 | 40,500 | 30% |
| 8 | 19,300 | 9,600 | 50,100 | 33% |
| 9 | 19,300 | 9,600 | 59,700 | 34% |
| 10 | 19,300 | 9,600 | 69,300 | 36% |
| 11 | 19,300 | 9,600 | 78,900 | 37% |
| 12 | 19,300 | 9,600 | 88,500 | 38% |

| Year | Fixed Administrative Cost | Per Participant Variable Administrative Costs<br>$25<br>Total Variable Admin. Cost | Per Participant Measure Cost<br>$708<br>Total Part. Measure Cost | Per Participant Incentive<br>$500<br>Total Part. Incentive |
|---|---|---|---|---|
| 1 | $700,000 | $72,500 | $2,053,200 | $1,450,000 |
| 2 | $500,000 | $97,500 | $2,761,200 | $1,950,000 |
| 3 | $500,000 | $120,000 | $3,398,400 | $2,400,000 |
| 4 | $500,000 | $145,000 | $4,106,400 | $2,900,000 |
| 5 | $500,000 | $167,500 | $4,743,600 | $3,350,000 |
| 6 | $500,000 | $192,500 | $5,451,600 | $3,850,000 |
| 7 | $500,000 | $217,500 | $6,159,600 | $4,350,000 |
| 8 | $500,000 | $240,000 | $6,796,800 | $4,800,000 |
| 9 | $500,000 | $240,000 | $6,796,800 | $4,800,000 |
| 10 | $500,000 | $240,000 | $6,796,800 | $4,800,000 |
| 11 | $500,000 | $240,000 | $6,796,800 | $4,800,000 |
| 12 | $500,000 | $240,000 | $6,796,800 | $4,800,000 |

## NEW HOMES PROGRAM

### Overview

The New Homes Program promotes higher efficiency standards and quality construction in new homes. Incentives are provided for homebuilders who meet the weatherization and equipment efficiency requirements of a basic package, with additional incentives for specific thermal envelope and equipment upgrades beyond the basic package.

### Target Market

This program targets homebuyers in participating power distributor areas.

### Implementation Strategy

The New Homes Program will promote higher efficiency standards and quality construction in new homes. Incentives are proposed for homebuilders who meet the weatherization and equipment efficiency requirements of a basic package, and additional incentives will be available for specific thermal envelope and equipment upgrades beyond the levels of the basic package. The thermal performance requirements of the basic package will exceed the standards of the Model Energy Code. The proposed minimum performance requirements for equipment are SEER 12/HSPF 7.5 or SEER 12/AFUE 90. Trade-offs will be allowed for some measures.

The program will provide training for homebuilders and trade allies to ensure the proper installation of efficiency measures. Technical requirements with an emphasis on quality installation should produce significant improvement in the energy efficiency of new homes.

The program will emphasize the responsibility of the dealer to provide a quality installation. A Quality Contractor Network provides training for dealers, execution of post-inspection checklists, and awards for maintaining high installation standards. Standards will be established for all program installations to ensure the satisfaction of the consumer and the proper operation of the system. Inspections during the building process will ensure adherence to program standards.

### Incentives

- Builder incentives are provided for meeting the base program standards.
- Builder incentives are provided for additional measures that exceed the base standard.

### Program Assumptions

| | |
|---|---|
| Package Measure Life (Years) | 15 |
| Free-Rider Rate | 15% |
| Free-Driver Rate | 0% |
| Dropouts | 0% |
| Take-Back Percentage | 5% |
| Free-Rider Market Barrier Costs Eliminated | 60% |
| Non-Free-Rider Market Barrier Costs Eliminated | 75% |
| Annual Energy Impact (kWh) | 4,187 |

| Year | Annual Eligible Population | New Participants | Total Participants | Cumulative Participation Rate |
|---|---|---|---|---|
| 1 | 17,500 | 3,000 | 3,000 | 17% |
| 2 | 17,500 | 3,800 | 6,800 | 19% |
| 3 | 17,500 | 5,000 | 11,800 | 22% |
| 4 | 17,500 | 6,000 | 17,800 | 25% |
| 5 | 17,500 | 7,200 | 25,000 | 29% |
| 6 | 17,500 | 8,600 | 33,600 | 32% |
| 7 | 17,500 | 8,800 | 42,400 | 35% |
| 8 | 17,500 | 8,800 | 51,200 | 37% |
| 9 | 17,500 | 8,800 | 60,000 | 38% |
| 10 | 17,500 | 8,800 | 68,800 | 39% |
| 11 | 17,500 | 8,800 | 77,600 | 40% |
| 12 | 17,500 | 8,800 | 86,400 | 41% |

| Year | Fixed Administrative Cost | Per Participant Variable Administrative Costs<br>$25<br>Total Variable Admin. Cost | Per Participant Measure Cost<br>$627<br>Total Part. Measure Cost | Per Participant Incentive<br>$723<br>Total Part. Incentive |
|---|---|---|---|---|
| 1 | $1,070,000 | $75,000 | $1,881,000 | $2,169,000 |
| 2 | $1,070,000 | $95,000 | $2,382,600 | $2,747,400 |
| 3 | $1,070,000 | $125,000 | $3,135,000 | $3,615,000 |
| 4 | $1,070,000 | $150,000 | $3,762,000 | $4,338,000 |
| 5 | $1,070,000 | $180,000 | $4,514,400 | $5,205,600 |
| 6 | $1,070,000 | $215,000 | $5,392,200 | $6,217,800 |
| 7 | $1,070,000 | $220,000 | $5,517,600 | $6,362,400 |
| 8 | $1,070,000 | $220,000 | $5,517,600 | $6,362,400 |
| 9 | $1,070,000 | $220,000 | $5,517,600 | $6,362,400 |
| 10 | $1,070,000 | $220,000 | $5,517,600 | $6,362,400 |
| 11 | $1,070,000 | $220,000 | $5,517,600 | $6,362,400 |
| 12 | $1,070,000 | $220,000 | $5,517,600 | $6,362,400 |

## Monitoring and Evaluation

For impact evaluation estimates, state energy codes will be assumed as the baseline for new construction. Prototype simulation models will be developed to determine the impacts of both the base package and the additional measures package. Additionally, billing analysis will be performed on a sample of participants for comparison with non-participating homes. QA inspections are performed to verify measures in 10 percent of program homes.

| Measure | Incremental Energy (kWh/yr) | Incremental Cost ($) | Incentive ($) | # /home | Weighted Energy (kWh/yr) | Weighted Cost ($) | Weighted Incentive ($) |
|---|---|---|---|---|---|---|---|
| Compact Fluorescent Light | 57 | 13 | 3 | 8.00 | 456 | 102 | 20 |
| DHW Pipe Insulation | 78 | 20 | — | 1.00 | 78 | 20 | — |
| Programmable Thermostat | 1,057 | 122 | 31 | 0.25 | 264 | 31 | 7 |
| Ceiling Insulation—New | 1,995 | 266 | 640 | 1.00 | 1,995 | 266 | 640 |
| Bottom Board | 75 | 3 | 3 | 1.00 | 75 | 3 | 3 |
| Low Flow Showerhead | 271 | 20 | — | 2.50 | 677 | 50 | — |
| Base ASHP 12 to ASHP 14 | 3,500 | 118 | 63 | 0.14 | 490 | 17 | 9 |
| Base ASHP 12 to GSHP | 1,546 | 1,660 | 500 | 0.08 | 124 | 133 | 40 |
| Efficient Dishwasher | 111 | 20 | 15 | 0.25 | 28 | 5 | 4 |
| | | | | **Total** | **4,187** | **626** | **723** |

## MANUFACTURED HOUSING – NEW CONSTRUCTION PROGRAM

### Overview

This program will promote the installation of efficient HVAC and water heating equipment by the manufacturer during the construction process. The program also promotes improved methods of connecting and sealing ductwork when the home is readied for occupancy. New HUD standards have increased the building shell requirements to optimal cost-effective levels for new construction, so the program will not address them. This program is simiilar to TVA's Energy Efficient New Manufactured Home Plan.

### Target Market

Buyers of residential new construction manufactured housing including single- and double-wide mobile homes, as well as slab-sited pre-manufactured housing are targeted.

### Implementation Strategy

TVA will work with stakeholders in the manufactured housing industry to ensure comprehensive coverage of the market. For manufacturers, training classes will explain the benefits of heat pumps and proper installation practices for water heaters and HVAC systems, including pipe insulation and ductwork.

Dealers will receive information, promotional materials, and financial incentives to promote the use of heat pumps in homes. Customer education materials will detail the energy and economic benefits of heat pumps and other retrofit measures, including insulated skirting. Additional educational materials including lesson plans and handouts will be provided to high school teachers in areas of high manufactured housing growth.

Related efforts for this program include lobbying lenders to consider the implications of lower utility bills from heat pumps on the financing process. Additionally, participating power distributors will be encouraged to waive or reduce hook-up charges for program housing as an additional participation incentive.

### Incentives

The cost of pipe insulation in the water heater compartment and reduced duct leakage measures are paid by TVA. Four compact fluorescent light bulbs are installed in each program home. Seventeen percent of the estimated cost of the heat pump will be paid to the manufacturer. Dealers will be paid $100 for each qualifying home sold, and an additional $150 will be provided for up to two homes ordered for stock on the dealer's lots.

### Program Assumptions

| | |
|---|---|
| Package Measure Life (Years) | 15 |
| Free-Rider Rate | 5% |
| Free-Driver Rate | 0% |
| Dropouts | 0% |
| Take-Back Percentage | 5% |
| Free-Rider Market Barrier Costs Eliminated | 70% |
| Non-Free-Rider Market Barrier Costs Eliminated | 90% |
| Annual Energy Impact (kWh) | 2,366 |

| Year | Annual Eligible Population | New Participants | Total Participants | Cumulative Participation Rate |
|---|---|---|---|---|
| 1 | 8,000 | 2,400 | 2,400 | 30% |
| 2 | 8,200 | 4,900 | 7,300 | 45% |
| 3 | 8,300 | 7,500 | 14,800 | 60% |
| 4 | 8,500 | 8,100 | 22,900 | 69% |
| 5 | 8,700 | 8,200 | 31,100 | 75% |
| 6 | 8,800 | 8,400 | 39,500 | 78% |
| 7 | 9,000 | 8,600 | 48,100 | 81% |
| 8 | 9,200 | 8,700 | 56,800 | 83% |
| 9 | 9,400 | 8,900 | 65,700 | 84% |
| 10 | 9,600 | 9,100 | 74,800 | 85% |
| 11 | 9,800 | 9,300 | 84,100 | 86% |
| 12 | 9,900 | 9,400 | 93,500 | 87% |

| Year | Fixed Administrative Cost | Per Participant Variable Administrative Costs<br>$20<br>Total Variable Admin. Cost | Per Participant Measure Cost<br>$615<br>Total Part. Measure Cost | Per Participant Incentive<br>$381<br>Total Part. Incentive |
|---|---|---|---|---|
| 1 | $575,000 | $48,000 | $1,476,000 | $914,400 |
| 2 | $500,000 | $98,000 | $3,013,500 | $1,866,900 |
| 3 | $500,000 | $150,000 | $4,612,500 | $2,857,500 |
| 4 | $500,000 | $162,000 | $4,981,500 | $3,086,100 |
| 5 | $500,000 | $164,000 | $5,043,000 | $3,124,200 |
| 6 | $500,000 | $168,000 | $5,166,000 | $3,200,400 |
| 7 | $500,000 | $172,000 | $5,289,000 | $3,276,600 |
| 8 | $500,000 | $174,000 | $5,350,500 | $3,314,700 |
| 9 | $500,000 | $178,000 | $5,473,500 | $3,390,900 |
| 10 | $500,000 | $182,000 | $5,596,500 | $3,467,100 |
| 11 | $500,000 | $186,000 | $5,719,500 | $3,543,300 |
| 12 | $500,000 | $188,000 | $5,781,000 | $3,581,400 |

## Monitoring and Evaluation

A database will be developed to track the incentives paid to manufacturers and dealers; another will contain information on customers buying program homes. Program impacts will be estimated with engineering calculations representing average savings per home. The engineering assumptions will be compared and calibrated to monitored field data after the first year of the program. A process evaluation will also be conducted after the first year of the program to improve the administrative processes and customer, dealer, and manufacturer satisfaction.

Approximately 25 percent of heat pumps installed will be inspected, with particular focus on new manufacturers.

| Measure | Incremental Energy (kWh/yr) | Incremental Cost ($) | Incentive ($) | # /home | Weighted Energy (kWh/yr) | Weighted Cost ($) | Weighted Incentive ($) |
|---|---|---|---|---|---|---|---|
| Compact Fluorescent Light | 57 | 13 | 13 | 4.00 | 228 | 51 | 51 |
| DHW Pipe Insulation | 78 | 8 | 8 | 1.00 | 78 | 8 | 8 |
| Reduced Duct Leakage | 1,905 | 275 | 275 | 1.00 | 1,905 | 275 | 275 |
| High Efficiency Heat Pump | 2,133 | 4,865 | 811 | 0.03 | 64 | 146 | 24 |
| Insider Heat Pump | 1,517 | 2,250 | 375 | 0.06 | 91 | 135 | 23 |
| | | | | **Total** | **2,366** | **615** | **381** |

## DIRECT INSTALL PROGRAM—SITE VISIT

### Overview

This is a direct install program. A neighborhood is targeted and a contractor goes door-to-door. In a single visit, installation crews install energy efficient lighting, attic insulation, water heater tank wraps, pipe insulation, faucet aerators, low-flow shower heads, caulking, and clean equipment coils and filters.

### Target Market

This program targets all residential customers in selected neighborhoods.

### Implementation Strategy

All residents in a neighborhood, including single-family homes and individually metered multi-family homes are eligible to participate. The installation crew will spend from one to two weeks in a target neighborhood, depending on the size of the area. Initial contact is made through a postcard or brochure mailed to each home. A canvasser will precede the crews, going door-to-door to make installation appointments, if possible on the same day. Installers will be radio-dispatched to the appointment. Advertisements on the installation crews' program vans will also promote the program.

One crew member will perform a quick site survey and provide a computerized printout of recommended improvements to the homeowner. The installation crew then installs appropriate measures and performs a walk-through with the customer to explain what they have done and how this benefits the customer. This educational portion of the program is extremely important in ensuring energy savings.

TVA and its distributors will work with community-based organizations to coordinate the program. Neighborhood and community groups will be recruited to assist in advertising the program.

### Incentives

The measures are provided and installed free of charge.

### Program Assumptions

| | |
|---|---|
| Package Measure Life (Years) | 15 |
| Free-Rider Rate | 20% |
| Free-Driver Rate | 0% |
| Dropouts | 2% |
| Take-Back Percentage | 10% |
| Free-Rider Market Barrier Costs Eliminated | 70% |
| Non-Free-Rider Market Barrier Costs Eliminated | 90% |
| Annual Energy Impact (kWh) | 1,803 |

| Year | Annual Eligible Population | New Participants | Total Participants | Cumulative Participation Rate |
|---|---|---|---|---|
| 1 | 2,510,000 | 25,100 | 25,100 | 1% |
| 2 | 2,513,900 | 75,400 | 100,500 | 4% |
| 3 | 2,467,500 | 123,400 | 223,900 | 9% |
| 4 | 2,373,100 | 142,400 | 366,300 | 15% |
| 5 | 2,259,700 | 135,600 | 501,900 | 20% |
| 6 | 2,153,100 | 129,200 | 631,100 | 25% |
| 7 | 2,053,000 | 123,200 | 754,300 | 30% |
| 8 | 1,958,800 | 117,500 | 871,800 | 35% |
| 9 | 1,870,200 | 112,200 | 984,000 | 39% |
| 10 | 1,787,000 | 89,400 | 1,073,400 | 43% |

| Year | Fixed Administrative Cost | Per Participant Variable Administrative Costs<br>$40<br>Total Variable Admin. Cost | Per Participant Measure Cost<br>$295<br>Total Part. Measure Cost | Per Participant Incentive<br>$295<br>Total Part. Incentive |
|---|---|---|---|---|
| 1 | $1,650,000 | $1,004,000 | $7,404,500 | $7,404,500 |
| 2 | $1,550,000 | $3,016,000 | $22,243,000 | $22,243,000 |
| 3 | $1,300,000 | $4,936,000 | $36,403,000 | $36,403,000 |
| 4 | $1,300,000 | $5,696,000 | $42,008,000 | $42,008,000 |
| 5 | $1,300,000 | $5,424,000 | $40,002,000 | $40,002,000 |
| 6 | $1,300,000 | $5,168,000 | $38,114,000 | $38,114,000 |
| 7 | $1,300,000 | $4,928,000 | $36,344,000 | $36,344,000 |
| 8 | $1,300,000 | $4,700,000 | $34,662,500 | $34,662,500 |
| 9 | $1,300,000 | $4,488,000 | $33,099,000 | $33,099,000 |
| 10 | $1,300,000 | $3,576,000 | $26,373,000 | $26,373,000 |

## Monitoring and Evaluation

Engineering estimates calibrated with information on hours of use and consumption patterns gathered for each participant will be used to estimate program savings. Spot inspections will be done on homes receiving attic insulation.

| Measure | Incremental Energy (kWh/yr) | Incremental Cost ($) | # /home | Weighted Energy (kWh/yr) | Weighted Cost ($) |
|---|---|---|---|---|---|
| Compact Fluorescent Light | 57 | 13 | 6.00 | 342 | 77 |
| DHW Pipe Insulation | 78 | 20 | 1.00 | 78 | 20 |
| DHW Tank Wrap | 271 | 35 | 0.50 | 136 | 18 |
| Attic Insulation R0-R30 ASHP | 2,042 | 590 | 0.03 | 61 | 17 |
| Attic Insulation R0-R30 ER/AC | 2,544 | 590 | 0.04 | 110 | 25 |
| Attic Insulation R11-R30 ASHP | 1,480 | 393 | 0.04 | 65 | 17 |
| Attic Insulation R11-R30 ER/AC | 1,842 | 393 | 0.06 | 117 | 25 |
| Low Flow Showerhead/Aerator | 271 | 20 | 2.50 | 678 | 50 |
| Maintain ASHP | 477 | 106 | 0.18 | 84 | 19 |
| Maintain ER/AC | 520 | 106 | 0.25 | 132 | 27 |
| | | | **Total** | **1,803** | **295** |

*#/home: in some cases reflects market share*
*Homes will receive all applicable measures*

## LOW INCOME PROGRAM—SITE VISIT

### Overview

This is a direct install program for targeted low-income neighborhoods. The program uses a contractor to perform the site visits. The installation crew, in a single visit, installs energy efficient lighting, attic insulation, water heater tank wraps, pipe insulation, faucet aerators, low-flow shower heads, caulking, and cleans equipment coils and filters.

### Target Market

This program targets residential low-income customers.

### Implementation Strategy

All residents in a neighborhood, including single-family homes and individually metered multi-family homes, are eligible to participate. The installation crew will spend from one to two weeks in a target neighborhood, depending on the size of the area. Initial contact is made through a postcard or brochure mailed to each home. A canvasser will precede the crews, going door-to-door to make installation appointments, if possible on the same day. Installers will be radio-dispatched to the appointment. Advertisements on the installation crews' program vans will also promote the program.

One crew member will perform a quick site survey and provide a computerized printout of recommended improvements to the homeowner. Most of the program measures will be cost-effective for almost every home. The installation crew then installs appropriate measures and performs a walk-through with the customer to explain what they have done and how this benefits the customer. This educational portion of the program is extremely important in ensuring energy savings.

TVA and its distributors will work with community-based organizations to coordinate the program. This program can leverage federal low income weatherization efforts, as well as state and local low income programs, to increase the energy efficiency services provided to these customers. Neighborhood and community groups will be recruited to assist in advertising the program, and program displays will be provided for community centers.

### Incentives

The measures are provided and installed free of charge.

### Program Assumptions

| | |
|---|---|
| Package Measure Life (Years) | 15 |
| Free-Rider Rate | 5% |
| Free-Driver Rate | 0% |
| Dropouts | 2% |
| Take-Back Percentage | 15% |
| Free-Rider Market Barrier Costs Eliminated | 70% |
| Non-Free-Rider Market Barrier Costs Eliminated | 90% |
| Annual Energy Impact (kWh) | 1,638 |

| Year | Annual Eligible Population | New Participants | Total Participants | Cumulative Participation Rate |
|---|---|---|---|---|
| 1 | 475,000 | 4800 | 4,800 | 1% |
| 2 | 475,900 | 14,300 | 19,100 | 4% |
| 3 | 467,200 | 23,400 | 42,500 | 9% |
| 4 | 449,400 | 27,000 | 69,500 | 15% |
| 5 | 428,100 | 25,700 | 95,200 | 20% |
| 6 | 408,000 | 24,500 | 119,700 | 25% |
| 7 | 389,100 | 23,300 | 143,000 | 30% |
| 8 | 371,300 | 22,300 | 165,300 | 35% |
| 9 | 354,700 | 21,300 | 186,600 | 39% |
| 10 | 339,000 | 16,900 | 203,500 | 43% |
| 11 | 327,600 | 16,400 | 219,900 | 46% |
| 12 | 316,900 | 15,800 | 235,700 | 50% |

| Year | Fixed Administrative Cost | Per Participant Variable Administrative Costs<br>$40<br>Total Variable Admin. Cost | Per Participant Measure Cost<br>$304<br>Total Part. Measure Cost | Per Participant Incentive<br>$304<br>Total Part. Incentive |
|---|---|---|---|---|
| 1 | $300,000 | $192,000 | $1,459,200 | $1,459,200 |
| 2 | $250,000 | $572,000 | $4,347,200 | $4,347,200 |
| 3 | $250,000 | $936,000 | $7,113,600 | $7,113,600 |
| 4 | $250,000 | $1,080,000 | $8,208,000 | $8,208,000 |
| 5 | $250,000 | $1,028,000 | $7,812,800 | $7,812,800 |
| 6 | $250,000 | $980,000 | $7,448,000 | $7,448,000 |
| 7 | $250,000 | $932,000 | $7,083,200 | $7,083,200 |
| 8 | $250,000 | $892,000 | $6,779,200 | $6,779,200 |
| 9 | $250,000 | $852,000 | $6,475,200 | $6,475,200 |
| 10 | $250,000 | $676,000 | $5,137,600 | $5,137,600 |
| 11 | $250,000 | $656,000 | $4,985,600 | $4,985,600 |
| 12 | $250,000 | $632,000 | $4,803,200 | $4,803,200 |

## Monitoring and Evaluation

Engineering estimates calibrated with information on hours of use and consumption patterns gathered for each participant will be used to estimate program savings. Spot inspections will be done on homes receiving attic insulation.

| Measure | Incremental Energy (kWh/yr) | Incremental Cost ($) | # /home | Weighted Energy (kWh/yr) | Weighted Cost ($) |
|---|---|---|---|---|---|
| Compact Fluorescent Light | 57 | 13 | 4.00 | 228 | 51 |
| DHW Pipe Insulation | 78 | 20 | 1.00 | 78 | 20 |
| DHW Tank Wrap | 271 | 35 | 0.50 | 136 | 18 |
| Attic Insulation R0-R30 ASHP | 2,042 | 590 | 0.06 | 119 | 34 |
| Attic Insulation R0-R30 ER/AC | 2,544 | 590 | 0.08 | 213 | 49 |
| Attic Insulation R11-R30 ASHP | 1,480 | 393 | 0.06 | 86 | 23 |
| Attic Insulation R11-R30 ER/AC | 1,842 | 393 | 0.08 | 155 | 33 |
| Low Flow Showerhead | 271 | 20 | 1.50 | 407 | 30 |
| Maintain ASHP | 477 | 106 | 0.18 | 84 | 19 |
| Maintain ER/AC | 520 | 106 | 0.25 | 132 | 27 |
| | | | **Total** | **1,638** | **304** |

*#/home: in some cases reflects market share*
*Homes will receive all applicable measures*

## LOW INCOME WEATHERIZATION PROGRAM

### Overview

This program complements the Low Income Program by providing for more extensive home repairs identified during the direct install site visit. The program is coordinated with state and local agencies to leverage existing low income efforts.

### Target Market

This program targets residential low-income customers.

### Implementation Strategy

During the Low Income Program site survey, homes needing significant improvements are identified. These homes may need insulation, infiltration reduction or significant HVAC equipment improvements. The necessary measures will be provided and installed free of charge. The weatherized structure will provide a more comfortable living space for tenants, and will increase property value and lower electric bills as a result of the efficiency improvements.

TVA and its distributors will work with community-based organizations to coordinate the program. This program can leverage federal low income weatherization efforts, as well as state and local low income programs, to increase the energy efficiency services provided to these customers. Neighborhood and community groups will be recruited to assist in advertising the program, and program displays will be provided in community centers.

### Incentives

The measures are provided and installed free of charge.

### Monitoring and Evaluation

Both engineering estimates calibrated with information on hours of use and consumption patterns gathered for each participant will be used to estimate program savings. Spot inspections will be done on homes receiving attic insulation.

### Program Assumptions

| | |
|---|---|
| Package Measure Life (Years) | 15 |
| Free-Rider Rate | 5% |
| Free-Driver Rate | 0% |
| Dropouts | 2% |
| Take-Back Percentage | 25% |
| Free-Rider Market Barrier Costs Eliminated | 70% |
| Non-Free-Rider Market Barrier Costs Eliminated | 90% |
| Annual Energy Impact (kWh) | 3,100 |

| Year | Annual Eligible Population | New Participants | Total Participants | Cumulative Participation Rate |
|---|---|---|---|---|
| 1 | 356,300 | 400 | 400 | 0% |
| 2 | 360,200 | 700 | 1,100 | 0% |
| 3 | 363,800 | 1,000 | 2,100 | 1% |
| 4 | 367,300 | 1,000 | 3,100 | 1% |
| 5 | 370,700 | 1,000 | 4,100 | 1% |
| 6 | 374,200 | 1,000 | 5,100 | 1% |
| 7 | 377,600 | 1,000 | 6,100 | 2% |
| 8 | 381,100 | 1,000 | 7,100 | 2% |
| 9 | 384,500 | 1,000 | 8,100 | 2% |
| 10 | 388,000 | 1,000 | 9,100 | 3% |
| 11 | 391,400 | 1,000 | 10,100 | 3% |
| 12 | 394,900 | 1,000 | 11,100 | 3% |

| Year | Fixed Administrative Cost | Per Participant Variable Administrative Costs<br>$1,000 Total Variable Admin. Cost | Per Participant Measure Cost<br>$2,000 Total Part. Measure Cost | Per Participant Incentive<br>$2,000 Total Part. Incentive |
|---|---|---|---|---|
| 1 | $300,000 | $400,000 | $800,000 | $800,000 |
| 2 | $250,000 | $700,000 | $1,400,000 | $1,400,000 |
| 3 | $250,000 | $1,000,000 | $2,000,000 | $2,000,000 |
| 4 | $250,000 | $1,000,000 | $2,000,000 | $2,000,000 |
| 5 | $250,000 | $1,000,000 | $2,000,000 | $2,000,000 |
| 6 | $250,000 | $1,000,000 | $2,000,000 | $2,000,000 |
| 7 | $250,000 | $1,000,000 | $2,000,000 | $2,000,000 |
| 8 | $250,000 | $1,000,000 | $2,000,000 | $2,000,000 |
| 9 | $250,000 | $1,000,000 | $2,000,000 | $2,000,000 |
| 10 | $250,000 | $1,000,000 | $2,000,000 | $2,000,000 |
| 11 | $250,000 | $1,000,000 | $2,000,000 | $2,000,000 |
| 12 | $250,000 | $1,000,000 | $2,000,000 | $2,000,000 |

## HEAT PUMP WATER HEATER LEASING PROGRAM

### Overview

The Heat Pump Water Heater Leasing Program allows for a qualified heat pump water heater to be selected by a customer and installed by the utility, with the customer paying a monthly "service charge" on his electric bill. This program is designed to promote efficient heat pump water heaters which have an initial cost that is a significant barrier to customer participation. Additionally, this program simplifies the maintenance and service of complicated equipment by moving the risk to the utility.

### Target Market

This program targets residential customers who own or are purchasing their dwelling.

### Implementation Strategy

The program works in conjunction with local equipment retailers similar to a financing program. The customer selects the contractor and appropriate equipment and contacts the utility for an installation inspection and to complete the necessary paperwork. Two payment options are offered. The first is a continual monthly charge with the utility maintaining ownership of the equipment and providing all necessary maintenance and repair of the equipment for as long as the customer is in the program. Early termination (before the customer has repaid the debt) requires the customer to settle for the remaining debt.

The second option is a larger monthly payment designed to pay back the debt. Once the debt has been repaid, ownership of the equipment is transferred to the homeowner. During the repayment period, the utility maintains and repairs the equipment free of charge. At the end of the repayment period, the customer can change to a maintenance/replacement contract payment if so desired.

The specified lease equipment must meet minimum Energy Factor (EF) levels.

Repair and replacement work will be performed by local contractors. A local phone number with answering service will be available 24 hours per day, 365 days per year. The customer is guaranteed replacement or repair within 48 hours of the call.

### Incentives

A service contract will be provided for each heat pump water heater.

### Monitoring and Evaluation

Some equipment monitoring is required for program analysis purposes. Inspections will be performed for 100 percent of program installations for QA purposes. Inspections will verify appropriate equipment sizing, equipment charge, air flow, and location. A complaint phone number also listed on the appliance will provide significant feedback on the equipment and its timely repair.

### Program Assumptions

| | |
|---|---|
| Package Measure Life (Years) | 10 |
| Free-Rider Rate | 0% |
| Free-Driver Rate | 0% |
| Dropouts | 2% |
| Take-Back Percentage | 0% |
| Free-Rider Market Barrier Costs Eliminated | 40% |
| Non-Free-Rider Market Barrier Costs Eliminated | 50% |
| Annual Energy Impact (kWh) | 1,990 |

| Year | Annual Eligible Population | New Participants | Total Participants | Cumulative Participation Rate |
|---|---|---|---|---|
| 1 | 198,000 | 9,900 | 9,900 | 5% |
| 2 | 198,000 | 19,800 | 29,700 | 8% |
| 3 | 198,000 | 29,700 | 59,400 | 10% |
| 4 | 198,000 | 33,700 | 93,100 | 12% |
| 5 | 198,000 | 37,600 | 130,700 | 13% |
| 6 | 198,000 | 41,600 | 172,300 | 15% |
| 7 | 198,000 | 43,600 | 215,900 | 16% |
| 8 | 198,000 | 44,600 | 260,500 | 16% |
| 9 | 198,000 | 45,500 | 306,000 | 17% |
| 10 | 198,000 | 45,500 | 351,500 | 18% |
| 11 | 198,000 | 45,500 | 397,000 | 18% |
| 12 | 198,000 | 45,500 | 442,500 | 19% |

| Year | Fixed Administrative Cost | Per Participant Variable Administrative Costs<br>$10<br>Total Variable Admin. Cost | Per Participant Measure Cost<br>$500<br>Total Part. Measure Cost | Per Participant Incentive<br>$192<br>Total Part. Incentive |
|---|---|---|---|---|
| 1 | $850,000 | $99,000 | $4,950,000 | $1,900,800 |
| 2 | $800,000 | $198,000 | $9,900,000 | $3,801,600 |
| 3 | $800,000 | $297,000 | $14,850,000 | $5,702,400 |
| 4 | $800,000 | $337,000 | $16,850,000 | $6,470,400 |
| 5 | $800,000 | $376,000 | $18,800,000 | $7,219,200 |
| 6 | $800,000 | $416,000 | $20,800,000 | $7,987,200 |
| 7 | $800,000 | $436,000 | $21,800,000 | $8,371,200 |
| 8 | $800,000 | $446,000 | $22,300,000 | $8,563,200 |
| 9 | $800,000 | $455,000 | $22,750,000 | $8,736,000 |
| 10 | $800,000 | $455,000 | $22,750,000 | $8,736,000 |
| 11 | $800,000 | $455,000 | $22,750,000 | $8,736,000 |
| 12 | $800,000 | $455,000 | $22,750,000 | $8,736,000 |

## SOLAR WATER HEATER PROGRAM

### Overview

This program will promote solar water heaters through the use of a significant upfront rebate and an equipment lease. The lease includes a maintenance contract for the equipment. These incentives are designed to offset two significant market barriers to solar water heating: initial cost and maintenance.

### Target Market

All residential customers in participating power distributor areas are targeted.

### Implementation Strategy

The program works in conjunction with local equipment retailers similar to a financing program. The customer selects the contractor and appropriate equipment and contacts the utility for an installation inspection and to complete the necessary paperwork. Two payment options are offered. The first is a continual monthly charge with the utility maintaining ownership of the equipment and providing all necessary maintenance and repair of the equipment for as long as the customer is in the program. Early termination (before the customer the repaid his debt) requires the customer to settle for the remaining debt.

The second option is a larger monthly payment designed to pay back the debt. Once the debt has been repaid, ownership of the equipment is transferred to the homeowner. During the repayment period, the utility maintains and repairs the equipment free of charge. At the end of the repayment period, the customer can change to a maintenance/replacement contract payment if so desired.

Repair and replacement work will be performed by local contractors. A local phone number with answering service will be available 24 hours per day, 365 days per year. The customer is guaranteed replacement or repair within 48 hours of the call.

### Incentives

- First cost buy-down will be offered.
- Equipment maintenance will be provided.

### Monitoring and Evaluation

Program impacts will be evaluated through pre- and post-billing analysis of program homes. Quality assurance inspections are performed for approximately 25 percent of program installations, with emphasis on new installers and problem installers. Inspections will verify appropriate equipment sizing, orientation, tank and pipe insulation, controls, and freeze protection. A complaint phone number provided to the participant will provide significant feedback on the equipment and its timely repair. Follow-up surveys of equipment operation and usage patterns will also be conducted.

### Program Assumptions

| | |
|---|---|
| Package Measure Life (Years) | 20 |
| Free-Rider Rate | 0% |
| Free-Driver Rate | 0% |
| Dropouts | 2% |
| Take-Back Percentage | 20% |
| Free-Rider Market Barrier Costs Eliminated | 40% |
| Non-Free-Rider Market Barrier Costs Eliminated | 50% |
| Annual Energy Impact (kWh) | 2,500 |

| Year | Annual Eligible Population | New Participants | Total Participants | Cumulative Participation Rate |
|---|---|---|---|---|
| 1 | 50,300 | 200 | 200 | 0% |
| 2 | 50,300 | 600 | 800 | 1% |
| 3 | 50,300 | 1,000 | 1,800 | 1% |
| 4 | 50,300 | 1,000 | 2,800 | 1% |
| 5 | 50,300 | 1,000 | 3,800 | 2% |
| 6 | 50,300 | 1,000 | 4,800 | 2% |
| 7 | 50,300 | 1,000 | 5,800 | 2% |
| 8 | 50,300 | 1,000 | 6,800 | 2% |
| 9 | 50,300 | 1,000 | 7,800 | 2% |
| 10 | 50,300 | 1,000 | 8,800 | 2% |

| Year | Fixed Administrative Cost | Per Participant Variable Administrative Costs<br>$10<br>Total Variable Admin. Cost | Per Participant Measure Cost<br>$3,000<br>Total Part. Measure Cost | Per Participant Incentive<br>$1,956<br>Total Part. Incentive |
|---|---|---|---|---|
| 1 | $550,000 | $2,000 | $600,000 | $391,200 |
| 2 | $500,000 | $6,000 | $1,800,000 | $1,173,600 |
| 3 | $500,000 | $10,000 | $3,000,000 | $1,956,000 |
| 4 | $400,000 | $10,000 | $3,000,000 | $1,956,000 |
| 5 | $400,000 | $10,000 | $3,000,000 | $1,956,000 |
| 6 | $400,000 | $10,000 | $3,000,000 | $1,956,000 |
| 7 | $400,000 | $10,000 | $3,000,000 | $1,956,000 |
| 8 | $400,000 | $10,000 | $3,000,000 | $1,956,000 |
| 9 | $400,000 | $10,000 | $3,000,000 | $1,956,000 |
| 10 | $400,000 | $10,000 | $3,000,000 | $1,956,000 |

## EFFICIENCY PRODUCTS CATALOG—MAIL ORDER

### Overview

This program makes it easy for customers to purchase smaller, easily installed technologies that are not readily available in the marketplace. The product descriptions in the catalog will also educate customers about the benefits of each technology. For many products, TVA will "buy down" the cost to encourage people to adopt unfamiliar technologies. Promoted products could include efficient lighting, motion sensors, flow restricters, pipe insulation, and outlet insulation.

### Target Market

This program targets all residential customers.

### Implementation Strategy

Through the services of a professional fulfillment company, TVA will offer a catalog featuring a variety of shippable, easily installed energy efficiency technologies. Quantity limits may be imposed on certain products. The catalog will offer information on applications and how to select the appropriate models for various uses.

Consumers will obtain the catalog through a 1-800 number and may place their orders via the same number or by mail. A retail component will also be developed to provide local shopping options after the catalog effort is launched. By educating Valley consumers on the benefits and applications of energy-efficient products and offering them the opportunity to purchase these products conveniently at a reduced price, the catalog should stimulate the development of a retail infrastructure through increased demand for the products.

### Incentives

- Specific measures have discounted purchase prices in the catalog.
- Overhead and administrative costs for the fulfillment contractor are paid by TVA.

### Program Assumptions

| | |
|---|---|
| Package Measure Life (Years) | 7 |
| Free-Rider Rate | 15% |
| Free-Driver Rate | 0% |
| Dropouts | 5% |
| Take-Back Percentage | 10% |
| Free-Rider Market Barrier Costs Eliminated | 65% |
| Non-Free-Rider Market Barrier Costs Eliminated | 80% |
| Annual Energy Impact (kWh) | 823 |

| Year | Annual Eligible Population | New Participants | Total Participants | Cumulative Participation Rate |
|---|---|---|---|---|
| 1 | 2,985,000 | 35,800 | 35,800 | 1% |
| 2 | 3,020,000 | 67,000 | 102,800 | 3% |
| 3 | 3,055,000 | 73,300 | 176,100 | 6% |
| 4 | 3,090,000 | 74,200 | 250,300 | 8% |
| 5 | 3,125,000 | 83,400 | 333,700 | 11% |
| 6 | 3,160,000 | 88,500 | 422,200 | 13% |
| 7 | 3,195,000 | 95,900 | 518,100 | 16% |
| 8 | 3,230,000 | 96,900 | 615,000 | 19% |
| 9 | 3,265,000 | 98,000 | 713,000 | 22% |
| 10 | 3,300,000 | 99,000 | 812,000 | 25% |
| 11 | 3,335,000 | 100,100 | 912,100 | 27% |
| 12 | 3,370,000 | 101,100 | 1,013,200 | 30% |

| Year | Fixed Administrative Cost | Per Participant Variable Administrative Costs<br>$17<br>Total Variable Admin. Cost | Per Participant Measure Cost<br>$70<br>Total Part. Measure Cost | Per Participant Incentive<br>$9<br>Total Part. Incentive |
|---|---|---|---|---|
| 1 | $430,000 | $608,600 | $2,506,000 | $322,200 |
| 2 | $430,000 | $1,139,000 | $4,690,000 | $603,000 |
| 3 | $430,000 | $1,246,100 | $5,131,000 | $659,700 |
| 4 | $430,000 | $1,261,400 | $5,194,000 | $667,800 |
| 5 | $430,000 | $1,417,800 | $5,838,000 | $750,600 |
| 6 | $430,000 | $1,504,500 | $6,195,000 | $796,500 |
| 7 | $430,000 | $1,630,300 | $6,713,000 | $863,100 |
| 8 | $430,000 | $1,647,300 | $6,783,000 | $872,100 |
| 9 | $430,000 | $1,666,000 | $6,860,000 | $882,000 |
| 10 | $430,000 | $1,683,000 | $6,930,000 | $891,000 |
| 11 | $430,000 | $1,701,700 | $7,007,000 | $901,000 |
| 12 | $430,000 | $1,718,700 | $7,077,000 | $910,000 |

## Monitoring and Evaluation

Phone surveys of program participants will provide feedback on the equipment installed and its hours of use. This information will be incorporated into engineering impacts developed for each measure to estimate program-wide energy benefits.

| Measure | Incremental Energy (kWh/yr) | Wholesale Cost ($) | Incentive ($) | # /home | Weighted Energy (kWh/yr) | Weighted Cost ($) | Weighted Incentive ($) |
|---|---|---|---|---|---|---|---|
| Compact Fluorescent Light | 57 | 13 | 2.05 | 4.00 | 228 | 51 | 8 |
| Motion Detectors (Outdoor) | 53 | 10 | 1.60 | 0.25 | 13 | 3 | 0 |
| High Pressure Sodium Light | 1,604 | 34 | 5.37 | 0.05 | 80 | 2 | 0 |
| DHW Pipe Insulation | 78 | 10 | 1.00 | 0.25 | 20 | 3 | 0 |
| DHW Tank Wrap | 271 | 10 | 1.00 | 0.50 | 136 | 5 | 1 |
| Low Flow Showerhead | 271 | 10 | 1.00 | 1.50 | 407 | 15 | 2 |
| Programmable Thermostat | 1,273 | 92 | 9.15 | 0.18 | 224 | 16 | 2 |
| | | | **Weighted Total For 5 Products** | | **823** | **70** | **9** |

*Wholesale cost is known for lighting, calculated at 75 percent of retail for thermostats, calculated at 50 percent of retail for other measures.*
*Incentive is buy-down of wholesale cost.*

## LIGHTING PRODUCTS RETAIL COMPONENT

### Overview

This program augments the Efficiency Products Catalog, which makes it easy for customers to purchase smaller, easily-installed technologies that are not readily available in the marketplace. This program works by influencing customers to purchase additional quantities of the same efficient products from their local retailers. This market transformation will help to encourage people to adopt unfamiliar technologies. Promoted products could include efficient lighting, motion sensors, flow restricters, pipe insulation, and outlet insulation.

### Target Market

This program targets all residential customers.

### Implementation Strategy

TVA will offer a catalog featuring a variety of energy efficiency technologies. Coupons in the catalog will be redeemable in local retail outlets to purchase the same efficiency technologies at discounted prices. The coupons can also be distributed through other complimentary DSM programs, power distributor displays, direct mail, or by customer request.

By working with manufacturers and distributors of these products, TVA will encourage local retailers to participate in the program. The coupon booklet will educate Valley consumers on the benefits and applications of energy-efficient products and will offer them the opportunity to purchase these products at a reduced price. Customer information completed on the coupon will provide feedback on customer purchases and utilization of the efficient products.

### Incentives

Retail rebate coupons will be provided.

### Monitoring and Evaluation

The rebate coupon will provide information on participant usage. Additionally, phone surveys of program participants will provide feedback on the equipment installed and its hours of use. This information will be incorporated into engineering impacts developed for each measure to estimate program-wide energy benefits.

### Program Assumptions

| | |
|---|---|
| Package Measure Life (Years) | 7 |
| Free-Rider Rate | 15% |
| Free-Driver Rate | 0% |
| Dropouts | 5% |
| Take-Back Percentage | 5% |
| Free-Rider Market Barrier Costs Eliminated | 60% |
| Non-Free-Rider Market Barrier Costs Eliminated | 75% |
| Annual Energy Impact (kWh) | 823 |

| Year | Annual Eligible Population | New Participants | Total Participants | Cumulative Participation Rate |
|---|---|---|---|---|
| 1 | 2,985,000 | 7,500 | 7,500 | 0% |
| 2 | 3,020,000 | 15,100 | 22,600 | 1% |
| 3 | 3,055,000 | 22,900 | 45,500 | 1% |
| 4 | 3,090,000 | 30,900 | 76,400 | 2% |
| 5 | 3,125,000 | 37,500 | 113,900 | 4% |
| 6 | 3,160,000 | 44,200 | 158,100 | 5% |
| 7 | 3,195,000 | 54,300 | 212,400 | 7% |
| 8 | 3,230,000 | 64,600 | 277,000 | 9% |
| 9 | 3,265,000 | 71,800 | 348,800 | 11% |
| 10 | 3,300,000 | 79,200 | 428,000 | 13% |
| 11 | 3,335,000 | 86,700 | 514,700 | 15% |
| 12 | 3,370,000 | 101,100 | 615,800 | 18% |

| | | Per Participant Variable Administrative Costs | Per Participant Measure Cost | Per Participant Incentive |
|---|---|---|---|---|
| Year | Fixed Administrative Cost | $10 Total Variable Admin. Cost | $102 Total Part. Measure Cost | $26 Total Part. Incentive |
| 1 | $900,000 | $75,000 | $765,000 | $195,000 |
| 2 | $850,000 | $151,000 | $1,540,200 | $392,600 |
| 3 | $850,000 | $229,000 | $2,335,800 | $595,400 |
| 4 | $850,000 | $309,000 | $3,151,800 | $803,400 |
| 5 | $850,000 | $375,000 | $3,825,000 | $975,000 |
| 6 | $850,000 | $442,000 | $4,508,400 | $1,149,200 |
| 7 | $850,000 | $543,000 | $5,538,600 | $1,411,800 |
| 8 | $850,000 | $646,000 | $6,589,200 | $1,679,600 |
| 9 | $850,000 | $718,000 | $7,323,600 | $1,866,800 |
| 10 | $850,000 | $792,000 | $8,078,400 | $2,059,200 |
| 11 | $850,000 | $867,000 | $8,843,400 | $2,254,200 |
| 12 | $850,000 | $1,011,000 | $10,312,200 | $2,628,600 |

## APPLIANCE REBATES PROGRAM

### Overview

This program will promote efficient appliances using rebates and point-of-sale displays. Appliances will include high efficiency dishwashers, heat pump clothes dryers, clothes dryers with moisture sensors, horizontal axis clothes washers, high efficiency room air-conditioners, high efficiency freezers, high efficiency refrigerators, and high efficiency pool pumps.

### Target Market

All residential customers in participating power distributor areas are targeted.

### Implementation Strategy

Rebate coupons, point-of-sale displays, and appliance labeling are utilized to promote efficient appliances. Utility representatives will work with retail outlets to label applicable appliances and to distribute displays and coupons. Additionally, coupons will be distributed through other compatible DSM programs, power distributor offices, and upon phone request.

### Incentives

Rebate coupons will be provided.

### Program Assumptions

| | |
|---|---|
| Package Measure Life (Years) | 15 |
| Free-Rider Rate | 15% |
| Free-Driver Rate | 0% |
| Dropouts | 0% |
| Take-Back Percentage | 5% |
| Free-Rider Market Barrier Costs Eliminated | 60% |
| Non-Free-Rider Market Barrier Costs Eliminated | 80% |
| Annual Energy Impact (kWh) | 181 |

| Year | Annual Eligible Population | New Participants | Total Participants | Cumulative Participation Rate |
|---|---|---|---|---|
| 1 | 573,500 | 13,800 | 13,800 | 2% |
| 2 | 573,500 | 27,600 | 41,400 | 4% |
| 3 | 573,500 | 55,200 | 96,600 | 6% |
| 4 | 573,500 | 110,400 | 207,000 | 9% |
| 5 | 573,500 | 110,400 | 317,400 | 11% |
| 6 | 573,500 | 110,400 | 427,800 | 12% |
| 7 | 573,500 | 110,400 | 538,200 | 13% |
| 8 | 573,500 | 110,400 | 648,600 | 14% |
| 9 | 573,500 | 110,400 | 759,000 | 15% |
| 10 | 573,500 | 110,400 | 869,400 | 15% |
| 11 | 573,500 | 110,400 | 979,800 | 16% |
| 12 | 573,500 | 110,400 | 1,090,200 | 16% |

| Year | Fixed Administrative Cost | Per Participant Variable Administrative Costs<br>$7<br>Total Variable Admin. Cost | Per Participant Measure Cost<br>$90<br>Total Part. Measure Cost | Per Participant Incentive<br>$71<br>Total Part. Incentive |
|---|---|---|---|---|
| 1 | $530,000 | $96,600 | $1,242,000 | $979,800 |
| 2 | $430,000 | $193,200 | $2,484,000 | $1,959,600 |
| 3 | $430,000 | $386,400 | $4,968,000 | $3,919,200 |
| 4 | $430,000 | $772,800 | $9,936,000 | $7,838,400 |
| 5 | $430,000 | $772,800 | $9,936,000 | $7,838,400 |
| 6 | $430,000 | $772,800 | $9,936,000 | $7,838,400 |
| 7 | $430,000 | $772,800 | $9,936,000 | $7,838,400 |
| 8 | $430,000 | $772,800 | $9,936,000 | $7,838,400 |
| 9 | $430,000 | $772,800 | $9,936,000 | $7,838,400 |
| 10 | $430,000 | $772,800 | $9,936,000 | $7,838,400 |
| 11 | $430,000 | $772,800 | $9,936,000 | $7,838,400 |
| 12 | $430,000 | $772,800 | $9,936,000 | $7,838,400 |

## Monitoring and Evaluation

Rebate coupons will provide initial information on replacement and usage patterns. A database will be completed from returned rebate coupons. Follow-up surveys of equipment installed and usage patterns will be conducted.

| Measure | Incremental Energy (kWh/yr) | Incremental Cost ($) | Incentive ($) | Appliance Saturation Weighting | Long-Term Penetration Weighting |
|---|---|---|---|---|---|
| High-Efficiency dishwasher | 130 | 20 | 20 | 41% | 20% |
| High-Efficiency Pool Pump | 281 | 39 | 39 | 4% | 10% |
| Heat Pump Clothes Dryer | 661 | 301 | 200 | 78% | 2% |
| Best Current Freezer | 152 | 68 | 68 | 48% | 30% |
| Best Current Refrigerator | 119 | 85 | 54 | 99% | 30% |
| High-Efficiency Room A/C | 414 | 142 | 142 | 40% | 30% |
| Dryer with Moisture Sensor | 122 | 75 | 56 | 78% | 30% |
| Horizontal Axis Clothes Washer | 450 | 350 | 200 | 85% | 2% |

*Incentive based on incremental energy times average $/annual kWh, capped at full incremental cost, or capped at $200*
*Appliance saturation weighting based on TVA 1992 appliance survey.*
*Long-term penetration weighting based on information from BCI 08/03/94.*

## REFRIGERATOR TURN-IN AND RECYCLING PROGRAM

### Overview

This is a second refrigerator and freezer pick-up program. The utility will remove unwanted refrigerators and freezers and ensure that they are disposed of properly in accordance with applicable environmental regulations. The appliance must be in working condition. The customer is given a $50 U.S. savings bond incentive for participation.

### Target Market

All residential customers with second refrigerators or freezers are targeted.

### Implementation Strategy

A turn-key contractor will administer and implement the program. The contractor sets up telephone lines to take customer phone calls. The call is screened to eliminate free ridership in the program. Then, an appointment is made to pick up the applicable device. The pick-up crew verifies that the equipment is operable and removes it, leaving the incentive with the customer. The equipment is taken to the contractor's warehouse/processing facility where the refrigerant is removed and recycled, and other components are disassembled and recycled.

The contractor handles administrative aspects of the program, providing monthly reports of removals, energy consumption of removed equipment and participants' names and addresses. Utility involvement is limited to contract administration and QA control over contract performance.

### Incentives

A $50 U.S. savings bond is given to the customer when the operating appliance is picked up.

### Monitoring and Evaluation

Reporting by turn-key contractor provides energy measurement and customer account information. Contractor performance and customer satisfaction data will be collected as part of a process evaluation.

### Program Assumptions

| | |
|---|---|
| Package Measure Life (Years) | 7 |
| Free-Rider Rate | 34% |
| Free-Driver Rate | 0% |
| Dropouts | 25% |
| Take-Back Percentage | 0% |
| Free-Rider Market Barrier Costs Eliminated | 60% |
| Non-Free-Rider Market Barrier Costs Eliminated | 75% |
| Annual Energy Impact (kWh) | 929 |

| Year | Annual Eligible Population | New Participants | Total Participants | Cumulative Participation Rate |
|---|---|---|---|---|
| 1 | 298,500 | 12,900 | 12,900 | 1% |
| 2 | 298,500 | 18,700 | 31,600 | 3% |
| 3 | 298,500 | 30,200 | 61,800 | 6% |
| 4 | 298,500 | 30,200 | 92,000 | 9% |
| 5 | 298,500 | 24,400 | 116,400 | 11% |
| 6 | 298,500 | 18,700 | 135,100 | 13% |
| 7 | 298,500 | 18,700 | 153,800 | 15% |
| 8 | 298,500 | 18,700 | 172,500 | 17% |
| 9 | 298,500 | 18,700 | 191,200 | 19% |
| 10 | 298,500 | 12,900 | 204,100 | 20% |
| 11 | 298,500 | 12,900 | 217,000 | 21% |
| 12 | 298,500 | 12,900 | 229,900 | 23% |

| Year | Fixed Administrative Cost | Per Participant Variable Administrative Costs<br>$0<br>Total Variable Admin. Cost | Per Participant Measure Cost<br>$110<br>Total Part. Measure Cost | Per Participant Incentive<br>$25<br>Total Part. Incentive |
|---|---|---|---|---|
| 1 | $275,000 | $0 | $1,419,000 | $322,500 |
| 2 | $200,000 | $0 | $2,057,000 | $467,500 |
| 3 | $200,000 | $0 | $3,322,000 | $755,000 |
| 4 | $200,000 | $0 | $3,322,000 | $755,000 |
| 5 | $200,000 | $0 | $2,684,000 | $610,000 |
| 6 | $200,000 | $0 | $2,057,000 | $467,500 |
| 7 | $200,000 | $0 | $2,057,000 | $467,500 |
| 8 | $200,000 | $0 | $2,057,000 | $467,500 |
| 9 | $200,000 | $0 | $2,057,000 | $467,500 |
| 10 | $200,000 | $0 | $1,419,000 | $322,500 |
| 11 | $200,000 | $0 | $1,419,000 | $322,500 |
| 12 | $200,000 | $0 | $1,419,000 | $322,500 |

## STUDENT SELF-AUDIT—SCHOOLS ENVIRONMENTAL PROGRAM

### Overview

This program builds upon the energy information materials TVA already provides to Valley teachers. In addition to general information, a self-audit package will be presented to students who will be required to conduct a home audit, fill out an audit form, and return it to school, where it will be analyzed by an audit software program. The software will analyze the audit form and recommend cost-effective environmental and energy efficiency measures that the students and their families can implement. Many materials recommended in the audit report will be available through the catalog mail program. Discount coupons for catalog materials may be provided to students. This audit report will also provide coordinated promotion of other TVA and distributor energy efficiency programs.

### Target Market

High school students in participating power distributor areas are targeted.

### Implementation Strategy

Lesson plans on energy and environment, audit forms, and a computer with audit analysis software will be provided to each school. TVA will provide training on all materials for teachers. Audit data collected by the students is entered on the computer and a custom audit report is generated. The survey data is also compiled for teacher and utility use.

### Incentives

- TVA will pay for substitute teachers during the training.
- Class materials and audit materials will be provided.

### Program Assumptions

| | |
|---|---|
| Package Measure Life (Years) | 10 |
| Free-Rider Rate | 0% |
| Free-Driver Rate | 0% |
| Dropouts | 0% |
| Take-Back Percentage | 5% |
| Free-Rider Market Barrier Costs Eliminated | 60% |
| Non-Free-Rider Market Barrier Costs Eliminated | 75% |
| Annual Energy Impact (kWh) | 102 |

| Year | Annual Eligible Population | New Participants | Total Participants | Cumulative Participation Rate |
|---|---|---|---|---|
| 1 | 3,900 | 3,700 | 3,700 | 95% |
| 2 | 32,500 | 30,900 | 34,600 | 95% |
| 3 | 130,000 | 123,500 | 158,100 | 95% |
| 4 | 130,000 | 123,500 | 281,600 | 95% |
| 5 | 130,000 | 123,500 | 405,100 | 95% |
| 6 | 130,000 | 123,500 | 528,600 | 95% |
| 7 | 130,000 | 123,500 | 652,100 | 95% |
| 8 | 130,000 | 123,500 | 775,600 | 95% |
| 9 | 130,000 | 123,500 | 899,100 | 95% |
| 10 | 130,000 | 123,500 | 1,022,600 | 95% |
| 11 | 130,000 | 123,500 | 1,146,100 | 95% |
| 12 | 130,000 | 123,500 | 1,269,600 | 95% |

| Year | Fixed Administrative Cost | Per Participant Variable Administrative Costs<br>$5<br>Total Variable Admin. Cost | Per Participant Measure Cost<br>$19<br>Total Part. Measure Cost | Per Participant Incentive<br>$0<br>Total Part. Incentive |
|---|---|---|---|---|
| 1 | $1,432,000 | $18,500 | $70,300 | $0 |
| 2 | $982,000 | $154,500 | $587,100 | $0 |
| 3 | $796,400 | $617,500 | $2,346,500 | $0 |
| 4 | $796,400 | $617,500 | $2,346,500 | $0 |
| 5 | $796,400 | $617,500 | $2,346,500 | $0 |
| 6 | $796,400 | $617,500 | $2,346,500 | $0 |
| 7 | $796,400 | $617,500 | $2,346,500 | $0 |
| 8 | $796,400 | $617,500 | $2,346,500 | $0 |
| 9 | $796,400 | $617,500 | $2,346,500 | $0 |
| 10 | $796,400 | $617,500 | $2,346,500 | $0 |
| 11 | $796,400 | $617,500 | $2,346,500 | $0 |
| 12 | $796,400 | $617,500 | $2,346,500 | $0 |

## Monitoring and Evaluation

Follow-up phone surveys of students will determine which measures were installed and allow estimation of the energy savings attributable to the program. Savings for the first year of the program will be estimated as a small fraction of the measures expected to be recommended on the audit reports.

| Measure | Incremental Energy (kWh/yr) | Incremental Cost ($) | Unitized Weighting | Weighted Energy (kWh/yr) | Weighted Cost ($) |
|---|---|---|---|---|---|
| NEW MH Motion Detectors—Outdoor Lighting | 52.50 | 2.45 | 0.03 | 1.83 | 0.09 |
| Existing AC/HP Maintenance | 52.50 | 2.45 | 0.03 | 1.83 | 0.09 |
| NEW MF Motion Detectors—Outdoor Lighting | 60.00 | 2.80 | 0.03 | 2.09 | 0.10 |
| NEW MH High Pressure Sodium (Outdoor) | 60.00 | 2.80 | 0.03 | 2.09 | 0.10 |
| Existing Ceiling Insulation (R11-R30) | 130.02 | 20.00 | 0.03 | 4.50 | 0.69 |
| Existing Reduced Duct Leakage | 110.22 | 20.00 | 0.03 | 3.82 | 0.69 |
| Existing Ceiling Insulation (R0-R19) | 110.88 | 20.00 | 0.03 | 3.84 | 0.69 |
| Existing DHW Heater Tank Insulation | 77.56 | 20.00 | 0.03 | 2.69 | 0.69 |
| NEW MH Efficient Incandescent | 271.46 | 20.00 | 0.03 | 9.40 | 0.69 |
| Existing Ceiling Fans | 193.90 | 28.00 | 0.03 | 6.69 | 0.97 |
| NEW MH Motion Detectors (Outdoor) | 271.46 | 35.00 | 0.03 | 9.34 | 1.20 |
| Existing MH High-Efficiency Dishwasher | 477.45 | 105.88 | 0.03 | 15.90 | 3.53 |
| Existing Ceiling Fans | 1,119.10 | 105.88 | 0.03 | 37.26 | 3.53 |
| Existing Programmable Thermostat (HP) | 519.76 | 105.88 | 0.03 | 17.31 | 3.53 |
| Existing Programmable Thermostat | 1,011.26 | 105.88 | 0.03 | 33.67 | 3.53 |
| Existing High-Efficiency Heat Pump | 1,666.29 | 122.00 | 0.03 | 55.06 | 4.03 |
| NEW MF Efficient Incandescent | 1,272.99 | 122.00 | 0.03 | 42.07 | 4.03 |
| Existing MF High-Efficiency Dishwasher | 935.29 | 146.00 | 0.03 | 30.56 | 4.77 |
| Existing Ground-Source Heat Pump | 960.59 | 146.00 | 0.03 | 31.38 | 4.77 |
| Existing SF High-Efficiency Dishwasher | 1,905.06 | 275.00 | 0.03 | 58.40 | 8.43 |
| NEW MF High Pressure Sodium (Outdoor) | 1,133.22 | 275.00 | 0.03 | 34.74 | 8.43 |
| NEW MF Efficient Incandescent | 1,302.48 | 392.92 | 0.03 | 37.53 | 11.32 |
| NEW MH High Pressure Sodium (Outdoor) | 1,480.48 | 392.92 | 0.03 | 42.65 | 11.32 |
| NEW MH Efficient Incandescent | 1,623.30 | 392.92 | 0.03 | 46.77 | 11.32 |
| NEW SF High Pressure Sodium (Outdoor) | 1,842.03 | 392.92 | 0.03 | 53.07 | 11.32 |
| NEW SF Motion Detectors for Outdoor Lighting | 1,835.07 | 425.00 | 0.03 | 51.95 | 12.03 |
| NEW MF Motion Detectors for Outdoor Lighting | 3,488.64 | 590.00 | 0.03 | 89.77 | 15.18 |
| NEW SF High Pressure Sodium (Outdoor) | 1,366.27 | 650.32 | 0.02 | 33.87 | 16.12 |
| Existing Low Flow Showerhead | 4,655.83 | 650.32 | 0.02 | 115.42 | 16.12 |
| Existing DHW Heat Trap | 1,542.13 | 650.32 | 0.02 | 38.23 | 16.12 |
| Existing DHW Pipe Insulation | 4,069.82 | 650.32 | 0.02 | 100.89 | 16.12 |
| Existing Reduced Duct Leakage | 6,968.22 | 708.00 | 0.01 | 0.70 | 0.07 |
| Wood Furnace w/Wood Cost | 7,902.00 | 2,237.00 | 0.01 | 0.79 | 0.22 |
| | | **Total** | **1** | **1,016** | **192** |

*Same measure mix as Self-Audit Program, assumed 10 percent of homes will implement.*

## SELF-AUDIT PROGRAM

### Overview

Customers will conduct home audits using materials provided by TVA. TVA will analyze the audits and provide recommendations for cost-effective energy and environmental conservation measures applicable to the customer's home.

### Target Market

Residential customers in participating power distributor areas are targeted.

### Implementation Strategy

Home audit forms and instructions will be available at mall kiosks and participating distributors' offices. Customers completing the audit form will take it to their distributor or mail it to TVA, and receive a customized computer-generated report recommending the implementation of specific environmental and energy efficiency measures. The custom printout will be coordinated with other programs and will provide referrals to other existing distributor DSM programs.

### Incentives

No incentives will be provided.

### Program Assumptions

| | |
|---|---|
| Package Measure Life (Years) | 10 |
| Free-Rider Rate | 0% |
| Free-Driver Rate | 0% |
| Dropouts | 0% |
| Take-Back Percentage | 5% |
| Free-Rider Market Barrier Costs Eliminated | 50% |
| Non-Free-Rider Market Barrier Costs Eliminated | 60% |
| Annual Energy Impact (kWh) | 1,016 |

| Year | Annual Eligible Population | New Participants | Total Participants | Cumulative Participation Rate |
|---|---|---|---|---|
| 1 | 481,000 | 4,800 | 4,800 | 1% |
| 2 | 478,600 | 19,100 | 23,900 | 5% |
| 3 | 469,000 | 14,100 | 38,000 | 8% |
| 4 | 462,000 | 11,100 | 49,100 | 11% |
| 5 | 456,400 | 11,000 | 60,100 | 13% |
| 6 | 451,000 | 10,800 | 70,900 | 16% |
| 7 | 445,600 | 10,700 | 81,600 | 18% |
| 8 | 440,200 | 10,600 | 92,200 | 21% |
| 9 | 434,900 | 10,400 | 102,600 | 24% |
| 10 | 429,700 | 10,300 | 112,900 | 26% |
| 11 | 424,600 | 10,200 | 123,100 | 29% |
| 12 | 419,500 | 10,100 | 133,200 | 32% |

| | | Per Participant Variable Administrative Costs | Per Participant Measure Cost | Per Participant Incentive |
|---|---|---|---|---|
| Year | Fixed Administrative Cost | $5 Total Variable Admin. Cost | $192 Total Part. Measure Cost | $0 Total Part. Incentive |
| 1 | $437,500 | $24,000 | $921,600 | $0 |
| 2 | $187,500 | $95,500 | $3,667,200 | $0 |
| 3 | $187,500 | $70,500 | $2,707,200 | $0 |
| 4 | $187,500 | $55,500 | $2,131,200 | $0 |
| 5 | $187,500 | $55,000 | $2,112,000 | $0 |
| 6 | $187,500 | $54,000 | $2,073,600 | $0 |
| 7 | $187,500 | $53,500 | $2,054,400 | $0 |
| 8 | $187,500 | $53,000 | $2,035,200 | $0 |
| 9 | $187,500 | $52,000 | $1,996,800 | $0 |
| 10 | $187,500 | $51,500 | $1,977,600 | $0 |
| 11 | $187,500 | $51,000 | $1,958,400 | $0 |
| 12 | $187,500 | $50,500 | $1,939,200 | $0 |

## Monitoring and Evaluation

Follow-up phone surveys of participating customers will determine the number of installed measures, and allow estimation of the energy savings attributable to the program. Savings for the first year of the program will be estimated as a small fraction of the measures expected to be recommended on the audit reports.

| Measure | Incremental Energy (kWh/yr) | Incremental Cost ($) | Unitized Weighting | Weighted Energy (kWh/yr) | Weighted Cost ($) |
|---|---|---|---|---|---|
| NEW MH Motion Detectors—Outdoor Lighting | 52.50 | 2.45 | 0.03 | 1.83 | 0.09 |
| Existing AC/HP Maintenance | 52.50 | 2.45 | 0.03 | 1.83 | 0.09 |
| NEW MF Motion Detectors—Outdoor Lighting | 60.00 | 2.80 | 0.03 | 2.09 | 0.10 |
| NEW MH High Pressure Sodium (Outdoor) | 60.00 | 2.80 | 0.03 | 2.09 | 0.10 |
| Existing Ceiling Insulation (R11-R30) | 130.02 | 20.00 | 0.03 | 4.50 | 0.69 |
| Existing Reduced Duct Leakage | 110.22 | 20.00 | 0.03 | 3.82 | 0.69 |
| Existing Ceiling Insulation (R0-R19) | 110.88 | 20.00 | 0.03 | 3.84 | 0.69 |
| Existing DHW Heater Tank Insulation | 77.56 | 20.00 | 0.03 | 2.69 | 0.69 |
| NEW MH Efficient Incandescent | 271.46 | 20.00 | 0.03 | 9.40 | 0.69 |
| Existing Ceiling Fans | 193.90 | 28.00 | 0.03 | 6.69 | 0.97 |
| NEW MH Motion Detectors (Outdoor) | 271.46 | 35.00 | 0.03 | 9.34 | 1.20 |
| Existing MH High-Efficiency Dishwasher | 477.45 | 105.88 | 0.03 | 15.90 | 3.53 |
| Existing Ceiling Fans | 1,119.10 | 105.88 | 0.03 | 37.26 | 3.53 |
| Existing Programmable Thermostat (HP) | 519.76 | 105.88 | 0.03 | 17.31 | 3.53 |
| Existing Programmable Thermostat | 1,011.26 | 105.88 | 0.03 | 33.67 | 3.53 |
| Existing High-Efficiency Heat Pump | 1,666.29 | 122.00 | 0.03 | 55.06 | 4.03 |
| NEW MF Efficient Incandescent | 1,272.99 | 122.00 | 0.03 | 42.07 | 4.03 |
| Existing MF High-Efficiency Dishwasher | 935.29 | 146.00 | 0.03 | 30.56 | 4.77 |
| Existing Ground-Source Heat Pump | 960.59 | 146.00 | 0.03 | 31.38 | 4.77 |
| Existing SF High-Efficiency Dishwasher | 1,905.06 | 275.00 | 0.03 | 58.40 | 8.43 |
| NEW MF High Pressure Sodium (Outdoor) | 1,133.22 | 275.00 | 0.03 | 34.74 | 8.43 |
| NEW MF Efficient Incandescent | 1,302.48 | 392.92 | 0.03 | 37.53 | 11.32 |
| NEW MH High Pressure Sodium (Outdoor) | 1,480.48 | 392.92 | 0.03 | 42.65 | 11.32 |
| NEW MH Efficient Incandescent | 1,623.30 | 392.92 | 0.03 | 46.77 | 11.32 |
| NEW SF High Pressure Sodium (Outdoor) | 1,842.03 | 392.92 | 0.03 | 53.07 | 11.32 |
| NEW SF Motion Detectors for Outdoor Lighting | 1,835.07 | 425.00 | 0.03 | 51.95 | 12.03 |
| NEW MF Motion Detectors for Outdoor Lighting | 3,488.64 | 590.00 | 0.03 | 89.77 | 15.18 |
| NEW SF High Pressure Sodium (Outdoor) | 1,366.27 | 650.32 | 0.02 | 33.87 | 16.12 |
| Existing Low Flow Showerhead | 4,655.83 | 650.32 | 0.02 | 115.42 | 16.12 |
| Existing DHW Heat Trap | 1,542.13 | 650.32 | 0.02 | 38.23 | 16.12 |
| Existing DHW Pipe Insulation | 4,069.82 | 650.32 | 0.02 | 100.89 | 16.12 |
| Existing Reduced Duct Leakage | 6,968.22 | 708.00 | 0.01 | 0.70 | 0.07 |
| Wood Furnace w/Wood Cost | 7,902.00 | 2,237.00 | 0.01 | 0.79 | 0.22 |
| | | **Total** | **1** | **1,016** | **192** |

## LOAD MANAGEMENT PROGRAM—AIR CONDITIONERS

### Overview

TVA presently has a radio control system that cycles water heaters and air-conditioning load to reduce power demand during hours of peak electrical usage. This program expands participation in the coverage area of the TVA-owned and -maintained radio control system.

### Target Market

Residential customers with central air conditioners or heat pumps in participating power distributor areas are targeted.

### Implementation Strategy

In participating power distributors' areas, the load management program will be promoted to encourage additional load management installations. Free maintenance of the load-controlled HVAC is used as an incentive. This provides multiple benefits including increased HVAC efficiency, increased QA inspections at no cost, and enhanced HVAC contractor buy-in to the program.

### Incentives

TVA will pay the full cost of the switch and its installation. An incentive to the distributor is included and can be used to pay employees to sign up participants and/or part or all of the incentive can be passed on to participants. Free maintenance contracts are provided for central air conditioners and heat pumps participating in the program.

### Monitoring and Evaluation

QA inspections of program switches and their operation are performed by the contractor during an annual maintenance inspection. Some spot checking of maintenance procedures and switch operation will be required.

### Program Assumptions

| | |
|---|---|
| Package Measure Life (Years) | 15 |
| Free-Rider Rate | 0% |
| Free-Driver Rate | 0% |
| Dropouts | 2% |
| Take-Back Percentage | 5% |
| Free-Rider Market Barrier Costs Eliminated | 0% |
| Non-Free-Rider Market Barrier Costs Eliminated | 100% |
| Annual Energy Impact (kWh) | 520 |

| Year | Annual Eligible Population | New Participants | Total Participants | Cumulative Participation Rate |
|---|---|---|---|---|
| 1 | 52,900 | 1,100 | 1,100 | 2% |
| 2 | 52,900 | 3,200 | 4,300 | 8% |
| 3 | 52,900 | 4,200 | 8,500 | 16% |
| 4 | 52,900 | 5,300 | 13,800 | 26% |
| 5 | 52,900 | 6,300 | 20,100 | 38% |
| 6 | 52,900 | 6,300 | 26,400 | 50% |
| 7 | 52,900 | 5,300 | 31,700 | 60% |
| 8 | 52,900 | 4,200 | 35,900 | 68% |
| 9 | 52,900 | 3,200 | 39,100 | 74% |
| 10 | 52,900 | 500 | 39,600 | 75% |

| Year | Fixed Administrative Cost | Per Participant Variable Administrative Costs<br>$225<br>Total Variable Admin. Cost | Per Participant Measure Cost<br>$0<br>Total Part. Measure Cost | Annual Per Participant Incentive<br>$65<br>Total Part. Incentive |
|---|---|---|---|---|
| 1 | $100,000 | $247,500 | $0 | $71,500 |
| 2 | $100,000 | $720,000 | $0 | $279,500 |
| 3 | $100,000 | $945,000 | $0 | $552,500 |
| 4 | $100,000 | $1,192,500 | $0 | $897,000 |
| 5 | $100,000 | $1,417,500 | $0 | $1,306,500 |
| 6 | $100,000 | $1,417,500 | $0 | $1,716,000 |
| 7 | $100,000 | $1,192,500 | $0 | $2,060,500 |
| 8 | $100,000 | $945,000 | $0 | $2,333,500 |
| 9 | $100,000 | $720,000 | $0 | $2,541,500 |
| 10 | $100,000 | $112,500 | $0 | $2,574,000 |

## LOAD MANAGEMENT PROGRAM—WATER HEATERS

### Overview

TVA presently has a radio control system that cycles water heaters and air-conditioning load to reduce power demand during hours of peak electrical usage. This program expands participation in the coverage area of the TVA-owned and -maintained radio control system.

### Target Market

Residential customers with electric water heaters in participating power distributor areas are targeted.

### Implementation Strategy

In participating power distributors' areas, the load management program will be promoted to encourage additional load management installations. For water heater control, direct incentives can be paid to the homeowner for participating in the program.

### Incentives

TVA will pay the full cost of the switch and its installation. An incentive to the distributor is included, which can be used to pay employees to sign up participants and/or part or all of the incentive can be passed on to participants.

### Monitoring and Evaluation

QA inspections of program switches and their operation are performed by the contractor during an annual maintenance inspection. Some spot checking of maintenance procedures and switch operation will be required.

### Program Assumptions

| | |
|---|---|
| Package Measure Life (Years) | 10 |
| Free-Rider Rate | 0% |
| Free-Driver Rate | 0% |
| Dropouts | 2% |
| Take-Back Percentage | 0% |
| Free-Rider Market Barrier Costs Eliminated | 0% |
| Non-Free-Rider Market Barrier Costs Eliminated | 100% |
| Annual Energy Impact (kWh) | — |

| Year | Annual Eligible Population | New Participants | Total Participants | Cumulative Participation Rate |
|---|---|---|---|---|
| 1 | 215,900 | 4,300 | 4,300 | 2% |
| 2 | 215,900 | 13,000 | 17,300 | 8% |
| 3 | 215,900 | 19,400 | 36,700 | 17% |
| 4 | 215,900 | 25,900 | 62,600 | 29% |
| 5 | 215,900 | 25,900 | 88,500 | 41% |
| 6 | 215,900 | 25,900 | 114,400 | 53% |
| 7 | 215,900 | 21,600 | 136,000 | 63% |
| 8 | 215,900 | 17,300 | 153,300 | 71% |
| 9 | 215,900 | 8,600 | 161,900 | 75% |
| 10 | 215,900 | — | 161,900 | 75% |

| Year | Fixed Administrative Cost | Per Participant Variable Administrative Costs<br>$554<br>Total Variable Admin. Cost | Per Participant Measure Cost<br>$0<br>Total Part. Measure Cost | Annual Per Participant Incentive<br>$24<br>Total Part. Incentive |
|---|---|---|---|---|
| 1 | $100,000 | $2,382,200 | $0 | $103,200 |
| 2 | $100,000 | $7,202,000 | $0 | $415,200 |
| 3 | $100,000 | $10,747,600 | $0 | $880,800 |
| 4 | $100,000 | $14,348,600 | $0 | $1,502,400 |
| 5 | $100,000 | $14,348,600 | $0 | $2,124,000 |
| 6 | $100,000 | $14,348,600 | $0 | $2,745,600 |
| 7 | $100,000 | $11,966,400 | $0 | $3,264,000 |
| 8 | $100,000 | $9,584,200 | $0 | $3,679,200 |
| 9 | $100,000 | $4,764,400 | $0 | $3,885,600 |
| 10 | $100,000 | $0 | $0 | $3,885,600 |

## LOAD MANAGEMENT PROGRAM—STORAGE WATER HEATERS

### Overview

TVA presently has a radio control system that cycles water heaters and air-conditioning load to reduce power demand during hours of peak electrical usage. This program prolongs cycling by using larger storage water heaters. Participation is limited to the coverage area of the TVA-owned and -maintained radio control system. The program also provides for a free water heater, installation, and free maintenance of the water heater as an incentive for program participation.

### Target Market

Residential customers with electric water heaters in participating power distributor areas are targeted.

### Implementation Strategy

In participating power distributors' areas, the load management program will be promoted to encourage additional load management installations. The homeowner will have a storage water heater installed free of charge, with free maintenance as an additional incentive. The storage water heater allows TVA to cycle the water heater for longer periods of time in order to minimize payback spikes at the end of a typical control period.

The specified storage water heater must meet specific efficiency requirements (Energy Factor) corresponding to the tank size. The water heater will be sized to accommodate the water heating needs of the home and to minimize hot water outages.

Repair and replacement work will be performed by local contractors. A local phone number with answering service will be available 24 hours per day, 365 days per year. The customer is guaranteed replacement or repair within 48 hours of the call.

### Incentives

TVA will pay the full cost of the storage water heater, the control switch, and its installation. Also a free maintenance contract is provided for the storage water heater.

### Monitoring and Evaluation

QA inspections of program switches and their operation are performed by the contractor during an annual maintenance inspection. Some spot checking of maintenance procedures and switch operation will be required.

### Program Assumptions

| | |
|---|---|
| Package Measure Life (Years) | 10 |
| Free-Rider Rate | 0% |
| Free-Driver Rate | 0% |
| Dropouts | 2% |
| Take-Back Percentage | 0% |
| Free-Rider Market Barrier Costs Eliminated | 0% |
| Non-Free-Rider Market Barrier Costs Eliminated | 100% |
| Annual Energy Impact (kWh) | — |

| Year | Annual Eligible Population | New Participants | Total Participants | Cumulative Participation Rate |
|---|---|---|---|---|
| 1 | 108,000 | 2,200 | 2,200 | 2% |
| 2 | 108,000 | 6,500 | 8,700 | 8% |
| 3 | 108,000 | 9,700 | 18,400 | 17% |
| 4 | 108,000 | 10,800 | 29,200 | 27% |
| 5 | 108,000 | 10,800 | 40,000 | 37% |
| 6 | 108,000 | 10,800 | 50,800 | 47% |
| 7 | 108,000 | 10,800 | 61,600 | 57% |
| 8 | 108,000 | 8,600 | 70,200 | 65% |
| 9 | 108,000 | 4,300 | 74,500 | 69% |
| 10 | 108,000 | 2,200 | 76,700 | 71% |

| Year | Fixed Administrative Cost | Per Participant Variable Administrative Costs<br>$600<br>Total Variable Admin. Cost | Per Participant Measure Cost<br>$400<br>Total Part. Measure Cost | Per Participant Incentive<br>$460<br>Total Part. Incentive |
|---|---|---|---|---|
| 1 | $350,000 | $1,320,000 | $880,000 | $1,012,000 |
| 2 | $350,000 | $3,900,000 | $2,600,000 | $2,990,000 |
| 3 | $350,000 | $5,820,000 | $3,880,000 | $4,462,000 |
| 4 | $350,000 | $6,480,000 | $4,320,000 | $4,968,000 |
| 5 | $350,000 | $6,480,000 | $4,320,000 | $4,968,000 |
| 6 | $350,000 | $6,480,000 | $4,320,000 | $4,968,000 |
| 7 | $350,000 | $6,480,000 | $4,320,000 | $4,968,000 |
| 8 | $350,000 | $5,160,000 | $3,440,000 | $3,956,000 |
| 9 | $350,000 | $2,580,000 | $1,720,000 | $1,978,000 |
| 10 | $350,000 | $1,320,000 | $880,000 | $1,012,000 |

## LOAD MANAGEMENT PROGRAM—DIRECT CONTROL WITH SCADA

### Overview

Many TVA distributors presently have a Supervisory Control and Data Acquisition system. These SCADA systems can be upgraded to allow direct load control of water heaters in order to reduce power demand during hours of peak electrical usage. Through incentives, homeowners will be encouraged to have a load management device installed on their water heaters. This program expands load management participation from the coverage area of the TVA-owned and -maintained radio control system.

### Target Market

Eligible residential customers have electric water heaters in participating power distributor areas that have SCADA systems and do not participate in the existing load management program using radio control.

### Implementation Strategy

In participating power distributors' areas, the SCADA system will be upgraded to allow the direct load control of residential water heaters. Promotion of the load management program will encourage homeowners to have a load management device installed on their existing water heaters.

### Incentives

TVA will pay the full cost of the switch and its installation. An incentive to the distributor is included and can be used to pay employees to sign up participants and/or part or all of the incentive can be passed on to participants.

### Monitoring and Evaluation

QA inspections of program switches and their operation are performed by the contractor during an annual maintenance inspection. Some spot checking of maintenance procedures and switch operation will be required.

### Program Assumptions

| | |
|---|---|
| Package Measure Life (Years) | 10 |
| Free-Rider Rate | 0% |
| Free-Driver Rate | 0% |
| Dropouts | 2% |
| Take-Back Percentage | 0% |
| Free-Rider Market Barrier Costs Eliminated | 0% |
| Non-Free-Rider Market Barrier Costs Eliminated | 100% |
| Annual Energy Impact (kWh) | — |

| Year | Annual Eligible Population | New Participants | Total Participants | Cumulative Participation Rate |
|---|---|---|---|---|
| 1 | 793,000 | 7,900 | 7,900 | 1% |
| 2 | 793,000 | 15,900 | 23,800 | 3% |
| 3 | 793,000 | 23,800 | 47,600 | 6% |
| 4 | 793,000 | 19,800 | 67,400 | 9% |
| 5 | 793,000 | — | 67,400 | 9% |
| 6 | 793,000 | — | 67,400 | 9% |
| 7 | 793,000 | — | 67,400 | 9% |
| 8 | 793,000 | — | 67,400 | 9% |
| 9 | 793,000 | — | 67,400 | 9% |
| 10 | 793,000 | — | 67,400 | 9% |
| 11 | 793,000 | — | 67,400 | 9% |
| 12 | 793,000 | — | 67,400 | 9% |

| Year | Fixed Administrative Cost | Per Participant Variable Administrative Costs<br>$125<br>Total Variable Admin. Cost | Per Participant Measure Cost<br>$0<br>Total Part. Measure Cost | Annual Per Participant Incentive<br>$24<br>Total Part. Incentive |
|---|---|---|---|---|
| 1 | $1,911,000 | $987,500 | $0 | $189,600 |
| 2 | $1,811,000 | $1,987,500 | $0 | $571,200 |
| 3 | $1,711,000 | $2,975,000 | $0 | $1,142,400 |
| 4 | $410,000 | $2,475,000 | $0 | $1,617,600 |
| 5 | $335,000 | $0 | $0 | $1,617,600 |
| 6 | $335,000 | $0 | $0 | $1,617,600 |
| 7 | $335,000 | $0 | $0 | $1,617,600 |
| 8 | $335,000 | $0 | $0 | $1,617,600 |
| 9 | $335,000 | $0 | $0 | $1,617,600 |
| 10 | $335,000 | $0 | $0 | $1,617,600 |
| 11 | $335,000 | $0 | $0 | $1,617,600 |
| 12 | $335,000 | $0 | $0 | $1,617,600 |

## LOAD MANAGEMENT PROGRAM—NEW TECHNOLOGY

### Overview

This program utilizes a two-way communication network to provide a combination of benefits to the consumer, increased efficiency for utility operations, and possibly profitable side businesses. The main focus for the utility is direct load control of applicable residential appliances, and real-time-pricing or time-of-use pricing for the customer. The rate options provide for additional customer load management control of other appliances, and open the door for home automation and energy storage appliances.

### Target Market

All residential customers in participating power distributor areas are targeted.

### Implementation Strategy

The direct load control aspect of the information superhighway allows the utility to control air conditioners, water heaters, storage water heaters, and pool pumps when required. In return the customer receives a monthly or seasonal incentive for this control. Different control levels and incentive levels are available.

The utility can also improve operations through remote meter reading, remote connection and disconnection of electrical service, and easier bill payment methods.

The real-time-pricing and time-of-use rate options provide the customer with the ability to perform load management based on price signals from the utility. The customer maintains control and has the ability to lower costs.

The information superhighway or equivalent two-way communication network provides many benefits to the customer. They will be able to have competitive cable TV service, competitive telephone service, home security system monitoring, home automation, real-time electricity pricing, itemized utility bills, and remote bill payment, all from their home.

### Incentives

- The real-time pricing provides a rate incentive to the customer.
- The time-of-use rate option is another rate incentive for the customer.
- For direct load control, a comparable incentive to the rate incentives can be provided to the customer in the form of a monthly incentive on their power bill.

### Monitoring and Evaluation

The two-way communications network provides real-time feedback of loads shed and the impacts on their utility system.

### Program Assumptions

| | |
|---|---|
| Package Measure Life (Years) | 10 |
| Free-Rider Rate | 0% |
| Free-Driver Rate | 0% |
| Dropouts | 2% |
| Take-Back Percentage | 0% |
| Free-Rider Market Barrier Costs Eliminated | 0% |
| Non-Free-Rider Market Barrier Costs Eliminated | 100% |
| Annual Energy Impact (kWh) | — |

| Year | Annual Eligible Population | New Participants | Total Participants | Cumulative Participation Rate |
|---|---|---|---|---|
| 1 | 1,621,300 | 32,400 | 32,400 | 2% |
| 2 | 1,621,300 | 64,900 | 97,300 | 6% |
| 3 | 1,621,300 | 97,300 | 194,600 | 12% |
| 4 | 1,621,300 | 81,100 | 275,700 | 17% |
| 5 | 1,621,300 | — | 275,700 | 17% |
| 6 | 1,621,300 | — | 275,700 | 17% |
| 7 | 1,621,300 | — | 275,700 | 17% |
| 8 | 1,621,300 | — | 275,700 | 17% |
| 9 | 1,621,300 | — | 275,700 | 17% |
| 10 | 1,621,300 | — | 275,700 | 17% |
| 11 | 1,621,300 | — | 275,700 | 17% |
| 12 | 1,621,300 | — | 275,700 | 17% |

| Year | Fixed Administrative Cost and New Business Revenue | Per Participant Variable Administrative Costs $25 Total Variable Admin. Cost | Per Participant Measure Cost $500 Total Part. Measure Cost | Per Participant Incentive $500 Total Part. Incentive |
|---|---|---|---|---|
| 1 | $150,056,000 | $810,000 | $16,200,000 | $16,200,000 |
| 2 | $146,795,000 | $1,622,500 | $32,450,000 | $32,450,000 |
| 3 | $143,633,000 | $2,432,500 | $48,650,000 | $48,650,000 |
| 4 | ($12,095,000) | $2,027,500 | $40,550,000 | $40,550,000 |
| 5 | ($12,095,000) | $0 | $0 | $0 |
| 6 | ($12,095,000) | $0 | $0 | $0 |
| 7 | ($12,095,000) | $0 | $0 | $0 |
| 8 | ($12,095,000) | $0 | $0 | $0 |
| 9 | ($12,095,000) | $0 | $0 | $0 |
| 10 | ($12,095,000) | $0 | $0 | $0 |
| 11 | ($12,095,000) | $0 | $0 | $0 |
| 12 | ($12,095,000) | $0 | $0 | $0 |

# COMMERCIAL AND INDUSTRIAL ENERGY EFFICIENCY OPTIONS

## SUMMARY OF PROJECTED IMPACTS IN YEAR 2010

| Option Name | 2010 Winter MW | 2010 Summer MW | GWh | Units Million (sq. ft ) | ¢kWh TRC |
|---|---|---|---|---|---|
| COMMERCIAL TECHNOLOGY REBATES | | | | | |
| Lighting Rebates | 265 | 511 | 2,845 | 1,626 | 2.0 |
| HVAC & Building Shell Rebates | 255 | 223 | 670 | 630 | 7.7 |
| Appliance Rebates | 40 | 69 | 364 | 501 | 3.2 |
| New Construction | 124 | 188 | 762 | 360 | 4.4 |
| New Construction—Renewables | 30 | 40 | 159 | 30 | 7.4 |
| SMALL COMMERCIAL SECTOR | | | | | |
| Retrofit - Direct Install | 65 | 98 | 465 | 315 | 3.1 |
| HVAC Maintenance Program | 38 | 26 | 87 | 236 | 13.7 |
| LARGE COMMERCIAL SECTOR | | | | | |
| Comprehensive Measures Financing | 120 | 170 | 713 | 284 | 4.9 |
| Comprehensive Measures Rebates | 242 | 311 | 1,278 | 449 | 4.9 |
| COMMERCIAL LOAD MANAGEMENT | | | | | |
| Commercial Cool Storage | 0 | 120 | 13 | 59 | 453 [1] |
| Rooftop Cool Storage | 0 | 93 | 3 | 44 | 167 [1] |
| Commercial Group Load Curtailment | 244 | 242 | 227 | 2,240 [2] | 169 [1] |
| INDUSTRIAL PROGRAMS | | | | | |
| Industrial Technology Rebates | 21 | 24 | 167 | 2,100 [2] | 3.2 |
| Industrial Process EE—Distributor Served | 149 | 169 | 1,057 | 11,226 [3] | 4.1 |
| Industrial Process EE—Direct Served | 167 | 190 | 1,325 | 8,420 [3] | 4.0 |
| Energy-Efficient Rates (opt-out) | 50 | 56 | 394 | 2,504 [3] | 3.2 |

*[1] Cost in $/kW*
*[2] Number of participants*
*[3] Participant defined as industrial customer with one million kWh of energy use.*

*Values are the impacts occuring only in the year 2010 for the cumulative participation in the program to that date.*

TVA developed commercial and industrial options for evaluation in Energy Vision 2020 with applications for all major uses of electricity and for all types of building. Some of the options are designed to promote specific technologies and some options address the financial, environmental, or productivity needs of end-use customers. Detailed descriptions of the options follow.

## COMMERCIAL TECHNOLOGY REBATES—LIGHTING/HVAC & BUILDING SHELL/APPLIANCES

### Overview

The installation of energy-efficient equipment can help commercial and industrial customers cut energy costs and enhance competitiveness and viability. Many energy-efficient technologies have widespread applicability in the commercial sector. This program provides pre-determined rebates to encourage installation of specified energy-efficient equipment.

### Target Market

This program targets all commercial and industrial customers, representing over three billion square feet of floorspace in the Tennessee Valley region, interested in replacing or upgrading HVAC, lighting, water heating, or other electrical equipment. In addition to providing services for customers replacing a single technology, this program provides prescriptive rebates to customers who are not eligible for or for whom it would not be cost-effective to provide comprehensive design assistance or analysis.

### Implementation Strategy

This program will be promoted to commercial and industrial customers through direct advertising, through trade allies, and at the point of purchase. The benefits of increased energy efficiency to a customer's operations will be promoted. By providing easily understandable information about these benefits, along with the rebates, customers are encouraged to select more efficient technologies. Technical assistance, such as lighting design assistance, will be available to ensure customer satisfaction and maximize the savings from the energy- efficient technologies.

Trade allies, such as equipment dealers, will receive incentives to stock and promote the energy efficient technologies included in the program to their commercial customers.

### Incentives

This program targets customers at the time of natural equipment replacement and reflects a market-driven, lost opportunity resource. Once a customer has replaced equipment, the efficiency improvement may not be cost-effective until the end of the equipment's lifetime. Therefore, under this program, customers will be offered rebates equal to 75 percent of the incremental cost to achieve the desired level of participation and to make energy-efficient technologies more widely available across the Valley.

*Commercial Technology Rebates—Lighting*

### Program Assumptions

| | |
|---|---|
| Package Measure Life (Years) | 12 |
| Free-Rider Rate | 15% |
| Free-Driver Rate | 0% |
| Dropouts | 0% |
| Take-Back Percentage | 5% |
| Free-Rider Market Barrier Costs Eliminated | 50% |
| Non-Free-Rider Market Barrier Costs Eliminated | 75% |
| Annual Energy Impact (kWh) | 1,650 |

| Year | Annual Eligible Population | New Participants | Total Participants | Cumulative Participation Rate |
|---|---|---|---|---|
| 1 | 271,040 | 54,210 | 54,210 | 20% |
| 2 | 271,040 | 81,310 | 135,520 | 25% |
| 3 | 271,040 | 108,420 | 243,940 | 30% |
| 4 | 271,040 | 135,520 | 379,460 | 35% |
| 5 | 271,040 | 135,520 | 514,980 | 38% |
| 6 | 271,040 | 135,520 | 650,500 | 40% |
| 7 | 271,040 | 135,520 | 786,020 | 41% |
| 8 | 271,040 | 135,520 | 921,540 | 43% |
| 9 | 271,040 | 135,520 | 1,057,060 | 43% |
| 10 | 271,040 | 135,520 | 1,192,580 | 44% |
| 11 | 271,040 | 135,520 | 1,328,100 | 49% |
| 12 | 271,040 | 135,520 | 1,463,620 | 54% |

| Year | Fixed Administrative Cost | Per Participant Variable Administrative Costs<br>$20<br>Total Variable Admin. Cost | Per Participant Measure Cost<br>$200<br>Total Part. Measure Cost | Per Participant Incentive<br>$150<br>Total Part. Incentive |
|---|---|---|---|---|
| 1 | $575,000 | $1,084,200 | $10,842,000 | $8,131,500 |
| 2 | $575,000 | $1,626,200 | $16,262,000 | $12,196,500 |
| 3 | $575,000 | $2,168,400 | $21,684,000 | $16,263,000 |
| 4 | $575,000 | $2,710,400 | $27,104,000 | $20,328,000 |
| 5 | $575,000 | $2,710,400 | $27,104,000 | $20,328,000 |
| 6 | $575,000 | $2,710,400 | $27,104,000 | $20,328,000 |
| 7 | $575,000 | $2,710,400 | $27,104,000 | $20,328,000 |
| 8 | $575,000 | $2,710,400 | $27,104,000 | $20,328,000 |
| 9 | $575,000 | $2,710,400 | $27,104,000 | $20,328,000 |
| 10 | $575,000 | $2,710,400 | $27,104,000 | $20,328,000 |
| 11 | $575,000 | $2,710,400 | $27,104,000 | $20,328,000 |
| 12 | $575,000 | $2,710,400 | $27,104,000 | $20,328,000 |

## Monitoring and Evaluation

Process evaluation will be conducted to compare the cost and effectiveness of the delivery strategy. Impact evaluation will be conducted to determine the program benefits.

**COMMERCIAL TECHNOLOGY REBATES—LIGHTING**

| *Per Participant Costs and Impacts Based on:* | | Annual Energy Impact | Cost ($) | Measure Penetration | Weighted Energy Impact | Weighted Cost ($) |
|---|---|---|---|---|---|---|
| **Efficient Measures** | **Base Measures** | | | | | |
| T-8/Electronic Ballasts | 4' - 40W Fluor. Lamps/EE Ballasts | 631 | 62 | 75% | 473 | 47 |
| Refl/Delamp: 4' - 40W/Elec. Ballasts | 4' - 40W Fluor. Lamps/EE Ballasts | 1,998 | 185 | 5% | 100 | 9 |
| Refl/Delamp 8' - 75W/EE Ballasts | 8' - 75W Fluor. Lamps/EE Ballasts | 1,442 | 103 | 2% | 29 | 2 |
| Compact Fluorescent | Incandescent Lamps | 8,480 | 179 | 3% | 254 | 5 |
| Occupancy Sensors | All Interior Fluorescent Lighting | 847 | 135 | 25% | 212 | 34 |
| Photoelectric Control | Existing Lighting - Outdoor | 232 | 6 | 10% | 23 | 1 |
| Fluorescent Exit Signs | Incandescent Exit Signs | 88 | 28 | 10% | 9 | 3 |
| LED Exit Signs | Incandescent Exit Signs | 289 | 103 | 30% | 87 | 31 |
| Electroluminescent Exit Signs | Incandescent Exit Signs | 342 | 118 | 10% | 34 | 12 |
| Daylighting Design | 4' - 40W Fluor. Lamps/EE Ballasts | 1,760 | 250 | 10% | 176 | 25 |
| High Pressure Sodium | Mercury Vapor Fixtures | 1,544 | 184 | 2% | 31 | 4 |
| High Pressure Sodium (35W) | Incandescent Lamps (150W) | 11,967 | 1,559 | 2% | 239 | 31 |
| | | **Total** | | | **1,667** | **204** |

*The penetration of a measure is based on its cost-effectiveness, potential net benefits, persistence of energy savings over time, technical feasibility, and the current penetration of the base and efficient technologies.*

*Commercial Technology Rebates—HVAC & Building Shell*

## Program Assumptions

| | |
|---|---|
| Package Measure Life (Years) | 20 |
| Free-Rider Rate | 0% |
| Free-Driver Rate | 0% |
| Dropouts | 0% |
| Take-Back Percentage | 5% |
| Free-Rider Market Barrier Costs Eliminated | 50% |
| Non-Free-Rider Market Barrier Costs Eliminated | 75% |
| Annual Energy Impact (kWh) | 950 |

| Year | Annual Eligible Population | New Participants | Total Participants | Cumulative Participation Rate |
|---|---|---|---|---|
| 1 | 101,640 | 20,330 | 20,330 | 20% |
| 2 | 101,640 | 20,330 | 40,660 | 20% |
| 3 | 101,640 | 20,330 | 60,990 | 20% |
| 4 | 101,640 | 30,490 | 91,480 | 23% |
| 5 | 101,640 | 30,490 | 121,970 | 24% |
| 6 | 101,640 | 30,490 | 152,460 | 25% |
| 7 | 101,640 | 40,660 | 193,120 | 27% |
| 8 | 101,640 | 40,660 | 233,780 | 29% |
| 9 | 101,640 | 40,660 | 274,440 | 30% |
| 10 | 101,640 | 50,820 | 325,260 | 32% |
| 11 | 101,640 | 50,820 | 376,080 | 34% |
| 12 | 101,640 | 50,820 | 426,900 | 35% |

| Year | Fixed Administrative Cost | Per Participant Variable Administrative Costs<br>$40<br>Total Variable Admin. Cost | Per Participant Measure Cost<br>$350<br>Total Part. Measure Cost | Per Participant Incentive<br>$265<br>Total Part. Incentive |
|---|---|---|---|---|
| 1 | $325,000 | $813,200 | $7,115,500 | $5,387,450 |
| 2 | $325,000 | $813,200 | $7,115,500 | $5,387,450 |
| 3 | $325,000 | $813,200 | $7,115,500 | $5,387,450 |
| 4 | $325,000 | $1,219,600 | $10,671,500 | $8,079,850 |
| 5 | $325,000 | $1,219,600 | $10,671,500 | $8,079,850 |
| 6 | $325,000 | $1,219,600 | $10,671,500 | $8,079,850 |
| 7 | $325,000 | $1,626,400 | $14,231,000 | $10,774,900 |
| 8 | $325,000 | $1,626,400 | $14,231,000 | $10,774,900 |
| 9 | $325,000 | $1,626,400 | $14,231,000 | $10,774,900 |
| 10 | $325,000 | $2,032,800 | $17,787,000 | $13,467,300 |
| 11 | $325,000 | $2,032,800 | $17,787,000 | $13,467,300 |
| 12 | $325,000 | $2,032,800 | $17,787,000 | $13,467,300 |

**COMMERCIAL TECHNOLOGY REBATES—HVAC**

| *Per Participant Costs and Impacts Based on:*<br>Efficient Measures | Base Measures | Annual Energy Impact | Cost ($) | Measure Penetration | Weighted Energy Impact | Weighted Cost ($) |
|---|---|---|---|---|---|---|
| High-Efficiency Chiller | Standard Eff. Chiller | 28 | 12 | 60% | 17 | 7 |
| Speed Control for Cooling Tower | Standard Cooling Tower | 70 | 6 | 60% | 42 | 4 |
| High-Efficiency A/C DX | Standard Eff. A/C DX | 500 | 225 | 30% | 150 | 68 |
| High-Efficiency Room A/C | Standard Efficiency Room A/C | 464 | 289 | 10% | 46 | 29 |
| High-Efficiency Heat Pump | Standard Eff. Heat Pump | 300 | 464 | 20% | 60 | 93 |
| Ground-Source Heat Pump | Standard Eff. Heat Pump | 1,167 | 2,680 | 1% | 12 | 27 |
| High-Efficiency Ventilation Motors | Stan. Eff. Constant Speed Motors | 38 | 11 | 25% | 10 | 3 |
| ASD Ventilation Controls w/VAV | Stan. Eff. Constant Speed Motors | 95 | 66 | 30% | 29 | 20 |
| Timer/Programmable Vent. Cont. | Stan. Eff. Constant Speed Motors | 128 | 119 | 5% | 6 | 6 |
| Roof Insulation | All Heating, Cooling, Ventilation | 2,458 | 228 | 15% | 369 | 34 |
| Wall Insulation | All Heating, Cooling, Ventilation | 285 | 334 | 5% | 14 | 17 |
| Window Film | Standard Windows | 570 | 65 | 15% | 86 | 10 |
| Leak-Free Ducts | All Heating, Cooling, Ventilation | 256 | 127 | 15% | 38 | 19 |
| HVAC Air Duct/Water Pipe Insul. | All Heating, Cooling, Ventilation | 173 | 79 | 15% | 26 | 12 |
| Temperature Setback/Setup | All Heating, Cooling, Ventilation | 246 | 22 | 25% | 62 | 6 |
| | | **Total** | | | **967** | **355** |

*• High Efficiency Chillers and Speed Control for Cooling Towers Applicable in Large Office and Hospital Buildings*
*• ASD Ventilation Controls w/VAV Applicable in University Buildings*

*The penetration of a measure is based on its cost-effectiveness, potential net benefits, persistence of energy savings over time, technical feasibility, and the current penetration of the base and efficient technologies.*

*Commercial Technology Rebates—Appliances*

## Program Assumptions

| | |
|---|---|
| Package Measure Life (Years) | 10 |
| Free-Rider Rate | 10% |
| Free-Driver Rate | 0% |
| Dropouts | 0% |
| Take-Back Percentage | 10% |
| Free-Rider Market Barrier Costs Eliminated | 50% |
| Non-Free-Rider Market Barrier Costs Eliminated | 75% |
| Annual Energy Impact (kWh) | 600 |

| Year | Annual Eligible Population | New Participants | Total Participants | Cumulative Participation Rate |
|---|---|---|---|---|
| 1 | 102,995 | 20,600 | 20,600 | 20% |
| 2 | 102,995 | 20,600 | 41,200 | 20% |
| 3 | 102,995 | 30,900 | 72,100 | 23% |
| 4 | 102,995 | 30,900 | 103,000 | 25% |
| 5 | 102,995 | 41,200 | 144,200 | 28% |
| 6 | 102,995 | 41,200 | 185,400 | 30% |
| 7 | 102,995 | 51,500 | 236,900 | 33% |
| 8 | 102,995 | 51,500 | 288,400 | 35% |
| 9 | 102,995 | 51,500 | 339,900 | 37% |
| 10 | 102,995 | 51,500 | 391,400 | 38% |
| 11 | 102,995 | 51,500 | 442,900 | 39% |
| 12 | 102,995 | 51,500 | 494,400 | 40% |

| | | Per Participant Variable Administrative Costs | Per Participant Measure Cost | Per Participant Incentive |
|---|---|---|---|---|
| Year | Fixed Administrative Cost | $15 Total Variable Admin. Cost | $100 Total Part. Measure Cost | $75 Total Part. Incentive |
| 1 | $165,000 | $309,000 | $2,060,000 | $1,545,000 |
| 2 | $165,000 | $309,000 | $2,060,000 | $1,545,000 |
| 3 | $165,000 | $463,500 | $3,090,000 | $2,317,500 |
| 4 | $165,000 | $463,500 | $3,090,000 | $2,317,500 |
| 5 | $165,000 | $618,000 | $4,120,000 | $3,090,000 |
| 6 | $165,000 | $618,000 | $4,120,000 | $3,090,000 |
| 7 | $165,000 | $772,500 | $5,150,000 | $3,862,500 |
| 8 | $165,000 | $772,500 | $5,150,000 | $3,862,500 |
| 9 | $165,000 | $772,500 | $5,150,000 | $3,862,500 |
| 10 | $165,000 | $772,500 | $5,150,000 | $3,862,500 |
| 11 | $165,000 | $772,500 | $5,150,000 | $3,862,500 |
| 12 | $165,000 | $772,500 | $5,150,000 | $3,862,500 |

**COMMERCIAL TECHNOLOGY REBATES—APPLIANCES**

| *Per Participant Costs and Impacts Based on:* | | Annual Energy | Cost | Measure | Weighted Energy | Weighted Cost |
|---|---|---|---|---|---|---|
| **Efficient Measures** | **Base Measures** | **Impact** | **($)** | **Penetration** | **Impact** | **($)** |
| WATER HEATING | | | | | | |
| Heat Pump Water Heater | Electric Water Heater—Standard | 494 | 81 | 50% | 247 | 40 |
| Heat Recovery Water Heaters | Electric Water Heater—Standard | 247 | 19 | 35% | 86 | 6 |
| Solar Water Heaters | Electric Water Heater—Standard | 638 | 520 | 5% | 32 | 26 |
| Low Flow Showerheads | Electric Water Heater—Standard | 148 | 1 | 15% | 22 | 1 |
| DHW Heat Trap/Pipe Insulation | Electric Water Heater—Standard | 99 | 1 | 10% | 10 | 1 |
| DHW Heater Insulation | Electric Water Heater—Standard | 49 | 1 | 5% | 3 | 1 |
| DWH Recirculation Pumps | Electric Water Heater—Standard | 592 | 4 | 5% | 30 | 1 |
| | Water Heating Total | | | | **430** | **76** |
| REFRIGERATION | | | | | | |
| Ref./Ambient Subcooling | Conv. Ref./No Subcooling | 22 | 17 | 20% | 4 | 3 |
| High R-Value Glass Doors | Conventional Refrigeration System | 283 | 20 | 40% | 113 | 8 |
| Anti-Condensate Heater Control | Conventional Refrigeration System | 47 | 3 | 25% | 12 | 1 |
| Dual-Path Ref. System | Conventional Refrigeration System | 68 | 10 | 20% | 14 | 2 |
| | Refrigeration Total | | | | **143** | **14** |
| COOKING | | | | | | |
| Energy-Efficient Electric Fryers | Standard Eff. Electric Fryers | 52 | 5 | 40% | 21 | 2 |
| Electric Forced Convection Oven | Electric Nat. Convection Oven | 47 | 16 | 20% | 9 | 3 |
| | Cooking Total | | | | **30** | **5** |
| | **Total** | | | | **603** | **95** |

- *Ref./Ambient Subcooling Applicable in Restaurant, Grocery, Warehouse, and Hospital Buildings.*
- *High-R Value Glass Doors and Anti-Condensate Heater Controls Applicable in Restaurant, Retail, Grocery, School, College, Hospital, and Lodging Buildings*
- *Dual-Path Supermarket Air Conditioning Applicable in Grocery Buildings*
- *Energy-Efficient Fryers and Forced Convection Ovens Applicable in Restaurant, Grocery, School, Hospital, and Lodging Buildings*

*The penetration of a measure is based on its cost-effectiveness, potential net benefits, persistence of energy savings over time, technical feasibility, and the current penetration of the base and efficient technologies.*

## COMMERCIAL NEW CONSTRUCTION/COMMERCIAL NEW CONSTRUCTION – RENEWABLES

### Overview

This program will encourage the design and construction of energy-efficient new commercial buildings that exceed existing energy and building codes. Buildings undergoing major renovations would also be eligible to participate in this program. The program will have the goal of increasing the market acceptance of energy-efficient and renewable building technologies. This program will offer both a prescriptive path and a comprehensive path. For those customers choosing the comprehensive path, TVA will provide technical assistance to builders, architects, developers, and building owners from the early planning and design stages to the commissioning of the finished building. The prescriptive path would apply to smaller buildings or buildings too far along in their construction to participate in the comprehensive path.

### Target Market

This program targets owners and developers of new commercial buildings and building undergoing major renovation. The forecast estimates that Valley commercial floorspace will grow by approximately 60 million square feet per year through 2010.

### Implementation Strategy

The Commercial New Construction option will provide design assistance through provision of education and incentives to architects and engineers. Incentives provided to architects and engineers will be based on the energy efficiency performance of the building. The goal will be to make the design of energy-efficient electric buildings standard practice in the Valley. Additional design assistance will be provided to participants choosing the New Construction—Renewables option, which calls for the adoption of passive solar design.

Building commissioning services will be offered to ensure that installed efficiency measures operate as designed. Building commissioning includes balancing HVAC systems, setting controls on energy management systems, and fine tuning other equipment. Contractors will be trained to install equipment properly and building commissioning will enhance the reliability and cost-effectiveness of energy efficiency measures.

TVA will partner with trade allies in the design community in marketing the Commercial New Construction Program. Coordination with architects, engineers, and others will result in the most rapid adoption and acceptance of more energy efficient building design and construction.

### Monitoring and Evaluation

Process evaluation will be conducted to compare the cost and the effectiveness of the different delivery strategies. Impact evaluation will be conducted to determine the program benefits.

*Commercial New Construction*

### Program Assumptions

| | |
|---|---|
| Package Measure Life (Years) | 20 |
| Free-Rider Rate | 10% |
| Free-Driver Rate | 0% |
| Dropouts | 0% |
| Take-Back Percentage | 5% |
| Free-Rider Market Barrier Costs Eliminated | 50% |
| Non-Free-Rider Market Barrier Costs Eliminated | 75% |
| Annual Energy Impact (kWh) | 2,050 |

| Year | Annual Eligible Population | New Participants | Total Participants | Cumulative Participation Rate |
|---|---|---|---|---|
| 1 | 46,650 | 9,330 | 9,330 | 20% |
| 2 | 46,650 | 13,995 | 23,325 | 25% |
| 3 | 46,650 | 18,660 | 41,985 | 30% |
| 4 | 46,650 | 23,325 | 65,310 | 35% |
| 5 | 46,650 | 23,325 | 88,635 | 38% |
| 6 | 48,450 | 24,225 | 112,860 | 40% |
| 7 | 48,450 | 24,225 | 137,085 | 42% |
| 8 | 48,450 | 24,225 | 161,310 | 43% |
| 9 | 48,450 | 24,225 | 185,535 | 43% |
| 10 | 48,450 | 24,225 | 209,760 | 44% |
| 11 | 49,350 | 24,675 | 234,435 | 45% |
| 12 | 49,350 | 24,675 | 259,110 | 45% |

| Year | Fixed Administrative Cost | Per Participant Variable Administrative Costs<br>$75<br>Total Variable Admin. Cost | Per Participant Measure Cost<br>$500<br>Total Part. Measure Cost | Per Participant Incentive<br>$375<br>Total Part. Incentive |
|---|---|---|---|---|
| 1 | $475,000 | $699,750 | $4,665,000 | $3,498,750 |
| 2 | $475,000 | $1,049,625 | $6,997,500 | $5,248,125 |
| 3 | $475,000 | $1,399,500 | $9,330,000 | $6,997,500 |
| 4 | $475,000 | $1,749,375 | $11,662,500 | $8,746,875 |
| 5 | $475,000 | $1,749,375 | $11,662,500 | $8,746,875 |
| 6 | $475,000 | $1,816,875 | $12,112,500 | $9,084,375 |
| 7 | $475,000 | $1,816,875 | $12,112,500 | $9,084,375 |
| 8 | $475,000 | $1,816,875 | $12,112,500 | $9,084,375 |
| 9 | $475,000 | $1,816,875 | $12,112,500 | $9,084,375 |
| 10 | $475,000 | $1,816,875 | $12,112,500 | $9,084,375 |
| 11 | $475,000 | $1,850,625 | $12,337,500 | $9,253,125 |
| 12 | $475,000 | $1,850,625 | $12,337,500 | $9,253,125 |

## Incentives

This sector is the classic example of the lost opportunity efficiency investment. It is most cost-effective to include energy efficiency measures in the design and the initial construction of a new building. To achieve the desired participation level and the market transformation goals of the program, incentives will be offered to building owners and developers. Building owners and developers will be offered rebates to cover 75 percent of the incremental cost of design and of the energy-efficient technologies specified for the new or renovated building.

**COMMERCIAL NEW CONSTRUCTION**

| *Per Participant Costs and Impacts Based on:* | | Annual Energy | | | Weighted Energy | Weighted Cost |
|---|---|---|---|---|---|---|
| **Efficient Measures** | **Base Measures** | **Impact** | **Cost ($)** | **Measure Penetration** | **Impact** | **($)** |
| LIGHTING | | | | | | |
| T-8/Electronic Ballasts | 4' - 40W Fluor. Lamps/EE Ballasts | 631 | 62 | 70% | 442 | 43 |
| Daylighting Design | 4' - 40W Fluor. Lamps/EE Ballasts | 1,760 | 250 | 25% | 440 | 63 |
| Occupancy Sensors | All Interior Fluorescent Lighting | 847 | 135 | 25% | 212 | 34 |
| Photoelectric Controls | Existing Lighting—Outdoor | 232 | 6 | 25% | 58 | 2 |
| LED Exit Lights | Incandescent Exit Signs | 289 | 103 | 50% | 144 | 51 |
| | Lighting Total | | | | **1,296** | **193** |
| HVAC | | | | | | |
| High-Efficiency Chiller | Standard Eff. Chiller | 93 | 41 | 50% | 46 | 21 |
| Speed Control for Cooling Tower | Standard Cooling Tower | 234 | 22 | 50% | 117 | 11 |
| High-Efficiency A/C DX | Standard Eff. A/C DX | 500 | 225 | 20% | 100 | 45 |
| High-Efficiency Heat Pump | Standard Eff. Heat Pump | 300 | 464 | 15% | 45 | 70 |
| Spectrally Selective Windows | Standard Windows | 324 | 294 | 15% | 49 | 44 |
| Roof Insulation | Standard Roof Insulation | 317 | 156 | 15% | 48 | 23 |
| Wall Insulation | All Heating, Cooling, Ventilation | 395 | 313 | 15% | 59 | 47 |
| | HVAC Total | | | | **464** | **261** |
| WATER HEATING | | | | | | |
| Heat Pump Water Heater | Electric Water Heater—Standard | 494 | 81 | 40% | 198 | 32 |
| Heat Recovery Water Heater | Electric Water Heater—Standard | 247 | 19 | 35% | 86 | 7 |
| Low Flow Showerheads | Electric Water Heater—Standard | 148 | 1 | 25% | 37 | 0 |
| | Water Heating Total | | | | **321** | **39** |
| | **Total** | | | | **2,081** | **493** |

*The penetration of a measure is based on its cost-effectiveness, potential net benefits, persistence of energy savings over time, technical feasibility, and the current penetration of the base and efficient technologies.*

*Commercial New Construction—Renewables*

## Program Assumptions

| | |
|---|---|
| Package Measure Life (Years) | 30 |
| Free-Rider Rate | 10% |
| Free-Driver Rate | 5% |
| Dropouts | 0% |
| Take-Back Percentage | 0% |
| Free-Rider Market Barrier Costs Eliminated | 50% |
| Non-Free-Rider Market Barrier Costs Eliminated | 75% |
| Annual Energy Impact (kWh) | 4,900 |

| Year | Annual Eligible Population | New Participants | Total Participants | Cumulative Participation Rate |
|---|---|---|---|---|
| 1 | 46,650 | 933 | 933 | 2% |
| 2 | 46,650 | 933 | 1,866 | 2% |
| 3 | 46,650 | 933 | 2,799 | 2% |
| 4 | 46,650 | 1,400 | 4,199 | 2% |
| 5 | 46,650 | 1,400 | 5,599 | 2% |
| 6 | 48,450 | 1,454 | 7,053 | 3% |
| 7 | 48,450 | 1,938 | 8,991 | 3% |
| 8 | 48,450 | 1,938 | 10,929 | 3% |
| 9 | 48,450 | 1,938 | 12,867 | 3% |
| 10 | 48,450 | 2,423 | 15,290 | 3% |
| 11 | 49,350 | 2,468 | 17,758 | 3% |
| 12 | 49,350 | 2,468 | 20,226 | 4% |

| Year | Fixed Administrative Cost | Per Participant Variable Administrative Costs<br>$150 Total Variable Admin. Cost | Per Participant Measure Cost<br>$2,150 Total Part. Measure Cost | Per Participant Incentive<br>$1,500 Total Part. Incentive |
|---|---|---|---|---|
| 1 | $225,000 | $139,950 | $2,005,950 | $1,399,500 |
| 2 | $225,000 | $139,950 | $2,005,950 | $1,399,500 |
| 3 | $225,000 | $139,950 | $2,005,950 | $1,399,500 |
| 4 | $225,000 | $210,000 | $3,010,000 | $2,100,000 |
| 5 | $225,000 | $210,000 | $3,010,000 | $2,100,000 |
| 6 | $225,000 | $218,100 | $3,126,100 | $2,181,000 |
| 7 | $225,000 | $290,700 | $4,166,700 | $2,907,000 |
| 8 | $225,000 | $290,700 | $4,166,700 | $2,907,000 |
| 9 | $225,000 | $290,700 | $4,166,700 | $2,907,000 |
| 10 | $225,000 | $363,450 | $5,209,450 | $3,634,500 |
| 11 | $225,000 | $370,200 | $5,306,200 | $3,702,000 |
| 12 | $225,000 | $370,200 | $5,306,200 | $3,702,000 |

**COMMERCIAL NEW CONSTRUCTION—RENEWABLES**

| *Per Participant Costs and Impacts Based on:*<br>Efficient Measures | Base Measures | Annual Energy Impact | Cost ($) | Measure Penetration | Weighted Energy Impact | Weighted Cost ($) |
|---|---|---|---|---|---|---|
| LIGHTING | | | | | | |
| Daylighting Design | 4' - 40W Fluor. Lamps/EE Ballasts | 1,760 | 250 | 100% | 1,760 | 250 |
| HVAC | | | | | | |
| Passive Solar Design | All Heating, Cooling, Ventilation | 2,500 | 1,350 | 100% | 2,500 | 1,350 |
| WATER HEATING | | | | | | |
| Solar Water Heaters | Electric Water Heater—Standard | 638 | 544 | 100% | 638 | 544 |
| | | **Total** | | | **4,898** | **2,144** |

*The penetration of a measure is based on its cost-effectiveness, potential net benefits, persistence of energy savings over time, technical feasibility, and the current penetration of the base and efficient technologies.*

## SMALL COMMERCIAL RETROFIT—DIRECT INSTALL

### Overview

The installation of energy-efficient equipment can assist small commercial and industrial customers in reducing operating costs and enhancing their competitiveness and viability. This program will focus on promoting energy efficiency and renewable technologies that benefit the local business community, the utility, and the customer by reducing costs, improving reliability, and enhancing customer satisfaction.

### Target Market

This program is most applicable to existing and new small commercial and industrial companies with less than 50 kilowatts of demand. These customers, occupying about one-half of the commercial floorspace in the Valley, often do not have the staff or the capital to analyze or invest in energy efficiency improvements. This program utilizes a very aggressive delivery strategy to address the needs of these customers who are considered the most difficult commercial and industrial customers to reach.

### Implementation Strategy

The Small Commercial Retrofit Program would provide participants with an on-site audit. At the time of the audit, the auditor installs cost-effective lighting, water heating, and weatherization measures. The auditor will also identify and recommend any additional cost-effective energy-efficient opportunities that may exist in the customer's facility. The auditor will refer the customer to other programs offered by TVA and/or the distributors that offer rebates or financing for energy-efficient measures that cannot be installed by the auditor (e.g., HVAC system upgrade). Customers may be asked to pay a nominal charge for this service to minimize free-ridership and program dropouts.

### Incentives

Direct installation of measures at the time of site visit and audit, as well as rebates or financing for other measures installed by the customer based on audit recommendations.

### Program Assumptions

| | |
|---|---|
| Package Measure Life (Years) | 7 |
| Free-Rider Rate | 0% |
| Free-Driver Rate | 0% |
| Dropouts | 0% |
| Take-Back Percentage | 10% |
| Free-Rider Market Barrier Costs Eliminated | 60% |
| Non-Free-Rider Market Barrier Costs Eliminated | 80% |
| Annual Energy Impact (kWh) | 1,500 |

| Year | Annual Eligible Population | New Participants | Total Participants | Cumulative Participation Rate |
|---|---|---|---|---|
| 1 | 1,500,000 | 30,000 | 30,000 | 2% |
| 2 | 1,500,000 | 45,000 | 75,000 | 5% |
| 3 | 1,500,000 | 60,000 | 135,000 | 9% |
| 4 | 1,500,000 | 60,000 | 195,000 | 13% |
| 5 | 1,500,000 | 60,000 | 255,000 | 17% |
| 6 | 1,500,000 | 60,000 | 315,000 | 21% |
| 7 | 1,500,000 | 60,000 | 375,000 | 25% |
| 8 | 1,500,000 | 60,000 | 435,000 | 29% |
| 9 | 1,500,000 | 60,000 | 495,000 | 33% |
| 10 | 1,500,000 | 45,000 | 540,000 | 36% |
| 11 | 1,500,000 | 45,000 | 585,000 | 39% |
| 12 | 1,500,000 | 45,000 | 630,000 | 42% |

| Year | Fixed Administrative Cost | Per Participant Variable Administrative Costs<br>$40<br>Total Variable Admin. Cost | Per Participant Measure Cost<br>$280<br>Total Part. Measure Cost | Per Participant Incentive<br>$250<br>Total Part. Incentive |
|---|---|---|---|---|
| 1 | $375,000 | $1,200,000 | $8,400,000 | $7,500,000 |
| 2 | $375,000 | $1,800,000 | $12,600,000 | $11,250,000 |
| 3 | $375,000 | $2,400,000 | $16,800,000 | $15,000,000 |
| 4 | $375,000 | $2,400,000 | $16,800,000 | $15,000,000 |
| 5 | $375,000 | $2,400,000 | $16,800,000 | $15,000,000 |
| 6 | $375,000 | $2,400,000 | $16,800,000 | $15,000,000 |
| 7 | $375,000 | $2,400,000 | $16,800,000 | $15,000,000 |
| 8 | $375,000 | $2,400,000 | $16,800,000 | $15,000,000 |
| 9 | $375,000 | $2,400,000 | $16,800,000 | $15,000,000 |
| 10 | $375,000 | $1,800,000 | $12,600,000 | $11,250,000 |
| 11 | $375,000 | $1,800,000 | $12,600,000 | $11,250,000 |
| 12 | $375,000 | $1,800,000 | $12,600,000 | $11,250,000 |

## Monitoring and Evaluation

Process evaluation will be conducted to compare the cost and the effectiveness of different delivery strategies. Impact evaluation will be conducted to determine the program benefits.

**SMALL COMMERCIAL RETROFIT—DIRECT INSTALL**

| *Per Participant Costs and Impacts Based on:* | | | | | | |
|---|---|---|---|---|---|---|
| **Efficient Measures** | **Base Measures** | **Annual Energy Impact** | **Cost ($)** | **Measure Penetration** | **Weighted Energy Impact** | **Weighted Cost ($)** |
| LIGHTING | | | | | | |
| Compact Fluorescent Lighting | Incandescent Lighting | 8,600 | 1,280 | 10% | 860 | 128 |
| LED Exit Lights | Incandescent Lighting | 289 | 135 | 50% | 145 | 68 |
| T-8/Electronic Ballasts | 4' - 40W Fluor. Lamps/EE Ballasts | 1,234 | 230 | 25% | 308 | 57 |
| | | Lighting Total | | | **1,313** | **253** |
| HVAC | | | | | | |
| Temperature Setup/Setback | All Heating, Cooling, Ventilation | 246 | 22 | 25% | 61 | 5 |
| Window Film | Standard Windows | 570 | 65 | 10% | 57 | 7 |
| Leak-Free Ducts | All Heating, Cooling, Ventilation | 256 | 127 | 10% | 26 | 13 |
| | | HVAC Total | | | **144** | **25** |
| WATER HEATING | | | | | | |
| DHW Heater Insulation | Electric Water Heater—Standard | 50 | 5 | 50% | 25 | 3 |
| DHW Heat Trap/Pipe Insulation | Electric Water Heater—Standard | 99 | 5 | 20% | 20 | 1 |
| | | Water Heating Total | | | **45** | **4** |
| | | **Total** | | | **1,502** | **282** |

*The penetration of a measure is based on its cost-effectiveness, potential net benefits, persistence of energy savings over time, technical feasibility, and the current penetration of the base and efficient technologies.*

## COMMMERCIAL HVAC MAINTENANCE PROGRAM

### Overview

This program offers commercial customers maintenance contracts for their HVAC systems. A monthly charge, included on the customer's electricity bill, covers regular maintenance of the customer's HVAC equipment by TVA or a contractor. The contract also provides repairs at a reduced cost in case of failure of the HVAC system. The proper maintenance of the system will result in energy savings and improved performance for the customer.

### Target Market

This program targets small to medium commercial customers without building maintenance staffs.

### Implementation Strategy

TVA would contract with local dealers to provide this service to the small commercial and industrial customers. The program will be promoted directly by TVA and through its trade allies. Approved TVA contractors would be enlisted to promote this program to their commercial and industrial customers. The cost of providing this service to customers would be recovered through a small charge on the customer's monthly bill. However, the customer should see a net reduction in the total bill as a result of the energy savings realized.

This program will build TVA's long-term relationship with its customers, as well as provide an opportunity to promote other TVA programs to the customer.

### Incentives

The customer receives HVAC maintenance services for a fee. The maintenance contract may provide a performance guarantee or insurance coverage to protect the customer in the case of equipment failure.

### Monitoring and Evaluation

Standard monitoring and evaluation will be conducted to determine program costs and benefits. Process evaluation will be conducted to assess the value of this service to customers.

### Program Assumptions

| | |
|---|---|
| Package Measure Life (Years) | 10 |
| Free-Rider Rate | 0% |
| Free-Driver Rate | 0% |
| Dropouts | 0% |
| Take-Back Percentage | 0% |
| Free-Rider Market Barrier Costs Eliminated | 50% |
| Non-Free-Rider Market Barrier Costs Eliminated | 70% |
| Annual Energy Impact (kWh) | 350 |

| Year | Annual Eligible Population | New Participants | Total Participants | Cumulative Participation Rate |
|---|---|---|---|---|
| 1 | 2,250,000 | 5,625 | 5,625 | 0% |
| 2 | 2,250,000 | 5,625 | 11,250 | 1% |
| 3 | 2,250,000 | 5,625 | 16,875 | 1% |
| 4 | 2,250,000 | 11,250 | 28,125 | 1% |
| 5 | 2,250,000 | 11,250 | 39,375 | 2% |
| 6 | 2,250,000 | 11,250 | 50,625 | 2% |
| 7 | 2,250,000 | 16,875 | 67,500 | 3% |
| 8 | 2,250,000 | 16,875 | 84,375 | 4% |
| 9 | 2,250,000 | 16,875 | 101,250 | 5% |
| 10 | 2,250,000 | 22,500 | 123,750 | 6% |
| 11 | 2,250,000 | 22,500 | 146,250 | 7% |
| 12 | 2,250,000 | 22,500 | 168,750 | 8% |

| Year | Fixed Administrative Cost | Per Participant Annual Variable Administrative Costs<br>$40<br>Total Variable Admin. Cost | Per Participant Annual Measure Cost<br>$50<br>Total Part. Measure Cost | Per Participant Incentive<br>$0<br>Total Part. Incentive |
|---|---|---|---|---|
| 1 | $160,000 | $225,000 | $281,250 | $0 |
| 2 | $160,000 | $450,000 | $562,500 | $0 |
| 3 | $160,000 | $675,000 | $843,750 | $0 |
| 4 | $160,000 | $1,125,000 | $1,406,250 | $0 |
| 5 | $160,000 | $1,575,000 | $1,968,750 | $0 |
| 6 | $160,000 | $2,025,000 | $2,531,250 | $0 |
| 7 | $160,000 | $2,700,000 | $3,375,000 | $0 |
| 8 | $160,000 | $3,375,000 | $4,218,750 | $0 |
| 9 | $160,000 | $4,050,000 | $5,062,500 | $0 |
| 10 | $160,000 | $4,950,000 | $6,187,500 | $0 |
| 11 | $160,000 | $5,850,000 | $7,312,500 | $0 |
| 12 | $160,000 | $6,750,000 | $8,437,500 | $0 |

## COMPREHENSIVE MEASURES PROGRAM—FINANCING/REBATES

### Overview

This program targets large commercial customers to encourage the installation of a comprehensive set of energy efficiency measures. Technical assistance is provided to program participants to encourage them to install a combination of lighting, HVAC, water heating, and other measures in order to achieve the maximum energy savings at the lowest cost. This program will also pursue retrofits in conjunction with market-driven investments in commercial chiller and packaged HVAC unit overhauls. The program would encourage installation of high-efficiency lighting and other cooling load reductions, such as HVAC system optimization measures that allow installation of new high-efficiency, properly sized HVAC units.

### Target Market

This program targets commercial customers with a demand greater than 50 kilowatts. Customer research estimates that this reflects one-third of the approximately 3 billion square feet of commercial floor space in the Tennessee Valley.

### Implementation Strategy

This program provides technical assistance, low-interest financing, and rebates to customers to encourage the installation of a comprehensive set of energy efficiency measures. This program will encourage the application of energy efficient technologies to meet customers' financial, environmental, and productivity needs. TVA will employ account representatives to promote this program to its largest customers. TVA will establish partnerships with trade allies to identify industry-specific opportunities to promote energy efficiency. TVA will work with customers to assess their needs and evaluate technology-based solutions.

### Incentives

Under this program, customers will be offered low interest financing to encourage installation of energy-efficient measures. Low interest financing of the full cost of the energy-efficient investment assists customers in overcoming the initial capital expenditure barrier to investing in energy efficiency, while having a minimal effect on rates. In a more aggressive scenario, customers would be offered a rebate equal to 50 percent of the cost of energy-efficient technologies. These rebates would be offered to encourage greater participation, as well as higher energy and demand savings.

*Comprehensive Measures Program—Financing*

### Program Assumptions

| | |
|---|---|
| Package Measure Life (Years) | 15 |
| Free-Rider Rate | 5% |
| Free-Driver Rate | 0% |
| Dropouts | 0% |
| Take-Back Percentage | 5% |
| Free-Rider Market Barrier Costs Eliminated | 40% |
| Non-Free-Rider Market Barrier Costs Eliminated | 60% |
| Annual Energy Impact (kWh) | 2,400 |

| Year | Annual Eligible Population | New Participants | Total Participants | Cumulative Participation Rate |
|---|---|---|---|---|
| 1 | 945,923 | 9,460 | 9,460 | 1% |
| 2 | 945,923 | 9,460 | 18,920 | 2% |
| 3 | 945,923 | 9,460 | 28,380 | 3% |
| 4 | 945,923 | 14,190 | 42,570 | 5% |
| 5 | 945,923 | 14,190 | 56,760 | 6% |
| 6 | 945,923 | 14,190 | 70,950 | 8% |
| 7 | 945,923 | 18,920 | 89,870 | 10% |
| 8 | 945,923 | 18,920 | 108,790 | 12% |
| 9 | 945,923 | 18,920 | 127,710 | 14% |
| 10 | 945,923 | 23,650 | 151,360 | 16% |
| 11 | 945,923 | 23,650 | 175,010 | 19% |
| 12 | 945,923 | 23,650 | 198,660 | 21% |

| Year | Fixed Administrative Cost | Per Participant Variable Administrative Costs<br>$60<br>Total Variable Admin. Cost | Per Participant Measure Cost<br>$600<br>Total Part. Measure Cost | Per Participant Incentive<br>$75<br>Total Part. Incentive |
|---|---|---|---|---|
| 1 | $400,000 | $567,600 | $5,676,000 | $709,500 |
| 2 | $400,000 | $567,600 | $5,676,000 | $709,500 |
| 3 | $400,000 | $567,600 | $5,676,000 | $709,500 |
| 4 | $400,000 | $851,400 | $8,514,000 | $1,064,250 |
| 5 | $400,000 | $851,400 | $8,514,000 | $1,064,250 |
| 6 | $400,000 | $851,400 | $8,514,000 | $1,064,250 |
| 7 | $400,000 | $1,135,200 | $11,352,000 | $1,419,000 |
| 8 | $400,000 | $1,135,200 | $11,352,000 | $1,419,000 |
| 9 | $400,000 | $1,135,200 | $11,352,000 | $1,419,000 |
| 10 | $400,000 | $1,419,000 | $14,190,000 | $1,773,750 |
| 11 | $400,000 | $1,419,000 | $14,190,000 | $1,773,750 |
| 12 | $400,000 | $1,419,000 | $14,190,000 | $1,773,750 |

## Applicable Measures

A comprehensive set of customized measures will be identified for each participant. The measures will be selected to achieve the maximum level of energy savings at the lowest cost. While several technologies have been identified for promotion in this program, the program also allows for the identification of customized applications of energy-efficient technologies that are cost-effective on a site-specific basis.

**COMPREHENSIVE MEASURES PROGRAM—FINANCING**

*Per Participant Costs and Impacts Based on:*

| Efficient Measures | Base Measures | Annual Energy Impact | Cost ($) | Measure Penetration | Weighted Energy Impact | Weighted Cost ($) |
|---|---|---|---|---|---|---|
| LIGHTING | | | | | | |
| T-8/Electronic Ballasts | 4' - 40W Fluor. Lamps/EE Ballasts | 1,234 | 230 | 70% | 864 | 161 |
| Refl/Delamp: 4' - 40W/Elec. Ballast | 4' - 40W Fluor. Lamps/EE Ballasts | 2,184 | 321 | 10% | 218 | 32 |
| LED Exit Lights | Incandescent Exit Signs | 289 | 135 | 50% | 144 | 67 |
| Occupancy Sensors | All Interior Fluorescent Lighting | 911 | 135 | 25% | 228 | 34 |
| | | Lighting Total | | | **1,454** | **294** |
| HVAC | | | | | | |
| High-Efficiency Chiller | Standard Eff. Chiller | 93 | 41 | 50% | 46 | 21 |
| Speed Control for Cooling Tower | Standard Cooling Tower | 234 | 22 | 50% | 117 | 11 |
| High-Efficiency A/C DX | Standard Eff. A/C DX | 500 | 225 | 20% | 100 | 45 |
| Chiller Downsizing | | | | | | |
| High-Efficiency Heat Pump | Standard Eff. Heat Pump | 150 | 232 | 20% | 30 | 46 |
| Roof Insulation | All Heating, Cooling, Ventilation | 2,458 | 228 | 10% | 246 | 23 |
| Window Film | Standard Windows | 570 | 65 | 10% | 57 | 7 |
| ASD Ventilation Controls w/VAV | Stan. Eff. Constant Speed Motors | 690 | 930 | 10% | 69 | 93 |
| Leak-Free Ducts | All Heating, Cooling, Ventilation | 256 | 127 | 10% | 26 | 13 |
| | | HVAC Total | | | **691** | **257** |
| WATER HEATING | | | | | | |
| Heat Pump Water Heater | Electric Water Heater—Standard | 494 | 104 | 35% | 173 | 36 |
| Heat Recovery Water Heater | Electric Water Heater—Standard | 247 | 43 | 30% | 74 | 13 |
| Low Flow Showerheads | Electric Water Heater—Standard | 148 | 1 | 15% | 22 | 0 |
| | | Water Heating Total | | | **269** | **49** |
| | | **Total** | | | **2,415** | **602** |

*The penetration of a measure is based on its cost-effectiveness, potential net benefits, persistence of energy savings over time, technical feasibility, and the current penetration of the base and efficient technologies.*

*Comprehensive Measures Program—Rebates*

## Program Assumptions

| | |
|---|---|
| Package Measure Life (Years) | 15 |
| Free-Rider Rate | 10% |
| Free-Driver Rate | 0% |
| Dropouts | 0% |
| Take-Back Percentage | 8% |
| Free-Rider Market Barrier Costs Eliminated | 45% |
| Non-Free-Rider Market Barrier Costs Eliminated | 65% |
| Annual Energy Impact (kWh) | 2,700 |

| Year | Annual Eligible Population | New Participants | Total Participants | Cumulative Participation Rate |
|---|---|---|---|---|
| 1 | 945,923 | 14,190 | 14,190 | 2% |
| 2 | 945,923 | 14,190 | 28,380 | 3% |
| 3 | 945,923 | 18,920 | 47,300 | 5% |
| 4 | 945,923 | 18,920 | 66,220 | 7% |
| 5 | 945,923 | 23,650 | 89,870 | 10% |
| 6 | 945,923 | 23,650 | 113,520 | 12% |
| 7 | 945,923 | 28,380 | 141,900 | 15% |
| 8 | 945,923 | 28,380 | 170,280 | 18% |
| 9 | 945,923 | 33,110 | 203,390 | 22% |
| 10 | 945,923 | 33,110 | 236,500 | 25% |
| 11 | 945,923 | 37,840 | 274,340 | 29% |
| 12 | 945,923 | 37,840 | 312,180 | 33% |

| Year | Fixed Administrative Cost | Per Participant Variable Administrative Costs<br>$50<br>Total Variable Admin. Cost | Per Participant Measure Cost<br>$700<br>Total Part. Measure Cost | Per Participant Incentive<br>$350<br>Total Part. Incentive |
|---|---|---|---|---|
| 1 | $500,000 | $709,500 | $9,933,300 | $4,966,500 |
| 2 | $500,000 | $709,500 | $9,933,300 | $4,966,500 |
| 3 | $500,000 | $946,000 | $13,244,000 | $6,622,000 |
| 4 | $500,000 | $946,000 | $13,244,000 | $6,622,000 |
| 5 | $500,000 | $1,182,500 | $16,555,000 | $8,277,500 |
| 6 | $500,000 | $1,182,500 | $16,555,000 | $8,277,500 |
| 7 | $500,000 | $1,419,000 | $19,866,000 | $9,933,000 |
| 8 | $500,000 | $1,419,000 | $19,866,000 | $9,933,000 |
| 9 | $500,000 | $1,655,500 | $23,177,000 | $11,588,500 |
| 10 | $500,000 | $1,655,500 | $23,177,000 | $11,588,500 |
| 11 | $500,000 | $1,892,000 | $26,488,000 | $13,244,000 |
| 12 | $500,000 | $1,892,000 | $26,488,000 | $13,244,000 |

**COMPREHENSIVE MEASURES PROGRAM—REBATES**

*Per Participant Costs and Impacts Based on:*

| Efficient Measures | Base Measures | Annual Energy Impact | Cost ($) | Measure Penetration | Weighted Energy Impact | Weighted Cost ($) |
|---|---|---|---|---|---|---|
| LIGHTING | | | | | | |
| T-8/Electronic Ballasts | 4' - 40W Fluor. Lamps/EE Ballasts | 1,234 | 230 | 75% | 925 | 173 |
| Refl/Delamp: 4' - 40W/Elec. Ballast | 4' - 40W Fluor. Lamps/EE Ballasts | 2,184 | 321 | 10% | 218 | 32 |
| LED Exit Lights | Incandescent Exit Signs | 289 | 135 | 40% | 116 | 54 |
| Electroluminescent Exit Signs | Incandescent Exit Signs | 342 | 150 | 10% | 34 | 15 |
| Occupancy Sensors | All Interior Fluorescent Lighting | 911 | 135 | 25% | 228 | 34 |
| | | Lighting Total | | | **1,521** | **308** |
| HVAC | | | | | | |
| High Efficiency Chiller | Standard Eff. Chiller | 93 | 41 | 50% | 46 | 20 |
| Speed Control for Cooling Tower | Standard Cooling Tower | 234 | 22 | 50% | 117 | 11 |
| High Efficiency A/C DX | Standard Eff. A/C DX | 500 | 225 | 20% | 100 | 45 |
| Chiller Downsizing | | | | | | |
| High Efficiency Heat Pump | Standard Eff. Heat Pump | 150 | 232 | 20% | 30 | 46 |
| Roof Insulation | All Heating, Cooling, Ventilation | 2,458 | 228 | 15% | 369 | 34 |
| Window Film | Standard Windows | 570 | 65 | 15% | 86 | 10 |
| ASD Ventilation Controls w/VAV | Stan. Eff. Constant Speed Motors | 690 | 930 | 15% | 104 | 140 |
| Leak Free Ducts | All Heating, Cooling, Ventilation | 256 | 127 | 15% | 38 | 19 |
| | | HVAC Total | | | **890** | **325** |
| WATER HEATING | | | | | | |
| Heat Pump Water Heater | Electric Water Heater—Standard | 494 | 104 | 40% | 198 | 42 |
| Heat Recovery Water Heater | Electric Water Heater—Standard | 247 | 43 | 30% | 74 | 13 |
| Solar Water Heaters | Electric Water Heater—Standard | 638 | 544 | 5% | 32 | 27 |
| Low Flow Showerheads | Electric Water Heater—Standard | 148 | 1 | 15% | 22 | 0 |
| | | Water Heating Total | | | **326** | **82** |
| | | **Total** | | | **2,737** | **715** |

*The penetration of a measure is based on its cost-effectiveness, potential net benefits, persistence of energy savings over time, technical feasibility, and the current penetration of the base and efficient technologies.*

## COMMERCIAL LOAD MANAGEMENT—COOL STORAGE/ ROOFTOP COOL STORAGE

### Overview

This program offers customers incentives to encourage the adoption of cool storage technologies to reduce the customer's peak billing demand and thus reduce the TVA system peak demand. By encouraging customers to utilize cool storage technologies, TVA's load factor is enhanced by shifting on-peak cooling demand to off-peak periods, which lowers generating costs. The program will also promote rooftop cool storage, an emerging technology that provides efficiency and load management opportunities for small commercial customers.

### Target Markets

This program is targeted at large commercial customers, particularly large offices and hospitals, with significant year-round cooling loads. The program will also be targeted to the large percentage of commercial customers using rooftop cooling equipment. The program is open both to new and existing customers able to incorporate cool storage into their building design.

### Implementation Strategy

The cool storage technology will be promoted through TVA field staff technical assistance and through trade allies, particularly HVAC contractors. Customers will be offered assistance in designing the cool storage systems and incentives to cover the additional cost of installing them.

### Incentives

This program offers customers a rebate of 150 percent of the incremental cost of the cool storage equipment, or offers customers a technology-specific rate option, in order to encourage adoption of cool storage technologies and to cover increased operating costs. HVAC contractors will be offered incentives to promote cool storage technology to commercial customers.

Customers are offered an incentive of 50 percent of the incremental cost of rooftop cool storage units which offer efficiency benefits. A technology specific rate for cool storage could be offered as alternative incentive to customers.

### Monitoring and Evaluation

The cool storage system will be demand-metered in order to determine the demand savings to the TVA system. Bill analyses will be conducted to determine the impact on customers.

### Applicable Technologies

- Thermal Storage Systems - Ice or Water
- Rooftop Cool Storage Units

*Commercial Load Management—Cool Storage*

### Program Assumptions

| | |
|---|---|
| Package Measure Life (Years) | 20 |
| Free-Rider Rate | 0% |
| Free-Driver Rate | 0% |
| Dropouts | 0% |
| Take-Back Percentage | 0% |
| Free-Rider Market Barrier Costs Eliminated | 50% |
| Non-Free-Rider Market Barrier Costs Eliminated | 75% |
| Annual Energy Impact (kWh) | (100) |
| Average Demand Impacts (kW) | 2 |

| Year | Annual Eligible Population | New Participants | Total Participants | Cumulative Participation Rate |
|---|---|---|---|---|
| 1 | 342,000 | 1,710 | 1,710 | 1% |
| 2 | 342,000 | 1,710 | 3,420 | 1% |
| 3 | 342,000 | 1,710 | 5,130 | 2% |
| 4 | 342,000 | 1,710 | 6,840 | 2% |
| 5 | 342,000 | 3,420 | 10,260 | 3% |
| 6 | 342,000 | 3,420 | 13,680 | 4% |
| 7 | 342,000 | 3,420 | 17,100 | 5% |
| 8 | 342,000 | 3,420 | 20,520 | 6% |
| 9 | 342,000 | 3,420 | 23,940 | 7% |
| 10 | 342,000 | 3,420 | 27,360 | 8% |
| 11 | 342,000 | 3,420 | 30,780 | 9% |
| 12 | 342,000 | 3,420 | 34,200 | 10% |

| Year | Fixed Administrative Cost | Per Participant Variable Administrative Costs<br>$40<br>Total Variable Admin. Cost | Per Participant Measure Cost<br>$300<br>Total Part. Measure Cost | Per Participant Incentive<br>$450<br>Total Part. Incentive |
|---|---|---|---|---|
| 1 | $175,000 | $68,400 | $513,000 | $769,500 |
| 2 | $175,000 | $68,400 | $513,000 | $769,500 |
| 3 | $175,000 | $68,400 | $513,000 | $769,500 |
| 4 | $175,000 | $68,400 | $513,000 | $769,500 |
| 5 | $175,000 | $136,800 | $1,026,000 | $1,539,000 |
| 6 | $175,000 | $136,800 | $1,026,000 | $1,539,000 |
| 7 | $175,000 | $136,800 | $1,026,000 | $1,539,000 |
| 8 | $175,000 | $136,800 | $1,026,000 | $1,539,000 |
| 9 | $175,000 | $136,800 | $1,026,000 | $1,539,000 |
| 10 | $175,000 | $136,800 | $1,026,000 | $1,539,000 |
| 11 | $175,000 | $136,800 | $1,026,000 | $1,539,000 |
| 12 | $175,000 | $136,800 | $1,026,000 | $1,539,000 |

*Commercial Load Management—Rooftop Cool Storage*

## Program Assumptions

| | |
|---|---|
| Package Measure Life (Years) | 20 |
| Free-Rider Rate | 0% |
| Free-Driver Rate | 0% |
| Dropouts | 0% |
| Take-Back Percentage | 0% |
| Free-Rider Market Barrier Costs Eliminated | 50% |
| Non-Free-Rider Market Barrier Costs Eliminated | 75% |
| Annual Energy Impact (kWh) | 50 |
| Average Demand Impact (kW) | 2 |

| Year | Annual Eligible Population | New Participants | Total Participants | Cumulative Participation Rate |
|---|---|---|---|---|
| 1 | 1,500,000 | 2,050 | 2,050 | 0% |
| 2 | 1,500,000 | 2,050 | 4,010 | 0% |
| 3 | 1,500,000 | 3,050 | 7,150 | 1% |
| 4 | 1,500,000 | 3,050 | 10,200 | 1% |
| 5 | 1,500,000 | 3,050 | 13,250 | 1% |
| 6 | 1,500,000 | 3,050 | 16,300 | 1% |
| 7 | 1,500,000 | 4,070 | 20,370 | 1% |
| 8 | 1,500,000 | 4,070 | 24,440 | 2% |
| 9 | 1,500,000 | 5,080 | 29,520 | 2% |
| 10 | 1,500,000 | 5,080 | 34,600 | 2% |
| 11 | 1,500,000 | 5,080 | 39,680 | 3% |
| 12 | 1,500,000 | 5,080 | 44,760 | 3% |

| Year | Fixed Administrative Cost | Per Participant Variable Administrative Costs<br>$25<br>Total Variable Admin. Cost | Per Participant Measure Cost<br>$1,000<br>Total Part. Measure Cost | Per Participant Incentive<br>$500<br>Total Part. Incentive |
|---|---|---|---|---|
| 1 | $131,250 | $51,250 | $2,050,000 | $1,025,000 |
| 2 | $131,250 | $51,250 | $2,050,000 | $1,025,000 |
| 3 | $131,250 | $76,250 | $3,050,000 | $1,525,000 |
| 4 | $131,250 | $76,250 | $3,050,000 | $1,525,000 |
| 5 | $131,250 | $76,250 | $3,050,000 | $1,525,000 |
| 6 | $131,250 | $76,250 | $3,050,000 | $1,525,000 |
| 7 | $131,250 | $101,750 | $4,070,000 | $2,035,000 |
| 8 | $131,250 | $101,750 | $4,070,000 | $2,035,000 |
| 9 | $131,250 | $127,000 | $5,080,000 | $2,540,000 |
| 10 | $131,250 | $127,000 | $5,080,000 | $2,540,000 |
| 11 | $131,250 | $127,000 | $5,080,000 | $2,540,000 |
| 12 | $131,250 | $127,000 | $5,080,000 | $2,540,000 |

## COMMERCIAL GROUP LOAD CURTAILMENT

### Overview

This program is designed to reduce the electricity demand of commercial customers at the time of the system peak. Commercial customers would band together to shed 100 kilowatts blocks from the system peak. Commercial customers would select their own load reduction strategy. Customers would receive bill credits as an incentive to reduce load at the system peak.

### Target Market

This program targets large commercial customers, or groups of customers that can reduce electricity demand by at least 100 kilowatts at the time of the system peak.

### Implementation Strategy

TVA would employ account representatives to promote this program directly to customers. The program would provide technical assistance to customers helping them to choose the most beneficial load reduction strategy. The utility would select the method and timing for notifying the customer of the need to reduce load.

Customers will select the load reduction strategy. The utility will advise customers on appropriate technologies for accomplishing load reductions.

### Incentives

Participants will be offered financial incentives or bill credits based on the level of their load reduction. The amount of the incentive or bill credit will vary based on the length and frequency of interruption and the amount of notice the participating customer(s) is given.

### Monitoring and Evaluation

Monitoring and evaluation will be conducted to determine program impacts, costs, and benefits. Process evaluation will monitor customers' compliance with the terms and conditions of the load reduction contract.

### Program Assumptions

| | |
|---|---|
| Package Measure Life (Years) | 10 |
| Free-Rider Rate | 0% |
| Free-Driver Rate | 0% |
| Dropouts | 0% |
| Take-Back Percentage | 0% |
| Free-Rider Market Barrier Costs Eliminated | 20% |
| Non-Free-Rider Market Barrier Costs Eliminated | 30% |
| Annual Energy Impact (kWh) | 4,000 |
| Average Demand Impact (kW) | 100 |

| Year | Annual Eligible Population | New Participants | Total Participants | Cumulative Participation Rate |
|---|---|---|---|---|
| 1 | 32,039 | 80 | 80 | 0% |
| 2 | 32,039 | 80 | 160 | 1% |
| 3 | 32,039 | 80 | 240 | 1% |
| 4 | 32,039 | 80 | 320 | 1% |
| 5 | 32,039 | 160 | 480 | 2% |
| 6 | 32,039 | 160 | 640 | 2% |
| 7 | 32,039 | 160 | 800 | 3% |
| 8 | 32,039 | 160 | 960 | 3% |
| 9 | 32,039 | 240 | 1,200 | 4% |
| 10 | 32,039 | 240 | 1,440 | 5% |
| 11 | 32,039 | 160 | 1,600 | 5% |
| 12 | 32,039 | 160 | 1,760 | 6% |

| Year | Fixed Administrative Cost | Annual Per Participant Variable Administrative Costs<br>$250 Total Variable Admin. Cost | Annual Per Participant Measure Cost<br>$4,500 Total Part. Measure Cost | Annual Per Participant Incentive<br>$4,500 Total Part. Incentive |
|---|---|---|---|---|
| 1 | $200,000 | $20,000 | $360,000 | $360,000 |
| 2 | $200,000 | $40,000 | $720,000 | $720,000 |
| 3 | $200,000 | $60,000 | $1,080,000 | $1,080,000 |
| 4 | $200,000 | $80,000 | $1,440,000 | $1,440,000 |
| 5 | $200,000 | $120,000 | $2,160,000 | $2,160,000 |
| 6 | $200,000 | $160,000 | $2,880,000 | $2,880,000 |
| 7 | $200,000 | $200,000 | $3,600,000 | $3,600,000 |
| 8 | $200,000 | $240,000 | $4,320,000 | $4,320,000 |
| 9 | $200,000 | $300,000 | $5,400,000 | $5,400,000 |
| 10 | $200,000 | $360,000 | $6,480,000 | $6,480,000 |
| 11 | $200,000 | $400,000 | $7,200,000 | $7,200,000 |
| 12 | $200,000 | $440,000 | $7,920,000 | $7,920,000 |

## INDUSTRIAL TECHNOLOGY REBATES—HIGH-EFFICIENCY MOTORS/ADJUSTABLE SPEED DRIVES/ COMPRESSED AIR EFFICIENCY

### Overview

More than 70 percent of the electricity consumed by TVA's industrial customers is used to power electric motors. To save energy and money, standard motors can be replaced with energy-efficient motors. Energy-efficient motors use less electricity, run cooler, often last longer, and outperform standard motors of the same size. This program would encourage the use of properly sized high-efficiency motors and variable speed motor drives in cost-effective applications. This program also promotes energy-efficient compressors and the proper maintenance of compressed air systems to reduce leaks.

### Target Market

This program targets industrial customers using standard efficiency equipment in process or manufacturing applications.

### Implementation Strategy

This program will address the delivery and availability of energy-efficient motors. Energy-efficient motors are very cost-effective and usually meet the strict payback requirements of commercial and industrial customers. However, customers' motor replacement patterns often prevent selection of such high-efficiency motors. Motors are most often replaced when they fail. The replacement motor comes out of the existing stock at the customer's site or from the motor distributor. The customer generally cannot wait several weeks to receive an efficient motor to replace a failed motor. In order to change current motor replacement practices, customers need education about the significant cost savings potential of high-efficiency motors. The program will work to create market acceptance and demand for high-efficiency motors through incentives. TVA will also partner with motor distributors in promoting high-efficiency motors. Motor distributors will be offered incentives to stock them and make them available to customers.

### Incentives

Financial incentives will be offered, in addition to education and technical assistance, to help customers adopt the practice of replacing standard motors with high-efficiency motors, and using adjustable speed drives. Rebates will be offered to program participants to offset the incremental cost of the energy-efficient measures. In addition, incentives will be directed to motor dealers to enhance the availability of high-efficiency motors in the Tennessee Valley region. Incentives would be based on the size and efficiency of the replacement motor.

### Monitoring and Evaluation

Standard monitoring and evaluation will be conducted to determine program costs and benefits. Process evaluation will be conducted to assess the market transformation effects of the program.

*Industrial Technology Rebates—High-Efficiency Motors*

## Program Assumptions

| | |
|---|---|
| Package Measure Life (Years) | 15 |
| Free-Rider Rate | 20% |
| Free-Driver Rate | 0% |
| Dropouts | 0% |
| Take-Back Percentage | 0% |
| Free-Rider Market Barrier Costs Eliminated | 50% |
| Non-Free-Rider Market Barrier Costs Eliminated | 75% |
| Annual Energy Impact (kWh) | 40,000 |

| Year | Annual Eligible Population | New Participants | Total Participants | Cumulative Participation Rate |
|---|---|---|---|---|
| 1 | 2,369 | 36 | 36 | 2% |
| 2 | 2,369 | 71 | 107 | 5% |
| 3 | 2,369 | 107 | 214 | 9% |
| 4 | 2,369 | 142 | 356 | 15% |
| 5 | 2,369 | 142 | 498 | 21% |
| 6 | 2,369 | 142 | 640 | 27% |
| 7 | 2,369 | 142 | 782 | 33% |
| 8 | 2,369 | 142 | 924 | 39% |
| 9 | 2,369 | 142 | 1,066 | 45% |
| 10 | 2,369 | 142 | 1,208 | 51% |
| 11 | 2,369 | 142 | 1,350 | 57% |
| 12 | 2,369 | 142 | 1,492 | 63% |

| Year | Fixed Administrative Cost | Per Participant Variable Administrative Costs<br>$100<br>Total Variable Admin. Cost | Per Participant Measure Cost<br>$2,000<br>Total Part. Measure Cost | Per Participant Incentive<br>$1,500<br>Total Part. Incentive |
|---|---|---|---|---|
| 1 | $225,000 | $3,600 | $72,000 | $54,000 |
| 2 | $225,000 | $7,100 | $142,000 | $106,500 |
| 3 | $225,000 | $10,700 | $214,000 | $160,500 |
| 4 | $225,000 | $14,200 | $284,000 | $213,500 |
| 5 | $225,000 | $14,200 | $284,000 | $213,500 |
| 6 | $225,000 | $14,200 | $284,000 | $213,500 |
| 7 | $225,000 | $14,200 | $284,000 | $213,500 |
| 8 | $225,000 | $14,200 | $284,000 | $213,500 |
| 9 | $225,000 | $14,200 | $284,000 | $213,500 |
| 10 | $225,000 | $14,200 | $284,000 | $213,500 |
| 11 | $225,000 | $14,200 | $284,000 | $213,500 |
| 12 | $225,000 | $14,200 | $284,000 | $213,500 |

*Industrial Technology Rebate—Adjustable Speed Drives*

## Program Assumptions

| | |
|---|---|
| Package Measure Life (Years) | 15 |
| Free-Rider Rate | 10% |
| Free-Driver Rate | 0% |
| Dropouts | 0% |
| Take-Back Percentage | 0% |
| Free-Rider Market Barrier Costs Eliminated | 50% |
| Non-Free-Rider Market Barrier Costs Eliminated | 75% |
| Annual Energy Impact (kWh) | 40,000 |

| Year | Annual Eligible Population | New Participants | Total Participants | Cumulative Participation Rate |
|---|---|---|---|---|
| 1 | 2,369 | 24 | 24 | 1% |
| 2 | 2,369 | 36 | 60 | 3% |
| 3 | 2,369 | 47 | 107 | 5% |
| 4 | 2,369 | 59 | 166 | 7% |
| 5 | 2,369 | 59 | 225 | 10% |
| 6 | 2,369 | 59 | 284 | 12% |
| 7 | 2,369 | 59 | 343 | 15% |
| 8 | 2,369 | 59 | 402 | 17% |
| 9 | 2,369 | 59 | 461 | 20% |
| 10 | 2,369 | 59 | 520 | 22% |
| 11 | 2,369 | 59 | 579 | 25% |
| 12 | 2,369 | 59 | 638 | 27% |

| Year | Fixed Administrative Cost | Per Participant Variable Administrative Costs<br>$125<br>Total Variable Admin. Cost | Per Participant Measure Cost<br>$5,000<br>Total Part. Measure Cost | Per Participant Incentive<br>$3,750<br>Total Part. Incentive |
|---|---|---|---|---|
| 1 | $100,000 | $3,000 | $120,000 | $90,000 |
| 2 | $100,000 | $4,500 | $180,000 | $135,000 |
| 3 | $100,000 | $5,875 | $236,000 | $176,250 |
| 4 | $100,000 | $7,375 | $295,000 | $221,250 |
| 5 | $100,000 | $7,375 | $295,000 | $221,250 |
| 6 | $100,000 | $7,375 | $295,000 | $221,250 |
| 7 | $100,000 | $7,375 | $295,000 | $221,250 |
| 8 | $100,000 | $7,375 | $295,000 | $221,250 |
| 9 | $100,000 | $7,375 | $295,000 | $221,250 |
| 10 | $100,000 | $7,375 | $295,000 | $221,250 |
| 11 | $100,000 | $7,375 | $295,000 | $221,250 |
| 12 | $100,000 | $7,375 | $295,000 | $221,250 |

*Industrial Technology Rebate—Compressed Air Efficiency*

## Program Assumptions

| | |
|---|---|
| Package Measure Life (Years) | 15 |
| Free-Rider Rate | 10% |
| Free-Driver Rate | 0% |
| Dropouts | 0% |
| Take-Back Percentage | 0% |
| Free-Rider Market Barrier Costs Eliminated | 50% |
| Non-Free-Rider Market Barrier Costs Eliminated | 75% |
| Annual Energy Impact (kWh) | 75,000 |

| Year | Annual Eligible Population | New Participants | Total Participants | Cumulative Participation Rate |
|---|---|---|---|---|
| 1 | 2,369 | 12 | 12 | 1% |
| 2 | 2,369 | 18 | 30 | 1% |
| 3 | 2,369 | 18 | 48 | 2% |
| 4 | 2,369 | 24 | 72 | 3% |
| 5 | 2,369 | 24 | 95 | 4% |
| 6 | 2,369 | 24 | 120 | 5% |
| 7 | 2,369 | 30 | 150 | 6% |
| 8 | 2,369 | 30 | 180 | 8% |
| 9 | 2,369 | 30 | 210 | 9% |
| 10 | 2,369 | 36 | 246 | 10% |
| 11 | 2,369 | 36 | 282 | 12% |
| 12 | 2,369 | 36 | 318 | 13% |

| Year | Fixed Administrative Cost | Per Participant Variable Administrative Costs<br>$400<br>Total Variable Admin. Cost | Per Participant Measure Cost<br>$25,000<br>Total Part. Measure Cost | Per Participant Incentive<br>$18,750<br>Total Part. Incentive |
|---|---|---|---|---|
| 1 | $100,000 | $4,800 | $300,000 | $225,000 |
| 2 | $100,000 | $7,200 | $450,000 | $337,500 |
| 3 | $100,000 | $7,200 | $450,000 | $337,500 |
| 4 | $100,000 | $9,600 | $600,000 | $450,000 |
| 5 | $100,000 | $9,600 | $600,000 | $450,000 |
| 6 | $100,000 | $9,600 | $600,000 | $450,000 |
| 7 | $100,000 | $12,000 | $750,000 | $562,500 |
| 8 | $100,000 | $12,000 | $750,000 | $562,500 |
| 9 | $100,000 | $12,000 | $750,000 | $562,500 |
| 10 | $100,000 | $14,400 | $900,000 | $675,000 |
| 11 | $100,000 | $14,400 | $900,000 | $675,000 |
| 12 | $100,000 | $14,400 | $900,000 | $675,000 |

## INDUSTRIAL PROCESS ENERGY EFFICIENCY PROGRAM—DISTRIBUTOR SERVED/DIRECT SERVED

### Overview

This program is designed to promote energy-efficient technologies to the industrial customers served by TVA and the distributors of TVA power. The program provides technical assistance to identify opportunities for energy efficiency improvements in industrial processes. This program will encourage applications of energy-efficient technologies to address customers' financial, environmental, and productivity needs.

### Target Market

This program targets large industrial customers served by TVA and the distributors of TVA power.

### Implementation Strategy

TVA will employ account representatives to promote this program directly to customers. The program would enlist trade allies and technical specialists to identify energy and demand savings opportunities. This program will help to build long-term relationships with this vulnerable customer group and establish a partnership to promote future economic development.

### Incentives

Customers will be encouraged to participate with financial incentives, cost savings, and productivity improvements.

### Monitoring and Evaluation

Monitoring and evaluation will be conducted to determine program impacts, costs, and benefits.

### Applicable Measures

Customized energy-efficient technology applications will be identified for each participant.

*Industrial Process Energy Efficiency Program— Distributor Served*

### Program Assumptions

| | |
|---|---|
| Package Measure Life (Years) | 15 |
| Free-Rider Rate | 10% |
| Free-Driver Rate | 0% |
| Dropouts | 0% |
| Take-Back Percentage | 0% |
| Free-Rider Market Barrier Costs Eliminated | 70% |
| Non-Free-Rider Market Barrier Costs Eliminated | 80% |
| Annual Energy Impact (kWh) | 150,000 |

| Year | Annual Eligible Population | New Participants | Total Participants | Cumulative Participation Rate |
|---|---|---|---|---|
| 1 | 14,625 | 219 | 219 | 2% |
| 2 | 15,000 | 225 | 444 | 3% |
| 3 | 15,375 | 308 | 752 | 5% |
| 4 | 15,750 | 315 | 1,067 | 7% |
| 5 | 16,125 | 403 | 1,470 | 9% |
| 6 | 16,500 | 413 | 1,883 | 11% |
| 7 | 16,875 | 506 | 2,389 | 14% |
| 8 | 17,250 | 518 | 2,907 | 17% |
| 9 | 17,625 | 617 | 3,524 | 20% |
| 10 | 18,000 | 630 | 4,154 | 23% |
| 11 | 18,375 | 735 | 4,889 | 27% |
| 12 | 18,750 | 750 | 5,639 | 30% |

| Year | Fixed Administrative Cost | Per Participant Variable Administrative Costs<br>$500 Total Variable Admin. Cost | Per Participant Measure Cost<br>$33,000 Total Part. Measure Cost | Per Participant Incentive<br>$16,500 Total Part. Incentive |
|---|---|---|---|---|
| 1 | $187,500 | $109,500 | $7,227,000 | $3,613,500 |
| 2 | $187,500 | $112,500 | $7,425,000 | $3,712,500 |
| 3 | $187,500 | $154,000 | $10,164,000 | $5,082,000 |
| 4 | $187,500 | $157,500 | $10,395,000 | $5,197,500 |
| 5 | $187,500 | $201,500 | $13,299,000 | $6,649,500 |
| 6 | $187,500 | $206,500 | $13,629,000 | $6,814,500 |
| 7 | $187,500 | $253,000 | $16,698,000 | $8,349,000 |
| 8 | $187,500 | $259,000 | $17,094,000 | $8,547,000 |
| 9 | $187,500 | $308,500 | $20,361,000 | $10,180,500 |
| 10 | $187,500 | $315,000 | $20,790,000 | $10,395,000 |
| 11 | $187,500 | $367,500 | $24,255,000 | $12,127,500 |
| 12 | $187,500 | $375,000 | $24,750,000 | $12,375,000 |

*Industrial Process Energy Efficiency Program—Direct Served*

## Program Assumptions

| | |
|---|---|
| Package Measure Life (Years) | 15 |
| Free-Rider Rate | 10% |
| Free-Driver Rate | 0% |
| Dropouts | 0% |
| Take-Back Percentage | 0% |
| Free-Rider Market Barrier Costs Eliminated | 70% |
| Non-Free-Rider Market Barrier Costs Eliminated | 80% |
| Annual Energy Impact (kWh) | 100,000 |

| Year | Annual Eligible Population | New Participants | Total Participants | Cumulative Participation Rate |
|---|---|---|---|---|
| 1 | 19,500 | 293 | 293 | 2% |
| 2 | 20,000 | 300 | 593 | 3% |
| 3 | 20,500 | 410 | 1,003 | 5% |
| 4 | 21,000 | 420 | 1,423 | 7% |
| 5 | 21,500 | 538 | 1,961 | 9% |
| 6 | 22,000 | 550 | 2,511 | 11% |
| 7 | 22,500 | 675 | 3,186 | 14% |
| 8 | 23,000 | 690 | 3,876 | 17% |
| 9 | 23,500 | 823 | 4,699 | 20% |
| 10 | 24,000 | 840 | 5,539 | 23% |
| 11 | 24,500 | 980 | 6,519 | 27% |
| 12 | 25,000 | 1,000 | 7,519 | 30% |

| Year | Fixed Administrative Cost | Per Participant Variable Administrative Costs<br>$500<br>Total Variable Admin. Cost | Per Participant Measure Cost<br>$22,500<br>Total Part. Measure Cost | Per Participant Incentive<br>$11,250<br>Total Part. Incentive |
|---|---|---|---|---|
| 1 | $187,500 | $146,500 | $6,592,500 | $3,296,250 |
| 2 | $187,500 | $150,000 | $6,750,000 | $3,375,000 |
| 3 | $187,500 | $205,000 | $9,225,000 | $4,612,500 |
| 4 | $187,500 | $210,000 | $9,450,000 | $4,725,000 |
| 5 | $187,500 | $269,000 | $12,105,000 | $6,052,500 |
| 6 | $187,500 | $275,000 | $12,375,000 | $6,187,500 |
| 7 | $187,500 | $337,500 | $15,187,500 | $7,593,750 |
| 8 | $187,500 | $345,000 | $15,525,000 | $7,762,500 |
| 9 | $187,500 | $411,500 | $18,517,500 | $9,258,750 |
| 10 | $187,500 | $420,000 | $18,900,000 | $9,450,000 |
| 11 | $187,500 | $490,000 | $22,050,000 | $11,025,000 |
| 12 | $187,500 | $500,000 | $22,500,000 | $11,250,000 |

## ENERGY-EFFICIENT RATES (OPT OUT)

### Overview

Customers who have made investments in energy-efficient measures and who, therefore, cannot participate in the programs offered by TVA and its distributors would be eligible for the Energy-Efficient Rate. This program rewards customers who have taken action to use energy wisely and protect the environment. These customers are granted a rate discount for five years. The rate discount is put into effect after the customers demonstrate that they have made all cost-effective energy efficiency investments to their facilities.

In addition to the rate discount, customers will be provided with cooperative advertising materials that they can use to promote themselves as an energy-efficient supplier of goods and services. The promotional materials will emphasize the environmental benefits of energy efficiency and the wise use of resources by customers who have made investments in energy-efficient measures and processes.

This program provides in effect an opt-out option for customers who chose to make investments in energy-efficient measures themselves, without financial assistance from the utility. To qualify for the Energy-Efficient Rate, the customer must agree to a co-funded audit of its facilities. If the auditor identifies any remaining opportunities for cost-effective energy efficiency investments, the customer must agree to adopt the auditor's recommendations that meet a mutually agreed upon investment hurdle rate.

### Program Assumptions

| | |
|---|---|
| Package Measure Life (Years) | 15 |
| Free-Rider Rate | 10% |
| Free-Driver Rate | 0% |
| Dropouts | 0% |
| Take-Back Percentage | 0% |
| Free-Rider Market Barrier Costs Eliminated | 70% |
| Non-Free-Rider Market Barrier Costs Eliminated | 80% |
| Annual Energy Impact (kWh) | 150,000 |

| Year | Annual Eligible Population | New Participants | Total Participants | Cumulative Participation Rate |
|---|---|---|---|---|
| 1 | 14,625 | 293 | 293 | 2% |
| 2 | 15,000 | 300 | 593 | 4% |
| 3 | 15,375 | 308 | 901 | 6% |
| 4 | 15,750 | 236 | 1,137 | 7% |
| 5 | 16,125 | 242 | 1,379 | 9% |
| 6 | 16,500 | 248 | 1,627 | 10% |
| 7 | 16,875 | 169 | 1,796 | 11% |
| 8 | 17,250 | 173 | 1,969 | 11% |
| 9 | 17,625 | 176 | 2,145 | 12% |
| 10 | 18,000 | 90 | 2,235 | 12% |
| 11 | 18,375 | 92 | 2,327 | 13% |
| 12 | 18,750 | 94 | 2,421 | 13% |

| | | Per Participant Variable Administrative Costs | Per Participant Measure Cost | Annual Per Participant Incentive |
|---|---|---|---|---|
| Year | Fixed Administrative Cost | $2,000 Total Variable Admin. Cost | $35,000 Total Part. Measure Cost | $2,000 Total Part. Incentive |
| 1 | $100,000 | $586,000 | $10,255,000 | $586,000 |
| 2 | $100,000 | $600,000 | $10,500,000 | $1,186,000 |
| 3 | $100,000 | $616,000 | $10,780,000 | $1,802,000 |
| 4 | $100,000 | $472,000 | $8,260,000 | $2,274,000 |
| 5 | $100,000 | $484,000 | $8,470,000 | $2,758,000 |
| 6 | $100,000 | $496,000 | $8,680,000 | $3,254,000 |
| 7 | $100,000 | $338,000 | $5,915,000 | $3,592,000 |
| 8 | $100,000 | $345,000 | $6,055,000 | $3,938,000 |
| 9 | $100,000 | $352,000 | $6,160,000 | $4,290,000 |
| 10 | $100,000 | $180,000 | $3,150,000 | $4,470,000 |
| 11 | $100,000 | $184,000 | $3,220,000 | $4,654,000 |
| 12 | $100,000 | $188,000 | $3,290,000 | $4,842,000 |

# RENEWABLE/SELF-GENERATION CUSTOMER SERVICE OPTIONS

## SUMMARY OF PROJECTED IMPACTS IN YEAR 2010

| Option Name | 2010 Winter MW | 2010 Summer MW | GWh | Units (# part.) | ¢/kWh TRC |
|---|---|---|---|---|---|
| RENEWABLE GENERATION PROGRAMS | | | | | |
| Landfill Gas/Fuel Cells | 74 | 74 | 585 | 36 | 6.0 |
| Small Head Hydro | 5 | 5 | 29 | 5 | 5.9 |
| Biomass/Wood Waste | 54 | 54 | 374 | 62 | 3.6 |
| Photovoltaics | 1 | 1.5 | 5 | 1,975 | 33.0 |
| Photovoltaics/Technology Advancement. | 3 | 3.3 | 11 | 4,600 | 19.0 |
| SELF-GENERATION | | | | | |
| Existing Cogeneration—Commercial | 95 | 95 | 118 | 416 | 7.7 |
| New Cogeneration—Commercial | 18 | 18 | 51 | 84 | 12.1 |
| New Cogeneration—Industrial | 30 | 30 | 17 | 208 | 8.8 |

Values are the impacts occuring only in the year 2010 for the cumulative participation in the program to date.

TVA developed eight self-generation options, including cogeneration and options utilizing renewable fuels. The greatest potential for self-generation is from land-fill gas, wood wastes and existing commercial cogeneration. Detailed descriptions of the self-generation options follow.

## RENEWABLE ENERGY GENERATION: LANDFILL GAS/FUEL CELLS, SMALL-HEAD HYDRO, BIOMASS/WOOD WASTE, PHOTOVOLTAICS, PHOTOVOLTAICS/TECHNOLOGY ADVANCEMENT

### Overview

This program will encourage the development of customer-owned renewable generation resources. Renewable energy resources include generation from wood waste, biogas derived from anaerobic digestion of animal waste, and methane recovered from landfills. These fuels can be used with a number of generating technologies and fuel cells. Other renewable energy resources with cost-effective potential include small-head hydro systems and the use of photovoltaics in remote locations. This program provides annual incentives to customers to develop renewable resources to provide energy for their own use and for the benefit of the TVA system.

### Target Market

This program targets customers with access to or in close proximity of renewable energy resources.

### Implementation Strategy

Customers with access to renewable energy sources would be provided assistance to develop those resources. In addition to technical assistance, financial incentives would be provided to customers to improve the cost-effectiveness of renewable energy.

### Incentives

Customers would be offered incentives of 2¢/kilowatt-hour for energy produced by combustion-based renewable resources. For non-combustion-based renewable resources, such as hydro resources and photovoltaics, customers would be offered an incentive of 3¢/kilowatt-hour. The incentives cover the higher costs and higher uncertainties associated with energy produced from renewable resources and reflect the environmental benefits of renewable and non-combustion-based resources. These incentives are for energy produced for the customer's own use which defers the need for TVA to add to its system resources. Excess energy produced could be sold to the TVA system at a market price.

### Monitoring and Evaluation

Monitoring and evaluation will be conducted to determine program costs and benefits. Information on the cost and performance of renewable resources will be gathered and documented.

*Renewable Energy Generation—Landfill Gas/Fuel Cells*

### Program Assumptions

| | |
|---|---|
| Package Measure Life (Years) | 15 |
| Free-Rider Rate | 10% |
| Free-Driver Rate | 0% |
| Dropouts | 0% |
| Take-Back Percentage | 0% |
| Free-Rider Market Barrier Costs Eliminated | 70% |
| Non-Free-Rider Market Barrier Costs Eliminated | 80% |
| Annual Energy Impact (kWh) | 15,768,600 |
| Average Demand Impact (kW) | 2000 |

| Year | Annual Eligible Population | New Participants | Total Participants | Cumulative Participation Rate |
|---|---|---|---|---|
| 1 | — | — | — | n/a |
| 2 | — | 1 | 1 | n/a |
| 3 | — | 1 | 2 | n/a |
| 4 | — | 2 | 4 | n/a |
| 5 | — | 2 | 6 | n/a |
| 6 | — | 2 | 8 | n/a |
| 7 | — | 2 | 10 | n/a |
| 8 | — | 2 | 12 | n/a |
| 9 | — | 3 | 15 | n/a |
| 10 | — | 3 | 18 | n/a |
| 11 | — | 3 | 21 | n/a |
| 12 | — | 3 | 24 | n/a |

| Year | Fixed Administrative Cost | Per Participant Variable Administrative Costs<br>$1,000<br>Total Variable Admin. Cost | Per Participant Measure Cost<br>$3,360,000<br>Total Part. Measure Cost | Annual Per Participant Incentive<br>$160/kW<br>Total Part. Incentive |
|---|---|---|---|---|
| 1 | $50,000 | $0 | $0 | $0 |
| 2 | $50,000 | $1,000 | $3,360,000 | $320,000 |
| 3 | $50,000 | $1,000 | $3,360,000 | $640,000 |
| 4 | $50,000 | $2,000 | $6,720,000 | $1,280,000 |
| 5 | $50,000 | $2,000 | $6,720,000 | $1,920,000 |
| 6 | $50,000 | $2,000 | $6,720,000 | $2,560,000 |
| 7 | $50,000 | $2,000 | $6,720,000 | $3,200,000 |
| 8 | $50,000 | $2,000 | $6,720,000 | $3,840,000 |
| 9 | $50,000 | $3,000 | $10,080,000 | $4,800,000 |
| 10 | $50,000 | $3,000 | $10,080,000 | $5,760,000 |
| 11 | $50,000 | $3,000 | $10,080,000 | $6,720,000 |
| 12 | $50,000 | $3,000 | $10,080,000 | $7,680,000 |

*Renewable Energy Generation—Small-Head Hydro*

## Program Assumptions

| | |
|---|---|
| Package Measure Life (Years) | 30 |
| Free-Rider Rate | 10% |
| Free-Driver Rate | 0% |
| Dropouts | 0% |
| Take-Back Percentage | 0% |
| Free-Rider Market Barrier Costs Eliminated | 70% |
| Non-Free-Rider Market Barrier Costs Eliminated | 80% |
| Annual Energy Impact (kWh) | 1,000,000 |
| Average Demand Impact (kW) | 163 |

| Year | Annual Eligible Population | New Participants | Total Participants | Cumulative Participation Rate |
|---|---|---|---|---|
| 1 | — | — | — | n/a |
| 2 | — | 10 | 10 | n/a |
| 3 | — | — | 10 | n/a |
| 4 | — | 1 | 10 | n/a |
| 5 | — | — | 10 | n/a |
| 6 | — | 5 | 15 | n/a |
| 7 | — | — | 15 | n/a |
| 8 | — | 9 | 25 | n/a |
| 9 | — | — | 25 | n/a |
| 10 | — | 4 | 29 | n/a |
| 11 | — | — | 29 | n/a |
| 12 | — | — | 29 | n/a |

| Year | Fixed Administrative Cost | Per Participant Variable Administrative Costs: $0 Total Variable Admin. Cost | Per Participant Measure Cost: Varies Total Part. Measure Cost | Annual Per Participant Incentive: $185/kW Total Part. Incentive |
|---|---|---|---|---|
| 1 | $50,000 | $0 | $0 | $0 |
| 2 | $50,000 | $0 | $3,162,587 | $295,519 |
| 3 | $50,000 | $0 | $0 | $295,519 |
| 4 | $50,000 | $0 | $216,056 | $313,612 |
| 5 | $50,000 | $0 | $0 | $313,612 |
| 6 | $50,000 | $0 | $1,957,192 | $461,372 |
| 7 | $50,000 | $0 | $0 | $461,372 |
| 8 | $50,000 | $0 | $5,407,107 | $738,798 |
| 9 | $50,000 | $0 | $0 | $738,798 |
| 10 | $50,000 | $0 | $2,481,976 | $862,433 |
| 11 | $50,000 | $0 | $0 | $862,433 |
| 12 | $50,000 | $0 | $0 | $862,433 |

*Renewable Energy Generation—Biomass/Wood Waste*

## Program Assumptions

| | |
|---|---|
| Package Measure Life (Years) | 30 |
| Free-Rider Rate | 10% |
| Free-Driver Rate | 0% |
| Dropouts | 0% |
| Take-Back Percentage | 0% |
| Free-Rider Market Barrier Costs Eliminated | 70% |
| Non-Free-Rider Market Barrier Costs Eliminated | 80% |
| Annual Energy Impact (kWh) | 5,550,000 |
| Average Demand Impact (kW) | 800 |

| Year | Annual Eligible Population | New Participants | Total Participants | Cumulative Participation Rate |
|---|---|---|---|---|
| 1 | — | 3 | 3 | n/a |
| 2 | — | 3 | 6 | n/a |
| 3 | — | 3 | 9 | n/a |
| 4 | — | 4 | 13 | n/a |
| 5 | — | 4 | 17 | n/a |
| 6 | — | 5 | 22 | n/a |
| 7 | — | 5 | 27 | n/a |
| 8 | — | 4 | 31 | n/a |
| 9 | — | 4 | 35 | n/a |
| 10 | — | 3 | 38 | n/a |
| 11 | — | 3 | 41 | n/a |
| 12 | — | 3 | 44 | n/a |

| Year | Fixed Administrative Cost | Participant Variable Administrative Costs: $0 Total Variable Admin. Cost | Per Participant Measure Cost: $1,200,000 Total Part. Measure Cost | Per Annual Per Participant Incentive: $140/kW Total Part. Incentive |
|---|---|---|---|---|
| 1 | $75,000 | $3,000 | $3,600,000 | $336,000 |
| 2 | $75,000 | $3,000 | $3,600,000 | $672,000 |
| 3 | $75,000 | $3,000 | $3,600,000 | $1,008,000 |
| 4 | $75,000 | $4,000 | $4,800,000 | $1,456,000 |
| 5 | $75,000 | $4,000 | $4,800,000 | $1,904,000 |
| 6 | $75,000 | $5,000 | $6,000,000 | $2,464,000 |
| 7 | $75,000 | $5,000 | $6,000,000 | $3,024,000 |
| 8 | $75,000 | $4,000 | $4,800,000 | $3,472,000 |
| 9 | $75,000 | $4,000 | $4,800,000 | $3,920,000 |
| 10 | $75,000 | $3,000 | $3,600,000 | $4,256,000 |
| 11 | $75,000 | $3,000 | $3,600,000 | $4,592,000 |
| 12 | $75,000 | $3,000 | $3,600,000 | $4,928,000 |

*Renewable Energy Generation—Photovoltaics*

## Program Assumptions

| | |
|---|---|
| Package Measure Life (Years) | 30 |
| Free-Rider Rate | 10% |
| Free-Driver Rate | 0% |
| Dropouts | 0% |
| Take-Back Percentage | 0% |
| Free-Rider Market Barrier Costs Eliminated | 70% |
| Non-Free-Rider Market Barrier Costs Eliminated | 80% |
| Annual Energy Impact (kWh) | 2,230 |
| Average Demand Impact (kW) | 1 |

| Year | Annual Eligible Population | New Participants | Total Participants | Cumulative Participation Rate |
|---|---|---|---|---|
| 1 | — | 50 | 50 | n/a |
| 2 | — | 50 | 100 | n/a |
| 3 | — | 75 | 175 | n/a |
| 4 | — | 100 | 275 | n/a |
| 5 | — | 100 | 375 | n/a |
| 6 | — | 125 | 500 | n/a |
| 7 | — | 125 | 625 | n/a |
| 8 | — | 150 | 775 | n/a |
| 9 | — | 150 | 925 | n/a |
| 10 | — | 150 | 1,075 | n/a |
| 11 | — | 150 | 1,225 | n/a |
| 12 | — | 150 | 1,375 | n/a |

| Year | Fixed Administrative Cost | Per Participant Variable Administrative Costs<br>$10<br>Total Variable Admin. Cost | Per Participant Measure Cost<br>$5,000<br>Total Part. Measure Cost | Annual Per Participant Incentive<br>$100/kW<br>Total Part. Incentive |
|---|---|---|---|---|
| 1 | $50,000 | $500 | $250,000 | $5,000 |
| 2 | $50,000 | $500 | $250,000 | $10,000 |
| 3 | $50,000 | $750 | $375,000 | $17,500 |
| 4 | $50,000 | $1,000 | $500,000 | $27,500 |
| 5 | $50,000 | $1,000 | $500,000 | $37,500 |
| 6 | $50,000 | $1,250 | $625,000 | $50,000 |
| 7 | $50,000 | $1,250 | $625,000 | $62,500 |
| 8 | $50,000 | $1,500 | $750,000 | $77,500 |
| 9 | $50,000 | $1,500 | $750,000 | $92,500 |
| 10 | $50,000 | $1,500 | $750,000 | $107,500 |
| 11 | $50,000 | $1,500 | $750,000 | $122,500 |
| 12 | $50,000 | $1,500 | $750,000 | $137,500 |

*Renewable Energy Generation—Photovoltaics/Technology Advancement*

## Program Assumptions

| | |
|---|---|
| Package Measure Life (Years) | 30 |
| Free-Rider Rate | 10% |
| Free-Driver Rate | 0% |
| Dropouts | 0% |
| Take-Back Percentage | 0% |
| Free-Rider Market Barrier Costs Eliminated | 70% |
| Non-Free-Rider Market Barrier Costs Eliminated | 80% |
| Annual Energy Impact (kWh) | 2,230 |
| Average Demand Impact (kW) | 1 |

| Year | Annual Eligible Population | New Participants | Total Participants | Cumulative Participation Rate |
|---|---|---|---|---|
| 1 | — | 150 | 150 | n/a |
| 2 | — | 150 | 300 | n/a |
| 3 | — | 200 | 500 | n/a |
| 4 | — | 200 | 700 | n/a |
| 5 | — | 250 | 950 | n/a |
| 6 | — | 250 | 1,200 | n/a |
| 7 | — | 300 | 1,500 | n/a |
| 8 | — | 300 | 1,800 | n/a |
| 9 | — | 350 | 2,150 | n/a |
| 10 | — | 350 | 2,500 | n/a |
| 11 | — | 350 | 2,850 | n/a |
| 12 | — | 350 | 3,200 | n/a |

| Year | Fixed Administrative Cost | Per Participant Variable Administrative Costs<br>$10<br>Total Variable Admin. Cost | Per Participant Measure Cost<br>$3,000<br>Total Part. Measure Cost | Annual Per Participant Incentive<br>$100/kW<br>Total Part. Incentive |
|---|---|---|---|---|
| 1 | $50,000 | $1,500 | $450,000 | $15,000 |
| 2 | $50,000 | $1,500 | $450,000 | $30,000 |
| 3 | $50,000 | $2,000 | $600,000 | $50,000 |
| 4 | $50,000 | $2,000 | $600,000 | $70,000 |
| 5 | $50,000 | $2,500 | $750,000 | $95,000 |
| 6 | $50,000 | $2,500 | $750,000 | $120,000 |
| 7 | $50,000 | $3,000 | $900,000 | $150,000 |
| 8 | $50,000 | $3,000 | $900,000 | $180,000 |
| 9 | $50,000 | $3,500 | $1,050,000 | $215,000 |
| 10 | $50,000 | $3,500 | $1,050,000 | $250,000 |
| 11 | $50,000 | $3,500 | $1,050,000 | $285,000 |
| 12 | $50,000 | $3,500 | $1,050,000 | $320,000 |

## EXISTING COGENERATION—COMMERCIAL

### Overview

The program will promote the use of existing 150-kilowatt to 20-megawatt cogeneration installations in the commercial market sector as a means of load reduction.

### Target Market

SIC codes most likely to be operating existing cogeneration systems are targeted SICs 40 - 49 (transportation), SIC 54 (supermarkets), SIC 58 (restaurants), SICs 60 - 67 (finance, insurance), SIC 70 (hotels/motels), SIC 805 (hospitals), and SIC 806 (nursing homes).

### Implementation Strategy

TVA will work with commercial decision-makers in the above-mentioned SIC classifications to ensure comprehensive coverage of the market. Business decision-makers will receive information, technical studies, and/or financial incentives to promote the installation of new cogeneration technologies. The technologies are targeted to be in the 150-kilowatt to 20- megawatt range and will supply power to the business for all or part of their total load during TVA system peak loads.

### Incentives

TVA will pay the customer for on-peak load reductions, acheived through self-generation, at a cost range averaging $25 per kilwatt. Excess energy produced could be sold to the TVA system at a market price.

### Monitoring and Evaluation

TVA engineers will work with the on-site personnel and the vendor to ensure proper installation and synchronization with local distribution systems and the facility. Contracted payments to the company will be paid based on actual peak load demand reductions.

### Applicable Technologies

- Reciprocating Engine Systems
- Gas Turbine Systems
- Coal-Fired Steam Turbine Systems

### Program Assumptions

| | |
|---|---|
| Package Measure Life (Years) | 20 |
| Free-Rider Rate | 0% |
| Free-Driver Rate | 0% |
| Dropouts | 0% |
| Take-Back Percentage | 0% |
| Free-Rider Market Barrier Costs Eliminated | 70% |
| Non-Free-Rider Market Barrier Costs Eliminated | 80% |
| Annual Energy Impact (kWh) | 3,423,382 |
| Average Demand Impact (kW) | 615 |

| Year | Annual Eligible Population | New Participants | Total Participants | Cumulative Participation Rate |
|---|---|---|---|---|
| 1 | 803 | 3 | 3 | n/a |
| 2 | 803 | 6 | 9 | n/a |
| 3 | 803 | 12 | 21 | n/a |
| 4 | 803 | 18 | 39 | n/a |
| 5 | 803 | 21 | 60 | n/a |
| 6 | 803 | 18 | 78 | n/a |
| 7 | 803 | 12 | 90 | n/a |
| 8 | 803 | 12 | 102 | n/a |
| 9 | 803 | 9 | 111 | n/a |
| 10 | 803 | 7 | 118 | n/a |

| Year | Fixed Administrative Cost | Per Participant Variable Administrative Costs<br>$5,000 Total Variable Admin. Cost | Per Participant Measure Cost<br>$0 Total Part. Measure Cost | Annual Per Participant Incentive<br>$25/kW Total Part. Incentive |
|---|---|---|---|---|
| 1 | $76,000 | $15,000 | $0 | $46,125 |
| 2 | $76,000 | $30,000 | $0 | $138,375 |
| 3 | $76,000 | $60,000 | $0 | $322,875 |
| 4 | $76,000 | $90,000 | $0 | $599,625 |
| 5 | $76,000 | $105,000 | $0 | $922,500 |
| 6 | $76,000 | $90,000 | $0 | $1,199,250 |
| 7 | $76,000 | $60,000 | $0 | $1,383,750 |
| 8 | $76,000 | $60,000 | $0 | $1,568,250 |
| 9 | $76,000 | $45,000 | $0 | $1,706,625 |
| 10 | $76,000 | $35,000 | $0 | $1,814,250 |

## NEW COGENERATION—COMMERCIAL

### Overview

The program will promote new 150-kilowatt to 20-megawatt cogeneration installations in the commercial market sector as a means of load reduction.

### Target Market

SIC codes most receptive to adding new cogeneration systems are targeted SICs 40 - 49 (transportation), SIC 54 (supermarkets), SIC 58 (restaurants), SICs 60 - 67 (finance, insurance), SIC 70 (hotels/motels).

### Implementation Strategy

TVA will work with commercial decision-makers in the above-mentioned SIC classifications to ensure comprehensive coverage of the market. Industry decision-makers will receive information, technical studies, and/or financial incentives to promote the installation of new cogeneration technologies. The technologies are targeted to be in the 150-kilowatt to 20- megawatt range and will supply power to the business for all or part of their total load during TVA system peak loads.

### Incentives

TVA will pay the customer for on-peak load reductions, acheived through self-generation, at a cost range averaging $40 per kilowatt. Excess energy produced could be sold to the TVA system at a market price.

### Monitoring and Evaluation

TVA engineers will work with on-site personnel and the vendor to ensure proper installation and synchronization with local distribution systems and the facility. Contracted payments to the company will be paid based on actual peak load demand reductions.

### Applicable Technologies

- Reciprocating Engine Systems
- Gas Turbine Systems
- Coal-Fired Steam Turbine Systems

### Program Assumption

| | |
|---|---|
| Package Measure Life (Years) | 20 |
| Free-Rider Rate | 0% |
| Free-Driver Rate | 0% |
| Dropouts | 0% |
| Take-Back Percentage | 0% |
| Free-Rider Market Barrier Costs Eliminated | 70% |
| Non-Free-Rider Market Barrier Costs Eliminated | 80% |
| Annual Energy Impact (kWh) | 1,614,455 |
| Average Demand Impact (kW) | 328 |

| Year | Annual Eligible Population | New Participants | Total Participants | Cumulative Participation Rate |
|---|---|---|---|---|
| 1 | 12,800 | 1 | 1 | n/a |
| 2 | 12,800 | 3 | 4 | n/a |
| 3 | 12,800 | 5 | 9 | n/a |
| 4 | 12,800 | 8 | 17 | n/a |
| 5 | 12,800 | 9 | 26 | n/a |
| 6 | 12,800 | 8 | 34 | n/a |
| 7 | 12,800 | 5 | 39 | n/a |
| 8 | 12,800 | 5 | 44 | n/a |
| 9 | 12,800 | 4 | 48 | n/a |
| 10 | 12,800 | 3 | 51 | n/a |

| Year | Fixed Administrative Cost | Per Participant Variable Administrative Costs<br>$7,200 Total Variable Admin. Cost | Per Participant Measure Cost<br>$595,320 Total Part. Measure Cost | Annual Per Participant Incentive<br>$40/kW Total Part. Incentive |
|---|---|---|---|---|
| 1 | $76,000 | $7,200 | $595,320 | $13,120 |
| 2 | $76,000 | $21,600 | $1,785,960 | $52,480 |
| 3 | $76,000 | $36,000 | $2,976,600 | $118,080 |
| 4 | $76,000 | $57,600 | $4,762,560 | $223,040 |
| 5 | $76,000 | $64,800 | $5,357,880 | $341,120 |
| 6 | $76,000 | $57,600 | $4,762,560 | $446,080 |
| 7 | $76,000 | $36,000 | $2,976,600 | $511,680 |
| 8 | $76,000 | $36,000 | $2,976,600 | $577,280 |
| 9 | $76,000 | $28,800 | $2,381,280 | $629,760 |
| 10 | $76,000 | $21,600 | $1,785,960 | $669,120 |

## NEW COGENERATION—INDUSTRIAL MARKET SECTOR

### Overview

The program will promote new 150-kilowatt to 20-megawatt cogeneration installations in the industrial manufacturing sectors in SIC codes 20 through 39, as a means of achieving peak load reduction.

### Target Market

The SIC codes in the industrial sector that are most receptive to cogeneration are the food industry (SIC 20), the wood industry (SIC 24), the pulp and paper industry (SIC 26), and the chemical industry (SIC 28). These SIC codes are targeted.

### Implementation Strategy

TVA will work with industry decision-makers in the above-mentioned SIC classifications to ensure comprehensive coverage of the market. Industry decision-makers will receive information, technical studies, and/or financial incentives to promote the installation of new cogeneration technologies. The technologies are targeted to be in the 150-kilowatt to 20- megawatt range and will supply power to the plant for all or part of their total load during times of TVA system peak load.

### Incentives

TVA will pay the customer for on-peak load reductions, acheived through self-generation, at a cost range averaging $35 per kilowatt. Excess energy produced could be sold to the TVA system at a market price.

### Monitoring and Evaluation

TVA engineers will work with on-site plant personnel and the vendor to ensure proper installation and synchronization with local distribution systems and the facility. Contracted payments to the company will be paid based on actual peak load demand reductions.

### Applicable Technologies

- Reciprocating Engine Systems
- Gas Turbine Systems
- Coal-Fired Steam Turbine Systems

### Program Assumptions

| | |
|---|---|
| Package Measure Life (Years) | 20 |
| Free-Rider Rate | 0% |
| Free-Driver Rate | 0% |
| Dropouts | 0% |
| Take-Back Percentage | 0% |
| Free-Rider Market Barrier Costs Eliminated | 70% |
| Non-Free-Rider Market Barrier Costs Eliminated | 80% |
| Annual Energy Impact (kWh) | 11,126,814 |
| Average Demand Impact (kW) | 1600 |

| Year | Annual Eligible Population | New Participants | Total Participants | Cumulative Participation Rate |
|---|---|---|---|---|
| 1 | 1,600 | 1 | 1 | n/a |
| 2 | 1,600 | 2 | 3 | n/a |
| 3 | 1,600 | 4 | 7 | n/a |
| 4 | 1,600 | 5 | 12 | n/a |
| 5 | 1,600 | 6 | 18 | n/a |
| 6 | 1,600 | 5 | 23 | n/a |
| 7 | 1,600 | 4 | 27 | n/a |
| 8 | 1,600 | 4 | 31 | n/a |
| 9 | 1,600 | 3 | 34 | n/a |
| 10 | 1,600 | 1 | 35 | n/a |

| Year | Fixed Administrative Cost | Per Participant Variable Administrative Costs<br>$10,000 Total Variable Admin. Cost | Per Participant Measure Cost<br>$2,640,000 Total Part. Measure Cost | Per Participant Incentive<br>$35/kW Total Part. Incentive |
|---|---|---|---|---|
| 1 | $76,000 | $10,000 | $2,640,000 | $56,000 |
| 2 | $76,000 | $20,000 | $5,280,000 | $168,000 |
| 3 | $76,000 | $40,000 | $10,560,000 | $392,000 |
| 4 | $76,000 | $50,000 | $13,200,000 | $672,000 |
| 5 | $76,000 | $60,000 | $15,840,000 | $1,008,000 |
| 6 | $76,000 | $50,000 | $13,200,000 | $1,288,000 |
| 7 | $76,000 | $40,000 | $10,560,000 | $1,512,000 |
| 8 | $76,000 | $40,000 | $10,560,000 | $1,736,000 |
| 9 | $76,000 | $30,000 | $7,920,000 | $1,904,000 |
| 10 | $76,000 | $10,000 | $2,640,000 | $1,960,000 |

# BENEFICIAL ELECTRIFICATION OPTIONS

## SUMMARY OF PROJECTED IMPACTS IN YEAR 2010

| Option Name | MW | GWh | Units |
|---|---|---|---|
| INDUSTRIAL SECTOR | | | |
| Process Heating and Melting | -87 | -609 | 228 |
| Process Melting | -79 | -549 | 29 |
| Curing and Drying | -18 | -123 | 425 |
| Electrotechnologies/Food Processing | -53 | -368 | 29 |
| Electrotechnologies/Textiles | -3 | -19 | 64 |
| Electrotechnologies/Chemicals & Metals | -5 | -37 | 49 |
| Environmental Technologies | -33 | -227 | 140 |
| COMMERCIAL SECTOR | | | |
| Space Conditioning and Water Heating | -21 | -294 | 30,300 |
| Cooking and Security Lighting | -25 | -112 | 10,917 |
| RESIDENTIAL SECTOR | | | |
| HVAC and Water Heating | 119 | -374 | 101,256 |
| Security Lighting and Lawn Mowers | 0 | -51 | 236,407 |
| TRANSPORTATION | | | |
| Electric Buses | 0 | -9 | 259 |
| Fleet Vehicles | 0 | -4 | 503 |
| Electric Autos | 0 | -6 | 1,774 |

Values are the impacts occuring only in the year 2010 for the cumulative participation in the program to that date.

TVA developed 14 beneficial electrification options for evaluation in Energy Vision 2020 with applications in all customer sectors. The industrial sector options have the most impact. Commercial space conditioning and residential heating and cooling are also significant. Detailed descriptions of the beneficial electrification options follow.

## INDUSTRIAL PROCESS HEATING AND MELTING

### Overview

The Process Heating and Melting programs promote select electrotechnologies (induction, resistance, arc, plasma, and infrared) to assist industrial customers in optimizing their energy efficiency needs within process heat application. These electrotechnologies also allow customers to maintain and even enhance their competitiveness by lowering operating and maintenance costs, increasing productivity, allowing for increased operating flexibility, and by helping them to position their facilities for long-term environmental compliance.

Within this program, the customer is provided with a complete menu of technologies from which to select in order to determine the most appropriate solution. This program concept has applicability to a large part of the industrial sector, but will focus initially on key industrial segments with extensive process heating and melting requirements. A pilot program is recommended to gain experience and to allow market research to be conducted to refine estimates of market potential and cost-effectiveness.

### Target Markets

Target markets for the initial pilot will include: Primary Metals (SIC 33); Fabricated Metals (SIC 34); Transportation Equipment (SIC 37); Industrial Machinery (SIC 35); Electronic Equipment (SIC 36); Stone, Clay, Glass & Concrete (SIC 32); Rubber and Plastics (SIC 30).

### Implementation Strategy

TVA does not plan to use any prescriptive or customized rebates for the program. Each electrotechnology should be promoted based on its potential to offer practical solutions to each customer's problems. The program is application-specific and is targeted to large industrial customers and all industrial customers perceived at risk with regard to customer retention. The process heating and melting program should be marketed to enhance customer competitiveness. Understanding the customer's need for favorable paybacks on capital outlays, two additional offerings are considered: a customized rate and customer financing.

The program will be delivered jointly by TVA and participating power distributors. TVA will supply industrial specialists to assist distributor served industrial customers. The success of the program will depend upon TVA's ability to identify and target the most appropriate markets for this program. This effort will require open, two-way communication with distributors and trade allies.

*Industrial Process Heating*

### Program Assumptions

| | |
|---|---|
| Package Measure Life (Years) | 15 |
| Free-Rider Rate | 0% |
| Free-Driver Rate | 0% |
| Dropouts | 0% |
| Take-Back Percentage | 0% |
| Free-Rider Market Barrier Costs Eliminated | 0% |
| Non-Free-Rider Market Barrier Costs Eliminated | 20% |
| Annual Energy Impact (kWh) | (2,532,323) |

| Year | Annual Eligible Population | New Participants | Total Participants | Cumulative Participation Rate |
|---|---|---|---|---|
| 1 | 139 | — | — | 0% |
| 2 | 139 | 1 | 1 | 0% |
| 3 | 555 | 6 | 7 | 1% |
| 4 | 1,106 | 17 | 24 | 1% |
| 5 | 1,092 | 27 | 51 | 2% |
| 6 | 1,070 | 27 | 78 | 2% |
| 7 | 1,049 | 26 | 104 | 2% |
| 8 | 1,028 | 26 | 130 | 2% |
| 9 | 1,007 | 25 | 155 | 2% |
| 10 | 987 | 25 | 180 | 2% |
| 11 | 967 | 24 | 204 | 2% |
| 12 | 948 | 24 | 228 | 2% |

| Year | Fixed Administrative Cost | Per Participant Variable Administrative Costs<br>$0<br>Total Variable Admin. Cost | Per Participant Measure Cost<br>$368,000<br>Total Part. Measure Cost | Per Participant Incentive<br>$0<br>Total Part. Incentive |
|---|---|---|---|---|
| 1 | $138,125 | $0 | $0 | $0 |
| 2 | $138,125 | $0 | $368,000 | $0 |
| 3 | $138,125 | $0 | $2,208,000 | $0 |
| 4 | $138,125 | $0 | $6,256,000 | $0 |
| 5 | $175,938 | $0 | $9,936,000 | $0 |
| 6 | $175,938 | $0 | $9,936,000 | $0 |
| 7 | $175,938 | $0 | $9,568,000 | $0 |
| 8 | $175,938 | $0 | $9,568,000 | $0 |
| 9 | $175,938 | $0 | $9,200,000 | $0 |
| 10 | $175,938 | $0 | $9,200,000 | $0 |
| 11 | $175,938 | $0 | $8,932,000 | $0 |
| 12 | $175,938 | $0 | $8,832,000 | $0 |

## Promotional Strategies

The program will be marketed via a program brochure and personalized one-on-one marketing visits with potential program participants. Where possible, TVA should establish customer showcases that would allow other customers the opportunity to witness successful electrotechnology applications in operation. Technical seminars and training will be provided to promote the virtues of electrotechnologies for heating and melting applications.

**QUALITY GAIN ESTIMATES FOR DSMANAGER VALUE TEST**

| BE-1A | New Participants | Cumulative Penetration | One-Time Benefit/ Participant | Annual Benefit/ Participant | Quality Gain |
|---|---|---|---|---|---|
| 1995 | 0 | 0 | $200,000 | $1,963,000 | $0 |
| 1996 | 1 | 1 | $208,000 | $2,041,520 | $2,249,520 |
| 1997 | 6 | 7 | $216,320 | $2,123,181 | $16,160,187 |
| 1998 | 17 | 24 | $224,973 | $2,208,108 | $56,819,133 |
| 1999 | 27 | 51 | $233,972 | $2,296,432 | $123,435,276 |
| 2000 | 27 | 78 | $243,331 | $2,388,290 | $192,856,557 |
| 2001 | 26 | 104 | $253,064 | $2,483,821 | $264,897,048 |
| 2002 | 26 | 130 | $263,186 | $2,583,174 | $342,655,456 |
| 2003 | 25 | 155 | $273,714 | $2,686,501 | $423,250,505 |
| 2004 | 25 | 180 | $284,662 | $2,793,961 | $510,029,530 |
| 2005 | 24 | 204 | $296,049 | $2,905,720 | $599,872,056 |
| 2006 | 24 | 228 | $307,891 | $3,021,948 | $696,393,528 |

| | |
|---|---|
| *One-Time Environmental Savings* | *$200,000* |
| *Annual Productivity, O&M, Fuel Savings* | *$1,963,000* |
| *Escalation Rate* | *4%* |

*Industrial Process Melting*

## Program Assumptions

| | |
|---|---|
| Package Measure Life (Years) | 20 |
| Free-Rider Rate | 0% |
| Free-Driver Rate | 0% |
| Dropouts | 0% |
| Take-Back Percentage | 0% |
| Free-Rider Market Barrier Costs Eliminated | 0% |
| Non-Free-Rider Market Barrier Costs Eliminated | 30% |
| Annual Energy Impact (kWh) | (17,950,000) |

| Year | Annual Eligible Population | New Participants | Total Participants | Cumulative Participation Rate |
|---|---|---|---|---|
| 1 | 19 | — | — | 0% |
| 2 | 37 | 1 | 1 | 1% |
| 3 | 74 | 1 | 2 | 1% |
| 4 | 147 | 3 | 5 | 2% |
| 5 | 145 | 3 | 8 | 2% |
| 6 | 142 | 3 | 11 | 2% |
| 7 | 141 | 3 | 14 | 2% |
| 8 | 138 | 3 | 17 | 2% |
| 9 | 136 | 3 | 20 | 2% |
| 10 | 134 | 3 | 23 | 2% |
| 11 | 132 | 3 | 26 | 2% |
| 12 | 130 | 3 | 29 | 2% |

| Year | Fixed Administrative Cost | Per Participant Variable Administrative Costs<br>$0<br>Total Variable Admin. Cost | Per Participant Measure Cost<br>$1,490,000<br>Total Part. Measure Cost | Per Participant Incentive<br>$0<br>Total Part. Incentive |
|---|---|---|---|---|
| 1 | $138,125 | $0 | $0 | $0 |
| 2 | $138,125 | $0 | $1,490,000 | $0 |
| 3 | $138,125 | $0 | $1,490,000 | $0 |
| 4 | $138,125 | $0 | $4,470,000 | $0 |
| 5 | $138,125 | $0 | $4,470,000 | $0 |
| 6 | $138,125 | $0 | $4,470,000 | $0 |
| 7 | $138,125 | $0 | $4,470,000 | $0 |
| 8 | $138,125 | $0 | $4,470,000 | $0 |
| 9 | $138,125 | $0 | $4,470,000 | $0 |
| 10 | $138,125 | $0 | $4,470,000 | $0 |
| 11 | $138,125 | $0 | $4,470,000 | $0 |
| 12 | $138,125 | $0 | $4,470,000 | $0 |

**QUALITY GAIN ESTIMATES FOR DSMANAGER VALUE TEST**

| BE-1B | New Participants | Cumulative Penetration | One-Time Benefit/ Participant | Annual Benefit/ Participant | Quality Gain |
|---|---|---|---|---|---|
| 1995 | 0 | 0 | $900,000 | $1,748,000 | $0 |
| 1996 | 1 | 1 | $936,000 | $1,817,920 | $2,753,920 |
| 1997 | 1 | 2 | $973,440 | $1,890,637 | $4,754,714 |
| 1998 | 3 | 5 | $1,012,378 | $1,966,262 | $12,868,444 |
| 1999 | 3 | 8 | $1,052,873 | $2,044,913 | $19,517,923 |
| 2000 | 3 | 11 | $1,094,988 | $2,126,709 | $26,678,763 |
| 2001 | 3 | 14 | $1,138,787 | $2,211,778 | $34,381,253 |
| 2002 | 3 | 17 | $1,184,339 | $2,300,249 | $42,657,250 |
| 2003 | 3 | 20 | $1,231,712 | $2,392,259 | $51,540,316 |
| 2004 | 3 | 23 | $1,280,981 | $2,487,949 | $61,065,770 |
| 2005 | 3 | 26 | $1,332,220 | $2,587,467 | $71,270,802 |
| 2006 | 3 | 29 | $1,385,509 | $2,690,966 | $82,194,541 |

| | |
|---|---|
| *One-Time Environmental Savings* | *$900,000* |
| *Annual Productivity, O&M, Fuel Savings* | *$1,748,000* |
| *Escalation Rate* | *4%* |

## INDUSTRIAL CURING AND DRYING

### Overview

The Process Curing and Drying program promotes select electrotechnologies (infrared, radio-frequency, microwave, ultraviolet, and electron beam) to assist industrial customers to optimize their energy efficiency needs within curing and drying applications. These electrotechnologies also allow customers to maintain and even enhance their competitiveness by lowering operating and maintenance costs, increasing productivity, allowing for increased operating flexibility, and by helping them to position their facilities for long-term environmental compliance.

Within this program, customers are provided a complete menu of technologies from which to select in determining the most appropriate solution to meet their needs. This program concept is applicable to a large part of the industrial sector, but will focus initially on key industrial segments with extensive process curing and drying requirements. A pilot program is recommended to gain experience and to allow market research to be conducted to refine estimates of market potential and cost-effectiveness.

### Target Markets

Target markets for the initial pilot will include: Food and Kindred Products (SIC 20); Textiles (SIC 22); Lumber and Wood Products (SIC 24); Paper and Allied Products (SIC 26); Printing and Publishing (SIC 27); Chemicals and Allied Products (SIC 28); Rubber and Plastics (SIC 30); Fabricated Metals (SIC 34); and Transportation (SIC 37).

### Implementation Strategy

TVA does not plan to use any prescriptive or customized rebates for the program. Each electrotechnology will be promoted based on its potential to offer practical solutions to each customer's problems. The Process Curing and Drying program should be marketed to enhance customer competitiveness. Understanding the customer's need for favorable paybacks on capital outlays, two additional offerings are considered: a customized rate and customer financing.

The program would be delivered jointly by TVA and participating power distributors. TVA would supply industrial specialists to assist distributor served industrial customers. The success of the program will depend upon TVA's ability to identify and target the most appropriate markets for this program. This effort will require open, two-way communication with distributors and trade allies.

### Program Assumptions

| | |
|---|---|
| Package Measure Life (Years) | 12 |
| Free-Rider Rate | 0% |
| Free-Driver Rate | 0% |
| Dropouts | 0% |
| Take-Back Percentage | 0% |
| Free-Rider Market Barrier Costs Eliminated | 0% |
| Non-Free-Rider Market Barrier Costs Eliminated | 10% |
| Annual Energy Impact (kWh) | (273,122) |

| Year | Annual Eligible Population | New Participants | Total Participants | Cumulative Participation Rate |
|---|---|---|---|---|
| 1 | 141 | — | — | 0% |
| 2 | 141 | 3 | 3 | 1% |
| 3 | 562 | 11 | 14 | 2% |
| 4 | 1,115 | 33 | 47 | 2% |
| 5 | 1,088 | 54 | 101 | 3% |
| 6 | 1,045 | 52 | 153 | 4% |
| 7 | 1,003 | 50 | 203 | 4% |
| 8 | 963 | 48 | 251 | 4% |
| 9 | 925 | 46 | 297 | 4% |
| 10 | 887 | 44 | 341 | 4% |
| 11 | 852 | 43 | 394 | 4% |
| 12 | 818 | 41 | 425 | 4% |

| Year | Fixed Administrative Cost | Per Participant Variable Administrative Costs: $0 Total Variable Admin. Cost | Per Participant Measure Cost: $200,000 Total Part. Measure Cost | Per Participant Incentive: $0 Total Part. Incentive |
|---|---|---|---|---|
| 1 | $276,250 | $0 | $0 | $0 |
| 2 | $276,250 | $0 | $600,000 | $0 |
| 3 | $276,250 | $0 | $2,200,000 | $0 |
| 4 | $276,250 | $0 | $6,600,000 | $0 |
| 5 | $351,875 | $0 | $10,800,000 | $0 |
| 6 | $351,875 | $0 | $10,400,000 | $0 |
| 7 | $351,875 | $0 | $10,000,000 | $0 |
| 8 | $351,875 | $0 | $9,600,000 | $0 |
| 9 | $351,875 | $0 | $9,200,000 | $0 |
| 10 | $351,875 | $0 | $8,800,000 | $0 |
| 11 | $351,875 | $0 | $8,600,000 | $0 |
| 12 | $351,875 | $0 | $8,200,000 | $0 |

## Promotional Strategies

The program will be marketed via a program brochure and personalized one-on-one marketing visits with potential program participants. Where possible, TVA should establish customer showcases that would allow other customers the opportunity to witness successful electrotechnology applications in operation. Technical seminars and training will be provided to promote the virtues of electrotechnologies for heating and melting applications.

**QUALITY GAIN ESTIMATES FOR DSMANAGER VALUE TEST**

| BE-2 | New Participants | Cumulative Penetration | One-Time Benefit/ Participant | Annual Benefit/ Participant | Quality Gain |
|---|---|---|---|---|---|
| 1995 | 0 | 0 | $100,000 | $2,303,000 | $0 |
| 1996 | 3 | 3 | $104,000 | $2,395,120 | $7,497,360 |
| 1997 | 11 | 14 | $108,160 | $2,490,925 | $36,062,710 |
| 1998 | 33 | 47 | $112,486 | $2,590,562 | $125,468,452 |
| 1999 | 54 | 101 | $116,986 | $2,694,184 | $278,429,828 |
| 2000 | 52 | 153 | $121,665 | $2,801,952 | $435,025,236 |
| 2001 | 50 | 203 | $126,532 | $2,914,030 | $597,874,690 |
| 2002 | 48 | 251 | $131,593 | $3,030,591 | $766,994,805 |
| 2003 | 46 | 297 | $136,857 | $3,151,815 | $942,384,477 |
| 2004 | 44 | 341 | $142,331 | $3,277,887 | $1,124,022,031 |
| 2005 | 43 | 384 | $148,024 | $3,409,003 | $1,315,422,184 |
| 2006 | 41 | 425 | $153,945 | $3,545,363 | $1,513,091,020 |

| | |
|---|---|
| *One-Time Environmental Savings* | *$100,000* |
| *Annual Productivity, O&M, Fuel Savings* | *$2,303,000* |
| *Escalation Rate* | *4%* |

## INDUSTRIAL ELECTROTECHNOLOGIES

### Overview

The Process-Specific Electrification program promotes select electrotechnologies (freeze concentration, reverse osmosis, vacuum slot heating and drying, and electrolytics) that represent niche opportunities for beneficial electrification. These electrotechnologies also allow customers to maintain and even enhance their competitiveness by lowering operating and maintenance costs, increasing productivity, allowing for increased operating flexibility, and by helping them to position their facilities for long-term environmental compliance.

Within this program, the customer is provided a complete menu of technologies to select from when determining the most appropriate solution to meet their needs. This program concept has applicability to a large part of the industrial sector, but will focus initially on key industrial segments with extensive process-specific electrification requirements. A pilot program is recommended to gain experience and to conduct market research in order to refine estimates of market potential and cost-effectiveness.

### Target Markets

Target markets with corresponding niche opportunities for electrotechnologies include: Food and Kindred Products (SIC 20), Freeze Concentration and Reverse Osmosis Textiles (SIC 22), Vacuum Slot Heating and Drying Chemicals (SIC 28), Primary Metals (SIC 33), and Fabricated Metals (SIC 34) for electrolytics.

### Implementation Strategy

TVA does not plan to use any prescriptive or customized rebates for the program. Each electrotechnology will be promoted based on its potential to offer practical solutions to each customer's problems. The Process-Specific Electrification program should be marketed to enhance customer competitiveness. The introduction of niche technologies that allow incremental gains in overall productivity assumes an extensive screening for opportunities. Understanding the customer's need for favorable paybacks on capital outlays, TVA will consider offering a customized rate and customer financing.

The program would be delivered jointly by TVA and participating power distributors. TVA will supply industrial specialists to assist distributor served industrial customers. The success of the program will depend upon TVA's ability to identify and target the most appropriate markets for this program and will require open, two-way communication with distributors and trade allies.

### Promotional Strategies

The program will be marketed via a program brochure and personalized one-on-one marketing visits with potential program participants. Where possible, TVA will establish customer showcases that allow other customers the opportunity to witness successful electrotechnology applications in operation. Technical seminars and training will be provided to promote the virtues of electrotechnologies for heating and melting applications. Presentations should be made at industry trade organizations and to trade allies to promote program awareness.

*Industrial Electrotechnologies/Food Processing*

## Program Assumptions

| | |
|---|---|
| Package Measure Life (Years) | 18 |
| Free-Rider Rate | 0% |
| Free-Driver Rate | 0% |
| Dropouts | 0% |
| Take-Back Percentage | 0% |
| Free-Rider Market Barrier Costs Eliminated | 0% |
| Non-Free-Rider Market Barrier Costs Eliminated | 50% |
| Annual Energy Impact (kWh) | (12,044,480) |

| Year | Annual Eligible Population | New Participants | Total Participants | Cumulative Participation Rate |
|---|---|---|---|---|
| 1 | 35 | — | — | 0% |
| 2 | 35 | 1 | 1 | 1% |
| 3 | 88 | 1 | 2 | 1% |
| 4 | 175 | 3 | 5 | 2% |
| 5 | 173 | 3 | 8 | 2% |
| 6 | 171 | 3 | 11 | 2% |
| 7 | 170 | 3 | 14 | 2% |
| 8 | 168 | 3 | 17 | 2% |
| 9 | 166 | 3 | 20 | 2% |
| 10 | 165 | 3 | 23 | 2% |
| 11 | 163 | 3 | 26 | 2% |
| 12 | 161 | 3 | 29 | 2% |

| Year | Fixed Administrative Cost | Per Participant Variable Administrative Costs<br>$0<br>Total Variable Admin. Cost | Per Participant Measure Cost<br>$4,730,000<br>Total Part. Measure Cost | Per Participant Incentive<br>$0<br>Total Part. Incentive |
|---|---|---|---|---|
| 1 | $102,500 | $0 | $0 | $0 |
| 2 | $102,500 | $0 | $4,730,000 | $0 |
| 3 | $102,500 | $0 | $4,730,000 | $0 |
| 4 | $102,500 | $0 | $14,190,000 | $0 |
| 5 | $102,500 | $0 | $14,190,000 | $0 |
| 6 | $102,500 | $0 | $14,190,000 | $0 |
| 7 | $102,500 | $0 | $14,190,000 | $0 |
| 8 | $102,500 | $0 | $14,190,000 | $0 |
| 9 | $102,500 | $0 | $14,190,000 | $0 |
| 10 | $102,500 | $0 | $14,190,000 | $0 |
| 11 | $102,500 | $0 | $14,190,000 | $0 |
| 12 | $102,500 | $0 | $14,190,000 | $0 |

**QUALITY GAIN ESTIMATES FOR DSMANAGER VALUE TEST**

| BE-3A | New Participants | Cumulative Penetration | One-Time Benefit/ Participant | Annual Benefit/ Participant | Quality Gain |
|---|---|---|---|---|---|
| 1995 | 0 | 0 | $2,400,000 | $8,410,000 | $0 |
| 1996 | 1 | 1 | $2,496,000 | $8,746,400 | $11,242,400 |
| 1997 | 1 | 2 | $2,595,840 | $9,096,256 | $20,788,352 |
| 1998 | 3 | 5 | $2,699,674 | $9,460,106 | $55,399,552 |
| 1999 | 3 | 8 | $2,807,661 | $9,838,510 | $87,131,063 |
| 2000 | 3 | 11 | $2,919,967 | $10,232,051 | $121,312,462 |
| 2001 | 3 | 14 | $3,036,766 | $10,641,333 | $158,088,960 |
| 2002 | 3 | 17 | $3,158,236 | $11,066,986 | $197,613,470 |
| 2003 | 3 | 20 | $3,284,566 | $11,509,666 | $240,047,018 |
| 2004 | 3 | 23 | $3,415,948 | $11,970,052 | $285,559,040 |
| 2005 | 3 | 26 | $3,552,586 | $12,448,854 | $334,327,962 |
| 2006 | 3 | 29 | $3,694,690 | $12,946,809 | $386,541,531 |

| | |
|---|---|
| *One-Time Environmental Savings* | *$2,400,000* |
| *Annual Productivity, O&M, Fuel Savings* | *$8,410,000* |
| *Escalation Rate* | *4%* |

*Industrial Electrotechnologies/Textiles*

## Program Assumptions

| | |
|---|---|
| Package Measure Life | 20 |
| Free-Rider Rate | 0% |
| Free-Driver Rate | 0% |
| Dropouts | 0% |
| Take-Back Percentage | 0% |
| Free-Rider Market Barrier Costs Eliminated | 0% |
| Non-Free-Rider Market Barrier Costs Eliminated | 25% |
| Annual Energy Impact (kWh) | (280,000) |

| Year | Annual Eligible Population | New Participants | Total Participants | Cumulative Participation Rate |
|---|---|---|---|---|
| 1 | 23 | — | — | 0% |
| 2 | 23 | 0 | 0 | 1% |
| 3 | 92 | 2 | 2 | 1% |
| 4 | 183 | 3 | 5 | 2% |
| 5 | 181 | 6 | 11 | 2% |
| 6 | 176 | 9 | 20 | 3% |
| 7 | 169 | 8 | 28 | 3% |
| 8 | 162 | 8 | 36 | 4% |
| 9 | 156 | 8 | 44 | 4% |
| 10 | 150 | 7 | 51 | 4% |
| 11 | 144 | 7 | 58 | 4% |
| 12 | 138 | 7 | 65 | 4% |

| Year | Fixed Administrative Cost | Per Participant Variable Administrative Costs<br>$0<br>Total Variable Admin. Cost | Per Participant Measure Cost<br>$76,000<br>Total Part. Measure Cost | Per Participant Incentive<br>$0<br>Total Part. Incentive |
|---|---|---|---|---|
| 1 | $102,500 | $0 | $0 | $0 |
| 2 | $102,500 | $0 | $0 | $0 |
| 3 | $102,500 | $0 | $152,000 | $0 |
| 4 | $102,500 | $0 | $228,000 | $0 |
| 5 | $102,500 | $0 | $456,000 | $0 |
| 6 | $102,500 | $0 | $684,000 | $0 |
| 7 | $102,500 | $0 | $608,000 | $0 |
| 8 | $102,500 | $0 | $608,000 | $0 |
| 9 | $102,500 | $0 | $608,000 | $0 |
| 10 | $102,500 | $0 | $532,000 | $0 |
| 11 | $102,500 | $0 | $532,000 | $0 |
| 12 | $102,500 | $0 | $532,000 | $0 |

**QUALITY GAIN ESTIMATES FOR DSMANAGER VALUE TEST**

| BE-3B | New Participants | Cumulative Penetration | One-Time Benefit/ Participant | Annual Benefit/ Participant | Quality Gain |
|---|---|---|---|---|---|
| 1995 | 0 | 0 | $38,000 | $607,000 | $0 |
| 1996 | 0 | 0 | $39,520 | $631,280 | $0 |
| 1997 | 2 | 2 | $41,101 | $656,531 | $1,395,264 |
| 1998 | 3 | 5 | $42,745 | $682,792 | $3,413,960 |
| 1999 | 6 | 11 | $44,455 | $710,104 | $7,811,144 |
| 2000 | 9 | 20 | $46,233 | $738,508 | $15,186,257 |
| 2001 | 8 | 28 | $48,082 | $768,049 | $21,505,372 |
| 2002 | 8 | 36 | $50,005 | $798,771 | $28,753,596 |
| 2003 | 8 | 44 | $52,006 | $830,721 | $36,551,724 |
| 2004 | 7 | 51 | $54,086 | $863,950 | $44,061,450 |
| 2005 | 7 | 58 | $56,249 | $898,508 | $52,113,464 |
| 2006 | 7 | 65 | $58,499 | $934,449 | $61,148,678 |

| | |
|---|---|
| *One-Time Environmental Savings* | *$38,000* |
| *Annual Productivity, O&M, Fuel Savings* | *$607,000* |
| *Escalation Rate* | *4%* |

*Industrial Electrotechnologies/Chemicals and Metals*

## Program Assumptions

| | |
|---|---|
| Package Measure Life | 20 |
| Free-Rider Rate | 0% |
| Free-Driver Rate | 0% |
| Dropouts | 0% |
| Take-Back Percentage | 0% |
| Free-Rider Market Barrier Costs Eliminated | 0% |
| Non-Free-Rider Market Barrier Costs Eliminated | 25% |
| Annual Energy Impact (kWh) | (705,536) |

| Year | Annual Eligible Population | New Participants | Total Participants | Cumulative Participation Rate |
|---|---|---|---|---|
| 1 | 60 | — | — | 0% |
| 2 | 60 | 1 | 1 | 1% |
| 3 | 150 | 2 | 3 | 1% |
| 4 | 300 | 4 | 7 | 1% |
| 5 | 298 | 4 | 11 | 1% |
| 6 | 295 | 4 | 15 | 1% |
| 7 | 293 | 5 | 20 | 1% |
| 8 | 291 | 6 | 26 | 2% |
| 9 | 288 | 6 | 32 | 2% |
| 10 | 285 | 6 | 38 | 2% |
| 11 | 282 | 6 | 44 | 2% |
| 12 | 279 | 6 | 50 | 2% |

| Year | Fixed Administrative Cost | Per Participant Variable Administrative Costs<br>$0<br>Total Variable Admin. Cost | Per Participant Measure Cost<br>$328,000<br>Total Part. Measure Cost | Per Participant Incentive<br>$0<br>Total Part. Incentive |
|---|---|---|---|---|
| 1 | $102,500 | $0 | $0 | $0 |
| 2 | $102,500 | $0 | $328,000 | $0 |
| 3 | $102,500 | $0 | $656,000 | $0 |
| 4 | $102,500 | $0 | $1,312,000 | $0 |
| 5 | $102,500 | $0 | $1,312,000 | $0 |
| 6 | $102,500 | $0 | $1,312,000 | $0 |
| 7 | $102,500 | $0 | $1,640,000 | $0 |
| 8 | $102,500 | $0 | $1,968,000 | $0 |
| 9 | $102,500 | $0 | $1,968,000 | $0 |
| 10 | $102,500 | $0 | $1,968,000 | $0 |
| 11 | $102,500 | $0 | $1,968,000 | $0 |
| 12 | $102,500 | $0 | $1,968,000 | $0 |

**QUALITY GAIN ESTIMATES FOR DSMANAGER VALUE TEST**

| BE-3C | New Participants | Cumulative Penetration | One-Time Benefit/ Participant | Annual Benefit/ Participant | Quality Gain |
|---|---|---|---|---|---|
| 1995 | 0 | 0 | $328,299 | $2,011,000 | $0 |
| 1996 | 1 | 1 | $341,431 | $2,091,440 | $2,432,871 |
| 1997 | 2 | 3 | $355,088 | $2,175,098 | $7,235,470 |
| 1998 | 4 | 7 | $369,292 | $2,262,102 | $17,311,882 |
| 1999 | 4 | 11 | $384,063 | $2,352,586 | $27,414,698 |
| 2000 | 4 | 15 | $399,426 | $2,446,689 | $38,298,039 |
| 2001 | 5 | 20 | $415,403 | $2,544,557 | $52,968,155 |
| 2002 | 6 | 26 | $432,019 | $2,646,339 | $68,804,814 |
| 2003 | 6 | 32 | $449,300 | $2,752,192 | $90,765,944 |
| 2004 | 6 | 38 | $467,272 | $2,862,280 | $111,570,272 |
| 2005 | 6 | 44 | $485,963 | $2,976,771 | $133,893,702 |
| 2006 | 6 | 50 | $505,401 | $3,095,842 | $157,824,506 |

| | |
|---|---|
| *One-Time Environmental Savings* | *$328,299* |
| *Annual Productivity, O&M, Fuel Savings* | *$2,011,000* |
| *Escalation Rate* | *4%* |

## ENVIRONMENTAL TECHNOLOGIES

### Overview

The Environmental Technology Solutions program will promote select environmental compliance technologies (ultrafiltration, nanofiltration, ozonation, and reverse osmosis) to assist industrial and commercial customers to address air and water regulation and by helping them to position their facilities for long-term environmental compliance. These electrotechnologies also allow customers to maintain and even enhance their competitiveness by reducing operating and maintenance costs and by enhancing product quality.

Within this program, the customer is provided a complete menu of technologies from which to chose in determining the most appropriate solution to meet its needs. This option concept is applicable to a large part of the industrial sector, but will focus initially on key industrial segments with extensive environmental problems. A pilot program is recommended to gain experience and to conduct market research in order to refine estimates of market potential and cost effectiveness.

### Target Markets

Target markets for the initial pilot will include: Municipal Waste Water Treatment Facilities (SIC 49); Select Commercial Institutions, Food and Kindred Products (SIC 20); Textiles (SIC 22); Chemicals (SIC 28); Primary Metals (SIC 33); Fabricated Metals (SIC 34); and Electronic Equipment (SIC 36).

### Implementation Strategy

TVA does not plan to use any prescriptive or customized rebates for the program. Each environmental electrotechnology will be promoted on its own merits, in terms of improving product quality and addressing long-term environmental compliance. Each technology should offer a practical long-term solution to an individual customer's problems.

It is suggested that TVA consider financing options to assist in the purchase of these technologies. TVA should also consider tailored collaboration projects with EPRI to secure leveraging of federal funds for process improvement projects.

The program would be delivered jointly by TVA and participating power distributors. TVA would supply industrial specialists to assist distributor served industrial customers. The success of the program will depend upon TVA's ability to identify and target the most appropriate markets for this program. This effort will require open, two-way communication with distributors and trade allies.

### Program Assumptions

| | |
|---|---|
| Package Measure Life (Years) | 14 |
| Free-Rider Rate | 0% |
| Free-Driver Rate | 0% |
| Dropouts | 0% |
| Take-Back Percentage | 0% |
| Free-Rider Market Barrier Costs Eliminated | 0% |
| Non-Free-Rider Market Barrier Costs Eliminated | 50% |
| Annual Energy Impact (kWh) | (1,537,918) |

| Year | Annual Eligible Population | New Participants | Total Participants | Cumulative Participation Rate |
|---|---|---|---|---|
| 1 | 144 | — | — | 0% |
| 2 | 144 | 1 | 1 | 1% |
| 3 | 432 | 6 | 7 | 1% |
| 4 | 860 | 13 | 20 | 1% |
| 5 | 852 | 13 | 33 | 1% |
| 6 | 844 | 13 | 46 | 1% |
| 7 | 837 | 13 | 59 | 1% |
| 8 | 829 | 16 | 75 | 2% |
| 9 | 820 | 17 | 92 | 2% |
| 10 | 809 | 16 | 108 | 2% |
| 11 | 800 | 16 | 124 | 2% |
| 12 | 790 | 16 | 140 | 2% |

| Year | Fixed Administrative Cost | Per Participant Variable Administrative Costs<br>$0<br>Total Variable Admin. Cost | Per Participant Measure Cost<br>$1,560,000<br>Total Part. Measure Cost | Per Participant Incentive<br>$0<br>Total Part. Incentive |
|---|---|---|---|---|
| 1 | $295,000 | $0 | $0 | $0 |
| 2 | $295,000 | $0 | $1,560,000 | $0 |
| 3 | $295,000 | $0 | $9,360,000 | $0 |
| 4 | $295,000 | $0 | $20,280,000 | $0 |
| 5 | $342,500 | $0 | $20,280,000 | $0 |
| 6 | $342,500 | $0 | $20,280,000 | $0 |
| 7 | $342,500 | $0 | $20,280,000 | $0 |
| 8 | $342,500 | $0 | $24,960,000 | $0 |
| 9 | $342,500 | $0 | $26,520,000 | $0 |
| 10 | $342,500 | $0 | $24,960,000 | $0 |
| 11 | $342,500 | $0 | $24,960,000 | $0 |
| 12 | $342,500 | $0 | $24,960,000 | $0 |

## Promotional Strategies

The program will be promoted via brochures outlining state-specific regulations/compliance issues, as well as technology solutions. TVA will take into consideration each state's specific regulations. Technical seminars and training will be provided to promote electrotechnology solutions to environmental problems.

**QUALITY GAIN ESTIMATES FOR DSMANAGER VALUE TEST**

| BE-4 | New Participants | Cumulative Penetration | One-Time Benefit/ Participant | Annual Benefit/ Participant | Quality Gain |
|---|---|---|---|---|---|
| 1995 | 0 | 0 | $3,100,000 | $1,904,000 | $0 |
| 1996 | 1 | 1 | $3,224,000 | $1,980,160 | $5,204,160 |
| 1997 | 6 | 7 | $3,352,960 | $2,059,366 | $34,533,322 |
| 1998 | 13 | 20 | $3,487,078 | $2,141,741 | $88,166,834 |
| 1999 | 13 | 33 | $3,626,562 | $2,227,411 | $120,649,869 |
| 2000 | 13 | 46 | $3,771,624 | $2,316,507 | $155,590,434 |
| 2001 | 13 | 59 | $3,922,489 | $2,409,167 | $193,133,210 |
| 2002 | 16 | 75 | $4,079,389 | $2,505,534 | $259,770,197 |
| 2003 | 17 | 92 | $4,242,564 | $2,605,755 | $307,610,484 |
| 2004 | 16 | 108 | $4,412,267 | $2,709,986 | $363,274,760 |
| 2005 | 16 | 124 | $4,588,757 | $2,818,385 | $422,899,852 |
| 2006 | 16 | 140 | $4,772,308 | $2,931,121 | $486,713,868 |

| | |
|---|---|
| *One-Time Environmental Savings* | *$3,100,000* |
| *Annual Productivity, O&M, Fuel Savings* | *$1,904,000* |
| *Escalation Rate* | *4%* |

## COMMERCIAL SPACE CONDITIONING AND WATER HEATING

### Overview

Beneficial water heating and space conditioning electrotechnologies will be promoted to new and existing commercial customers. The Commercial Space Conditioning and Water Heating option would promote technologies which overlap with measures being offered in the commercial energy efficiency options (heat pump water heaters [15kBtuh, 50kBtuh, &100kBtuh], air-source heat pumps, and dual-fuel heat pumps). In addition, the program will promote new water chillers designed to comply with ozone depletion regulations.

The Commercial Space Conditioning and Water Heating option will be designed to avoid overt load building. For example, it would be promoted through trade allies, thereby targeting customers already considering an equipment purchase, rather than actively encouraging customers to switch fuels to electricity. In addition, this option will only promote high-efficiency equipment using the same efficiency standards as the commercial energy efficiency options.

### Target Market

The program will target customers replacing failed non-electric water heaters, space conditioning equipment, and/or adding air conditioning. Some technologies will be targeted to specific business types. For example, chillers will be targeted to large office buildings, schools/colleges, hospitals, and government facilities. Heat pumps will be targeted to small office buildings, restaurants, and retail establishments.

### Implementation Strategy

The program will be offered in participating distributor service areas. It will be delivered through architects and engineers, and HVAC/plumbing contractors. TVA should provide trade allies with technical materials that inform potential purchasers of the benefit of replacing non-electric equipment with high-efficiency electric alternatives. To encourage contractors to educate customers, TVA will provide incentive payments to dealers. Heat pump incentives would match those of the energy efficiency options. For chillers, TVA would also provide analysis/design incentives that would reimburse owners for the cost of economic/feasibility studies.

TVA will maintain a flexible posture concerning the level of aggressiveness with which it promotes the program. Changes in market or resource conditions may warrant revising some elements of the program or terminating it completely.

### Program Assumptions

| | |
|---|---|
| Package Measure Life (Years) | 15 |
| Free-Rider Rate | 10% |
| Free-Driver Rate | 0% |
| Dropouts | 0% |
| Take-Back Percentage | 0% |
| Free-Rider Market Barrier Costs Eliminated | 50% |
| Non-Free-Rider Market Barrier Costs Eliminated | 75% |
| Annual Energy Impact (kWh) | (8,329) |

| Year | Annual Eligible Population | New Participants | Total Participants | Cumulative Participation Rate |
|---|---|---|---|---|
| 1 | 25,252 | 2,525 | 2,525 | 10% |
| 2 | 25,252 | 2,525 | 5,050 | 10% |
| 3 | 25,252 | 2,525 | 7,575 | 10% |
| 4 | 25,252 | 2,525 | 10,100 | 10% |
| 5 | 25,252 | 2,525 | 12,625 | 10% |
| 6 | 25,252 | 2,525 | 15,150 | 10% |
| 7 | 25,252 | 2,525 | 17,675 | 10% |
| 8 | 25,252 | 2,525 | 20,200 | 10% |
| 9 | 25,252 | 2,525 | 22,725 | 10% |
| 10 | 25,252 | 2,525 | 25,250 | 10% |
| 11 | 25,252 | 2,525 | 27,775 | 10% |
| 12 | 25,252 | 2,525 | 30,300 | 10% |

| | | Per Participant Variable Administrative Costs | Per Participant Measure Cost | Per Participant Incentive |
|---|---|---|---|---|
| Year | Fixed Administrative Cost | $1,525 Total Variable Admin. Cost | $7,920 Total Part. Measure Cost | $70 Total Part. Incentive |
| 1 | $624,000 | $3,850,625 | $19,998,000 | $176,750 |
| 2 | $624,000 | $3,850,625 | $19,998,000 | $176,750 |
| 3 | $624,000 | $3,850,625 | $19,998,000 | $176,750 |
| 4 | $624,000 | $3,850,625 | $19,998,000 | $176,750 |
| 5 | $624,000 | $3,850,625 | $19,998,000 | $176,750 |
| 6 | $624,000 | $3,850,625 | $19,998,000 | $176,750 |
| 7 | $624,000 | $3,850,625 | $19,998,000 | $176,750 |
| 8 | $624,000 | $3,850,625 | $19,998,000 | $176,750 |
| 9 | $624,000 | $3,850,625 | $19,998,000 | $176,750 |
| 10 | $624,000 | $3,850,625 | $19,998,000 | $176,750 |
| 11 | $624,000 | $3,850,625 | $19,998,000 | $176,750 |
| 12 | $624,000 | $3,850,625 | $19,998,000 | $176,750 |

## Promotional Strategies

Promotional efforts will emphasize personal contact between TVA and key equipment installers/decision-makers. The program should also be promoted through presentations and seminars to professional organizations such as the American Society of Heating, Refrigerating, and Air-Conditioning Engineers, Inc. Technical seminars and training would be provided to educate trade allies and explain program operating detail. In addition, the program should feature cooperative advertising and point-of-purchase information and displays.

**QUALITY GAIN ESTIMATES FOR DSMANAGER VALUE TEST**

| BE-5 | New Participants | Cumulative Penetration | One-Time Benefit/ Participant | Annual Benefit/ Participant | Quality Gain |
|---|---|---|---|---|---|
| 1995 | 2,525 | 2,525 | $0 | $3,000 | $7,575,000 |
| 1996 | 2,525 | 5,050 | $0 | $3,120 | $15,756,000 |
| 1997 | 2,525 | 7,575 | $0 | $3,245 | $24,580,875 |
| 1998 | 2,525 | 10,100 | $0 | $3,375 | $34,087,500 |
| 1999 | 2,525 | 12,625 | $0 | $3,510 | $44,313,750 |
| 2000 | 2,525 | 15,150 | $0 | $3,650 | $55,297,500 |
| 2001 | 2,525 | 17,675 | $0 | $3,796 | $67,094,300 |
| 2002 | 2,525 | 20,200 | $0 | $3,948 | $79,749,600 |
| 2003 | 2,525 | 22,725 | $0 | $4,106 | $93,308,850 |
| 2004 | 2,525 | 25,250 | $0 | $4,270 | $107,817,500 |
| 2005 | 2,525 | 27,775 | $0 | $4,441 | $123,348,775 |
| 2006 | 2,525 | 30,300 | $0 | $4,618 | $139,925,400 |

| | |
|---|---|
| *One-Time Environmental Savings* | *$0* |
| *Annual Productivity, O&M, Fuel Savings* | *$3,000* |
| *Escalation Rate* | *4%* |

## COMMERCIAL COOKING AND SECURITY LIGHTING

### Overview

Beneficial electrotechnologies addressing security lighting will be promoted among customers where appropriate. In this program the following technologies would be promoted:

- High pressure sodium (HPS) security lighting
- Cooking—convection oven
- Cooking—high-efficiency fryer

### Target Markets

These technologies will be promoted among a narrow range of customers. Security lighting will be promoted among retail customers and restaurants, where the technology can provide high value to customers by improving safety in walkways and parking lots. Cooking would be promoted among restaurants and hotels. Convection ovens provide value and efficiency by distributing heat more evenly in less time. High-efficiency fryers with their better insulation reduce heat loss through the bottom of the fry pot.

### Delivery Strategy

Security lighting and cooking will be delivered differently. TVA, in conjunction with power distributors, will purchase HPS lamps. Power distributors would install them in targeted geographical areas and recover costs through a leasing arrangement.

Cooking technologies would be delivered through retail vendors such as restaurant supply outlets. TVA will develop a list of qualifying equipment manufacturers and recruit vendors to participate in the program. Vendors will procure approved equipment through their own distribution channels. To encourage customers to purchase electric equipment, TVA will offer customer financing. Vendors will be expected to perform the following functions:

- Promote equipment via promotional material developed by TVA
- Maintain record of equipment sales (both electric and gas) to track participation and penetration

### Program Assumptions

| | |
|---|---|
| Package Measure Life (Years) | 15 |
| Free-Rider Rate | 0% |
| Free-Driver Rate | 10% |
| Dropouts | 0% |
| Take-Back Percentage | 0% |
| Free-Rider Market Barrier Costs Eliminated | 0% |
| Non-Free-Rider Market Barrier Costs Eliminated | 25% |
| Annual Energy Impact (kWh) | (9,470) |

| Year | Annual Eligible Population | New Participants | Total Participants | Cumulative Participation Rate |
|---|---|---|---|---|
| 1 | 109,238 | 550 | 550 | 1% |
| 2 | 109,228 | 550 | 1,100 | 1% |
| 3 | 109,218 | 550 | 1,650 | 2% |
| 4 | 109,208 | 550 | 2,200 | 2% |
| 5 | 109,198 | 1,100 | 3,300 | 3% |
| 6 | 109,188 | 1,100 | 4,400 | 4% |
| 7 | 109,178 | 1,100 | 5,500 | 5% |
| 8 | 109,168 | 1,100 | 6,600 | 6% |
| 9 | 109,158 | 1,100 | 7,700 | 7% |
| 10 | 109,148 | 1,100 | 8,800 | 8% |
| 11 | 109,139 | 1,100 | 9,900 | 9% |
| 12 | 109,129 | 1,100 | 11,000 | 10% |

| Year | Fixed Administrative Cost | Per Participant Variable Administrative Costs<br>$13<br>Total Variable Admin. Cost | Per Participant Measure Cost<br>$2,292<br>Total Part. Measure Cost | Per Participant Incentive<br>$0<br>Total Part. Incentive |
|---|---|---|---|---|
| 1 | $410,000 | $7,150 | $1,260,600 | $0 |
| 2 | $375,000 | $7,150 | $1,260,600 | $0 |
| 3 | $350,000 | $7,150 | $1,260,600 | $0 |
| 4 | $350,000 | $7,150 | $1,260,600 | $0 |
| 5 | $350,000 | $14,300 | $2,521,200 | $0 |
| 6 | $350,000 | $14,300 | $2,521,200 | $0 |
| 7 | $350,000 | $14,300 | $2,521,200 | $0 |
| 8 | $350,000 | $14,300 | $2,521,200 | $0 |
| 9 | $350,000 | $14,300 | $2,521,200 | $0 |
| 10 | $350,000 | $14,300 | $2,521,200 | $0 |
| 11 | $350,000 | $14,300 | $2,521,200 | $0 |
| 12 | $350,000 | $14,300 | $2,521,200 | $0 |

## Promotional Strategies

For security lighting, TVA and power distributors will emphasize direct mail, telemarketing, and face-to-face contact in targeted areas. In addition, TVA will make presentations and provide displays to regional retail chains and to local chambers of commerce, security organizations, etc. Promotional materials would illustrate how lighting can improve customer security. Materials will also discuss the low operating costs of HPS lamps.

Cooking equipment will be marketed through direct contact with restaurants and hotels. In addition, cooking supply outlets will be provided with information and encouraged to promote electric technologies among their customers. Sample equipment used to demonstrate the quality of electric cooked food should be made available to large vendors and at trade shows. TVA will develop point-of-purchase information and displays for participating vendors.

**QUALITY GAIN ESTIMATES FOR DSMANAGER VALUE TEST**

| BE-6 | New Participants | Cumulative Penetration | One-Time Benefit/ Participant | Annual Benefit/ Participant | Quality Gain |
|---|---|---|---|---|---|
| 1995 | 550 | 550 | $0 | $3,000 | $1,650,000 |
| 1996 | 550 | 1,100 | $0 | $3,120 | $3,432,000 |
| 1997 | 550 | 1,650 | $0 | $3,245 | $5,354,250 |
| 1998 | 550 | 2,200 | $0 | $3,375 | $7,425,000 |
| 1999 | 1,100 | 3,300 | $0 | $3,510 | $11,583,000 |
| 2000 | 1,100 | 4,400 | $0 | $3,650 | $16,060,000 |
| 2001 | 1,100 | 5,500 | $0 | $3,796 | $20,878,000 |
| 2002 | 1,100 | 6,600 | $0 | $3,948 | $26,056,800 |
| 2003 | 1,100 | 7,700 | $0 | $4,106 | $31,616,200 |
| 2004 | 1,100 | 8,800 | $0 | $4,270 | $37,576,000 |
| 2005 | 1,100 | 9,900 | $0 | $4,441 | $43,965,900 |
| 2006 | 1,100 | 11,000 | $0 | $4,618 | $50,798,000 |

| | |
|---|---|
| *One-Time Environmental Savings* | *$0* |
| *Annual Productivity, O&M, Fuel Savings* | *$3,000* |
| *Escalation Rate* | *4%* |

## RESIDENTIAL HVAC AND WATER HEATING

### Overview

This option promotes beneficial water heating and space conditioning electrotechnologies to new and existing residential customers. The Residential HVAC and Water Heating option promotes the following energy-efficient technologies: heat pump water heaters; air-source heat pumps with heat recovery; ground-source heat pumps with heat recovery; and dual-fuel heat pumps with heat recovery

Program features would be similar to the residential energy efficiency option. However, participation and impact levels would be tracked separately. Installations through this option would represent added load. Impacts among participants without air conditioning may represent the full requirements of a SEER 12 air-source heat pump. Impacts for participants that previously had air conditioning but no electric heat would represent the winter heat pump load requirements. In contrast, the energy efficiency option impacts would represent the energy and demand savings achieved by installing the high-efficiency measure rather than the standard efficiency replacement.

The Residential HVAC and Water Heating option is designed to avoid overt load building. For example, it would be promoted through trade allies to customers already considering an equipment purchase, rather than actively encouraging customers to switch from another fuel to electricity. The program will use the same efficiency standards as the related energy efficiency option, and both options will offer similar services and incentives.

### Target Markets

The program would target customers replacing failed nonelectric water heaters, space conditioning equipment, and/or adding air conditioning.

### Delivery Strategy

The program would be delivered through HVAC/plumbing contractors. TVA should provide trade allies with technical/educational materials that inform potential purchasers of the benefits of replacing non-electric equipment with high-efficiency electric alternatives. To encourage contractors to educate customers, TVA would provide incentive payments to dealers. Heat pump incentives will match those provided under the energy efficiency options. In addition, incentives will be provided to encourage dealers to promote heat pump water heaters.

TVA will maintain a flexible posture concerning the level of aggressiveness with which it promotes this option. Changes in market or resource conditions may warrant revising some elements of the program or terminating it completely.

### Program Assumptions

| | |
|---|---|
| Package Measure Life (Years) | 15 |
| Free-Rider Rate | 10% |
| Free-Driver Rate | 0% |
| Dropouts | 0% |
| Take-Back Percentage | 0% |
| Free-Rider Market Barrier Costs Eliminated | 50% |
| Non-Free-Rider Market Barrier Costs Eliminated | 75% |
| Annual Energy Impact (kWh) | (2,935) |

| Year | Annual Eligible Population | New Participants | Total Participants | Cumulative Participation Rate |
|---|---|---|---|---|
| 1 | 84,376 | 8,440 | 8,440 | 10% |
| 2 | 84,376 | 8,440 | 16,880 | 10% |
| 3 | 84,376 | 8,440 | 25,320 | 10% |
| 4 | 84,376 | 8,440 | 33,760 | 10% |
| 5 | 84,376 | 8,440 | 42,200 | 10% |
| 6 | 84,376 | 8,440 | 50,640 | 10% |
| 7 | 84,376 | 8,440 | 59,080 | 10% |
| 8 | 84,376 | 8,440 | 67,520 | 10% |
| 9 | 84,376 | 8,440 | 75,960 | 10% |
| 10 | 84,376 | 8,440 | 84,400 | 10% |
| 11 | 84,376 | 8,440 | 92,840 | 10% |
| 12 | 84,376 | 8,440 | 101,280 | 10% |

| Year | Fixed Administrative Cost | Per Participant Variable Administrative Costs<br>$25<br>Total Variable Admin. Cost | Per Participant Measure Cost<br>$2,900<br>Total Part. Measure Cost | Per Participant Incentive<br>$230<br>Total Part. Incentive |
|---|---|---|---|---|
| 1 | $624,000 | $211,000 | $24,476,000 | $1,914,200 |
| 2 | $624,000 | $211,000 | $24,476,000 | $1,914,200 |
| 3 | $624,000 | $211,000 | $24,476,000 | $1,914,200 |
| 4 | $624,000 | $211,000 | $24,476,000 | $1,914,200 |
| 5 | $624,000 | $211,000 | $24,476,000 | $1,914,200 |
| 6 | $624,000 | $211,000 | $24,476,000 | $1,914,200 |
| 7 | $624,000 | $211,000 | $24,476,000 | $1,914,200 |
| 8 | $624,000 | $211,000 | $24,476,000 | $1,914,200 |
| 9 | $624,000 | $211,000 | $24,476,000 | $1,914,200 |
| 10 | $624,000 | $211,000 | $24,476,000 | $1,914,200 |
| 11 | $624,000 | $211,000 | $24,476,000 | $1,914,200 |
| 12 | $624,000 | $211,000 | $24,476,000 | $1,914,200 |

## Promotional Strategies

Trade allies represent a key source of program promotion. The program will feature cooperative advertising and point-of-purchase display materials. In addition, training will be provided to educate trade allies and explain program operating details.

**QUALITY GAIN ESTIMATES FOR DSMANAGER VALUE TEST**

| BE-7 | New Participants | Cumulative Penetration | One-Time Benefit/ Participant | Annual Benefit/ Participant | Quality Gain |
|---|---|---|---|---|---|
| 1995 | 8,440 | 8,440 | $0 | $1,000 | $8,440,000 |
| 1996 | 8,440 | 16,880 | $0 | $1,040 | $17,555,200 |
| 1997 | 8,440 | 25,320 | $0 | $1,082 | $27,376,240 |
| 1998 | 8,440 | 33,760 | $0 | $1,125 | $37,980,000 |
| 1999 | 8,440 | 42,200 | $0 | $1,170 | $49,374,000 |
| 2000 | 8,440 | 50,640 | $0 | $1,217 | $61,628,880 |
| 2001 | 8,440 | 59,080 | $0 | $1,265 | $74,736,200 |
| 2002 | 8,440 | 67,520 | $0 | $1,316 | $88,856,320 |
| 2003 | 8,440 | 75,960 | $0 | $1,369 | $103,989,240 |
| 2004 | 8,440 | 84,400 | $0 | $1,423 | $120,101,200 |
| 2005 | 8,440 | 92,840 | $0 | $1,480 | $137,403,200 |
| 2006 | 8,440 | 101,280 | $0 | $1,539 | $155,869,920 |

| | |
|---|---|
| *One-Time Environmental Savings* | *$0* |
| *Annual Productivity, O&M, Fuel Savings* | *$1,000* |
| *Escalation Rate* | *4%* |

## RESIDENTIAL SECURITY LIGHTING AND LAWN MOWERS

### Overview

Beneficial electrification technologies addressing security lighting and lawn maintenance would be promoted among customers where appropriate. The following technologies would be promoted in this program: high pressure sodium (HPS) security lighting, cordless electric lawn mowers, and electric cord lawn mowers.

These technologies can provide high value to certain customers. Security lighting meets a growing concern for safety, and does it in a highly efficient manner. In the past, customers wanting to receive the benefits of security lighting had to pay relatively high operating costs associated with mercury vapor lamps.

Lawn mowing with traditional gasoline-powered engines has recently been identified by the U.S. Environmental Protection Agency as a major source of air pollution. While significant improvements have been made in reducing automobile emissions, lawn mowers remain a totally uncontrolled source.

### Target Markets

These technologies would be promoted among a relatively narrow range of customers. Security lighting would be promoted in rural and high crime areas. Lawn mowers would be promoted among urban and suburban customers in the market to replace existing equipment.

### Delivery Strategy

Program delivery would be handled differently for security lighting and lawn mowers. TVA and/or power distributors would purchase HPS lamps. Power distributors would install them in geographically targeted areas. Distributors would recover costs through a leasing arrangement with the customer.

The lawn mowing component would be delivered through retail vendors such as Home Depot, Sears, hardware stores, etc. TVA would provide vendors with point-of-purchase educational materials designed to persuade the customer to purchase the electric mower rather than a gasoline-powered mower. TVA should develop a list of qualifying equipment manufacturers and recruit vendors to participate in the program. Vendors will use the list to procure equipment through their own distribution channels.

### Program Assumptions

| | |
|---|---|
| Package Measure Life (Years) | 8 |
| Free-Rider Rate | 0% |
| Free-Driver Rate | 10% |
| Dropouts | 0% |
| Take-Back Percentage | 0% |
| Free-Rider Market Barrier Costs Eliminated | 0% |
| Non-Free-Rider Market Barrier Costs Eliminated | 75% |
| Annual Energy Impact (kWh) | (196) |

| Year | Annual Eligible Population | New Participants | Total Participants | Cumulative Participation Rate |
|---|---|---|---|---|
| 1 | 2,955,150 | 14,775 | 14,775 | 1% |
| 2 | 2,955,140 | 14,775 | 29,550 | 1% |
| 3 | 2,955,130 | 14,775 | 44,325 | 2% |
| 4 | 2,955,120 | 14,775 | 59,100 | 2% |
| 5 | 2,955,110 | 29,550 | 88,650 | 3% |
| 6 | 2,955,101 | 29,550 | 118,200 | 4% |
| 7 | 2,955,091 | 29,550 | 147,750 | 5% |
| 8 | 2,955,081 | 29,550 | 177,300 | 6% |
| 9 | 2,955,071 | 29,550 | 206,850 | 7% |
| 10 | 2,955,061 | 29,550 | 236,400 | 8% |
| 11 | 2,955,051 | 29,550 | 265,950 | 9% |
| 12 | 2,955,041 | 29,550 | 295,500 | 10% |

| Year | Fixed Administrative Cost | Per Participant Variable Administrative Costs<br>$13<br>Total Variable Admin. Cost | Per Participant Measure Cost<br>$220<br>Total Part. Measure Cost | Per Participant Incentive<br>$0<br>Total Part. Incentive |
|---|---|---|---|---|
| 1 | $410,000 | $192,075 | $3,250,500 | $0 |
| 2 | $375,000 | $192,075 | $3,250,500 | $0 |
| 3 | $350,000 | $192,075 | $3,250,500 | $0 |
| 4 | $350,000 | $192,075 | $3,250,500 | $0 |
| 5 | $350,000 | $384,150 | $6,501,000 | $0 |
| 6 | $350,000 | $384,150 | $6,501,000 | $0 |
| 7 | $350,000 | $384,150 | $6,501,000 | $0 |
| 8 | $350,000 | $384,150 | $6,501,000 | $0 |
| 9 | $350,000 | $384,150 | $6,501,000 | $0 |
| 10 | $350,000 | $384,150 | $6,501,000 | $0 |
| 11 | $350,000 | $384,150 | $6,501,000 | $0 |
| 12 | $350,000 | $384,150 | $6,501,000 | $0 |

## Promotional Strategies

Security lighting will be promoted through direct mail, telemarketing, and face-to-face contact. Promotional materials will illustrate how lights improve customer security. Vendors will be the key source of promotion for lawn mowers. This component of the program would feature cooperative advertising and point-of-purchase information developed by TVA. In addition, educational materials will be developed to discuss the environmental and other benefits of electric lawn mowers.

**QUALITY GAIN ESTIMATES FOR DSMANAGER VALUE TEST**

| BE-8 | New Participants | Cumulative Penetration | One-Time Benefit/ Participant | Annual Benefit/ Participant | Quality Gain |
|---|---|---|---|---|---|
| 1995 | 14,775 | 14,775 | $0 | $0 | $0 |
| 1996 | 14,775 | 29,550 | $0 | $0 | $0 |
| 1997 | 14,775 | 44,325 | $0 | $0 | $0 |
| 1998 | 14,775 | 59,100 | $0 | $0 | $0 |
| 1999 | 29,550 | 88,650 | $0 | $0 | $0 |
| 2000 | 29,550 | 118,200 | $0 | $0 | $0 |
| 2001 | 29,550 | 147,750 | $0 | $0 | $0 |
| 2002 | 29,550 | 177,300 | $0 | $0 | $0 |
| 2003 | 29,550 | 206,850 | $0 | $0 | $0 |
| 2004 | 29,550 | 236,400 | $0 | $0 | $0 |
| 2005 | 29,550 | 265,950 | $0 | $0 | $0 |
| 2006 | 29,550 | 295,500 | $0 | $0 | $0 |

| | |
|---|---|
| *One-Time Environmental Savings* | *$0* |
| *Annual Productivity, O&M, Fuel Savings* | *$0* |
| *Escalation Rate* | *4%* |

## ELECTRIC TRANSPORTATION

### Overview

The Electric Transportation option promotes select technologies (electric bus, electric fleet van, and electric cars) to assist all customer segments in reducing emissions and improving the environment in the TVA region. These technologies offer participating customers reduced operating and maintenance costs.

There are several market barriers related to this option that must be considered. This option represents a "cutting edge" strategy in promoting and accelerating the commercialization of this technology. The electric vehicle technology has not advanced to a high confidence level; in fact, it currently has reached a plateau and a technology breakthrough is required to instill enthusiasm and confidence into the marketplace.

Within the option, customers are offered a select menu of electrotechnologies from which to choose in determining the most appropriate solution to meet their needs. Electric buses and vans will target commercial, industrial, and municipal customers. Electric cars will target residential customers in select areas. A pilot program is recommended to gain experience in administering such a program. In addition, a pilot offers minimal risks to TVA and allows the evaluation of specific technologies and development of the optimal program delivery mechanisms.

### Target Markets

Target markets pursued in the initial pilot include select geographic areas and markets within the industrial, commercial, residential, and municipal sectors.

### Delivery Strategy

TVA does not plan to offer rebates as part of the program. The program and its technology options will be marketed as an innovative technology. TVA may consider financing or a technology-specific rate to stimulate consumer interest.

Program delivery will be administered through TVA marketing representatives and specific in-house technical staff working with power distributors and various trade allies/professionals. TVA should hire/develop an industry expert (transportation) for technical support of the program. TVA should also consider teaming up with trade professionals (equipment sales engineers and representatives) to assist in customer education and awareness. Coordination with the listed trade professionals from initial program design through program roll-out is essential to program success.

*Electric Transportation/Electric Buses*

### Program Assumptions

| | |
|---|---|
| Package Measure Life (Years) | 20 |
| Free-Rider Rate | 20% |
| Free-Driver Rate | 0% |
| Dropouts | 0% |
| Take-Back Percentage | 0% |
| Free-Rider Market Barrier Costs Eliminated | 0% |
| Non-Free-Rider Market Barrier Costs Eliminated | 75% |
| Annual Energy Impact (kWh) | (32,500) |

| Year | Annual Eligible Population | New Participants | Total Participants | Cumulative Participation Rate |
|---|---|---|---|---|
| 1 | 100 | — | — | 0% |
| 2 | 500 | 5 | 5 | 1% |
| 3 | 995 | 20 | 25 | 3% |
| 4 | 975 | 29 | 54 | 6% |
| 5 | 946 | 29 | 83 | 9% |
| 6 | 917 | 27 | 110 | 12% |
| 7 | 890 | 27 | 137 | 15% |
| 8 | 863 | 26 | 163 | 19% |
| 9 | 837 | 25 | 188 | 22% |
| 10 | 812 | 24 | 212 | 26% |
| 11 | 788 | 24 | 236 | 30% |
| 12 | 764 | 23 | 259 | 34% |

| Year | Fixed Administrative Cost | Per Participant Variable Administrative Costs<br>$0<br>Total Variable Admin. Cost | Per Participant Measure Cost<br>$200,000<br>Total Part. Measure Cost | Per Participant Incentive<br>$0<br>Total Part. Incentive |
|---|---|---|---|---|
| 1 | $88,333 | $0 | $0 | $0 |
| 2 | $88,333 | $0 | $1,000,000 | $0 |
| 3 | $88,333 | $0 | $4,000,000 | $0 |
| 4 | $88,333 | $0 | $5,800,000 | $0 |
| 5 | $117,500 | $0 | $5,800,000 | $0 |
| 6 | $117,500 | $0 | $5,400,000 | $0 |
| 7 | $117,500 | $0 | $5,400,000 | $0 |
| 8 | $117,500 | $0 | $5,200,000 | $0 |
| 9 | $117,500 | $0 | $5,000,000 | $0 |
| 10 | $117,500 | $0 | $4,800,000 | $0 |
| 11 | $117,500 | $0 | $4,800,000 | $0 |
| 12 | $117,500 | $0 | $4,600,000 | $0 |

## Promotional Strategies

The program will be promoted via program brochures and marketing materials to permit widespread awareness of the program and its electric technologies. Technical seminars and training will be provided to educate potential customers concerning the virtues of electric vehicles and corresponding customer benefits. Presentations will be made at various industry and general public meetings to further promote this option.

**QUALITY GAIN ESTIMATES FOR DSMANAGER VALUE TEST**

| BE-9A | New Participants | Cumulative Penetration | One-Time Benefit/ Participant | Annual Benefit/ Participant | Quality Gain |
|---|---|---|---|---|---|
| 1995 | 0 | 0 | $0 | $6,000 | $0 |
| 1996 | 5 | 5 | $0 | $6,240 | $31,200 |
| 1997 | 20 | 25 | $0 | $6,490 | $162,250 |
| 1998 | 29 | 54 | $0 | $6,749 | $364,446 |
| 1999 | 29 | 83 | $0 | $7,019 | $582,577 |
| 2000 | 26 | 110 | $0 | $7,300 | $803,000 |
| 2001 | 27 | 137 | $0 | $7,592 | $1,040,104 |
| 2002 | 26 | 163 | $0 | $7,896 | $1,287,048 |
| 2003 | 25 | 188 | $0 | $8,211 | $1,543,688 |
| 2004 | 24 | 212 | $0 | $8,540 | $1,810,480 |
| 2005 | 24 | 236 | $0 | $8,881 | $2,095,916 |
| 2006 | 23 | 259 | $0 | $9,237 | $2,392,383 |

| | |
|---|---|
| *One-Time Environmental Savings* | *$0* |
| *Annual Productivity, O&M, Fuel Savings* | *$6,000* |
| *Escalation Rate* | *4%* |

*Electric Transportation/Fleet Vehicles*

## Program Assumptions

| | |
|---|---|
| Package Measure Life (Years) | 20 |
| Free-Rider Rate | 20% |
| Free-Driver Rate | 0% |
| Dropouts | 0% |
| Take-Back Percentage | 0% |
| Free-Rider Market Barrier Costs Eliminated | 0% |
| Non-Free-Rider Market Barrier Costs Eliminated | 40% |
| Annual Energy Impact (kWh) | (7,800) |

| Year | Annual Eligible Population | New Participants | Total Participants | Cumulative Participation Rate |
|---|---|---|---|---|
| 1 | 500 | — | — | 0% |
| 2 | 500 | 5 | 5 | 1% |
| 3 | 1,998 | 30 | 35 | 2% |
| 4 | 3,972 | 60 | 95 | 2% |
| 5 | 3,924 | 82 | 177 | 5% |
| 6 | 3,858 | 62 | 239 | 6% |
| 7 | 3,809 | 61 | 300 | 8% |
| 8 | 3,760 | 41 | 341 | 9% |
| 9 | 3,727 | 41 | 382 | 10% |
| 10 | 3,694 | 41 | 423 | 11% |
| 11 | 3,662 | 40 | 463 | 13% |
| 12 | 3,630 | 40 | 503 | 14% |

| Year | Fixed Administrative Cost | Per Participant Variable Administrative Costs<br>$0<br>Total Variable Admin. Cost | Per Participant Measure Cost<br>$18,000<br>Total Part. Measure Cost | Per Participant Incentive<br>$0<br>Total Part. Incentive |
|---|---|---|---|---|
| 1 | $88,333 | $0 | $0 | $0 |
| 2 | $88,333 | $0 | $90,000 | $0 |
| 3 | $88,333 | $0 | $540,000 | $0 |
| 4 | $88,333 | $0 | $1,080,000 | $0 |
| 5 | $117,500 | $0 | $1,476,000 | $0 |
| 6 | $117,500 | $0 | $1,116,000 | $0 |
| 7 | $117,500 | $0 | $1,098,000 | $0 |
| 8 | $117,500 | $0 | $738,000 | $0 |
| 9 | $117,500 | $0 | $738,000 | $0 |
| 10 | $117,500 | $0 | $738,000 | $0 |
| 11 | $117,500 | $0 | $720,000 | $0 |
| 12 | $117,500 | $0 | $720,000 | $0 |

**QUALITY GAIN ESTIMATES FOR DSMANAGER VALUE TEST**

| BE-9B | New Participants | Cumulative Penetration | One-Time Benefit/ Participant | Annual Benefit/ Participant | Quality Gain |
|---|---|---|---|---|---|
| 1995 | 0 | 0 | $0 | $200 | $0 |
| 1996 | 5 | 5 | $0 | $208 | $1,040 |
| 1997 | 30 | 35 | $0 | $216 | $7,560 |
| 1998 | 60 | 95 | $0 | $225 | $21,375 |
| 1999 | 82 | 177 | $0 | $234 | $41,418 |
| 2000 | 62 | 239 | $0 | $243 | $58,077 |
| 2001 | 61 | 300 | $0 | $253 | $75,900 |
| 2002 | 41 | 341 | $0 | $263 | $89,683 |
| 2003 | 41 | 382 | $0 | $274 | $104,688 |
| 2004 | 41 | 423 | $0 | $285 | $120,555 |
| 2005 | 40 | 463 | $0 | $296 | $137,048 |
| 2006 | 40 | 503 | $0 | $308 | $154,924 |

| | |
|---|---|
| *One-Time Environmental Savings* | *$0* |
| *Annual Productivity, O&M, Fuel Savings* | *$200* |
| *Escalation Rate* | *4%* |

*Electric Transportation/Electric Autos*

## Program Assumptions

| | |
|---|---|
| Package Measure Life (Years) | 10 |
| Free-Rider Rate | 30% |
| Free-Driver Rate | 0% |
| Dropouts | 0% |
| Take-Back Percentage | 0% |
| Free-Rider Market Barrier Costs Eliminated | 0% |
| Non-Free-Rider Market Barrier Costs Eliminated | 75% |
| Annual Energy Impact (kWh) | (3,000) |

| Year | Annual Eligible Population | New Participants | Total Participants | Cumulative Participation Rate |
|---|---|---|---|---|
| 1 | 2,000 | — | — | 0% |
| 2 | 2,000 | 10 | 10 | 1% |
| 3 | 9,995 | 50 | 60 | 1% |
| 4 | 19,940 | 199 | 259 | 1% |
| 5 | 19,741 | 197 | 457 | 2% |
| 6 | 19,543 | 195 | 652 | 3% |
| 7 | 19,348 | 193 | 845 | 4% |
| 8 | 19,154 | 192 | 1,037 | 5% |
| 9 | 18,963 | 190 | 1,227 | 6% |
| 10 | 18,773 | 188 | 1,415 | 8% |
| 11 | 18,585 | 186 | 1,600 | 9% |
| 12 | 18,400 | 184 | 1,784 | 10% |

| Year | Fixed Administrative Cost | Per Participant Variable Administrative Costs<br>$0<br>Total Variable Admin. Cost | Per Participant Measure Cost<br>$25,000<br>Total Part. Measure Cost | Per Participant Incentive<br>$0<br>Total Part. Incentive |
|---|---|---|---|---|
| 1 | $88,333 | $0 | $0 | $0 |
| 2 | $88,333 | $0 | $250,000 | $0 |
| 3 | $88,333 | $0 | $1,250,000 | $0 |
| 4 | $88,333 | $0 | $4,975,000 | $0 |
| 5 | $117,500 | $0 | $4,925,000 | $0 |
| 6 | $117,500 | $0 | $4,875,000 | $0 |
| 7 | $117,500 | $0 | $4,825,000 | $0 |
| 8 | $117,500 | $0 | $4,800,000 | $0 |
| 9 | $117,500 | $0 | $4,750,000 | $0 |
| 10 | $117,500 | $0 | $4,700,000 | $0 |
| 11 | $117,500 | $0 | $4,650,000 | $0 |
| 12 | $117,500 | $0 | $4,600,000 | $0 |

**QUALITY GAIN ESTIMATES FOR DSMANAGER VALUE TEST**

| BE-9C | New Participants | Cumulative Penetration | One-Time Benefit/ Participant | Annual Benefit/ Participant | Quality Gain |
|---|---|---|---|---|---|
| 1995 | 0 | 0 | $0 | $700 | $0 |
| 1996 | 10 | 10 | $0 | $728 | $7,280 |
| 1997 | 50 | 60 | $0 | $757 | $45,427 |
| 1998 | 199 | 259 | $0 | $787 | $203,938 |
| 1999 | 197 | 457 | $0 | $819 | $374,283 |
| 2000 | 195 | 652 | $0 | $852 | $555,504 |
| 2001 | 193 | 845 | $0 | $886 | $748,670 |
| 2002 | 192 | 1,037 | $0 | $921 | $955,077 |
| 2003 | 190 | 1,227 | $0 | $958 | $1,175,466 |
| 2004 | 188 | 1,415 | $0 | $996 | $1,409,340 |
| 2005 | 186 | 1,600 | $0 | $1,036 | $1,657,874 |
| 2006 | 184 | 1,784 | $0 | $1,078 | $1,922,470 |

| | |
|---|---|
| *One-Time Environmental Savings* | *$0* |
| *Annual Productivity, O&M, Fuel Savings* | *$700* |
| *Escalation Rate* | *4%* |

# TECHNOLOGY INFORMATION

## DESCRIPTION OF TECHNOLOGY DATABASE

TVA developed a technology database that includes information on energy efficiency, load management, beneficial electrification, and self/generation and renewable technologies. The data used to develop the technology database included information from several primary and secondary data sources. Hourly simulations for all building types provided data for the weather-dependent technologies.

Development of the database began with a list of technologies that was reviewed for diversity and completeness by two leading DSM consultants. TVA worked with Synergic Resources Corporation (SRC) to develop the energy efficiency portions of the database for the residential, commercial, and industrial sectors. Barakat & Chamberlin, Inc. (BCI) provided information for renewable and beneficial electrification technologies. For some technologies, estimates of costs and impacts were obtained from more than one source. Technology information on small cogeneration systems was provided by Schiller Associates and UNIMAR Group, Ltd.

Technology costs and energy and demand impacts were included for both existing structures and new construction to provide estimates for retrofit and new construction options. Technologies were matched with appropriate base technologies for each market. Base technology energy use and shares were taken from detailed forecast information contained in TVA's files for REEPS (EPRI's Residential End-Use Energy Planning System software) and COMMEND (EPRI's Commercial End-Use Planning System software). Historical residential UECs (Unit Energy Consumption, kWh/yr) are based on conditional demand models using TVA survey and billing data. Some appliance data are based on manufacturers and EPRI estimates, along with other sources. The use of REEPS and COMMEND energy use and shares helped to ensure that technology estimates were consistent with load forecast assumptions. Forecast market shares were based on residential, commercial, and industrial surveys performed by TVA.

Additions and corrections to the database were made based on comments from TVA staff and reviews by the following organizations:

- National Renewable Energy Laboratory (NREL), Golden, Colorado
- TELLUS Institute, Boston, Massachusetts
- E Source, Boulder, Colorado
- TVA Energy Vision 2020 Review Group members and their consultants:
  - —Resource Insight, Inc., Middlebury, Vermont
  - —Xenergy, Allendale, New Jersey
  - —Vermont Energy Investment Corporation, Burlington, Vermont

## RESIDENTIAL

Primary data sources included existing saturation surveys, energy audits, end-use load forecasts, and institutional data. Hourly building simulations of prototypical buildings were developed using DOE-2 and TMY (Typical Meteorological Year) weather for Nashville, Tennessee, to estimate energy and demand impacts of HVAC technologies and building shell improvements. DOE-2 is public domain software developed with funding from the U.S. Department of Energy and used internationally to calculate the hourly energy use of buildings and their life cycle costs of operation, given information on building location, construction, operation, and heating and air conditioning systems.

Secondary data sources included Competitek, EPRI reports, energy journals, case studies, other utility filings, ESOURCE reports, manufacturers' literature, and previous work done by SRC and BCI. ESOURCE, formerly known as Competitek, is a proprietary information service and a subsidiary of Rocky Mountain Institute.

As much as possible, the energy impacts have been adjusted to be consistent with TVA's residential end-use forecast.

The residential technologies include electric conservation, load shifting, peak clipping, and beneficial electrification (load building) measures. A summary listing of the DSM technologies is shown in *Figure T7-5*.

The technologies were grouped by end use. The primary end-use catagories considered for the residential sector were: Space Conditioning, Water Heating, Appliance, and Lighting. For each end use, the technologies were mapped to an appropriate base technology and building type. In the residential market, three building types were included: single-family, multi-family, and manufactured homes. Following are descriptions of the technologies considered for each end use.

## *FIGURE T7-5.* Residential Technologies

| End-Use | Demand-Side Measure |
|---|---|
| Space Conditioning Cooling | High-Efficiency Room Air Conditioner |
| | High-Efficiency Central Air Conditioner (CAC) |
| | Two-Speed Central Air Conditioner |
| | Whole-House Fan |
| | Ceiling Fans |
| | Servicing Central Air Conditioner |
| | Central Air Conditioner Cycling or Direct Load Control |
| Space Conditioning Cool/Heat | High-Efficiency Heat Pump |
| | Standard Heat Pump |
| | Two-Speed Heat Pump |
| | Ground-Source Heat Pump |
| | Dual-Fuel Heat Pump |
| | Standard Add-On Heat Pump |
| | High-Efficiency Add-On Heat Pump |
| | Electric Heat Direct Load Control |
| | Insider Heat Pump |
| | Servicing Heat Pump |
| Space Conditioning Ducting & Controls | Ducts in Conditioned Spaces |
| | Reduced Duct Leakage |
| | Reduced Duct Heat Transfer |
| | Programmable Thermostat |
| Space Conditioning Building Shell | Wall Insulation |
| | Weather Stripping/Caulking |
| | Window Film/Reflective Glass |
| | Low-E Glass |
| | Window Shade Screens |
| | Reflective Roof Coating |
| | Attic Radiant Barrier |
| | Landscape Shading |
| | Ceiling Insulation |
| Water Heating | High-Efficiency Electric Resistance |
| | Integral Heat Pump Water Heater |
| | Add-On Heat Pump Water Heater |
| | Maintenance of Heat Pump Water Heater |
| | Solar Water Heater |
| | Heat Recovery Water Heater (Desuperheater) |
| | Instantaneous (Tankless) Electric Water Heater |
| | Water Heater Tank Wrap |
| | Water Heater Heat Trap |
| | Hot Water Pipe Insulation |
| | Low Flow Showerhead |
| | Direct Load Control of Electric Resistance |
| | Bottom Boards |
| | Standard Efficiency Gas Water Heater |
| | High-Efficiency Gas Water Heater |
| Appliances | Best Current Frost-Free Refrigerator |
| | Remove Second Refrigerator |
| | Best Current Frost-Free Freezer |
| | Remove Second Freezer |
| | Servicing Refrigerator or Freezer (Clean Coils) |
| | Microwave Clothes Dryer |
| | Electric Dryer with Moisture Sensor |
| | Heat Pump Clothes Dryer |
| | Horizontal-Axis Clothes Dryer |
| | High-Efficiency Dishwasher |
| | Induction Cooktop |
| | Electric Cordless Lawn Mower |
| | Electric Cord Lawn Mower |
| | Smart House (Home Automation & Real-Time Pricing) |
| | High-Efficiency Pool Pumps or Spa Pumps |
| | Downsized Pool Pumps with Oversized Piping |
| | Direct Load Control of Pool Pumps |
| | Pool Pump Timer |
| Lighting | Compact Fluorescent |
| | Efficient Incandescent |
| | Security Lighting |
| | High Pressure Sodium (Outdoor) |
| | Halogen Lamp (Outdoor) |
| | Halogen Lamp (Indoor) |
| | Motion Detectors for Outdoor Lighting |

## Residential Space Conditioning

Six prototypical buildings were simulated in DOE-2 with Nashville TMY weather data to develop some of the energy impacts for space conditioning technologies. Energy impacts from simulations of a building with and without a particular technology were combined with REEPS UECs to develop average kWh and kW demand impacts.

In the short descriptions of space conditioning technologies that follow, some abbreviations are used for ratings of equipment. The common rating terms are:

- COP—Coefficient of Performance
- HSPF—Heating Season Performance Factor
- SEER—Seasonal Energy Efficiency Ratio
- R-Value—Insulation Value

### *Cooling*

**High-Efficiency Room Air Conditioner—**A high-efficiency unit with an Energy Efficiency Ratio (EER) of 11.0 replaces a standard unit with an EER of 8.8.

**High-Efficiency Central Air Conditioner**—A high-efficiency unit with a SEER of 13.0 and a Coefficient of Performance (COP) of 3.437 replaces a standard unit with a SEER of 10.0 and a COP of 2.570.

**Two-Speed Central Air Conditioner**—A two-speed unit with a SEER of 14.8 and a COP of 3.074 replaces a standard unit with a SEER of 10.0 and a COP of 2.570. The two-speed unit has better performance than the high-efficiency unit at part load, but has a lower performance at design conditions.

**Whole-House Fan**—A whole-house fan is installed in new and existing single-family dwellings to reduce cooling energy use. The fan will be sized to provide 20 air changes per hour and will operate when the outdoor air temperature is above 72° F and below 83° F, and when relative humidity is 60 percent or less. When the fan is running, the air conditioning system is turned off.

**Ceiling Fans**—Ceiling fans will allow cooling thermostat settings to be increased by 2° F in single-family and multi-family dwellings. A ceiling fan will be installed for each 250 square feet of floor area.

**Servicing Central Air Conditioner**—Annual air conditioner maintenance reduces cooling energy use by 10 percent.

**Central Air Conditioner Cycling or Direct Load Control —** This measure involves the use of remote transmitters to control residential space cooling systems to reduce peak load by load shedding (turning units off at the time of the utility peak) or cycling (periodically turning units off).

### *Cool/Heat*

**High-Efficiency Heat Pump—**A high-efficiency air-source heat pump with SEER 13.0 and HSPF 8.1 replaces a standard efficiency heat pump with SEER 10.0 and HSPF 6.8 in new and existing construction. The standard unit has a cooling COP of 2.570 and a heating COP of 2.978. The high-efficiency unit has a cooling COP of 3.437 and a heating COP of 3.540.

**Standard Heat Pump**—The standard air-source heat pump has a SEER of 10.0 and a HSPF of 6.8 in new and existing construction. The standard unit has a cooling COP of 2.570 and a heating COP of 2.978.

**Two-Speed Heat Pump**—A heat pump with a two-speed compressor, a SEER of 14.8 and a HSPF of 8.45 replaces a standard heat pump. The heat pump has a cooling COP of 3.074 and a heating COP of 3.430. The primary advantage of the two-speed heat pump is better performance at part load. Part load is between no load and full load. At design conditions (full load), this heat pump is somewhat less efficient than a high-efficiency unit.

**Ground-Source Heat Pump—**A ground-source heat pump exchanges heat with water in thermal contact with the ground. Ground-source heat pumps can be closed-loop, where water is continuously circulated (while the heat pump is running) between the heat pump and pipes buried in the ground, or they can be open-loop, where water is extracted from a well or lake and dumped after use. A ground-source heat pump replaces a standard efficiency heat pump. For this analysis, only closed-loop systems were considered.

**Dual-Fuel Heat Pump**—A dual-fuel heat pump is an air-source heat pump with a fossil fuel burner system for back-up heating rather than resistance coils. Estimates were included for a SEER 12 unit.

**Standard Add-On Heat Pump**—This measure is promoted to households that currently have central air conditioning and gas heat and are approaching the time of replacement of their central air conditioners. In addition to providing cooling, an add-on heat pump would provide heating during the moderate heating season and gas heat would be used as a back-up. The cooling efficiency of the Central Air Conditioner (CAC) and heat pump is SEER 10.0. The gas heating efficiency is 78 percent Annual Fuel Utilization Efficiency (AFUE), and the heat pump heating efficiency is HSPF 6.8.

**High-Efficiency Add-On Heat Pump**—This measure is similar to the standard add-on heat pump, except a high-efficiency heat pump is promoted, having a SEER 13 and HSPF 8.1. This measure provides heating electrification and cooling conservation.

**Electric Heat Direct Load Control**—This measure involves the use of remote transmitters to control residential space heat-

ing systems to reduce peak load by load shedding (turning units off at the time of the utility peak) or cycling (periodically turning units off). This measure was only considered for utilities that already have load control programs, meaning the cost of the central transmitter is not included in the estimates.

**Insider Heat Pump**—Estimates for this particular heat pump were included for manufactured housing.

**Servicing Heat Pump**—Annual heat pump maintenance reduces cooling energy use by 10 percent and heating energy use by 9.2 percent.

### *Ducting and Controls*

**Ducts in Conditioned Spaces**—It is common in single-family detached dwellings to have space conditioning ductwork located in unconditioned spaces (primarily the attic). For this measure, the ductwork in new single-family detached dwellings will be located in the conditioned space to eliminate losses associated with duct leakage and duct heat gain/loss.

**Reduced Duct Leakage**—This measure involves the sealing of space conditioning ducts to eliminate the loss of conditioned air and/or the introduction of attic air into the duct system. An equivalent conditioning system efficiency change was used in DOE-2 to simulate a 70 percent reduction in duct air losses. One-third of this improvement was on the supply-side ducts and two-thirds were on the return side ducts.

**Reduced Duct Heat Transfer**—This measure involves the addition of insulation to ducting in new single-family detached dwellings. For this measure, it is assumed that additional insulation would be added to increase the duct total insulation level to R-12 from R-6 required by the energy code.

**Programmable Thermostat**—The programmable thermostat sets the thermostat up 5° F from 9:00 AM to 5:00 PM during weekdays in the cooling season and sets the thermostat down 5° F from 11:00 PM to 6:00 AM for all days during the heating season. The thermostat is assumed to have energy management recovery that allows for early recovery from a setup and involves the automatic calculation of when to begin raising (or lowering) the space temperature to reach the programmed temperature at a preset time.

### *Building Shell*

**Wall Insulation**—For this measure, wall insulation in existing frame dwellings is increased from R-0 to R-11. This measure only applies to dwellings with no wall insulation.

**Weather Stripping/Caulking**—Caulking and weather stripping of existing dwellings reduces air infiltration by 10 percent on average. This measure only applies to existing dwellings, as it is assumed that new construction is adequately sealed in accordance with the new construction building code.

**Window Film/Reflective Glass**—In existing dwellings, a reflective window film is applied to the interior surface of single-pane windows. Double-pane reflective glass is substituted for clear double-pane glass in new construction. This measure is applied to windows facing east and west because the solar gain is highest from these directions.

**Low-Emissivity Glass**—To represent this class of windows, double-pane glass with an argon gas fill and a low-emissivity coating on the inner surface of the outer pane replaces single- and double-pane clear glass windows. This measure reduces heat transmission through the windows.

**Window Shade Screens**—For this measure, shade screens that block solar gain are installed on single- and double-pane clear windows in existing and new construction. This measure is applied to windows facing east and west because solar gain is highest from these directions.

**Reflective Roof Coating**—This measure will involve the application of a reflective coating with an absorptivity of 0.30 to a standard roof with an absorptivity of 0.80 to reduce the cooling loads associated with roof solar gain.

**Attic Radiant Barrier**—This measure involves the installation of a reflective surface on the bottom of roof joists in new single-family detached construction to reduce solar gain through the roof. The reflective surface will have an emissivity of 0.08 on each side and result in an effective increase in the roof insulation of approximately R-7.

**Landscape Shading**—This measure involves the planting of six trees, three each on the east and west sides of new and existing single family dwellings, to provide external shading during the cooling season.

**Ceiling Insulation (new construction)—**This measure involves adding more ceiling insulation (from R-30 to R-38) to new dwellings.

**Ceiling Insulation (R-0 to R-19)**—In existing dwellings with no ceiling insulation, R-19 would be added.

**Ceiling Insulation (R-11 to R-30)**—In existing dwellings with R-11 ceiling insulation, R-19 would be added to achieve a total of R-30.

**Ceiling Insulation (R-19 to R-30)**—In existing dwellings with R-19 ceiling insulation, R-11 would be added to achieve a total of R-30.

**Ceiling Insulation (R-30 to R-38)—**In existing dwellings with R-30 ceiling insulation, R-8 would be added to achieve a total of R-38.

## Residential Water Heating

There are four general types of electric water heating equipment for the residential market:

- Electric resistance water heater
- Heat pump water heater
- Heat recovery water heater (desuperheater)
- Solar water heater

Each type has unique operating and consumption characteristics. The UEC for electric water heating is a combination (weighted average) of these four heating types for each building type. Individual UECs for each technology type were derived by disaggregating the weighted-average UEC (from REEPS) using the relative efficiencies and shares for each technology type. Efficiencies, saturations, and UECs for water heating are shown in *Figures T7-6, T7-7,* and *T7-8.*

Brief descriptions of the residential water heating technologies follow.

**High-Efficiency Electric Resistance—**Electric resistance water heaters with Efficiency Factors of 0.96 are compared to models that meet federal appliance standards (EF=0.90).

**Integral Heat Pump Water Heater—**Heat pump water heaters could be installed either to replace electric resistance water heaters or gas water heaters. When an electric resistance water heater is replaced, the electricity used for water heating is reduced by approximately half

*FIGURE T7-6.* **Electric Water Heating Technologies: Relative Efficiencies**

| Water Heater System Type | Annual COP | Normalized COP | Daily Use (kWh) | Percent Savings |
|---|---|---|---|---|
| Resistance Water Heaters | 0.82 | 1 | 9.60 | 0% |
| Heat Pump Water Heaters | 1.53 | 1.87 | 5.13 | 47% |
| Heat Recovery Water Heaters | 1.1 | 1.34 | 7.16 | 25% |
| Solar Water Heaters | 2.35 | 2.87 | 3.34 | 65% |

*SOURCE: FSEC, 1990. Florida Solar Energy Center, "Electrical Use, Efficiency, and Peak Demand of Electric Resistance, Heat Pump, Desuperheater, and Solar Hot Water Systems."*

*FIGURE T7-7.* **Electric Water Heating: Saturations**

| | EXISTING | | | NEW | | |
|---|---|---|---|---|---|---|
| | Single-Family | Multi-Family | Manufactured Home | Single-Family | Multi-Family | Manufactured Home |
| All Electric Water Heaters [1] | 75.54 | 78.40 | 84.68 | 75.54 | 78.40 | 84.68 |
| Resistance Water Heaters [2] | 96.00 | 97.00 | 100.00 | 96.00 | 97.00 | 100.00 |
| Heat Pump Water Heaters [2] | 2.00 | 2.00 | 0.00 | 2.00 | 2.00 | 0.00 |
| Heat Recovery Water Heaters [2] | 1.00 | 0.00 | 0.00 | 1.00 | 0.00 | 0.00 |
| Solar Water Heaters | 1.00 | 1.00 | 0.00 | 1.00 | 1.00 | 0.00 |

[1] Electric water heat saturations for existing households are taken directly from 1993 Residential Sales Profile. Saturations for new households are assumed to be the same as existing.

[2] Based on SRC assumptions of the distribution of electric water heating technologies.

*FIGURE T7-8.* **Electric Water Heating: Unit Energy Consumptions (UECs)**

| | EXISTING | | | NEW | | |
|---|---|---|---|---|---|---|
| | Single-Family | Multi-Family | Manufactured Home | Single-Family | Multi-Family | Manufactured Home |
| All Electric Water Heaters [1] | 4,178 | 3,304 | 3,200 | 3,807 | 3,011 | 2,916 |
| Resistance Water Heaters - STOCK [2] | 4,256 | 3,357 | 3,200 | 3,878 | 3,059 | 2,916 |
| Heat Pump Water Heaters [2] | 2,276 | 1,795 | 1,711 | 2,074 | 1,636 | 1,559 |
| Heat Recovery Water Heaters [2] | 3,176 | 2,505 | 2,388 | 2,894 | 2,283 | 2,176 |
| Solar Water Heaters [2] | 1,483 | 1,170 | 1,115 | 1,351 | 1,066 | 1,016 |
| Resistance Water Heaters- STANDARD [3] | 3,878 | 3,059 | 2,916 | 3,878 | 3,059 | 2,916 |

*[1] All electric water heat UEC values for existing households are directly from 1993 Residential Sales Profile and exclude energy used in conjunction with major hot water using appliances. All electric water heat UECs for new households are calculated based on the adjustment factor used for Stock to Standard.*

*[2] Calculated based on the shares and relative efficiencies such that the weighted average is consistent with the All Electric Water Heater UEC.*

*[3] Calculated based on the adjustment of STOCK consumption to account for natural increases in efficiency due to replacements . Efficiency of STOCK water heaters estimated to be EF=0.82 (average efficiency in 1986) and of STANDARD water heaters to be EF=0.90 (based on 1990 Federal Standards).*

(as well as providing reduced cooling loads in some cases). A heat pump water heater utilizes a vapor compressor refrigerator cycle similar to that of an air conditioner to draw heat from the surrounding air to heat water. The heat pump water heater condenser rejects heat to the domestic water supply. An integral unit includes both the water tank and the heat pump water heater located on top of the tank.

**Add-On Heat Pump Water Heater**—An add-on heat pump water heater supplements the existing electric resistance hot water system at the supply to the water heater.

**Maintenance of Heat Pump Water Heater**—Maintenance includes replacing filters, cleaning coils, checking refrigerant charge, checking plumbing connections, and checking plumbing insulation to maintain efficiency of the heat pump water heater.

**Solar Water Heater**—The solar water heating system actually assists rather than replaces an electric resistance water heater. When solar radiation is available, it is absorbed by collector panels and then transferred to the domestic hot water supply. Some systems heat water directly by circulating potable water through the solar loop. Others recirculate the same absorption fluid through the collectors and transfer the heat via a heat exchanger to the potable water supply.

**Heat Recovery Water Heater—**Estimates for the replacement of an electric resistance water heater with a heat recovery water heater show the majority of the savings occur during summer months. These units recover superheat from the compressor discharge gas of a central air conditioner or heat pump for the purpose of heating or preheating water.

**Instantaneous (Tankless) Electric Water Heater—**Energy savings result primarily from the elimination of tank losses. Demand increases may result in the winter because larger heating elements are used and hot water is frequently used during winter peak times.

**Water Heater Tank Wrap**—This measure includes the installation of R-11 external insulation blanket onto electric resistance water heater tanks.

**Water Heater Heat Trap**—This measure includes the installation of external heat traps on both the inlets and outlets of electric water heaters.

**Hot Water Pipe Insulation**—This measure includes the installation of pipe insulation to all accessible domestic hot water piping (assumed to be 70 feet of pipe in new homes, but only 20 feet in existing homes).

**Low Flow Showerhead**—This measure replaces existing showerheads (3-5 gallons per minute or gpm) with high quality low flow showerheads (2-2.5 gpm). Water savings, as well as energy to heat the water, result for each shower of equivalent quality. Estimates are per household.

**Direct Load Control of Electric Resistance Water Heaters** — Utility-controlled radio switches installed on residential electric water heaters could shut off 100 percent of participating water heaters during utility system peak periods.

**Bottom Boards**—This measure involves placing a 2-inch polystyrene (R-10) board under an electric resistance water heater. Savings measurements of 53 to 75 kWh/year have been recorded. Savings of 75 kWh/year were assumed for single-families, savings and 60 kWh/year savings were assumed for multi-family and manufactured housing.

**Standard Efficiency Gas Water Heater**—This measure includes replacing an existing electric water heater (assumed EF=0.82) with a standard efficiency gas water heater (EF=0.54 for 40-gallon heater and 0.56 for 30-gallon heater).

**High-Efficiency Gas Water Heater**—This measure includes replacing an existing electric water heater (assumed EF=0.82) with a high-efficiency gas water heater (EF=0.65 for 40-gallon and EF=0.63 for 30-gallon).

## Residential Appliances

The 1993 UECs and saturations (or shares) from REEPS were the basis for evaluating new appliances and are shown in *Figure T7-9* and *T7-10.*

Brief descriptions of residential appliance technologies follow.

**Best Current Frost-Free Refrigerator—**Estimates were included for frost-free refrigerators with efficiencies at least 16 percent better than those required by federal appliance efficiency standards.

**Remove Second Refrigerator**—Customers with second, older, and less efficient, yet still operating refrigerators could be encouraged to remove them. The utility would be responsible for picking up and disposing of the refrigerators.

**Best Current Frost-Free Freezer**—Estimates were included for frost-free freezers with efficiencies at least 22 percent better than those required by federal appliance efficiency standards.

**Remove Second Freezer—**Customers with second, older, and less efficient, yet still operating freezers could be encouraged to remove them. The utility would be responsible for picking up and disposing of the freezers.

**Servicing Refrigerator or Freezer (Primarily Clean Coils)—** This measure was included for direct-install type options (programs).

**Microwave Clothes Dryer—**Successful prototypes that vaporize the water in clothes rather than heating them may now have a solution to the metal button problem. Preliminary tests with a lower frequency magnetron have been successful. Energy, drying times, and drying temperatures are all reduced with this technology.

## *FIGURE T7-9.* Appliances: Unit Energy Consumptions (UECs)

| | EXISTING | | | NEW | | |
|---|---|---|---|---|---|---|
| Appliance | Single-Family | Multi-Family | Manufactured Home | Single-Family | Multi-Family | Manufactured Home |
| Refrigerator - 1st | 1,088 | 989 | 990 | 1,088 | 989 | 990 |
| Refrigerator - 2nd | 949 | 757 | 941 | 949 | 757 | 941 |
| Refrigerator - Average | 1,066 | 980 | 988 | 1,066 | 980 | 988 |
| Freezer | 989 | 800 | 815 | 989 | 800 | 815 |
| Clothes Dryer | 1,017 | 957 | 906 | 1,017 | 957 | 906 |
| Clothes Washer | 195 | 134 | 113 | 195 | 134 | 113 |
| Dishwasher | 394 | 336 | 334 | 394 | 336 | 334 |
| Electric Cooking | 994 | 845 | 746 | 994 | 845 | 746 |
| Pool Pumps (from FEO) | 3,117 | 3,117 | 3,117 | 3,117 | 3,117 | 3,117 |

*From Tennessee Valley Authority 1993 Residential Sales Profile*
*FEO = Florida Energy Office*

## *FIGURE T7-10.* Appliances: Saturations

| | EXISTING | | | NEW | | |
|---|---|---|---|---|---|---|
| Appliance | Single-Family | Multi-Family | Manufactured Home | Single-Family | Multi-Family | Manufactured Home |
| Refrigerator - 1st | 100 | 100 | 100 | 100 | 100 | 100 |
| Refrigerator - 2nd | 19 | 4 | 4 | 19 | 4 | 4 |
| Freezer | 57 | 16 | 36 | 57 | 16 | 36 |
| Clothes Dryer | 72 | 48 | 59 | 72 | 48 | 59 |
| Clothes Washer | 90 | 47 | 70 | 90 | 47 | 70 |
| Dishwasher | 53 | 51 | 29 | 53 | 51 | 29 |
| Electric Cooking | 87 | 89 | 85 | 87 | 89 | 85 |
| Pool Pumps | NA | NA | NA | NA | NA | NA |

*From Tennessee Valley Authority 1993 Residential Sales Profile*

**Electric Dryer with Moisture Sensor**—Most dryers utilize a temperature sensor to control the operation of the dryer. A moisture sensor in the exhaust provides more precise control for automatic shutoff of the dryer when the clothes are mostly dry.

**Heat Pump Clothes Dryer—**The heat pump clothes dryer (not yet commercially available) uses a refrigerant cycle to remove moisture from exhaust air. This dehumidified exhaust air is then rewarmed and recirculated into the dryer. Because the exhaust is recirculated, a vent is not needed. However, a condensate drain would be required.

**Horizontal-Axis Clothes Washer**—Horizontal-axis clothes washers, available overseas, use less water, energy, and detergent per cycle compared to the vertical-axis clothes washer common in the United States. Only the energy savings (from the use of less hot water) were estimated.

**High-Efficiency Dishwasher**—In 1994 U.S. energy efficiency standards for dishwashers improved the efficiency of dishwashers being purchased in the United States. However, models are available in the U.S. that surpass this standard by about 30 percent. Their savings may be attributed to booster water heaters, lower water use, more efficient motors, and air-drying features.

**Induction Cooktop**—This technology (gaining acceptance in the commercial market and available but limited for the residential market) consists of a high frequency electric coil located beneath a smooth cooking surface. The coil creates an alternating magnetic field that induces a current in ferrous metal pots, thus causing heating in the pot rather than the cooking surface. Induction cooktops have efficiency gains of 20 to 40 percent over electric resistance cooktops.

**Electric Cordless Lawn Mower—**A cordless lawn mower uses a rechargeable battery and an electric motor. Estimates are based on Black & Decker's 18-inch model with a 12-volt lead/acid battery.

**Electric Cord Lawn Mower—**Gas-powered lawn mowers have 94 percent of the market share, with the rest being accounted for by electric cord mowers. Estimates are based on Black & Decker models with 8-amp and 12-amp motors.

**Smart House (Home Automation & Real-Time Pricing)—**A home automation system consists of an interface node near the utility meter that communicates to a smart thermostat, as well as appliance monitoring and control modules in the home. Communication between the utility and residence goes in both directions, allowing for a wide array of advanced services. The homeowner can control appliances in response to time-of-use rates or real-time price signals from the utility or can allow for utility control of appliances.

**High-Efficiency Pool Pumps**—Estimates are included for replacing a standard efficiency pool pump with a high-efficiency pump.

**Downsized Pool Pumps with Oversized Piping**—This measure encourages the combination of (1) properly sizing pool pump motors (which are often oversized) and (2) modifying the piping to minimize losses (which includes installing larger diameter piping, eliminating sharp 90-degree elbows, and possibly installing a larger filter).

**Direct Load Control of Pool Pumps**—Utility-controlled radio switches could be installed on residential pool pumps, which could be controlled by the utility during times of system peak demand. During system peak periods 100 percent of participating pool pumps could be turned off.

**Pool Pump Timer**—Timers or adjustment of existing timers on pool pumps can be used to control the operation timing of pool pumps. The timer would be set to turn off the pool pump during expected times of system peak demand.

### Residential Lighting

Brief descriptions of residential lighting technologies follow:

**Compact Fluorescent**—Because prices and energy savings estimates vary based on procurement method and hours of operation, estimates for a single bulb or household were developed for each option (program).

**Efficient Incandescent**—Efficient incandescent light bulbs provide relatively equal lighting with reduced wattage due to a more efficient filament design and a phosphorescent coating. It is assumed that 80 percent of all standard incandescent lamps (40W, 60W, 75W, 100W) can be replaced with more efficient lamps.

**Residential Security Lighting**—High pressure sodium lamps operating 4,000 hours/yr were used for this estimate, although other types of lamps are available, such as mercury vapor and metal halide.

**High Pressure Sodium (Outdoor)**—Savings estimates for high pressure sodium fixtures that may be used for outdoor floodlight fixtures are based on 1,500 hours/yr operating time. This operating schedule assumes that the lights are turned off at bedtime.

**Halogen Lamp (Outdoor)—**One of the most significant improvements to incandescent lamps is to surround the filament with a separate capsule containing halogen gasses that capture vaporized tungsten and redeposit it on the filament, extending its life while preventing condensed tungsten from darkening the bulb. The halogen cycle creates more light per unit of electricity and provides a better quality of light.

**Halogen Lamp (Indoor)**—Thick walled A-lamps can be used in many residential applications.

**Motion Detectors for Outdoor Lighting**—Add-on controls that exclude the combination of both a motion detector and a photocell would be installed on existing outdoor lighting fixtures. Savings estimates assume that the motion detector would be activated only 5 percent of the time.

## COMMERCIAL

Primary data sources included existing saturation surveys, energy audits, end-use load forecasts, and TVA institutional data. Hourly building simulations of prototypical buildings were developed using micro-AXCESS and TMY weather for Nashville, Tennessee, to estimate the energy and demand impacts of HVAC technologies and building shell improvements. The detailed hourly building energy analysis software used for analyses of the commercial prototype buildings, micro-AXCESS, is available through EPRI's (Electric Power Research Institute) Electric Power Software Center.

Secondary data sources included Competitek, EPRI reports, energy journals, case studies, other utility filings, manufacturers' literature, E Source reports, and previous work done by SRC and BCI. ESOURCE, formerly known as Competitek, is a proprietary information service and a subsidiary of Rocky Mountain Institute.

As much as possible, the energy impacts have been adjusted to be consistent with TVA's commercial end-use forecast (i.e., COMMEND EUIs [End Use Intensities in kWh/sf/yr] and electric/gas shares). For example, the lighting EUI for retail buildings for 1993 was disaggregated into different lighting categories (e.g., incandescent, fluorescent, mercury vapor, high pressure sodium, metal halide) to account for their inherent lighting efficiencies and assumed distributions. These disaggregated EUIs

## *FIGURE T7-11.* Commercial Technologies

| End-Use | Demand-Side Measure |
|---|---|
| Space Conditioning Equipment | High-Efficiency Chiller |
| | High-Efficiency Chiller w/ASD |
| | High-Efficiency DX A/C |
| | High-Efficiency Room A/C |
| | Cool Storage (Partial Ice) |
| | Rooftop Cool Storage (Partial Ice) |
| | Thermal Energy Storage (General) |
| | Heat Pipe Enhanced DX A/C |
| | Hotel Occupancy Sensors |
| | 2-Speed Motor for Cooling Tower |
| | Speed Control for Cooling Tower |
| | Air Conditioning Maintenance |
| | HVAC Air Duct/Water Pipe Insulation |
| | Leak-Free Ducts |
| | HVAC Energy Management System |
| | Standard Efficiency Heat Pump (Electric Backup) |
| | High-Efficiency Heat Pump (Electric Backup) |
| | VAV System with Inlet Vanes |
| | ASD Ventilation Controls w/VAV |
| | Timer/Programmable Ventilation Control |
| | High-Efficiency Ventilation Motors |
| | Separate Makeup Air/Exhaust Hoods |
| | Dual-Fuel Heat Pump |
| | Ground-Source Water Loop Heat Pump |
| | Wood Furnace (Space Heating Only) |
| | Wood Boiler (Space and Water Heating) |
| | Passive Solar Space Heating and Cooling |
| | Temperature Setup/Setback |
| Space Conditioning Building Shell | Roof Insulation |
| | Wall Insulation |
| | Window Film |
| | Spectrally Selective Windows |
| | Light-Colored Roofs |
| Lighting | T8 Lamps / Electronic Ballasts |
| | Electronic Ballasts |
| | Refl/Delamp 4' - 40W Fluor. Lamps/ Electronic Ballasts |
| | Refl/Delamp 8' - 75W Fluor. Lamps/ Electronic Ballasts |
| | Refl/Delamp 4' - 40W Fluor. Lamps/ Hybrid Ballasts |
| | Refl/Delamp 8' - 75W Fluor. Lamps/ Hybrid Ballasts |
| | 4' – 34W Lamps/Electronic Ballasts |
| | 8' – 60W Lamps/Electronic Ballasts |
| | 4' – 34W Fluor. Lamps / Dimming Ballasts |
| | Compact Fluorescent Lamps and Fixtures |
| | Photoelectric Control |
| | Energy Management System Lighting Control |
| | Occupancy Sensors |
| | Indoor HID Lamps—High Pressure Sodium |
| | Outdoor HID Lamps—High Pressure Sodium |
| | Metal Halide (32W) |
| | LED Exit Signs (Light-Emitting Diode) |
| | Fluorescent Exit Signs |
| | Electroluminescent Exit Signs |
| | Daylighting Design |
| | LED Traffic Signal |
| | Sulfur Lamp |
| Refrigeration | Multiplex: Air-Cooled/No Subcooling |
| | Multiplex: Air-Cooled/Ambient Subcooling |
| | Multiplex: Air-Cooled/Mechanical Subcooling |
| | Multiplex: Air-Cooled/Ambient & Mechanical Subcooling |
| | Multiplex: Air-Cooled/External Liquid Suction HX |
| | Open-Drive Refrigeration System (ASD) |
| | Anti-Condensate Heater Controls |
| | High R-Value Glass Doors |
| | Refrigeration Energy Management System (EMS) |
| | Dual-Path Supermarket Air Conditioning |
| Water Heating | Heat Pump Water Heater |
| | Solar-Assisted Water Heater |
| | Heat Recovery Water Heater |
| | DHW Heater Insulation |
| | DHW Heat Trap |
| | Low Flow/Variable Flow Showerhead |
| | DWH Recirculation Pumps |
| Cooking | Electric Forced Convection Oven |
| | Electric Natural Convection Ovens |
| | Energy-Efficient Electric Fryers |
| | Flash Bake Oven |

then became the base case to which the DSM lighting technologies were compared. The use of these disaggregated EUIs helps to ensure that potential energy and demand impact estimates are consistent with the load forecast assumptions. These EUIs reflect the operating characteristics of the businesses in the TVA region, such as operating hours, lighting levels, etc.

The commercial technologies include electric conservation, load shifting, peak clipping, and beneficial electrification (load growth) measures. A listing of the commercial technologies included in the technology database is shown in *Figure T7-11*.

The technologies were grouped by end use. The primary end uses considered in the commercial sector included: Space Conditioning, Building Shell, Lighting, Refrigeration, Water Heating, and Cooking. For each end use, the technologies were mapped to an appropriate base technology and building type. In the commercial market, the following ten building types were considered:

- Office (OF)
- Restaurant, Fast Food, and Full Service (FF)
- Retail (RT)
- Grocery (GR)
- Warehouse (WH)
- School (SC)
- College or University (UN)
- Hospital (HS)
- Lodging, Hotel, or Motel (HM)
- Miscellaneous (MI)

The annual costs and energy impacts were expressed per thousand square feet for each appropriate building type. Energy-efficient office equipment was not included because often there is no incremental cost over less efficient models. Also, many of these efficient models are already the baseline in new purchases resulting from market transformation efforts such as EPA's Energy Star Program, which TVA supports.

## Commercial Space Conditioning

Brief descriptions of the space conditioning or building shell technologies follow:

### *Space Conditioning*

**High-Efficiency Chiller—**This measure consists of comparing standard efficiency [COMPRESSOR COP=5.0] centrifugal chillers to high-efficiency [COMPRESSOR COP=5.76] centrifugal chillers. This measure was analyzed only for hospitals and large offices and was modeled using micro-AXCESS.

**High-Efficiency Chiller w/ASD**—This option consists of retrofitting an adjustable speed drive (ASD) controller onto high-efficiency centrifugal chillers. The same assumptions apply here as in the high-efficiency centrifugal chillers. This measure was modeled in micro-AXCESS using an improved chiller part-load profile.

**High-Efficiency Direct Expansion (DX) Air Conditioning (A/C)—**The Energy Policy Act and ASHRAE figures indicate the following standards:

| Cooling Capacity (kBtu/hour) | EER |
|---|---|
| 65 – 135 | 8.9 |
| 135 – 760 | 8.3 |

An average baseline EER = 8.7 (1.38 kW/ton) is assumed. The high efficiency DX AC EER is assumed to be 9.8 (1.23 kW/ton). This measure was analyzed for all building types except hospitals.

**High Efficiency Room AC Units**—Federal Appliance Standards mandate the following efficiency standards for 1992:

| Cooling Capacity (kBtu/hour) | EER |
|---|---|
| Less than 8,000 | 8.9 |
| 8,000 – 13,000 | 8.3 |
| Greater than 13,000 | 7.9 |

An average baseline EER = 8.3 (1.45 kW/ton) is assumed. The high efficiency room AC EER is assumed to be 10.9. This measure applies to all building types.

**Cool Storage (Partial Ice)**—This load shifting measure is assumed to be specifically partial ice storage or load leveling, and is only applied to buildings with chillers. This measure was modeled using DSMSIM, an SRC Systems Software Model. The DSMSIM model uses basic algorithms to estimate the ice storage chiller and storage tank capacities based on the day with the highest accumulated cooling load (determined from base case load shapes developed by micro-AXCESS). Maximum cooling energy is shifted from on-peak to off-peak periods based on the partial ice storage capacity, using a chiller priority strategy. Ice-making capacity and efficiency derating factors are also taken into account. The capacities vary by building type and weather zone. The characteristics of the base and cool storage chillers were assumed to be the same (e.g., chiller type, COP).

**Rooftop Cool Storage (Partial Ice)**—Established test standards do not yet completely evaluate thermal energy storage systems; also suppliers of such systems are currently limited. The addition of thermal storage to this common A/C equipment offers humidity control, improved overall efficiency, and reduced demand during utility peak periods. Manufacturer estimates (from

Powell Energy Products, Inc.) for 5- to 20-ton rooftop thermal storage A/C equipment (The Ice Bear) were compared to standard efficiency rooftop DX A/C units. Demonstrations of this technology are underway or planned in the TVA region and throughout the United States.

**Thermal Energy Storage (General)**—The installation of a thermal energy storage system offers a whole range of options to permit all or part of a building's cooling or heating load to be shifted from peak to off-peak periods while still providing space conditioning.

**Heat Pipe Enhanced DX A/C**—Heat pipes installed upstream of the evaporator can substantially reduce the moisture content from incoming outside air, resulting in significant cooling savings. The performance of this technology was estimated using micro-AXCESS by setting up the baseline cooling setpoint by 4 degrees; this technique was suggested by experienced micro-AXCESS users. This applied only to DX AC systems. Cooling savings ranged from 0.8 to 30 percent (increases in heating and ventilation energy use were not included).

**Hotel Occupancy Sensors—**This measure is similar to a lighting occupancy sensor. The sensor turns off the air conditioning shortly after it detects the room is unoccupied. The option was estimated using micro-AXCESS by setting up the baseline cooling setpoint by 2 degrees during the on-peak period.

**2-Speed Motor for Cooling Tower**—This measure consists of replacing the single-speed motors in the cooling tower with a two-speed motor. This applied only to chiller systems. The energy savings are estimated to be 80 percent of the Speed Control for Cooling Tower measure.

**Speed Control for Cooling Tower—**This includes retrofitting an ASD (or VFD) to an existing cooling tower fan. This applies only to chiller systems. Load impacts from this measure were estimated from the micro-AXCESS model.

**Air Conditioning Maintenance**—This measure consists of annual cleaning and tuning up of DX A/C and chiller systems. The impacts of this measure were estimated using micro-AXCESS by increasing both the baseline compressor efficiency and capacity by 2 percent—suggested by experienced micro-AXCESS users.

**HVAC Air Duct/Water Pipe Insulation for Chiller and DX AC**—This measure consists of installing additional insulation on air ducts and additional insulation on chilled water pipes. The savings and cost estimates are based on ASHRAE methodology.

**Leak-Free Ducts**—This measure primarily consists of sealing all exterior ductwork for rooftop DX A/C equipment. Cooling and ventilation demand and energy savings of 7 percent for existing buildings and 3 percent for new buildings was estimated. These savings are based on a combination of estimates developed by Bosek, Gibson & Assoc. and micro-AXCESS simulation (by varying outside air percentage).

**HVAC Energy Management System (EMS)**—The impacts of this measure were estimated using micro-AXCESS by combining the inputs of two other simulated measures:

—Temperature Setup/Setback

—Timer/Programmable Ventilation Control

Chiller coil reset was eliminated from this combination since independent DOE 2.1 simulations of this particular measure for Florida by SRC yielded negative savings.

**Standard Efficiency Heat Pump (Electric Backup)**—This measure compares standard efficiency air-source heat pumps (EER=8.7, HSPF=6.8) to standard efficiency DX units (EER=8.7) with gas heat (AFUE=78 percent).

**High-Efficiency Heat Pump (Electric Backup)**—This measure compares a high-efficiency heat pump (EER=9.8, HSPF=7.5) to a standard efficiency DX unit (EER=8.7) with gas heat (AFUE=78 percent).

**VAV System with Inlet Vanes**—Micro-AXCESS was used to model ventilation fan, cooling, and heating energy and demand impacts between a constant volume system and a variable air volume system with inlet vanes for both DX A/C and chiller systems for all buildings.

**ASD Ventilation Control with VAV—**This measure includes an adjustable speed drive control for the ventilation fan in addition to the VAV system described above for the VAV System with Inlet Vanes. Energy and demand impacts of this combined measure were computed using micro-AXCESS. This was simulated for buildings with DX A/C and chiller systems. In addition to the cost of a VAV system, the installed capital cost for ASDs was included.

**Timer/Programmable Ventilation Control**—This measure was modeled using micro-AXCESS by simply shutting down the ventilation fan system one to three hours earlier (depending on the building type); consequently, the cooling and heating systems shut down (or shifted into night cycling mode), as well. This measure was not applied to the grocery, hospital, or lodging market segments.

**High-Efficiency Ventilation Motors**—This measure assumes the use of high-efficiency motors in place of standard efficiency motors, resulting in an average demand and energy savings of 3 percent for 1 to 25 horsepower motors.

**Separate Makeup Air/Exhaust Hoods**—This technology is typically installed in commercial kitchen areas to reduce the energy wasted in pre-conditioned supply air via exhaust hoods. Cooling energy and demand savings of 80 percent are estimated within the kitchen areas. This measure was applied to

the restaurant, school, college, hospital, and lodging market segments. It was assumed the kitchen areas with hoods are approximately 3 percent of school, college, and hospital; 10 percent of restaurant; and 2 percent of lodging total floorspace.

**Dual-Fuel Heat Pump**—A heating system which utilizes both electricity and fossil fuels. The system can be designed to minimize energy costs by economically dispatching the system based on outside temperature, system operating characteristics, and energy prices.

**Ground-Source Water Loop Heat Pump**—A ground-source water loop heat pump takes heat from a water source, such as a well or a surface water body, to deliver warm air to a building during the heating season and rejects heat from the indoor air to the water source to provide cooling.

**Wood Furnace (Space Heating Only)**—Estimates were made for a furnace which burns wood or biomass waste for space heat. In commercial buildings, this technology is appropriate for applications requiring one MBtu/hour or less.

**Wood Boiler (Space and Water Heating)**—Estimates were made for a boiler burning wood or biomass waste to supply space heating and water heating in commercial buildings. This technology is suitable for applications requiring more than one MBtu/hour.

**Passive Solar Space Heating and Cooling**—Basic passive solar applications utilize proper solar orientation, coupled with thermal mass, to heat a building in the winter and to reduce cooling load in the summer. These features provide a source of solar heat gain and a means to store heat collected.

**Temperature Setup/Setback**—This measure was modeled using micro-AXCESS. Based on the baseline prototype building characteristics, cooling is shut off at night, while for temperature setback, the heating setpoint was lowered to 55° F during off-peak hours. The measure is not applicable to grocery, hospital, and lodging. Modeling in micro-AXCESS did not incorporate adaptive recovery technology.

### *Building Shell*

**Roof Insulation**—Additional insulation is installed, raising the R-value from 2.53 to 10.53 in existing buildings and from 10 to 20 in new buildings. The measure was simulated in micro-AXCESS to determine the energy impacts.

**Wall Insulation—**This measure was applied only to new buildings. The R-value of the wall was increased from 5.26 to 11.76 in the buildings simulated.

**Window Film—**This measure consists of installing window film on existing and new construction. The option was modeled using micro-AXCESS by decreasing the window shading coefficient and glass U-value. For existing buildings, the shading coefficient was reduced from 0.85 to 0.23, and the U-value from 1.06 to 0.69. For new buildings, the shading coefficient was not changed, but the U-value was reduced from 1.06 to 0.69.

**Spectrally Selective Windows**—This measure, applied only to new buildings, was modeled using micro-AXCESS by reducing the U-value from 1.06 to 0.22 and reducing the shading coefficient to 0.20. (ACEEE 1992 Proceedings)

**Light-Colored Roofs**—This measure consists of installing lighter colored roofs or applying a reflective coating at the time of roof replacement. The energy savings estimate of 7 percent is a conservative assumption based on a report by FSEC.

## Commercial Lighting

For any lighting retrofit or new design, the entire lighting system should be considered. A lighting system might include both task and ambient lighting, lamps, ballasts, the number and location of switches, the number of lamps controlled by each switch, and the type of switch—on/off, dimming, occupancy, or timed.

The technical potential for savings available from lighting retrofits and lighting designs for new construction was determined by estimating savings for fixtures, applying a reasonable number of fixtures to each building type or activity within the building, and then multiplying those numbers by our estimate of the square footage of that type of building in the TVA service territory. Lighting technologies included in this database were selected to represent the more popular or promising ones, in terms of energy savings potential and the persistence of savings over time, from the enormous number of lighting products available.

TVA survey results were used to estimate the current penetration of some lighting technologies in the Valley. Where specific Valley information was not available, estimates for the United States were used.

Brief descriptions of the commercial lighting technologies follow:

**T8 Lamps**—Fluorescent lamps have three starting methods. Most lamps are only compatible with one starting method, but the T8 lamps can be rapid- or instant-started. T stands for tubular; the number describes lamp diameter in 1/8-inch increments. A T8 lamp is 8/8 inches in diameter; a T12 is 12/8 inches (or 1-1/4 inches) in diameter. Estimates considered were:

- **Existing Buildings**—Compared four 4 foot -T8 lamps with one electronic ballast to four 4 foot - 34W lamps with two magnetic ballasts that meet current standards.
- **New Construction**—Compared three 4 foot - T8 lamps with one electronic ballast to four 4 foot - 34W lamps with two magnetic ballasts that meet current standards.

**Electronic Ballasts—**An electronic ballast uses solid state components to provide current to a lamp at high frequency

(typically 25,000 to 60,000 cycles per second) in order to produce more light using fewer watts than magnetic ballasts.

**Reflector/Delamp 4 foot - 40W Fluorescent Lamps/ Electronic Ballast**—This measure (considered only for existing buildings) consists of modifying a 4 foot - 40W fixture by removing the four 40W lamps and installing an efficient reflector, along with two 34W lamps.

**Reflector/Delamp 8 foot - 75W Fluorescent Lamps/ Electronic Ballast**—This measure (considered only for existing buildings) consists of modifying an 8 foot - 75W fixture by removing the four 75W lamps and installing an efficient reflector, along with two 60W lamps.

**Reflector/Delamp 4 foot - 40W Fluorescent Lamps/ Hybrid Ballast**—This measure (considered only for existing buildings) consists of modifying a 4 foot - 40W fixture by removing the four 40W lamps and installing an efficient reflector, along with two 34W lamps. Hybrid ballasts use magnetic technology to power the lamp and electronic technology to control power to the cathodes.

**Reflector/Delamp 8 foot - 75W Fluorescent Lamps/ Hybrid Ballast—**This measure (considered only for existing buildings) consists of modifying an 8 foot - 75W fixture by removing the four 75W lamps and installing an efficient reflector, along with two 60W lamps.

**4 foot - 34W Lamps/Electronic Ballasts**—This measure compares four 4 foot - 34W lamps with one electronic ballast to four 4 foot - 40W lamps with two magnetic ballasts that meet current standards.

**8 foot - 60W Lamps/Electronic Ballasts**—This measure compares two 8 foot - 60W lamps with one electronic ballast to two 8 foot - 75W lamps and one magnetic ballast that meets current standards.

**4 foot - 34W Lamps/Dimming Ballasts (Existing Buildings Only)**—This measure compares four 4 foot - 34W lamps with the electronic dimming ballast (including daylight controls to four 4 foot - 40W lamps with two magnetic ballasts that meet current standards. The lighting energy and demand savings are based on benchmark results from DOE 2.1 simulations. The technical feasibility depends on the building type based on the percentage of perimeter floorspace (15 feet deep) to total floorspace.

**Compact Fluorescent Lamps and Fixtures—**This measure considers replacing a weighted mix of 60W, 75W, and 100W incandescent lamps and fixtures with the same mix of 15W, 18W, and 27W compact fluorescent lamps and fixtures in both new and existing buildings. The percentage breakdown of the mix varies by building type. The incremental installation cost is included for existing buildings. The annualized maintenance cost of replacing both incandescent and compact fluorescent lamps during the lifetime of the compact fluorescent ballast is considered.

**Photoelectric Control**—This measure consists of retrofitting photoelectric controls onto exterior lighting. Using micro-AXCESS, the base case exterior lighting schedule of 4:00 p.m. to 7:00 a.m. (set for most building types) was changed to automatically turn on and off relative to daylighting hours. Estimated exterior lighting energy savings ranged from 14.7 percent to 25.4 percent, depending on the base case schedule of each building type. As expected, there are no demand savings.

**Energy Management System Lighting Control**—This measure consists of retrofitting an energy management system (EMS) to automatically control the lighting operation. It was assumed that the EMS would save an average of 2 full load hours of lighting a day. This equates to lighting energy savings ranging from 7 percent to 16 percent relative to the operating hours for each building type. It is also assumed the lighting demand savings is 20 percent of the energy savings, thus ranging from 1 to 3 percent.

**Occupancy Sensors—**This measure consists of retrofitting occupancy sensors to shut off lights in unoccupied portions of a building. It is assumed that this measure saves 25 percent lighting energy and 5 percent lighting demand in both new and existing buildings.

**Indoor HID Lamps - High Pressure Sodium (HPS)—**This measure considers replacing one 150W incandescent lamp with one 35W HPS fixture in both new and existing buildings. Incremental installation cost is included for existing buildings. Annualized maintenance cost of replacing both incandescent and HPS lamps during the lifetime of the HPS ballast was considered.

**Outdoor HID Lamps - High Pressure Sodium (HPS)**—This measure considers a weighted mix of 70W, 100W, 150W, and 250W high pressure sodium lamps/fixtures replacing the same mix of 100W, 175W, 250W, and 400W mercury vapor lamps/fixtures. The percentage breakdown of the mix varies by building type.

**Metal Halide (32W)**—This measure considers replacing one 150W incandescent lamp with one 32W metal halide fixture in both new and existing buildings. The incremental installation cost is included for existing buildings. The annualized maintenance cost of replacing both incandescent and metal halide lamps during the lifetime of the metal halide ballast was considered.

**LED Exit Signs**—Light-emitting diode (LED) exit signs claim a 20-year life, are reducing in price, and have an energy consumption of less than 2 watts. This promising new product would replace exit signs now using 14 to 50 watts. If these

are recommended in an option, the power factor should be considered in selecting acceptable products.

**Fluorescent Exit Signs**—Most new fluorescent exit signs are equipped with two 5-watt twin-tube compact fluorescents. If these are recommended in an option, the power factor should be considered in selecting acceptable products.

**Electroluminescent (EL) Exit Signs**—EL exit signs have the lowest power consumption, but they also have the lowest luminance, as well. The EL lamps used are flat, thin-film sources. Typically thinner than a credit card, the lamps consist of a flexible plastic laminate made up of two electrode plates sandwiching a phosphor-doped dielectric film. Light is produced when the phosphors are excited upon application of alternating current to the electrode plates. Because of their slim design, Underwriters Laboratories (UL) lists EL retrofit kits for use in many existing "Listed" single-face exit signs and will "Classify" retrofit kits for use with specific manufacturers' emergency signs.

**Daylighting Design**—This measure would consist of a combination of dimming ballasts, doubling the window area, installing spectrally selective glass, and downsizing the cooling capacity by 10 percent. This measure applies to new buildings and excludes warehouses and lodging. Only lighting impacts were analyzed for this measure.

**LED Traffic Signal—**A recent breakthrough in the development of a blue LED (light-emitting diode) may be the last technical hurdle before the marketing of energy-efficient traffic signals. Each incandescent lamp in a traffic single uses 67 to 150 watts that could be replaced by an LED unit using only 9 to 25 watts.

**Sulfur Lamp**—The sulfur lamp is a small, rotating, air-cooled glass sphere filled with sulfur gas. A microprocessor- controlled magnetron stimulates the sulfur atoms with microwaves, generating light in the visible range. The light produced by the sulfur lamp has a high-quality color rendering and an adjustable color temperature.

## Commercial Refrigeration

Brief descriptions of the commercial refrigeration technologies follow:

**Multiplex: Air-Cooled/No Subcooling**—This measure considers the retrofitting of a "conventional" refrigeration system (i.e., numerous stand-alone compressor systems for each display case line-up or walk-in) with a multiplex refrigeration system. The term "multiplex refrigeration" refers to the use of multiple refrigeration compressors mounted on a rack and piped to common suction and discharge manifolds. Refrigeration to each display case lineup is provided from the rack by a pair of liquid and suction pipes. Several circuits can be connected by separate pairs of refrigerant piping. Multiplex systems commonly consist of two, three, or four compressors that are sized such that the operation of all compressors simultaneously can provide adequate capacity to meet the design refrigeration load. During off-design operation, the multiplex compressors can be cycled on or off so that the capacity of the operating compressors closely matches the refrigeration load.

**Multiplex: Air-Cooled/Ambient Subcooling**—Ambient subcooling is the cooling of the liquid refrigerant below the condensing temperature by heat rejection to the ambient. Some subcooling normally occurs in the condenser, and additional ambient subcooling can be obtained through the use of a separate coil, usually attached to the condenser.

**Multiplex: Air-Cooled/Mechanical Subcooling**—Further cooling of the liquid refrigerant can be done through the use of a vapor compression system. Liquid refrigerant associated with a refrigeration system operating with a low suction temperature is mechanically subcooled by a system operating at a higher suction temperature.

**Multiplex: Air-Cooled/Ambient and Mechanical Sub-cooling**—This measure combines the benefits of ambient subcooling and mechanical subcooling.

**Multiplex: Air-Cooled/External Liquid Suction HX—**This measure involves the installation of an externally mounted heat exchanger instead of merely soldering the liquid and suction lines together. The result is more efficient liquid-to-suction heat transfer, providing more refrigeration capacity. This measure is applicable only for the very low and low temperature refrigeration applications and is a more efficient alternative to mechanical subcooling.

**Open-Drive Refrigeration System (ASD)—**Open-drive systems consist of one or two open-drive compressors driven by external adjustable speed drive electric motors. The main advantage of open-drive compressors over multiplex compressors is the additional electric savings due to operating open-drive compressors at low speeds, which is intended to increase compressor efficiency. An open-drive system requires larger compressors, and thus higher compressor capital costs, but smaller remote condensers, and thus lower condenser capital costs, compared to a multiplex system of equal capacity.

**Anti-Condensate Heater Controls**—It is assumed that this measure saves 5 percent energy and demand, and is applied to all market segments, except office, warehouse, and miscellaneous. The cost and impact estimates are based on an assessment study done for Bonneville, 1988.

**High R-Value Glass Doors**—This measure consists of replacing single-glass doors or retrofitting refrigeration cases with high R-value glass doors. An average of 30 percent energy and demand

savings is assumed. This technology is applied to all market segments except office, warehouse, and miscellaneous, with various levels of technical feasibility and current penetration.

**Refrigeration Energy Management System**—This technology consists of strategically controlling many or all refrigeration systems in a given facility. From the EPRI Commercial TAG Volume, an energy and demand savings of 10 percent and 5 percent is assumed. It is assumed that this technology is only applicable to the grocery market segment, which has an assumed current penetration of 50 percent (SRC).

**Dual-Path Supermarket Air Conditioning**—Similar to Heat Pipe Enhanced Air Conditioning, this technology removes a significant amount of moisture from incoming air before passing over the evaporator. Its best application is where there are high humidity levels; therefore, the dual-path air conditioner is only analyzed for the grocery market segment. The energy and demand impacts and costs have been estimated based on a case study in Miami, Florida, presented in an EPRI brochure, *Dual-Path Supermarket HVAC Systems,* 1991 (CU.2053.10.91). Although this is an air conditioning technology, it is placed with refrigeration because its applicability is focused on high refrigeration loads. It is assumed this technology has no current penetration.

## Commercial Water Heating

Brief descriptions of the commercial water heating technologies follow:

**Heat Pump Water Heater**—This measure consists of replacing conventional electric hot water heaters with heat pump hot water heaters. The estimated energy and demand savings are 50 percent (assuming an average seasonal COP of 2.0). This measure has significantly higher capital cost compared to conventional electric water heaters (i.e., orders of magnitude). This measure was applied to all market segments.

**Solar Assisted Water Heater**—The solar water heating system actually assists rather than replaces an electric resistance water heater. When solar radiation is available, it is absorbed by collector panels and then transferred to the domestic hot water supply. Some systems heat water directly by circulating potable water through the solar loop. Others recirculate the same absorption fluid through the collectors and transfer the heat via a heat exchanger to the potable water supply.

**Heat Recovery Water Heater—**This measure consists of an electric water heater that utilizes a supplemental heat source from the cooling system waste heat from a double bundle chiller or condenser heat exchanger. There is an assumed 25 percent energy savings based on the WAPA Guidebook of Commercial DSM Technologies, assuming a summer and winter demand savings of 35 percent and 15 percent, respectively. The current penetration is assumed to be zero.

**DHW Heating Insulation**—This is a retrofit measure consisting of wrapping an existing water tank with additional insulation. Energy and demand savings of 5 percent are assumed. The technical feasibility and current penetration are assumed to be 50 percent and 20 percent, respectively (SRC).

**DHW Heat Trap**—This retrofit measure reduces hot water energy due to backflow through the pipes from natural convection. It is analyzed for all existing market segments; it is not analyzed in the new market since the technology is a requirement for some building codes. Energy savings of 10 percent are based on the WAPA Guidebook of commercial DSM technologies, while demand savings are assumed to be 2 percent. The technical feasibility and current penetration are assumed to be 80 percent and 15 percent, respectively (SRC).

**Low Flow/Variable Flow Showerhead—**This retrofit measure can easily be installed in place of existing showers and faucets to reduce the flow of hot water. It is assumed that there are approximately two showerheads and four faucets per water heater. The estimated energy and demand energy savings are 15 percent. Technical feasibility varies by building type based on an assumed percentage of hot water dedicated to showers and faucets:

- 80 percent—office, retail, school, college and lodging
- 50 percent—grocery, hospital, and miscellaneous
- 20 percent—restaurant

Current penetration of this measure is assumed to be 10 percent (SRC).

**DHW Recirculation Pumps**—This option consists of installing timers to prevent recirculation pumps on the hot water system, which are typically integrated with a boiler, and operating during periods of no hot water use. The energy saving due to this option was estimated to be 60 percent. There are no demand savings attributed to this measure, which is more applicable to schools, colleges, and hospitals than to other building types.

## Commercial Cooking

Brief descriptions of the commercial cooking technologies follow:

**Electric Forced Convection Ovens**—This technology was modeled as a replacement option for either electric natural convection ovens or gas-fired forced convection ovens. Electric forced convection ovens have an efficiency of 64 percent compared to the 62 percent efficiency of electric natural convection ovens. Additionally, forced convection ovens can cook three times the volume of natural convection ovens. The option was applied to restaurants, groceries, schools, hospitals, and

lodging. The cost estimates are based on two $4,285 convection ovens per 5,000 square-foot restaurant. The efficiency of gas-forced convection ovens is 46 percent, versus 64 percent for electric forced convection ovens. The costs for other building types were prorated based on energy use.

**Electric Natural Convection Ovens**—This electric technology was analyzed to replace gas-fired natural convection ovens (for load building). The efficiency of gas natural convection ovens is 28 percent versus 62 percent for electric natural convection ovens.

**Energy-Efficient Electric Fryers—**This technology was modeled as a replacement technology applicable to the same building types as the forced convection ovens. The energy and demand savings were estimated to be 10 percent. The cost estimates are based on two $2,935 efficient fryers per 5,000 square feet of restaurant, prorated to other building types based on energy use. This technology was also analyzed to replace standard efficiency gas fryers with energy-efficient electric fryers (for load building). The heating efficiency of gas fryers is 45 percent, versus 100 percent for electric fryers.

**Flash Bake Oven**—The flash bake lightwave oven uses a combination of intense visible light and infrared energy to cook foods almost instantly from the outside in and the inside out. Dramatically faster and better, shorter cooking times can enhance food flavor and texture. These ovens are particularly suited for cooking many fast food products.

## INDUSTRIAL

A list of industrial technologies was compiled by TVA. BCI and SRC suggested additional technologies. The technologies were ranked from 1 to 7, with 1 being the most important and 7 the least. Cost and energy impacts were sought for technologies that ranked 3 or better.

Technology data were not developed for the following technologies for the reasons listed below:

- **Ultrasound Treatment of Wet Textiles**—This can be used to improve the dye uptake in fabric dyeing processes. However, no information was found on the specific characteristics of this process.
- **Advanced Hybrid Membrane/Heat Pump Systems for Municipal Water Treatment**—No information on this technology was available.
- **Electron Beam Irradiation to Sterilize Municipal Water** — No information on this technology was available. A reference was found to a test performed by Massachusetts Institute of Technology in which a Van De Graaff generator was successfully used to detoxify waste water, however, based on the test, it was determined that a full-scale facility would not be economically beneficial.
- **Ceramic Membranes to Separate Oil/Water Emulsions**—No information on this technology was identified. Several references were found that referred to the development of ceramic membranes as representing a possible improvement in membrane separation processes in the future, but no specific information was provided.
- **Industrial Lighting**—Lighting applications (particularly indoor lighting) in industrial facilities are very similar to those in commercial warehouses and offices. No technology data unique to the industrial sector were developed.

The industrial technologies for which estimates were developed are shown in *Figure T7-12*.

### Process Separation

Brief descriptions of the industrial technologies follow:

**Freeze Concentration**—Used for the separation or concentration of components in a liquid solution, freeze concentration is a substitute for conventional distillation and evaporation. In the

*FIGURE T7-12.* **Industrial Technologies**

| End-Use | Demand-Side Measure |
|---|---|
| Process Separation | Freeze Concentration<br>Electrolytic Separation<br>Membrane Separation<br>Electrochemical Synthesis |
| Process Heating | Industrial Process Heat Pumps<br>DC Electric Arc Furnace<br>Plasma Processing<br>Induction Heating |
| Manufacturing | Flexible Manufacturing Module |
| Drying | RF & IR Drying |
| Fabrication/Finishing | Laser Processing<br>Electrical Discharge Machining<br>Electrogalvanization<br>Electrochemical Machining<br>Electron Beam Processing |
| Water Treatment | Waste Water Ozonation<br>Seawater Desalinization by Reverse Osmosis |
| Motors | 1 Horsepower High-Efficiency Motor<br>50 Horsepower High-Efficiency Motor<br>200 Horsepower High-Efficiency Motor |

freeze concentration process, heat is removed from a liquid mixture until one component of the mixture crystallizes and can be easily separated. The advantages of freeze concentration include improved product quality, lower energy consumption, increased product recovery/quality, reduced capital and maintenance costs, and lower product shipping costs due to product concentration.

**Electrolytic Separation**—Electrolytic separation results in the production of new products as a result of passing an electrical current through a conductive electrolyte. Electrolytic technologies for the separation of chemicals and metals were among the earliest commercialized applications of electricity and have been economically significant since the turn of the century.

**Membrane Separation**—Membrane separation uses permeable barriers to filter selected components from mixtures. Membranes may be made out of polymers, ceramics, or metals and are usually categorized by the size of the particle filtered. Alternatives to membrane separation include conventional distillation and evaporation, freeze concentration, and electroseparation.

**Electrochemical Synthesis**—Electrochemical Synthesis is basically a form of electrolytic separation. The difference is that in electrochemical synthesis, new compounds are introduced at the electrodes in the electrolytic cell that react with the ions attracted to the electrodes. Thus, compounds are formed at the electrodes that could not be formed from the components of the electrolyte alone.

## Process Heating

**Industrial Process Heat Pumps**—Heat pumpsw may be used to capture industrial waste heat. Where applicable, industrial process heat pumps can be used to capture relatively low temperature waste heat that has no other use and, using a moderate amount of mechanical energy, elevate the waste heat to a temperature that can supply process energy needs.

**DC Electric Arc Furnace**—Interest is increasing and units are being installed in the U.S. and abroad. The major benefit of a DC furnace is reduced electrode consumption as compared to 3-phase AC arc furnaces. Other benefits include lower noise levels, reduced maintenance, and less electrical disturbance on the power system.

**Plasma Processing**—Plasma processing involves the electrical production of a plasma in the temperature range from 2,000° to 10,000°C for metals production. At these high temperatures, the plasma is a mixture of molecules, atoms, electrons, and ions. It is the electrons and ions that allow for the conditions of electrical current or arc between two electrodes; the current may be AC or DC. The primary uses in metals production include scrap melting, heating steel in ladles, reduction of ores, treatment of electric furnace shop dusts, ferroalloy production, and the remelting of metals.

**Induction Heating**—Induction heating is a way to heat electrically conductive materials, such as metals. It is commonly used in process heating prior to metalworking and in heat treating, welding, and melting. Induction heating relies on electrical currents that are induced internally in the workpiece material. These so-called eddy currents dissipate energy and bring about heating. The basic components are an induction coil, an ac power supply, and the workpiece itself.

## Manufacturing

**Flexible Manufacturing Module**—A flexible manufacturing module can be a single machine tool with part-changing equipment. A flexible manufacturing cell includes two or more computer numerical control machine tools linked to operate sequentially. A flexible manufacturing system is a combination of modules or cells that are all controlled by a central computer. Flexible manufacturing allows a company to quickly respond to changing demand and avoid creating a large product inventory to service a fluctuating demand.

## Drying

**Radio Frequency and Infrared Drying**—These technologies cover the electromagnetic spectrum from visible light to radio waves. When a material absorbs infrared radiation, the motion of its molecules increases and it gets hotter. This is the basis of infrared process heating. Infrared radiation is produced by heating the filament of a source or emitter. Infrared heating can be applied to both conducting and nonconducting, whereas radio frequency drying/heating can only be used for dielectric, or nonconducting, materials. Radio frequencies for heating range from 2 to 200 MHz, which is in the range used for broadcasting and communications. A triode oscillator generates power in the RF range, and the products are usually heated between plate electrodes or through a series of rods.

## Fabrication/Finishing

**Laser Processing**—Involves cutting, drilling, welding, marking, and selectively heat-treating a variety of materials. Lasers used for metalworking either have a gas lasing material (carbon dioxide mixed with helium and nitrogen) or are solid state (yttrium-aluminum-garnet crystal). Lasers are best suited to situations that involve the need for rapid prototypes, small production runs of precise parts, and/or rapid delivery of many different kinds of parts.

**Electrical Discharge Machining**—Uses an arc from an electrode to remove metal from the piece being machined. The workpiece and the electrode are in a dielectric bath. In a ver-

tical EDM machine, a computer-controlled electrode can be moved in three axes of motion and can create complex parts. Wire-cut EDM acts like a band saw and uses a continuous wire electrode to cut parts. EDM can be used to create intricate and unusual parts and can be used to machine any material that is conductive.

**Electrogalvanization**—This involves the deposition of zinc on a steel sheet in an electrolytic cell. A continuous sheet of steel is run through the cell and can be coated on one or two sides. The conventional alternative is hot-dip galvanizing, which produces a thicker coating, but in which it is difficult to coat only one side of the steel and the coated surface, when painted, is not totally acceptable for high visibility, high gloss areas.

**Electrochemical Machining (ECM)**—this process can be used for sinking, cutting, deburring, and grinding. A conductive workpiece is located in an electrolytic cell containing a conductive electrolyte. A high amperage, low voltage DC current passes from the workpiece through the electrolyte to a shaped electrode. The current causes particles on the workpiece surface to dissolve by electrochemical action. The dissolved material is removed as the electrolyte is pumped through the cell. As the process continues, the workpiece becomes a mirror image of the electrode. ECM is best suited to situations that involve hard or high strength materials and/or complex shapes.

**Electron Beam Processing**—This technology can be used for welding or selective surface hardening. A beam of electrons from a heated emitter in an electron gun is accelerated by attraction to the positively charged anode and focused by a magnetic coil. The kinetic energy of the electrons striking the workpiece is converted to heat that vaporizes the metal directly in the path and melts the adjacent metal. If the beam is directed at a joint between two pieces of metal, a weld is formed. Depending on the metal being processed, a high, partial, or nonvacuum may be required. Electron beam processing is used when high precision parts must be welded with minimal heat effects, maximum reproducibility, and no gas contamination. Electron beam processing is also suitable when high production rates are required.

### Water Treatment

**Waste Water Ozonation**—This process is used for iron and manganese removal, oxidation of organics, microflocculation, bacterial disinfection, and viral inactivation. Ozone is generated on-site by an electrical discharge in an air or oxygen stream.

**Seawater Desalinization**—This process is used to produce potable water using seawater as a feedstock. The conventional approach is to evaporate seawater and condense the vapor as pure water. Reverse osmosis (RO) is an alternative to conventional evaporation techniques. The RO process uses semipermeable membranes which allow solution permeation, but act as barriers to the passage, or transport, of dissolved and suspended substance (i.e., salts, ions, and organic compounds). The solution transport in RO is accomplished by using a pressure high enough to overcome the natural osmotic pressure in the solution. The particle size of species separated is typically between 1 to 10 angstroms with a driving pressure of 200 to 1,000 pounds per square inch.

### Motors

**1 HP High-Efficiency Motor—**Compares the 77.8 percent baseline efficiency motor to a high-efficiency motor. The high-efficiency motor reflects NEMA Efficiency Standard definition 12-6C, having a nominal efficiency of 80.0 percent. Three different operating hours were analyzed. A load factor of 0.70 was assumed.

**50 HP High-Efficiency Motor**—this compares the standard 50 hp motor with an efficiency of 91.4 percent to the high-efficiency motor is defined as having 93.1 percent efficiency. Again, three different annual operating hours were analyzed. A load factor of 0.70 was assumed.

**200 HP High-Efficiency Motor**—Compares the standard 200 hp motor with an efficiency of 94.2 percent to the high- efficiency motor is defined as 95.0 percent efficiency. Again, three different annual operating hours were analyzed. A load factor of 0.70 was assumed.

## RENEWABLE/SELF-GENERATION

### Renewable Energy

Renewable energy technologies were characterized in four reports by BCI for TVA. In these reports technology information was divided into four categories: Residential, Commercial, Industrial, and Self-Generation. Both dispersed renewable technologies (e.g., solar water heating), as well as more centralized generation technologies were considered. Some renewable technologies have been mentioned in the earlier sections. Renewable energy technologies considered are listed in *Figure T7-13*. Schiller Associates, a subcontractor to BCI, provided two cost estimates for wood burning plants at a host facility.

### Self-Generation

Barakat & Chamberlin, Inc. subcontracted to Schiller Associates for the cogeneration technology characterization and market analysis. The market analysis, prepared by UNIMAR, Group. Ltd., identified potential industrial and commercial SIC codes where cogeneration would most likely occur. For these customers, Schiller Associates selected four system types as typical of cogeneration

installed in the under 30-megawatt range. The number of cost estimates (for purchase, installation, operation, and maintenance) that were developed are shown below:

- 8 – Natural gas-fueled reciprocating engine systems in the 100-kilowatt to 3,000-kilowatt size range
- 9 – Natural gas-fueled simple-cycle gas turbine systems in the 3,700-kilowatt to 21,500-kilowatt range
- 3 – Natural gas-fuel, combined-cycle gas turbine systems in the 13,400-kilowatt to 28,000-kilowatt range
- 1 – Coal-fueled, steam turbine (rankine cycle) system rated at 20,000-kilowatt

## BENEFICIAL ELECTRIFICATION

Beneficial electrification encompasses both electrotechnologies and economic development. Because of this connection, it was advantageous to have one team assess the market, collect technology data, and develop the options. A team from Barakat & Chamberlin, Inc. assisted TVA in developing a comprehensive list of beneficial electrification (BE) technologies and in conducting qualitative, economic, and market screens on the list. Next, nine program concepts were developed and were evaluated in DSManager in fourteen options. Some adjustments to the original estimates were made for consistency with the assumptions made in the analysis of energy efficiency options. *Figure T7-14*, a summary of the beneficial electrification options, includes four industrial programs, one program focused on environmental technologies, two commercial programs, two residential programs and one program, focused on transportation.

*Figure T7-15* lists the technologies for which fact sheets containing cost, energy, and demand impacts were developed.

*FIGURE T7-13.* **Renewable Energy Technologies**

| End-Use | Demand-Side Measure |
|---|---|
| Residential | Wood Furnace |
| | Passive Solar Design |
| | Wood Stove |
| | Interactive (Solar and Wood Stove) |
| | Solar Hot Water |
| | Residential Rooftop PV (4kW) |
| | Landscape Shading |
| | Ground-Source Heat Pump |
| Commercial | Passive Solar |
| | Wood Furnace (Space Heating Only) |
| | Wood Boiler (Space and Water Heating) |
| | Solar Hot Water |
| | Commercial Rooftop PV (4kW) |
| | Daylight Design |
| | Photoelectric Control |
| Industrial | Biomass Process and Drying Heat |
| | Solar Assisted Industrial Process Heat |
| | Wood Waste |
| Generation | Biomass Fuel - Wood Waste |
| | Biomass Fuel - Animal Waste |
| | Landfill Gas |
| | Fuel Cells |
| | Small-Head Hydro |
| | Wind Turbines |
| | Remote Photovoltaics |

## TECHNOLOGY LISTS

The residential technologies included in options are listed in *Figure T7-16*. *Figure T7-17* contains residential technologies that should be considered if the site-specific application promises to be cost-effective. *Figure T7-18* contains residential technologies that should not be included in options. Emerging technologies that should be considered for option implementation are listed in *Figure T7-19*.

Commercial and industrial technologies included in efficiency or load management options are listed in *Figure T7-20*. Commercial and industrial technologies that should be considered, especially in comprehensive programs that customize the set of technologies appropriate for each site, are listed in *Figure T7-21*. Technologies that were not included in options are listed in *Figure T7-22*. These technologies were either not appropriate for our climate, incentives may be unnecessary for the technology to be accepted, or were eliminated for some other reason. Emerging technologies for the commercial and industrial sectors that should be considered for option implementation are listed in *Figure T7-23*.

Technologies included in Self-Generation/Renewable Generation options are listed in *Figure T7-24*.

*Figure T7-25* contains a list of technologies included in beneficial electrification options.

*FIGURE T7-14.* **Summary of Beneficial Electrification Programs**

| Program Name | Target Market | BE Technologies |
|---|---|---|
| Process Heating | SICs 30, 32, 33, 34, 35, 36 & 37 | Induction, Resistance, Process Heat Pumps, Microwave RF Heating |
| Process Heating | SIC 33 | DC Arc, Plasma Arc, Induction & Vacuum Melting |
| Curing & Drying | SICs 20, 22, 24, 26, 27, 28 & 30 | UV Curing, EB Curing, Dielectric RF & Infrared Curing |
| Food Processing | SIC 20 | Freeze Concentration, Reverse Osmosis |
| Textiles SIC 20 | Vacuum Slots for Drying | |
| Chemicals and Metals | SICs 28, 33 &34 | Electrolytic Reduction, Remelting, Electrogalvanization, & Electroslag |
| Environmental Technology | SICs 49, 20, 22, 28, 33, 34 & 36 | Ultrafiltration, Microfiltration, Nanofiltration, Ozonation, & Reverse Osmosis |
| Space Conditioning and Water Heating | Schools, hospitals, & government facilities | Heat Pump Water Heaters, Air-Source Heat Pumps, & Dual-Fueled Heat Pumps |
| Cooking and Security Lighting | Restaurants, hotels, & other establishments | Electric Cooking & Security Lighting |
| Residential HVAC and Water Heating | Customers replacing non-electric heating and water heating systems | Heat Pump Water Heaters, Air-Source Heat Pumps, Ground-Source Heat Pumps, & Dual-Fuel Heat Pumps |
| Residential Security Lighting & Lawn Mowers | Promoted among relatively narrow range of customers in non-attainment and high crime areas | Electric Lawn Mowers & Security Lighting |
| Transportation - Electric Buses | Municipalities | Electric Buses |
| Transportation - Fleet Vehicles | Corporations and municipalities | Variety of Fleet Vehicles (vans, carts, fork lifts, etc.) |
| Transportation - Electric Autos | Residential consumers Electric cars | |

## *FIGURE T7-15.* Beneficial Electrification Technologies

| End-Use | Demand-Side Measure |
|---|---|
| Residential | Heat Pump Water Heater |
| | Air-Source Heat Pump |
| | Ground-Source Heat Pump |
| | Dual-Fuel Heat Pump |
| | Security Lighting |
| | Electric Cordless Lawn Mower |
| | Electric Cord Lawn Mower |
| Commercial | Heat Pump Water Heater |
| | High-Efficiency Air-Source Heat Pump |
| | Dual-Fuel Heat Pump |
| | Water Chiller |
| | Thermal Energy Storage |
| | Security Lighting |
| | Convection Oven |
| | High-Efficiency Fryer |
| | Solid Element Burners |
| | Flash Bake Oven |
| Industrial—Process Industries | Electrolysis |
| | Reverse Osmosis |
| | Ultrafiltration |
| | Microfiltration |
| | Freeze Concentration |
| | Electrochemical Synthesis |
| | Ozonation/Oxidation |
| | Ultraviolet (UV) Curing |
| | Electron Beam Curing |
| | Dielectric Curing |
| | Infrared (IR) Curing |
| | Industrial Process Heat Pumps |
| | Resistance Heating |
| | Microwave Heating |
| | Radio Frequency (RF) Heating |
| Industrial—Textiles | Nanofiltration |
| | Radio Frequency (RF) Drying |
| | Infrared (IR) Drying |
| | Ultrasound Drying |
| | Vacuum Slot Drying |
| Industrial—Metals Fabrication | Induction Heating |
| | Resistance Heating |
| | Electroforming |
| | Electrical Discharge Machining |
| | Electrochemical Machining |
| | Electrofinishing |
| | Electron Beam Welding |
| | Plasma Welding |
| | Direct Arc Welding |
| | Laser Welding |
| | Ultraviolet (UV) Curing |
| | Infrared (IR) Curing |
| | Electrogalvanization |
| | Electroslag Casting |
| Industrial—Primary Metals | DC Electric Arc Furnace |
| | Plasma Arc Furnace |
| | Induction Melting (Coreless Induction Furnace) |
| | Vacuum Melting |
| | Plasma Ladle Refiner |
| | Induction Heating |
| | Resistance Heating |
| | Electrolytic Reduction |
| | Electroslag Remelting |
| Municipal | Reverse Osmosis |
| | UV-Ozonation |
| | Plasma Arc Furnace |
| Transportation | Electric Car |
| | Electric Van |
| | Electric Bus (Overhead Electric Cable) |
| | Electric Bus (Battery-Powered) |
| | Electric Rail |
| | Electric Work Vehicle |

## *FIGURE T7-16.* Residential Technologies Included in Options

| End-Use | Demand-Side Measure |
|---|---|
| Cooling | Servicing Central Air Conditioner |
| | High-Efficiency Room Air Conditioner |
| | High-Efficiency Central Air Conditioner |
| | Servicing Room Air Conditioner |
| | Central AC Cycling or Direct Load Control |
| | Heat Pump Cycling or Direct Load Control |
| Cool/Heat | High-Efficiency Air-Source Heat Pump |
| | Ground-Source Heat Pump |
| | Insider Heat Pump |
| | Reduced Duct Leakage |
| | Servicing Heat Pump (Coils, Filters, Lubrication) |
| | Clock/Programmable Thermostat |
| Building Shell | Insulation (Ceiling) |
| | Double- or Triple-Pane Windows |
| | Low-Emissivity Window |
| | Reflective Glass/Window Film/Solar Screen |
| | Caulking/Weatherstripping |
| | Reduced Duct Leakage |
| Lighting | Compact Fluorescent Lamp |
| | High Pressure Sodium (Outdoor) |
| | Motion Detectors for Outdoor Lighting |
| Water Heating | Faucet Aerator |
| | Low Flow Showerhead |
| | Hot Water Pipe Insulation |
| | Water Heater Tank Wrap |
| | Water Heater Bottom Board |
| | Heat Pump Water Heater |
| | Maintain Heat Pump Water Heater |
| | Solar-Assisted Water Heating |
| | Storage Water Heater Cycling or Direct Load Control |
| | Standard Electric Water Heater Cycling or Direct Load Control |
| Appliances | High-Efficiency Frost Free Refrigerator |
| | High-Efficiency Freezer |
| | Servicing Refrigerator or Freezer (Clean Coils) |
| | Removal of Secondary Refrigerator or Freezer |
| | Clothes Dryer with Moisture Sensor |
| | Heat Pump Clothes Dryer |
| | High-Efficiency Dishwasher |
| | Smart House (Home Automation & Real-Time Pricing) |
| | High-Efficiency Pool or Spa Pump |
| | Horizontal-Axis Clothes Washer |

## *FIGURE T7-17.* Residential Technologies Under Further Consideration

| End-Use | Demand-Side Measure |
|---|---|
| Cooling | Two-Speed Central Air Conditioner |
| | High-Efficiency Central Air Conditioner |
| | Ceiling Fan |
| | Thermal Energy Storage (Cooling) |
| Heating | Wood Furnace |
| | Electric Thermal Storage |
| Cool/Heat | Dual-Fuel Heat Pump |
| | Two-Speed Heat Pump |
| | Std. Add-On Heat Pump |
| | High-Efficiency Add-On Heat Pump |
| | Ducts in Conditioned Spaces |
| | Reduced Duct Heat Transfer |
| Building Shell | Insulation (Wall, Foundation) |
| | Reflective Roof Coating |
| | Radiant Roof Barrier |
| | Storm or Thermal Door |
| Lighting | Halogen Lamp (Outdoor Applications) |
| | Efficient Incandescent |
| Water Heating | High-Efficiency Electric Water Heater |
| | Early Replacement of Old Water Heater |
| | High-Efficiency Gas Water Heater |
| Appliances | Best Current Refrigerator or Freezer |
| | Early Replacement of Old Refrigerator or Freezer |
| | High-Efficiency Clothes Dryer |
| | High-Efficiency Range and Oven |
| | Induction Cooktop |
| | Downsized Pool Pumps w/Oversized Piping |
| | Direct Load Control of Pool Pumps |
| | Green Plug Motor Control |

### *FIGURE T7-18.* Residential Technologies Not Included in Options

| End-Use | Demand-Side Measure |
|---|---|
| Cooling | Direct Evaporative Cooler |
| | Indirect Evaporative Cooler |
| | Two-Stage Indirect Evaporative Cooler |
| | Removal of Second Room Air Conditioner |
| | Attic Fan |
| | Whole-House Fan |
| | Shade Trees |
| Heating | Active Solar Space Heater |
| | Zoned Resistance Heating |
| | Resistance Heat & Heat Pump Cycling |
| Cool/Heat | Room Heat Pump |
| | Multi-Zone Heat Pump |
| Lighting | Halogen Lamp (Indoor Applications) |
| Water Heating | Heat Trap |
| | Water Heater Timer |
| | Water Heater Thermostat Setback |
| | Tankless Water Heater (Instantaneous) |
| | Heat Recovery Water Heater |
| Appliances | Refrigerator or Freezer Anti-Sweat Switch |
| | Duct Heat Recovery from Clothes Dryer |
| | Pool Pump Timer |

### *FIGURE T7-19.* Residential Emerging Technologies

| End-Use | Demand-Side Measure |
|---|---|
| Cool/Heat | Gas Absorption Heat Pump |
| | Aerosol Duct Sealing |
| Lighting | Hafnium Single Crystal Filaments |
| | Sulfur Lamp |
| Water Heating | Ultrasonic Faucet Control |
| Appliances | Microwave Clothes Dryer |
| | Whole-House Surge Protection |
| | Cordless Lawn Mowers |
| | High Spin Speed Clothes Washer |
| | Low Energy and Water Use Dishwasher |
| | Golden Carrot Refrigerator |
| | Automatic Clothes Washer Controls |
| | 200-to 300-kWh Refrigerator/Freezer |
| | Low Powered Color TV |
| | Bubble Action Clothes Washer |

## *FIGURE T7-20.* Commercial/Industrial Technologies Included in Options

| End-Use | Demand-Side Measure |
|---|---|
| Cooling | High-Efficiency Chiller |
| | Speed Control for Cooling Towers |
| | High-Efficiency DX A/C |
| | High-Efficiency Room A/C |
| | Thermal Energy Storage (Ice or Water) |
| | Rooftop Cool Storage |
| | HVAC Maintenance & Condenser Coil Cleaning |
| Cool/Heat | High-Efficiency Air-Source Heat Pump |
| | Ground Source Heat Pump |
| | Setback/Setup Thermostat |
| Ventilation | Adjustable Speed Ventilation Motor Drives |
| | Variable Air Volume Systems |
| | High-Efficiency Ventilation Motors |
| | Leak-Free Ducts |
| | Programmable Ventilation Control |
| | HVAC Air Duct/Water Pipe Insulation |
| Building Shell | Roof Insulation |
| | Wall Insulation |
| | High-Efficiency Windows (High R-value) |
| | Tinted Windows (Spectrally Selective) |
| | Low-Emissivity Films (Window Films) |
| | Passive Solar Design |
| Lighting | T8 Lamps |
| | Electronic Ballasts |
| | Ref./Delamp 4' - 40W Lamp/EE Ballasts |
| | Ref./Delamp 4' - 40W Lamp/Electronic Ballast |
| | Ref./Delamp 4' - 40W Lamp/Hybrid Ballast |
| | Ref./Delamp 8' - 75W Lamp/Electronic Ballasts |
| | 4' - 34W Lamps/Electronic Ballasts |
| | 8' - 60W Lamps/Electronic Ballasts |
| | Compact Fluorescent Lamps |
| | Compact Fluorescent Fixtures |
| | 4' - 34W Fluor. Lamps/Dimming Ballasts |
| | Photoelectric Control |
| | Lighting Timers |
| | Occupancy Sensors |
| | Indoor HID Lamps - High Pressure Sodium |
| | Outdoor HID Lamps - High Pressure Sodium |
| | LED Exit Signs |
| | Fluorescent Exit Signs |
| | Electroluminescent Exit Signs |
| | Daylighting Design |
| Water Heating | Heat Pump Water Heater |
| | Heat Recovery Water Heater |
| | High-Efficiency Water Heater - Increased Insulation |
| | Add Heat Trap |
| | Low Flow Showerheads |
| | Pipe Insulation |
| | DHW Recirculation Pumps |
| | Solar-Assisted Water Heater |
| Refrigeration | Glass Doors for Refrigerated Cases (High R-Value) |
| | Anti-Condensate Heater Controls |
| | Dual-Path Supermarket Air Conditioning |
| | Ambient Subcooling |
| Appliances | Energy-Efficient Electric Fryers |
| | Electric Forced Convection Ovens |
| Miscellaneous | Interruptible Rate Option |
| Industrial | High-Efficiency Motor |
| | Motor Downsizing |
| | Adjustable Speed Drives |
| | Compressed Air Efficiency Improvements |
| | Process Efficiency Improvements |

## *FIGURE T7-21.* Commercial/Industrial Technologies Under Further Consideration

| End-Use | Demand-Side Measure |
|---|---|
| Cooling | High-Efficiency Chiller w/ASD |
| | Heat Pipe Enhanced DX A/C |
| | Hotel Occupancy Sensors |
| | 2-Speed Motor for Cooling Tower |
| | Heat Recovery Absorption Chiller |
| | Outside Air Economizer Cycle |
| | Hydronic Economizer Cycle |
| | Cooling Towers - Fans |
| | Chilled Water Reset |
| Heating | Zonal Electric Heat |
| Cool/Heat | Closed Water Loop Heat Pump |
| | Ground-Coupled Heat Pump |
| | Dual-Fuel (Add-On) Heat Pump |
| Ventilation | Reduction in Fan Flowrate |
| | Fan Motor Downsizing |
| Building Shell | Double- and Triple-Pane Windows |
| Lighting | Lighting Management Systems |
| Water Heating | Desuperheater: Refrigeration or A/C |
| | Storage Water Heating |
| Refrigeration | High-Efficiency Evaporator Fan Motors |
| | Condenser Coil Cleaning |
| | Mechanical Subcooling |
| | Energy-Efficient Case Lighting |
| | High-Efficiency Evaporator Fan Motors |
| Office Equipment | Personal Computers |
| | Computer Printers |
| | Copiers |
| Miscellaneous | Energy Management System |
| | Time-of-Use Metering |
| | Real-Time Metering |
| Industrial | Other High-Efficiency Motors |
| | Voltage Unbalance |
| | Efficient Motor Rewinding Techniques |

## *FIGURE T7-22.* Commercial/Industrial Technologies Not Included in Options

| End-Use | Demand-Side Measure |
|---|---|
| Cooling | Direct & Indirect Evaporative |
| Heating | Active Solar Space Heater |
| Ventilation | Reduction of Outside Air |
| Building Shell | Interior Shade |
| | Thermal Scanning |
| | Vestibule/Revolving Doors |
| Lighting | Task Lighting |
| | Electrodeless Fluorescent |
| | Halogen Lamps |
| | Metal Halide |
| Refrigeration | Multideck Strip Curtains |
| | Dual Gaskets |
| | Liquid Pressure Amplifier |
| | Evaporative Pre-Cooler for Air-Cooled Condensers |
| | Parallel Unequal Compressor Systems |
| | Variable Speed Compressor Systems |
| Appliances | High-Efficiency Griddle |
| | Low Temperature Dishwasher - Stationary |
| | Low Temperature Dishwasher - Conveyer |
| | Clothes Dryer - Moisture Sensor |
| | Clothes Dryer - Heat Pump |
| | Clothes Washer - High-Efficiency Motor |
| Office Equipment | Fax Machines |
| | Telephone Systems |
| Miscellaneous | High-Efficiency Pool Pump |
| | Low Pressure Drop Pool Filters |
| | Time-of-Day Pool Pumps |

## *FIGURE T7-23.* Commercial/Industrial Emerging Technologies

| End-Use | Demand-Side Measure |
|---|---|
| Cool/Heat | Zeotropic Refrigerants |
| | GAX Absorption Heat Pump |
| | Absorption Heat Pump |
| | Aerosol Duct Sealing |
| | Electrohydrodynamic Heat Transfer Enhancement |
| Lighting | Hafnium Single-Crystal Filaments |
| | General Service Halogen IR |
| | Advanced Reflector Design |
| | Thermal Bridging for Fluorescent Fixtures |
| | Lower Cost Dimmable Ballast |
| | Integrated Fixtures/Controls |
| | Architectural Daylighting Device |
| | Electrodeless HID |
| | Coated Filament Incandescent |
| | Fluorescent Surface Wave Lamp |
| | Sulfur Lamp |
| | DC Lighting System |
| | LED Traffic Signals |
| Water Heating | Ultrasonic Faucet Control |
| | Ozonated Commercial Laundering |
| Refrigeration | Supermarket System Integration |
| Appliances | Microwave Clothes Dryer |
| | High Spin Speed Clothes Washer |
| | Automatic Clothes Washer Controls |
| | Bubble-Action Clothes Washer |
| | Green Plug Motor Controller |
| Industrial | Switched Reluctance Drive (Improved DC Motor) |
| | Five-Phase Motors (Improved Perm Magnet DC Motor) |

## *FIGURE T7-24.* Renewable/Self-Generation Energy Technologies

| End-Use | Demand-Side Measure |
|---|---|
| Renewables | Landfill Gas - Fuel Cells |
| | Small-Head Hydro |
| | Biomass Fuel - Wood Waste |
| | Photovoltaics |
| Self-Generation | Reciprocating Engine Systems |
| | Gas Turbine Systems |
| | Coal-Fired Steam Turbine Systems |

## *FIGURE T7-25.* Beneficial Electrification Technologies Included in Options

| End-Use | Demand-Side Measure |
|---|---|
| Residential | Heat Pump Water Heater |
| | Air-Source Heat Pump |
| | Ground-Source Heat Pump |
| | Dual-Fuel Heat Pump |
| | Security Lighting |
| | Electric Cordless Lawn Mower |
| | Electric Cord Lawn Mower |
| Commercial | Heat Pump Water Heater |
| | High-Efficiency Air-Source Heat Pump |
| | Dual-Fuel Heat Pump |
| | Security Lighting |
| | Convection Oven |
| | High-Efficiency Fryer |
| Industrial – Process Industries | Reverse Osmosis |
| | Ultrafiltration |
| | Microfiltration |
| | Freeze Concentration |
| | Ozonation/Oxidation |
| | Ultraviolet (UV) Curing |
| | Electron Beam Curing |
| | Dielectric Curing |
| | Infrared (IR) Curing |
| | Industrial Process Heat Pumps |
| | Microwave Heating |
| | Radio Frequency (RF) Heating |
| Industrial – Textiles | Nanofiltration |
| | Vacuum Slot Drying |
| Industrial – Primary Metals | DC Electric Arc Furnace |
| | Plasma Arc Furnace |
| | Induction Melting (Coreless Induction Furnace) |
| | Vacuum Melting |
| | Plasma Ladle Refiner |
| | Induction Heating |
| | Resistance Heating |
| | Electrolytic Reduction |
| | Electroslag Remelting |
| Industrial – Metals Fabrication | Induction Heating |
| | Resistance Heating |
| | Electrogalvanization |
| | Electroslag Casting |
| Municipal | Reverse Osmosis |
| | Ultraviolet-Ozonation |
| Transportation | Electric Car |
| | Electric Van |
| | Electric Bus (Battery-Powered) |
| | Electric Work Vehicle |

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# GLOSSARY

Below are definitions of terms that will be used often in this appendix. (Terms in definitions which are themselves defined in the Glossary are printed in *italics*.)

## A

**AC**—Air Conditioning.

**Add-Ons**—Purchases of new or additional equipment of a type previously not present in an existing facility, such as the purchase of a food freezer for a home that previously had none or the purchase of a second room air-conditioner.

**Administrative Costs**—Expenses incurred by the utility for program planning, design, management, and administration. They include labor, office supplies, data processing, etc. They exclude the costs of marketing, purchase of equipment for programs, incentives, and monitoring and evaluation.

**Advanced Batteries**—An advanced technology battery that has more storage capacity than a lead acid battery.

**AFUE**—Annual fuel utilization efficiency (AFUE) is an efficiency rating used for gas appliances based on average usage including on and off cycling described in a standardized Department of Energy test procedure. These ratings are listed in publications from the Gas Appliance Manufacturers Association (GAMA).

**Agricultural Sector**—The group of non-residential customers engaged in the production of crops or livestock, forestry, fishing, hunting, or trapping.

**Ambient**—Surrounding.

**Annual Participation**—The number of customers enrolled in a particular program for a given year.

**Annual Participation Rate**—The ratio of the number of participating units in a particular year to the number of eligible units.

**ASD**—An adjustable speed drive (ASD) may be used to control the speed of an electric motor.

**ASHRAE**—American Society of Heating, Refrigeration, and Air-Conditioning Engineers, Inc.

**Attributes**—Measures or criteria used to evaluate options and strategies. For example, total TVA debt is an attribute.

**Availability**—The percentage of time that a TVA power plant (or generating unit in a power plant) can be called on to produce power.

**Avoided Cost**—The incremental cost to TVA for *capacity* or *energy* or both which, but for an acquisition from another source, the TVA would have to incur. (In other words, the cost of Plant A, which TVA would have acquired except for that fact that it was able to acquire Plant B.)

## B

**Base Load Capacity**—Large power plants, often coal- or nuclear-fueled, which are designed to operate around the clock at high capacity factors.

**Baseline**—A mid-range set of assumptions on all variables, with a "business as usual" decision strategy.

**Beneficial Electrification**—Electricity may be used as a tool for economic development to fuel new products or replace other fuels for process improvement.

**Biomass**—Biomass involves the harvesting of stands of close growing whole trees, truck transport, tree storage, and drying using air heated by boiler flue gas, and combustion of the whole trees in a special deep bed burner at the bottom of the furnace.

**Boiler**—A component that consumes a fuel for a heat source to produce steam from water.

## C

**Capability**—(1) With respect to *supply-side resources*, the amount of electric power that a generating unit or electric system can reliably deliver under specified conditions over a specified period of time; (2) with respect to *demand-side resources*, the ability and skills to perform *demand-side management* activities such as market research, program design, evaluation, etc.

**Capacity**—The amount of electric power that can be delivered by a generating unit or electric system, as determined by manufacturer's nameplate ratings or by testing. (For example, the capacity of a com-

bustion turbine power plant, based on its nameplate rating, would be stated as 225 *MW*.

**Capacity Factor**—A universal standard for measuring power plant performance. It compares a plant's actual output with its maximum potential output, expressed as a percentage.

**CFC**—*Chlorofluorocarbons.*

**$CH_4$**—*Methane.*

**Chemical Coproduction**—The production of a chemical product while simultaneously producing electricity.

**Chlorofluoro-carbon (CFC)**—A family of inert, nontoxic, and easily liquified chemicals used in refrigeration, air conditioning, packaging, and insulation or as solvents and aerosol propellants. Because CFCs are not destroyed in the lower atmosphere, they drift into the upper atmosphere, where their chlorine components destroy ozone.

**Class 1 Areas**—Nonattainment area—the part of a state where a state fails to attain and maintain pollutant levels below the National Ambient Air Quality Standards. States are required to impose additional control requirements on sources of ozone, carbon monoxide, particulates (PM 10), sulfur dioxide, nitrogen dioxide, and lead within the nonattainment area in order to attain the ambient standard.

**Climate Challenge**—The principal utility industry component of the President's Climate Change Action Plan, which provides for a voluntary reduction of greenhouse gases (primarily *CO2*).

**CO**—*Carbon Monoxide.*

**$CO_2$**—*Carbon Dioxide.*

**Cogeneration**—The use of a primary fuel, such as natural gas, to produce both electrical energy and thermal energy used as steam or process heat.

**Coincident Peak**—The *demand* of a TVA customer or group of customers at the time TVA's entire system is at its *peak load.*

**Coincident Peak Demand**—The load (in kW) of an end use, customer, or group of customers at the time the utility experiences its greatest demand for electricity.

**Commercial Sector**—The group of nonresidential customers that provides services, including retail, wholesale, finance, insurance, and public administration.

**Conservation**—A reduction in either *energy* usage or *peak demand* so as to provide the prior end-use service levels at a lower cost.

**COP**—Coefficient of Performance (COP) is dimensionless and defined as the useful energy effect divided by the energy from external sources.

**Criteria**—Measuring rods used in integrated resource planning. They are derived from issues or concerns. Examples include concerns over future rates, acceptable levels of environmental impacts, etc.

**Cumulative Effects**—The changes in electricity use and demand caused by all of a program's participants from the program's inception through the current year.

**Cumulative Participation**—The number of participating units from the start of a program through the current year.

**Cumulative Participation Rate**—The ratio of the number of participating units from the start of a program through the current year to the number of eligible units.

**Customer Class**—A group of customers with similar characteristics, such as economic activity or level of electricity use.

**Customer Service Options**—Actions taken to influence the nature of loads on the customer-side of the meter.

## D

**Decision**—A choice that, although made ultimately by TVA's Board, contains input from all stakeholders.

**Decision Analysis**—A decision-making process that provides a mathematical framework by which a large set of resource *strategies* can be evaluated for a number of uncertain parameters. (For example, an ultimate decision might include five subdecisions, each with five key uncertain parameters, for which there are three values representing the range of likely outcomes. In this example, 1,115 scenarios would be evaluated in making the decision.)

**Declining Block Rates**—A utility rate where after a certain level of consumption in a period, additional consumption of energy is charged a lower rate.

**Demand**—The amount of electric energy used at a specific point in time, measured in watts (or multiples thereof, such as *kW*, *MW,* or *GW*). Demand is measured for individual customers, for groups or classes of customers, and for TVA's system as a whole.

**Demand-Side Management (DSM)**—Activities which influence electricity use on the customer's side of the meter. Examples include home weatherization, use of compact fluorescent lighting, etc.

**Demand-Side Management Measure**—A single technology, such as a compact fluorescent light bulb, which can be used to alter customer load.

**Demand-Side Management Programs**—Organized utility activities that are intended to affect the amount and timing of customer electricity use.

**Demand-Side Management Resource**—Bundles or packages of DSM activities that can be used to reduce customer energy demands, and thus be viewed in many respects like a generating source.

**Diesel Generators**—An electrical generator powered by a traditional diesel engine. Direct-Installation ProgramsActivities in which the utility (or its contractor) installs DSM measures in the facilities of participating customers; such programs generally cover low-cost measures, such as water-heater wraps and compact fluorescent lamps.

**Dispatchable**—Capable of being connected or disconnected from a utility's system as necessary for efficient operation of the system. Generally applies to generating facilities, but could also apply to a load that is interruptible when necessary.

**Distributed Generation**—Power generation facilities located close to energy users. These are normally small size units (i.e., less than 50 *MW*) and may include both generation and energy storage technologies.

**Diversified Coincident Peak Demand Effect**—The change caused by the utility's DSM program in the demand for electricity at the time the utility experiences its system peak.

**Diversified Demand**—The average load (in *kW*) across a group of customers or end uses.

**DOE 2**—A public domain building energy analysis software program developed with funding from the Department of Energy.

**DX**—Direct expansion (DX) refers to cooling equipment with a refrigerant to air coil and no chilled water system.

## E

**Early Replacement**—The removal of equipment before it reaches normal retirement age and the substitution of new equipment for the old.

**Eco-Efficiency**—Sustainable manufacturing and pollution prevention practices.

**Econometric Models**—Models that use past statistical relationships between electricity sales and the major assumptions such as economic activity and prices to forecast future electricity sales.

**Economic Dispatch**—The hour-by-hour operation of TVA's system of generating units to meet hourly and daily load swings in a way that minimizes the cost of producing electricity.

**Economic Potential**—An estimate of the possible energy savings assuming that all energy-efficient options will be adopted and all existing equipment will be replaced with the most efficient whenever it is cost-effective to do so, without regard to market acceptance.

**Economy Surplus Power (ESP)**—A form of interruptible power sold by TVA. The price for ESP changes hourly and is based on a markup over the incremental cost of the power. There are several variations of ESP with different markups and interruption provisions.

**EER**—Energy efficiency ratio (EER) is a ratio calculated by dividing the cooling capacity in Btu's per hour (Btuh) by the power input in watts at any given set of rating conditions, expressed in Btuh per watt (Btuh/watt). These ratings are listed in pub lications by the Air-Conditioning & Refrigeration Institute (ARI).

**EF**—Energy Factor (EF) is a measure of the overall efficiency rating of a water heater certified by the Gas Appliance Manufacturers Association (GAMA).

**Effluent**—Wastewater—treated or untreated—that flows out of a treatment plant, sewer, or industrial outfall. Generally refers to wastes discharged into surface waters.

**Electric and Magnetic Fields**—Two types of energy fields that are emitted from any device that generates, transmits, and uses electricity.

**Eligible Market**—The subset of the total market that is qualified to participate in a program based on the program's participation criteria.

**EMF**—*Electric and Magnetic Fields.*

**Emission**—Pollution discharged into the atmosphere from smokestacks, other vents, and surface areas of commercial or industrial facilities; from residential chimneys; and from motor vehicle, locomotive, or aircraft exhausts.

**EMS**—Energy management system is a term used for automated control of *HVAC* and lighting systems in buildings.

**End Use**—The ultimate benefits provided by electricity. For example, commercial electric energy uses can be segmented into several end uses, such as lighting, air conditioning, ventilation, heating, cooking, refrigerating, etc.

**End-Use Model**—An energy forecasting approach that focuses on the end uses of electricity, and the factors that influence such end uses.

**Energy**—The amount of power consumed over a period of time, measured in watt hours, *kWh*, *MWh*, or *GWh*.

**Energy Efficiency**—(1) With regard to *supply-side resources*, reducing the amount of fuel required to produce a given amount of electric energy; (2) with regard to *demand-side management resources*, reducing the amount of electric energy used without reducing the functionality of that use—for example, by replacing a 74 watt incandescent light bulb with an 18 watt compact fluorescent light bulb delivering the same amount of lumens.

**Energy Efficiency Programs**—Programs (sometimes called energy-conservation programs) that are aimed at reducing the energy used by specific end-use devices and systems without degrading the services provided, thereby reducing overall electricity consumption (*kWh*), often without regard for the timing of program-induced savings. Such savings are generally achieved by substituting technically more advanced equipment to produce the same level of end-use services (e.g., lighting or warmth) with less electricity.

**Energy Storage**—Mechanism of utilizing during the peak load period energy that was stored during the light load period when energy production costs were relatively low. The duration of an energy storage cycle rarely exceeds one week.

**Environmental Externalities**—Externalities are activities which result from the production and consumption of goods and services that impose costs or benefits on society that are not reflected in the prices of those goods or services. For example, negative externalities such as pollution and sonic booms can impose costs on a society that are not reflected in the prices of those goods associated with the pollution or sonic boom. Discussions of externalities in the utility industry have generally dealt with environmental externalities arising from various forms of pollution.

**Environmental Mitigation**—Making environmental pollutants less severe.

**Equipment Cost**—The price of components that the utility purchases directly for a *DSM* program, including the cost of *DSM measures* distributed free to participants.

**Evaluation Criteria**—Measures to evaluate the contribution of resource options to stated objectives and values.

**Existing Buildings**—Structures that are in use as of the beginning of the current year.

**Externalities**—Consequences or impacts of resource development that are not directly accounted for in the price paid for the resource developed.

## F

**Feedstock**—The raw materials utilized by a chemical production facility to make the final product.

**Firm Capacity**—(1) With regard to *supply-side resources*, a binding commitment to purchase or sell *capacity*. Purchases increase the *capability* of TVA's system; sales decrease TVA's *capability*; (2) with regard to *demand-side management resources*, the amount of *capability* that must be provided to a customer under normal conditions.

**Firm Power**—Power sales that do not have provisions in the contract for interruptions. (See *Interruptible Power*)

**Fixed Costs**—Costs associated with constructing and maintaining resources in an operable condition, including capitalized construction costs, fixed operating and maintenance costs and fuel inventory costs. These costs are recovered whether or not the resource is actually operated.

**Flexibility**—The degree to which resource decisions can be changed over time as events unfold, and near-term futures become more clearly known.

**Free Drivers**—Customers who take DSM-program-recommended actions because of the program, but who do not participate directly in the program (e.g., they do not claim rebates).

**Free Riders**—Customers who would have adopted program-recommended actions even without the program, but who participate directly in the program (e.g., they claim rebates).

**Fuel Cells**—A device capable of converting a fuel and an oxidizer directly to electricity.

**Fuel Switching Programs**—Programs that encourage customers to change from one fuel to another for a particular end-use.

**Full-Scale Programs**—Mature, system-wide programs that are available to all of the eligible customers in the utility's service area.

**Future**—A combination of discrete values for key uncertainties that are being treated explicitly. For example, a *future* might assume a high rate of load growth, low oil prices, low coal prices, high interest rates, and no new carbon dioxide ($CO_2$) regulations.

**Futures (Financial Market)**—The sale of a product for delivery at some time in the future for a specified price. Most major commodity markets have well-organized active futures markets. For

example, farmers will sometimes sell part of their crop for fall delivery before it is planted.

## G

**General Information Programs**—Programs that refer to utility efforts to inform customers about *DSM* options through such mechanisms as brochures, bill stuffers, TV and radio ads, and workshops.

**Global Warming**—The theory that certain gases such as *carbon dioxide ($CO_2$)*, *methane ($CH_4$)*, and *chlorofluorocarbon (CFC)* in the earth's atmosphere effectively restrict radiation cooling, thus elevating the earth's ambient temperatures.

**Greenhouse Effect**—The build-up of carbon dioxide or other trace gases that allows light from the sun's rays to heat the Earth but prevents a counterbalancing loss of heat.

**Greenhouse Gas Emissions**—A gas whose presence in the upper atmosphere contributes to the greenhouse effect by allowing visible light to pass through the atmosphere while preventing heat radiating back from the Earth from escaping. Greenhouse gases from anthropogenic sources include *carbon dioxide, nitrous oxide, methane,* and *chlorofluorocarbons (CFCs)*. There also are even larger quantities of naturally occurring greenhouse gases, notably ozone and water vapor, whose concentrations may be affected by interactions with atmospheric pollutants.

**GW**—Gigawatt, an amount of electric power equal to 1,000 *MW* or 1 billion watts.

**GWh**—Gigawatt hour, an amount of energy equal to 1,000 *MWh* or 1 billion watt hours.

## H

**Hazardous Waste**—A byproduct of society that can pose a substantial or potential hazard to human health or the environment when improperly managed. Possesses at least one of four characteristics (ignitability, corrosivity, reactivity, or toxicity) or appears on special Environmental Protection Agency lists.

**HSPF**—Heating Season Performance Factor (HSPF) is the total heating output of a heat pump during its normal annual usage period for heating divided by the total electric power input in watt-hours during the same period. This rating is listed in publications by the American Refrigeration Institute (ARI).

**HVAC**—Heating, Ventilation, and Air Conditioning

**Hydro Generation**—A dam creates an upper and a lower water reservoir. The height difference between the two reservoirs establishes potential energy that is used to generate electricity by allowing water from the upper reservoir to flow through a hydro turbine to the lower reservoir.

## I

**Incentive**—An award offered to encourage participation in a DSM program and adoption of recommended measures.

**Incentive Programs**—Programs that offer cash or noncash awards to customers, trade allies, or employees to encourage participation in a *DSM* program and adoption of recommended measures.

**Incremental Cost**—The additional cost incurred because of an activity. For example, a plant sitting idle has costs associated with it such as interest on funds used to build it and basic maintenance. When started up, the plant has additional costs such as fuel, additional maintenance, and other costs. These latter costs are the incremental costs of producing the product. Similar terms are avoided cost and marginal cost.

**Incremental Fuel Cost**—The cost of replacing a unit of fuel in today's market.

**Incremental Participation**—The number of annual participants in the current year minus the annual participants in the previous year.

**Industrial Sector**—The group of nonresidential customers that provides products, including agriculture, construction, mining, and manufacturing.

**Integrated Resource Planning**—A utility planning process that evaluates *supply-side resources* and *DSM resources* on a level playing field to reliably meet the future energy needs of customers.

**Internalized Costs**—Costs that result from the production and consumption of goods and services that are reflected in the price of those goods and services.

**Interruptible Power**—A type of *demand-side management* activity in which the power contract allows TVA limited rights to turn off the power when overall demand is high in return for a lower price to the customer. Many industrial customers buy part of their power as interruptible. (See *Firm Power*)

**Issue**—A concern expressed regarding TVA's energy resource plan or its implementation. For example, an industrial customer may see low electricity rates as vital to its continued operation.

**kW**—Kilowatt, which is the amount of power equal to 1,000 watts. Common measure of demand for electricity at any moment.

**kWh**—Kilowatt hour, which is the amount of energy equal to 1,000 watt-hours.

Common measure for use of electricity over time.

## L

**Life-Cycle Costs**—Method of expenditure evaluation that recognizes the sum total of all costs associated with the expenditure during the time it is in use.

**Limited Interruptible Power (LIP)**—A form of interruptible power sold by TVA. LIP customers get discounts from firm power rates in exchange for granting TVA limited rights to interrupt the power if necessary when the power supply situation is very tight.

**Load**—The amount of power that is drawn from TVA's electric system at a given point in time.

**Load Factor**—A measure of the variability in electric usage, defined as the ratio of energy actually consumed to the potential consumption at peak load for the period of time of interest. Load factor is usually calculated over a one year (8,760 hours) time period.

**Load Management**—The control of customer demand during peak periods or during periods when supplies of electricity are short. Unlike energy conservation, load management may not conserve energy.

**Load Not Served**—A measure of the reliability of a power system.

**Load Shape**—The time-of-use pattern of customer electricity use, generally a 24-hour pattern or an annual (8,760-hour) pattern.

**Load-Building Programs**—Programs that aim to increase electricity consumption, generally without regard to the timing of the increased usage.

**Load-Shifting Programs**—Programs that aim to move electricity consumption from one time to another (usually from the on-peak to off-peak periods during a single day).

## M

**Market Potential**—An estimate of the possible energy savings that would occur because of normal market forces (i.e., likely customer adoption over time of various actions without a *DSM* program)

**Methane ($CH_4$)**—A greenhouse gas that is colorless, nonpoisonous, and flammable and is created by anaerobic decomposition of organic compounds.

**micro-AXCESS**—A building energy analysis software program available through EPRI.

**Mitigation**—Measures taken to reduce adverse impacts on the environment.

**Monitoring and Evaluation Cost**—Expenditures associated with the collection and analysis of data used to assess program operation and effects.

**MW**—Megawatt, the amount of power equal to 1,000 KW or 1,000,000 watts.

**MWh**—Megawatt hour, the amount of power equal to 1,000 KWh or 1,000,000 watt hours.

## N

**Net Effect**—The change in electricity use or demand for a participating customer that can be attributed to the utility *DSM* program, expressed in *MWh*/year and *MW*.

**New Construction**—Buildings and facilities that are constructed during the current year; it may also include major renovations of existing facilities.

**New Construction Programs**—Programs that affect the design and construction of residential and commercial buildings and manufacturing facilities; such programs may also include major renovations of existing facilities.

**New Participants**—Customers who take part in a program during the current year and did not participate in the program during the previous year.

**NIMBY**—Not in my backyard.

**Non-Attainment Area**—A geographic area that does not meet one or more of the National Ambient Air Quality Standards for the criteria pollutants designated in the Clean Air Act.

**Noncoincident Peak**—The peak demand imposed on TVA by a customer, group of customers or all the customers as a whole, but not necessarily at the same time.

**Normal Replacement**—The removal of worn-out (and perhaps obsolete) equipment and the installation of new equipment.

## O

**Off-Peak**—The periods of time during which energy is being delivered far below the maximum demands that could be placed.

**On-Peak**—The periods of time during which energy is being delivered near, or at, the maximum *coincident peak load*.

**Operating and Maintenance Costs**—Noncapital, equipment-related expenses that continue over the life of the equipment; they include fuel costs, as well as costs for maintaining and servicing equipment.

**Option**—Actions TVA can take to resolve an issue. For example, if TVA forecasts an energy deficit, it has the option to meet it with *DSM* programs or other resources.

## P

**Participant Costs**—Those expenses associated with taking part in a *DSM* program paid by the customer and not reimbursed by the utility.

**Participants**—Units used by a utility to measure participation in its *DSM* programs; such units of measurement include customers or households for residentials programs and customers, floor area, or *kW*-connected for commercial and industrial customers.

**Participation Rate**—The ratio of the number of participants in a program to the number eligible for the program, with both the numerator and denominator defined in the same units.

**Peak Demand**—The maximum rate of electricity use, expressed in *kW*.

**Peak Load**—The maximum *load* experienced by TVA's electric system over a given period of time.

**Peak-Clipping Programs**—Programs that aim to reduce electricity *demand* (*kW*) at certain critical times, typically when the utility experiences system peaks.

**Peaking Capacity**—Capacity that is available for use and used to meet *peak load*. Such capacity, usually represented by combustion turbines, often has low capital costs and high fuel costs, and is designed to operate for relatively short periods of time.

**Penetration**—The ratio of the number of new units of a specific type installed to the total number of new units installed during a given time (e.g., the fraction of new air-conditioner sales that exceeds an energy-efficiency ratio of 10).

**Photovoltaics**—Solar-photovoltaic (PV) power plants convert solar energy to electricity using a semiconductor material, usually silicon doped with phosphorus and boron, to generate dc current.

**Point Sources**—A stationary location or fixed facility from which pollutants are discharged or emitted. Also, any single identifiable source of pollution, for example, a pipe, ditch, ship, ore pit, or factory smokestack.

**PSD**—*Prevention of Significant Deterioration.*

## R

**Real Prices**—(Or constant dollar prices, prices excluding inflation) As applied to price changes, the rate of change in a price over time adjusted for the overall inflation rate. For example, if the price of a widget goes up 1 percent while the average price of all goods sold in the economy goes up 2 percent, the real price of the widget is said to have declined 1 percent.

**Real-Time Pricing**—*Energy* is priced at the cost of producing it at the time it is consumed.

**Rebate**—Money given to customers, contractors, homebuilders, or other trade allies who make equipment choices to help defray the incremental cost of *DSM* measures.

**Reference Case**—One given set of circumstances used to compare other sets of circumstances.

**Reliability**—The ability of TVA's electric system to deliver uninterrupted power to its customers.

**Renewable Resources**—Power plants or other generating devices whose fuel source is generally considered to be renewable. These include generators fueled by *biomass*, water, *photovoltaics*, solar, wave or wind energy.

**Reserve Margin**—The difference between the capability of TVA's electric system and expected peak load, expressed as a percentage of expected peak load.

**Residential Sector**—The group of customers to whom electricity is sold for household purposes, including space heating, water heating, air conditioning, lighting, and appliances in single-family, multi-family, and mobile homes.

**Resources**—*Supply-side* or *DSM* options that can be used by TVA to meet future customer energy needs.

**Retrofit**—Replacement or upgrading of equipment before it reaches normal retirement age.

**Retrofit Programs**—Programs that upgrade existing facilities and equipment.

**Revenue Requirements**—The amount that must be recovered from customers to cover a utility's fixed and variable costs.

**Robustness**—The degree to which an energy strategy meets an objective for most or all futures.

## S

**Saturation**—On the demand side, the percentage of a group of customers that have a particular *end use*. For example, the residential saturation of heat pumps is 50 percent if half of residential customers have them. In the commercial sector, saturations (also know as fuel shares) are generally measured on a percentage of square footage basis.

**SCADA**—System Control and Data Acquisition

**Scenario**—The combining of one *strategy* with one *future*.

**SEER**—Seasonal Energy Efficiency Ratio (SEER) is the total cooling of a central unitary air conditioner or unitary heat pump in Btu's during its normal annual usage period for cooling divided by the total electric energy input in watt-hours during the same period. This rating is listed in publications by the American Refrigeration Institute (ARI).

**Stranded Cost**—Costs that a utility faces because of stranded investments. For example, a utility may owe money on a closed plant that is generating no income. If a stranded investment can operate and cover part of its cost, only the portion of the cost not covered would be stranded.

**Stranded Investment**—An investment in plant or equipment that loses its value because of competition that forces down the price of the product. In the electric utility industry, firms may have been allowed or directed by regulators to build high cost capacity to meet the obligation to serve their customers. If the market is open to competition, lower cost producers may capture these customers, causing the high cost capacity to close and become a stranded investment.

**Strategy**—A combination of *options* intended to fulfill a particular resource goal. For example, an energy deficiency in 2007 might be met with a combination of *supply-side resources* and *DSM resources*.

**Sunk Cost**—The sum of previous investments; monies that have already been spent.

**Supply-Side Resource**—Resources that meet customer needs by increased production of electricity.

**Sustainable Development**—Meeting the needs of the present without compromising the ability of future generations to meet their own needs.

**System Energy Requirements**—The total energy the generating system needs to produce to meet customer needs over some time period, generally a year. System energy requirements include all sales and *system losses*. Customer needs are measured before *load management* measures are applied.

**System Losses**—Difference between the energy metered at the generator and the energy recorded at the customers' meters.

## T

**Take-back**—Changes in customer behavior resulting in greater energy use stimulated by participation in a *DSM* program.

**Target Market**—The group of customers (a subset of the eligible market) that is the focus of utility marketing efforts.

**Total Program Costs**—All expenses associated with a *DSM* program regardless of whether borne by the utility, participating customer, or trade allies. The costs paid by customers and trade allies are first adjusted for incentives from the utility to avoid double-counting costs.

**Total Resource Costs (TRC) Test**—A benefit-cost test that measures the net costs of a *demand-side* program as a resource option based on the total cost of the program, including both the participants' and the utility's costs. The costs in this test are the program costs paid by both the utility and the participants plus the increase in supply costs for any period in which load has been increased. All equipment costs are included in this test.

**Total Value Test**—the *Total Resource Costs* test to not only include the total cost of an *option*, but also the effects upon the benefits or "value" that participants and ratepayers receive.

**Trade Allies**—Organizations (e.g., architect and engineer firms, building contractors, appliance manufacturers and dealers, and banks) that affect the energy-related decisions of customers who might participate in *DSM* programs.

## U

**Utility Costs**—All the expenses (administrative, equipment, incentives, marketing, monitoring and evaluation, etc.) incurred by a utility in a given year for operation of a *DSM* program regardless of whether the costs are capitalized or expensed.

## V

**Valley-Filling Programs**—Programs that typically seek to increase off-peak electricity consumption (without necessarily reducing *on-peak* demands).

**Variable Costs**—Costs associated with the generation of electricity that vary with the utilization of the generating station, such as fuel, consumable supplies, etc.

**Variable Frequency Drive (VFD)**—A variable frequency drive is a type of *ASD* that varies the frequency of the electricity to an electric motor to control its speed.

**VOCs**—*Volatile organic compounds.*

**Volatile Organic Compounds**—Any organic compound that participates in atmospheric photochemical reactions except for those designated by the

Environmental Protection Agency administrator as having negligible photochemical reactivity.

## W

**Weather Adjusted**—(Or weather normalized) Having the effects of the difference between actual and expected normal weather removed. For example, TVA forecasts summer peaks for a normally expected Valley-wide average temperature of 96 degrees. If the peak one year occurs at 100 degrees, a weather adjusted peak will be estimated by applying a per degree adjustment factor to the four-degree difference.