

Chapter Eight

Customer Service Options



Chapter 8: Customer Service Options

Customer service options are actions consumers can take on their side of the electric meter to obtain energy efficiencies and provide load management options for utilities. Customer service options also include actions consumers can take to use electricity to improve their productivity and quality of life.

TVA's catalog of customer service options contains traditional demand-side management (i.e., energy efficiency and load management), self-generation, beneficial electrification, and rate options. TVA designed the options to take advantage of existing and emerging technologies that could be effectively integrated into programs to meet varying customer and TVA needs.

These options were ranked by total resource cost as well as other evaluation criteria and combined into blocks of options suitable for analysis with power supply options. TVA's long- and short-term resource plans will include those customer service options that integrate well with desirable supply-side options and meet TVA's evaluation criteria.

This Chapter Includes:

- Range and Effects of Options
- Customer Objectives
- Key Areas for Customer Service Options
- Summary of All Customer Service Options
- Option Development Process
- Programs Used to Overcome Market Barriers
- Key Variables and Assumptions
- Results of Analysis
- Summary

Customer Service Options

Range and Effects of Options

The customer service options developed by TVA cover a wide range of technologies and pricing strategies. They also include other activities that change the way customers use electricity, providing both direct benefits to customers and resource benefits for the power system. These options would be implemented by TVA in partnership with distributors of TVA power for the benefit of end-use customers.

The integrated resource planning process also considers the indirect effects associated with customer service options; these include economic development, electricity prices, customer value, productivity, and the environment.

One of the primary goals of Energy Vision 2020 is to provide benefits to customers.

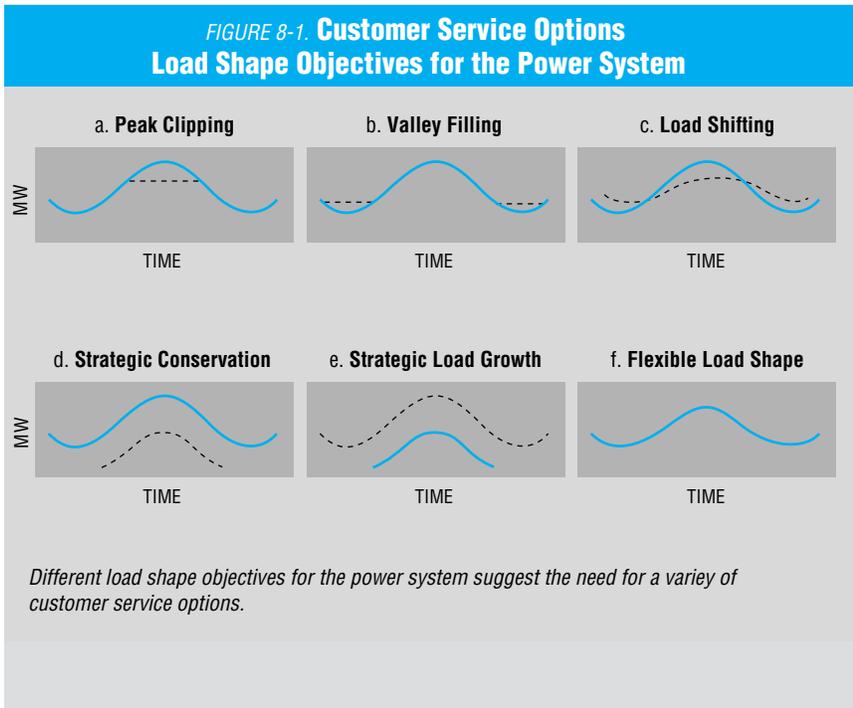
Customer Objectives

One of the primary goals of Energy Vision 2020 is to provide benefits to customers. In developing customer service options, TVA gave special consideration to the following objectives:

- **Minimum Rates** – Options that help TVA maintain competitive rates
- **Low Cost** – Options that are cost-effective for both the customer and the utility
- **Large Impacts** - Options that can quickly produce significant energy and capacity savings
- **Diversity** – Options that address all end uses (devices that use electricity) and improve the flexibility of the power system
- **Environmental Benefits** – Options that have important environmental benefits associated with them
- **Customer Service** – Options that create value for the customer by increasing productivity or lowering the costs of energy services
- **Social Equity** – Options that provide all ratepayers with an equal opportunity to participate in customer service programs and minimize the potential rate subsidies between one customer class and another

Customer service options are also associated with six different load shape objectives, as shown in *Figure 8-1*. A load shape shows the pattern of

electricity consumption in a utility’s service territory over a period of time. One of demand-side management’s objectives is to smooth the shape of energy demand to achieve a flatter load shape. A flatter load shape allows the utility to use generating facilities that have lower operating and fuel costs per unit of electricity produced and avoid the use of higher-cost peaking alternatives.



Key Areas for Customer Service Options

TVA developed customer service options in four key areas:

- Traditional demand-side management, which includes conservation and load management
- Self-generation
- Beneficial electrification
- Rates

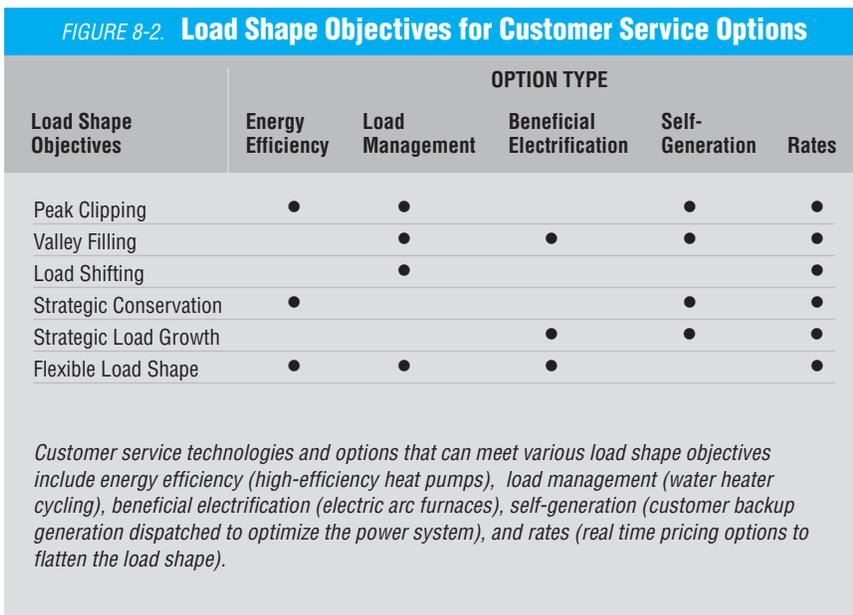
Figure 8-2 shows which of the load shape objectives can be achieved by the different customer service options.

DEMAND-SIDE MANAGEMENT

Demand-side management options include energy efficiency measures such as insulation, building construction designs, and the use of more efficient appliances and equipment. Demand-side management is also achieved through load management options, where the utility controls the heating cycle for water heaters, the use of other appliances, or encourages customers to modify their pattern of energy use by using storage technologies in order to reduce demand during peak hours.

SELF-GENERATION

Self-generation options refer to relatively small decentralized power systems that customers can use to meet a portion of their energy needs and also improve reliability. Utilities can encour-



age use of these options through financing rate programs or partnerships to provide benefits to the power system. Self-generation systems include both fossil and renewable technologies.

BENEFICIAL ELECTRIFICATION

Beneficial electrification options promote the use of electricity by identifying new, efficient uses of electricity or by substituting it for other fuels to increase productivity and product quality. Beneficial electrification can also provide increased convenience for the customer or environmental benefits. Electric buses, microwave heating, and electric lawn mowers are examples of potentially valuable new uses of electricity.

RATE OPTIONS

Rate options refer to changing the level and structure of charges for electricity use by customers. These charges include a customer charge, a demand charge, and an energy charge. The customer charge is based on the non-energy-related costs of serving each customer. Non-energy-related costs include administrative costs. The demand charge is based on the quantity of generating capacity required to serve a customer. Finally, the energy charge is based on the variable production costs of each unit of electricity. Fuel costs are a large component of the energy charge. As shown in *Figure 8-2*, rate options can achieve all load shape objectives. Rate options also include charges based on time of use in order to reduce demand during hours of peak use.

Summary of All Customer Service Options

Figure 8-3 summarizes the customer service options developed for consideration in Energy Vision 2020. In the demand-side management area, TVA has developed 39 options (23 for residential customers and 16 for commercial and industrial customers). There are 14 beneficial electrification options spanning all sectors of the economy. Eight self-generation options were developed for commercial and industrial customers. TVA also developed two rate options for each sector of the economy.

These options can change both the need for new generating capacity and the level of electricity sales that TVA would be required to provide. *Figure 8-3* shows that in 2010, more than 5,500 megawatts of electricity could be saved if all of the proposed energy efficiency options were adopted regardless of their cost-effectiveness. Small-scale self-generation could reduce direct demand on the TVA system by more than 280 megawatts.

Time-of-day rates for residential, commercial, and industrial sectors could reduce demand by 892 megawatts in 2010. Time-of-day rates charge customers more for energy use during hours when electricity must be produced

FIGURE 8-3. Customer Service Options Summary – Impacts for 2010

Resource Acquisition (Saving)	Options	Megawatts
Energy Efficiency & Load Management	39	5532
Self-Generation	8	281
Rates (Time-of-Day)	3	892
Load Growth (Sales)	Options	Megawatts
Beneficial Electrification	14	205
Rates(Declining Block)	3	169

Values are the impacts occurring only in the year 2010 for the cumulative participation in the program to that date. The customer service options identify a potential to save 6,705 megawatts of alternative capacity. Beneficial electrification and declining block rates would increase the required electricity production capacity by 374 megawatts.

by the power plants that are the most expensive to operate. A declining block rate option, which charges a lower price for electricity use when use exceeds a certain amount, provides a benefit for customers who use large amounts of electricity. The declining block rate option could increase electricity demand by 169 megawatts. Beneficial electrification could increase demand by 205 megawatts.

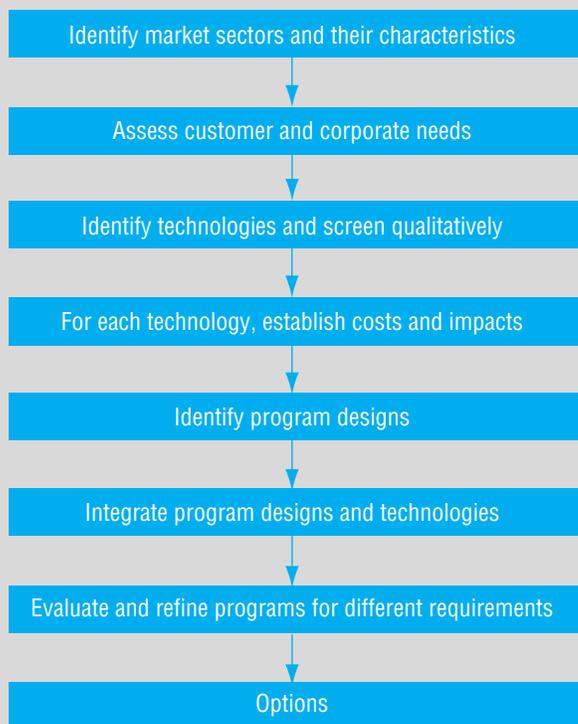
Option Development Process

TVA followed a specific process to develop and evaluate the initial set of customer service options. *Figure 8-4* 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.

IDENTIFY MARKET SECTORS AND ASSESS CUSTOMER NEEDS

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

FIGURE 8-4. Process for Development of Customer Service Options



Customer service options use specific technologies delivered through a variety of program designs to meet customer needs and improve energy efficiency.

IDENTIFY AND QUALITATIVELY SCREEN TECHNOLOGIES

To ensure that a wide range of options was developed for analysis in Energy Vision 2020, TVA identified a large variety of efficient technologies. TVA then eliminated those with no potential application in the Valley. For example, evaporative air conditioners were dismissed because they are not compatible with the Valley’s humid climate. 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 from the public and private sectors.

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 lower than the cost of the technology were included in one or more program options. Beneficial electrification measures were ranked according to their impact on average electricity prices. This ranking identified the technologies to be included in one or more of the beneficial electrification options.

IDENTIFY PROGRAM DESIGNS

A critical step in the 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 strategies that would meet TVA, distributor, and customer objectives. Past and present TVA programs 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
- Increase customer value
- Promote market transformation and changes in consumer behavior

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.

INTEGRATE PROGRAM DESIGNS AND TECHNOLOGIES

For customer service options, TVA combined technologies with delivery strategies to provide the most economical, efficient, and convenient 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.

EVALUATE AND REFINE OPTIONS TO MEET DIFFERENT REQUIREMENTS

TVA compiled a wide variety of different customer service 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 customer needs are met.

FIGURE 8-5. Objectives Satisfied by Program Designs

Program Concepts	PROGRAM OBJECTIVES					
	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	●	●		●	●	

Customer service options use different program delivery mechanisms or concepts that best satisfy the range of customer objectives.

Programs Used to Overcome Market Barriers

Figure 8-5 lists the program concepts or delivery mechanisms that were used to develop the customer service options and shows the customer objectives that can be satisfied by these programs. Some programs are more technology-specific, while others are designed to assist customers in identifying efficiency opportunities unique to their home or business. These programs provide value to customers 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
- Availability

Figure 8-6 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 alternatively, 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 a reduced charge.

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

FIGURE 8-6. Market Barriers Overcome by Program Designs

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

Program designs incorporate a variety of delivery mechanisms to overcome market barriers and deliver more energy-efficient technologies to customers.

Mail Order – Catalogs are distributed to promote appliances that are not widely available on a commercial basis, in order to discount cost and provide information for customers. Catalogs are most appropriate for smaller, easily installed items. This program is particularly attractive to people in rural or remote areas and to 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 – Utilities provide programs and support to activities that induce lasting structural or behavioral changes in the market that result in increases in the adoption and penetration of energy-efficient technology and practices.

Key Variables and Assumptions

TVA described and characterized the customer service options in terms of costs and benefits. To provide a reasonable estimate of the potential for energy efficiency, load management, small-scale self-generation, and beneficial electrification in the Valley, TVA used a number of assumptions to estimate the effects of these technologies on electricity use.

CUSTOMER ACCEPTANCE

Distributor and customer participation are critical in determining how an option will penetrate the market. Participation by both distributors and customers is assumed to be voluntary. Because of varying circumstances and needs, it is assumed that not all distributors and customers will participate in a given program. Participation rates for distributors and customers for each option can be found in Volume 2, Technical Document 7, Customer Service Options.

TECHNOLOGY ASSUMPTIONS

The energy savings of high-efficiency equipment depend on the average energy consumption of currently installed equipment and the number of units that might be replaced. TVA used surveys of residential and commercial customers to determine existing market shares of end-use equipment. For the industrial sector, TVA used equipment shares based on regional and national estimates, along with customer billing data.

The start date for options was assumed to be 1996 for the purpose of modeling program effects; however, any option or program could actually be started whenever needed. The number of participating customers and the impacts of many options could be scaled up or down, depending on how aggressively the options are pursued.

The Energy Vision 2020 load forecast includes a significant number of efficiency improvements driven by market and other forces. These forces include an underlying rate of technological innovation, price-driven efficiency improvements, and federal and state initiatives to improve appliance standards and building codes.

The options incorporate only those technologies that exceed the efficiency levels in existing or scheduled codes and standards. Emerging technologies may offer even greater efficiencies during the Energy Vision 2020 planning horizon. To the extent that data was available, TVA has included emerging technologies in its analysis.

FUTURE UNCERTAINTIES

There are a number of uncertainties in many of the key variables and assumptions in the customer service options development process. However, TVA's analysis indicates that some factors are more important than others in determining the cost-effectiveness of the various customer service options. TVA's current analysis indicates that the cost of energy saving technologies, the degree of customer acceptance, and the impact on the power system are the most significant factors influencing the cost-effectiveness of options. In order to test the sensitivity of the customer service options to these factors, TVA constructed both optimistic and pessimistic scenarios for the options. Optimistic scenarios assumed greater customer acceptance and lower costs for each technology, while pessimistic scenarios assumed the opposite.

Results of Analysis

DEMAND-SIDE MANAGEMENT

Using the process described earlier, TVA developed energy efficiency and load management options for residential, commercial, and industrial sectors. Together, these 39 options represent an energy savings potential of more than 23.0 billion kilowatt-hours and a peak demand reduction potential of 5,532 megawatts in the year 2010. These options are described below by sector.

Residential Sector

Residential Sector Overview

The TVA service area includes approximately 3 million residential households. Residential customers in the Valley purchase about 45 billion kilowatt-hours of electricity per year, which accounts for about 35 percent of all TVA sales. Residential electricity use can be categorized as shown in *Figure 8-7*. The combination of heating, ventilating, and air conditioning (HVAC) accounts for 34 percent of residential electricity use, while water heating accounts for 19 percent. Refrigeration and cooking use about 15 percent of residential electricity, with the remainder of residential electricity consumed by lighting and other appliances.

Eighty-five percent of Valley residents have central or window air conditioning. Electric water heaters are present in 77 percent of all homes, and electric space heaters are present in 47 percent. TVA identified options that can increase the efficiency of energy use for these end uses, as well as others.

Evaluation of Residential Technologies

TVA considered 107 residential efficiency measures and technologies, evaluating them in four end-use categories: heating, ventilating, and air conditioning; water heating; appliances; and lighting. *Figure 8-8* shows the number of technologies considered and those included in options by end-use category. Of the original 107 technologies that TVA considered, 42 are included in the residential options evaluated in Energy Vision 2020. Volume 2, Technical Document 7, Customer Service Options, lists the technologies evaluated in the residential option development process.

Residential Sector Option Features

TVA incorporated 42 technologies into program designs to create 23 residential options. The options use a variety of delivery systems and program features to overcome market barriers and to meet customer objectives (for example, low cost, equity, minimum rates). TVA included the following types of programs in the residential options.

Financing. TVA developed loan and leasing options for high-efficiency heat pumps and heat pump water heaters. Financing helps to overcome the relatively high initial cost of these technologies. When combined with financing of insulation measures, maintenance contracts, and strict efficiency and installation standards for the equipment, these options can provide significant energy savings and customer service benefits.

Direct Installation. This approach provides materials and equipment at no cost to participants. TVA developed such options for residential low-income home owners and rental properties. Measures include compact fluorescent lighting, low-cost water heating, air infiltration control measures, and attic insulation. When combined with a walk-through energy audit and an education session, TVA can save customers energy and money and reduce the need to generate power.

Rebates/Cash Incentives. TVA also developed options that would offer rebates for large appliances such as high-efficiency dishwashers, refrigerators, freezers, room air conditioners, horizontal axis clothes washers, and condensing clothes dryers. All appliance rebates would be offered at the retail level in cooperation with key trade allies (manufacturers,

FIGURE 8-7. Residential Uses of Electricity

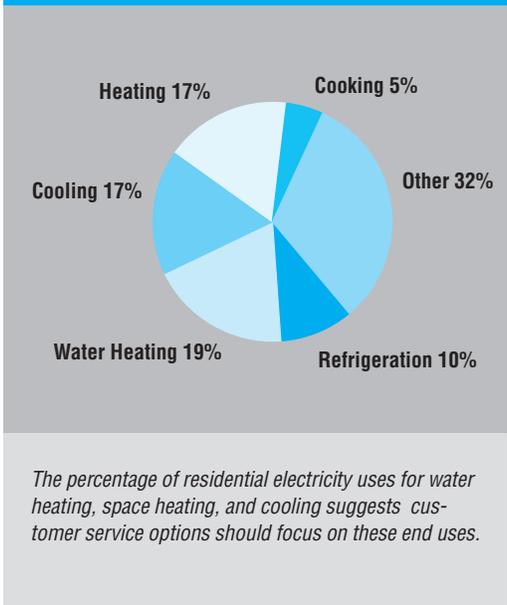


FIGURE 8-8. Technologies Considered for Residential Options

End Use	Included in Options	Emerging Technology	Total Considered
HVAC	18	2	48
Water Heating	11	1	20
Appliances	10	11	31
Lighting	3	2	8
TOTAL	42	16	107

TVA considered technologies for all building types for those residential end uses which consume the majority of the sector's total electricity use.

engineering firms, construction contractors, etc.). Rebate levels range from 50 to 75 percent of the difference in cost between the more efficient and the less efficient appliances.

Another appliance option provides a savings bond to residential customers for turning in each working refrigerator or freezer to TVA or the distributor. These appliances would be properly disposed of, and appropriate materials would be recycled.

Options targeting the new construction and new manufactured housing markets provide cash incentives to home builders, as well as mobile home manufacturers and dealers who meet or exceed TVA’s energy efficiency standards.

Mail Order. TVA could offer energy-efficient lighting products, programmable thermostats, and low-cost heating and hot water savings measures through a mail order catalog at low introductory prices. This option targets customers in rural or remote areas and typical mail-order shoppers.

FIGURE 8-9. Residential Energy Efficiency Options – Impacts for 2010

Energy Efficiency	Winter Megawatts	Summer Megawatts	Million Kilowatt-Hours	Thousands of Units	Total Resource Cost (1995 Cents/Kilowatt-Hour)
Heat Pump Loans	433	469	1347	254	5
Heat Pump Financing/Leasing	581	518	1688	266	1.6
Heat Pump Rebates	627	527	1787	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	1142	118	3
Manufactured Housing	164	53	358	131	4.4
Low Income Weatherization	12	6	36	10	12.9
Low Income	165	75	467	251	2.8
Direct Install	845	386	2399	1163	2.3
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 Retail Component	225	103	639	687	2.5
Appliance Rebates	39	41	304	1518	9.1
Refrigerator Turn-In	10	13	93	91	3.5
Student Self-Audit	53	23	150	1235	4.3
Self-Audit	42	19	120	102	2.6
Load Management					1995 Dollars/Kilowatt
Load Management - Air Conditioning	0	53	21	39	58
Load Management - Water Heater	212	84	0	158	55
Load Management - Storage Water Heater	100	39	0	75	934
Load Management - Supervisory Control and Data Acquisition	0	0	0	67	140
Load Management - New Technology	0	0	0	276	2039

Values are the impacts occurring only in the year 2010 for the cumulative participation in the program to that date. TVA developed 23 residential sector options for evaluation in Energy Vision 2020 with applications for all major end uses of electricity and for all types of housing.

Energy Audits/Education. Some options combine do-it-yourself energy audits for secondary school students or home owners. TVA or distributors would provide technical support with materials and analysis.

Load Management. Five load management options include TVA’s control of air conditioners and water heaters using FM radio, SCADA systems (supervisory control and data acquisition systems), and new two-way communication systems that are under development at many utilities in partnership with the telecommunication companies. TVA could offer customers cash incentives or service packages under these options.

Residential Sector Results

Figure 8-9 summarizes projected costs and load and energy impacts for all residential energy efficiency and load management options. This figure shows that in 2010, more than 12.7 billion kilowatt-hours of energy savings and 3,002 megawatts of summer capacity savings could be achieved if all of the proposed options were implemented. Savings from energy efficiency options can be obtained at resource costs ranging from 1.4 to 22.1 cents per kilowatt-hour. In the process of ranking options, these costs can be compared to the alternative costs of generating electricity from a power plant and to the average residential retail rate of 5.95 cents per kilowatt-hour.

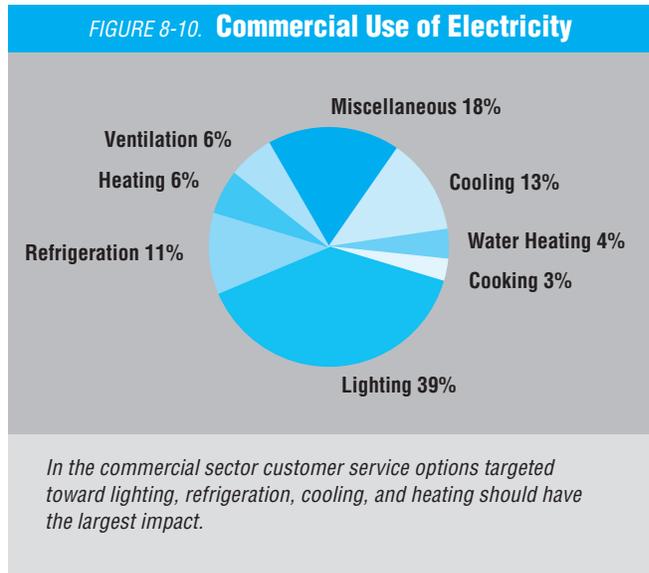
Commercial and Industrial Sectors

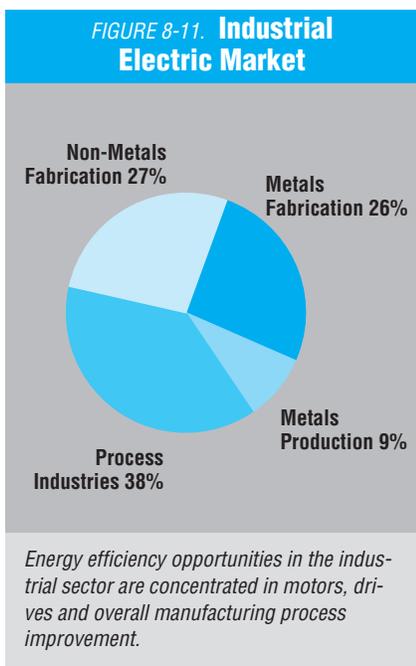
Commercial and Industrial Sector Overview

TVA and the distributors of its power serve about 486,750 commercial and industrial customers. These customers account for more than 4 billion square feet of floor space and consume almost 48 billion kilowatt-hours of electricity per year. Electricity is used to provide cooling in 70 percent of all commercial buildings, heating in 35 percent, and water heating in 45 percent. Industrial customers use electricity to operate all motor drives, to drive electrolytic processes that produce chemicals and primary metals, for lighting, and for a small fraction of the heat required in manufacturing processes.

Commercial customers use electricity in a variety of ways, as shown in Figure 8-10. Lighting accounts for 39 percent of energy use in the commercial sector, while heating, ventilation, and cooling use a total of 25 percent. The miscellaneous category, which includes office equipment, consumes 18 percent of electricity used and represents a rapidly growing load in the commercial sector. The remaining 18 percent is used in water heating, cooking, and refrigeration.

Figure 8-11 shows electricity use in the industrial sector by industry type. Process industries (e.g., paper-making) use 38 percent of the electricity in the





industrial market, while non-metals fabrication (e.g., rubber gloves) uses 27 percent, and metals fabrication (e.g., iron foundries), 26 percent. Metals production (e.g., tin refining) consumes 9 percent of the electricity used in the industrial market.

Figure 8-12 shows how electricity is consumed in each industrial subsector and in the industrial sector as a whole. In the industrial sector, 67 percent of electricity is used for motors, 16 percent for electrolytic production and electrotechnologies (such as microwave drying), 8 percent for heat used in the manufacturing process, and 9 percent for lighting and other end-uses (eg., space heating and cooling).

Evaluation of Commercial and Industrial Technologies

In commercial markets, TVA identified and evaluated energy-efficient technologies for 10 different building types: offices, restaurants, retail stores, groceries, warehouses, schools, colleges, hospitals, lodgings, and miscellaneous commercial buildings.(eg. churches) TVA determined the energy and demand impacts of weather and schedule-sensitive technologies (e.g., office lighting) by performing simulations that modeled electricity consumption in each type of building.

For each type of building, TVA considered several technologies for each end use (e.g., heating, cooling, lighting, etc.).

For industrial markets, TVA investigated technologies such as high-efficiency motors and adjustable-speed drives; however, many industrial technology applications are unique to a particular industry. In such cases, program options examine whether various technologies are appropriate and cost-effective for a specific site. Figure 8-13 lists the number of technologies that were included in the options for both the commercial and industrial sectors. Volume 2, Technical Document 7, Customer Service Options, lists the technologies considered.

Commercial and Industrial Option Features

TVA combined 62 technologies with various delivery strategies to form 16 commercial and industrial program options. The options are designed to overcome different market barriers and to address the needs of the different market segments

FIGURE 8-12. End Uses as a Percent of Total Industrial Electric Use

	Process Heating	Motor Drives	Electrolytics	Lighting & Other
Process Industries	< 1%	79%	11%	10%
Non-Metals Fabrication	15%	27%	53%	5%
Metals Fabrication	20%	69%	2%	9%
Metals Production	6%	83%	0%	12%
Total	8%	67%	16%	9%

Most electricity provided to the industrial sector is currently used to power motor drives.

or types of businesses within the commercial and industrial sectors. Some of these options promote specific technologies that have widespread application in commercial and industrial markets. Other options address customers’ financial, productivity, or environmental needs and provide customized applications of energy-efficient technologies. The following programs were incorporated in the commercial and industrial options.

Technology Rebates. Rebate options promote energy-efficient lighting; heating, ventilating, and cooling; water heating; refrigeration; and cooking technologies in the commercial sector. Rebates are also provided for high efficiency motors, adjustable-speed drives used in manufacturing equipment, and efficiency improvements for industrial customers producing compressed air. These options encourage customers to select higher-efficiency equipment by providing educational information and rebates. Rebate levels range from 50 to 75 percent of the additional cost of the high-efficiency equipment.

FIGURE 8-13. Technologies Considered for Commercial and Industrial Options

End Use	Included in Options	To Be Considered for Custom Applications	Emerging Technologies	Total Considered
Lighting	20	1	13	38
HVAC	16	15	5	39
Water Heating	8	2	2	12
Refrigeration	4	5	1	16
Industrial Process	5	3	2	10
Building Shell	6	1	-	10
Appliances	2	3	5	18
Miscellaneous	1	3	-	7
Total	62	33	28	150

Lighting, heating, ventilation, and air conditioning (HVAC), and water heating represent more than half of the technologies considered for the commercial and industrial sectors.

Comprehensive Measure Financing.

This option provides financing for large commercial customers who retrofit buildings with comprehensive sets of energy-saving measures. Low-interest loans or shared-savings arrangements are offered with this option. These cover the cost of the energy-efficient investment and overcome the initial-cost barrier of these investments. Customers repay the loan with electric bill savings, which would also yield a positive cash flow for customers. Under a shared savings arrangement, customers pay a percentage of their energy savings in exchange for the service provided by TVA. By recovering program costs from the program participants, financing options could minimize the rate impact of energy efficiency programs or non-participants.

Comprehensive Measure Rebates. This option uses the same process as the Comprehensive Measure Financing option to identify comprehensive sets of energy-saving measures for buildings. It uses rebates to increase participation and thus obtains more energy savings.

Technical Assistance. Technical assistance is combined with rebates and financing for new construction in the large commercial sectors. In new construction, technical assistance provided to customers includes incentives for architects and engineers to include energy-efficient systems in building design. Building commissioning (a careful tuning of all building energy systems) is also included for new construction to ensure that energy-efficient systems operate optimally. For older, large commercial buildings, technical assistance helps identify the optimal set of energy efficiency measures for the whole building, often with the use of customized technology applications.

Direct Installation. This program is for small commercial businesses and provides the installation of low-cost energy-efficient measures at no cost to the customer. While on site, the program calls for TVA to perform an audit to identify

additional cost-effective energy savings opportunities. Participants are then introduced to other programs offered by TVA.

Operation and Maintenance. This heating and cooling program is directed at small commercial businesses and other commercial customers who do not have building maintenance staffs. The customer's heating and cooling system is maintained for a small monthly charge included in the customer's electric bill. The program maintains the optimal operation of heating and cooling equipment to reduce electricity use.

Load Management. Three load management options were developed for the commercial sector. Two options encourage the adoption of thermal storage technologies for use with chillers or rooftop cooling units by offering rebates and technical assistance to design the installation. The other option provides the customers with bill credits for curtailing electricity use when notified to do so by the utility. Customers could choose the load reduction strategy that best fits their business operations. To participate in this option, customers must be able to reduce load or make arrangements to join with other customers in reducing load at times of high demand for TVA electricity.

Process Efficiency Improvements. Most of the energy savings potential in the industrial sector involves changing the actual nature of the various production processes. Customized applications of energy-efficient technologies include high-efficiency motors, adjustable-speed drives for manufacturing equipment, and other electric technologies. This program provides customers with technical assistance to identify cost-effective energy efficiency opportunities and to quantify any additional non-energy benefits related to a proposed project. Incentives include rebates for demand reduction or for energy savings.

Commercial and Industrial Results

The 16 program options for the commercial and industrial sectors provide ways to promote energy-efficient technologies. *Figure 8-14* summarizes the projected costs and impacts of these options in the year 2010.

The commercial and industrial options shown in *Figure 8-14* could account for more than 10.5 billion kilowatt-hours of energy savings and 2,530 megawatts of summer peak demand reduction in the year 2010 if all of these options were implemented. Energy savings in the commercial and industrial markets can be obtained at a resource cost of between 2 cents per kilowatt-hour to 13.7 cents per kilowatt-hour. This compares to the average commercial retail rate of 5.73 cents per kilowatt-hour and distributor industrial rate of 4.28 cents per kilowatt-hour. The demand reduction potential of all the options shown in *Figure 8-14* would be 17 percent of the total commercial and industrial sector demand in the year 2010. Similarly, potential energy savings are about 10 percent of the forecast energy use in these two sectors in the same year.

SELF-GENERATION AND RENEWABLE GENERATION

Overview

TVA used a set of customer characteristics and needs to identify the specific market segments most suitable for fossil fuel and renewable energy self-generation. These characteristics include:

- Industrial production processes generating byproducts or waste material that can be used to power a self-generation system.
- Facilities with a relatively constant high heating requirement. Waste heat from a cogeneration system could support the facility’s heating needs.
- Situations where electrical outages or disturbances could result in excessive lost production or business for the customer, create a hazardous situation, or cause a violation of environmental standards.
- Customers having a high peak demand and paying a high rate for peak demand electricity.
- Customers having access to renewable fuels or creating a renewable fuel as a byproduct of its manufacturing process.

FIGURE 8-14. Commercial and Industrial Options Summary – Impacts for 2010

Option Name	Winter Megawatts	Summer Megawatts	Million Kilowatt-Hours	Units (Million sq. ft.)	Total Resource Cost (1995 Cents/Kilowatt-Hour)
COMMERCIAL TECHNOLOGY REBATES					
Lighting Rebates	265	511	2845	1626	2.0
Heating, Ventilation, and Air Conditioning 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	94	40	159	30	7.4
SMALL COMMERCIAL SECTOR					
Retrofit-Direct Install	65	98	465	315	3.1
Heating, Ventilation, and Air Conditioning Maintenance	38	26	87	236	13.7
LARGE COMMERCIAL SECTOR					
Comprehensive Measures Financing	120	170	713	284	4.9
Comprehensive Measures Rebates	242	311	1278	449	4.9
COMMERCIAL LOAD MANAGEMENT					
Commercial Cool Storage	0	93	3	44	167 ¹
Rooftop Cool Storage	0	120	13	59	453 ¹
Commercial Group Load Curtailment	244	242	227	2240 ²	169 ¹
INDUSTRIAL PROGRAMS					
Industrial Technology Rebates	21	24	167	2100 ²	3.2
Industrial Process Energy Efficiency - Direct Serve	149	169	1057	11226 ³	4.1
Industrial Process Energy Efficiency - Distributor Serve	167	190	1325	8420 ³	4.0
Energy Efficient Rates (opt-out)	50	56	394	2504 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 occurring 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 buildings.

Based on these characteristics, TVA identified four industrial and seven commercial market segments as candidates for self-generation systems. The industrial candidates are the food, wood, pulp and paper, and chemical industries. The commercial market segments are transportation, supermarkets, restaurants, finance and insurance, hotel/motel, hospitals, and nursing homes. TVA also identified the potential for customer-owned generation using land-fill gas, wood waste, and small head hydro systems. Photovoltaic options (power produced from sunlight) were also considered, but current technology costs limit their use to highly specialized or remote applications.

Evaluation of Self-Generation and Renewable Generation Technologies

TVA examined technologies limited to the 100 kilowatt to 20 megawatt range. Units of this size, which are appropriate for the markets considered above, are used either as self-generation units or as emergency power units. Technologies that have suitable designs, commercial availabilities, and costs for integration with the power system are:

- Reciprocating Engine Systems (100-kilowatt to 3-megawatt systems)
- Gas Turbine Systems (4-megawatt to 21-megawatt systems)
- Coal-Fired Steam Turbine Systems (20-megawatt systems)
- Fuel Cells (2-megawatt systems)
- Wood Waste-Fired Steam Turbine Systems (800-kilowatt systems)
- Small Head Hydro Systems (various sizes)

Installation costs for these systems range from \$988 per kilowatt for a 10.7-megawatt gas turbine to \$2,557 per kilowatt for a 100-kilowatt reciprocating engine system. Photovoltaic options currently cost approximately \$5,000 per kilowatt, but are predicted to drop in price in the near future. Consequently, TVA studied the potential impacts of photovoltaics if the technology cost were to fall below \$3,000 per kilowatt.

Self-Generation and Renewable Generation Option Features

Options were developed for the following markets:

New Industrial Systems

TVA or distributors would contract to purchase excess power from commercial or industrial customers or would pay customers for generating their own power during times of peak demand. An incentive payment would be paid each year per kilowatt of capacity provided.

New and Existing Commercial Systems

TVA or distributors would contract to purchase excess power from the customer or pay the customers incentives each year for each kilowatt generated during times of peak demand for TVA power.

FIGURE 8-15. Renewables and Self-Generation Options Summary – Impacts for 2010

Option Name	Winter Megawatts	Summer Megawatts	Million Kilowatt-Hours	Number of Participants	Total Resource Cost 1995 Cents/Kilowatt-Hour
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	1975	33.0
Photovoltaics - Technology Advancements	3	3	11	4600	19.0
CUSTOMER-OWNED COGENERATION					
Commercial Existing Cogeneration	95	95	118	416	7.7
Commercial New Cogeneration	18	18	51	84	12.1
Industrial New Cogeneration	30	30	17	208	8.8

Values are the impacts occurring only in the year 2010 for the cumulative participation in the program to that date. The greatest potential for self-generation is from landfill gas, wood wastes, and existing commercial cogeneration.

Renewable-Based Energy Systems

Customers would be offered incentives for generating energy with combustible renewable resources such as wood or other renewable products. For non-combustible renewable resources, such as hydroelectric power and photovoltaics, customers would be offered an incentive for each kilowatt-hour produced. The incentives would cover the higher costs and higher uncertainties associated with energy produced from renewable resources and reflect the environmental benefits of renewable and non-combustible resources. As part of this option, information on the cost and performance of renewable resources would be gathered and documented to better assess the applicability of these technologies to the TVA system.

TVA would provide technical assistance to vendors and customers to ensure project feasibility and proper installation as well as synchronization between local distribution systems and the customer’s facility. Payments to participants for their power would be based on capacity and energy savings (e.g., avoided costs) for TVA. Incentives for renewable resources would be higher to encourage investment in these emerging technologies.

Self-Generation and Renewable Generation Results

TVA has developed eight self-generation/renewable generation options for the commercial and industrial sectors. *Figure 8-15* summarizes the estimated participation in these options, the options’ projected costs, and their potential energy and peaking capacity savings in the year 2010. In 2010, more than 1.1 billion kilowatt-hours of energy savings and 281 megawatts of capacity savings are projected for these proposed options.

FIGURE 8-16. Technologies Considered for Beneficial Electrification

Sector	Technologies Considered	Included in Option
Residential	12	11
Commercial	13	13
Industrial	87	35
Transportation	5	3
TOTAL	117	62

More than half of the technologies considered were in the industrial sector. Heating, ventilation, and cooling were important technologies considered in the residential and commercial sectors.

BENEFICIAL ELECTRIFICATION

Overview

Beneficial electrification options include technologies that take advantage of the unique characteristics of electricity (such as ease of control, flexibility of application, and high energy efficiency) and improve productivity and quality. The use of an electrotechnology (such as microwave drying) in manufacturing or using electric vehicles for transportation could also reduce adverse environmental impacts. Generally, electrotechnologies limit environmental pollutants to those produced by an electric generating plant. In this case, the pollutants are more easily controlled so there is less harm to the public or the environment. These

beneficial electrification options address transportation and electric manufacturing technologies, as well as commercial and residential options for cooking, heating, security lighting, and water heating.

Evaluation of Beneficial Electrification Technologies

TVA evaluated 117 beneficial electrification technologies and measures for four market sectors. *Figure 8-16* lists the number of technologies considered in each sector. Currently, 43 beneficial electrification technologies are included in the Energy Vision 2020 options. More than half of the technologies TVA considered and included in beneficial electrification options come from the industrial sector. Volume 2, Technical Document 7, Customer Service Options, lists the technologies and measures evaluated.

Beneficial Electrification Option Features

TVA integrated technologies with programs to form 14 beneficial electrification options covering the 4 major sectors as follows:

Industrial Electrotechnologies

Seven options cover process heating, melting, curing and drying, and specific applications in the chemical, metals, food, and textile industries. Industrial electrotechnology options do not use any program rebates or direct financial incentives. Technologies would be promoted on their own merits. These include the enhancement of the customer’s competitiveness through reduced operating and maintenance costs, increased productivity, improved product quality, increased operating flexibility, and contributions toward long-term environmental compliance. TVA’s primary role would be to provide information and technical assistance in conjunction with consultants and trade allies.

Commercial Sector

TVA developed two options for the commercial sector. Suitable commercial buildings would be targeted for high-efficiency air-source and water-source heat pumps, as well as heat pump water heaters. Restaurants, hotels, and other commercial facilities would be targeted for high-efficiency electric cooking and

security lighting equipment. These options would use the same efficiency standards and incentives as the commercial energy efficiency options.

Residential Sector

The first of two residential options targets customers replacing natural gas, oil, propane, and wood space heating or water heating. It encourages these customers to use high-efficiency electric heat pumps and heat pump water heaters. Incentives and efficiency standards would reflect those for the residential energy efficiency options. The second option would promote electric lawn mowers to customers in non-attainment areas (environmentally sensitive because of dirty air) and security lighting to customers in high crime areas.

Transportation Sector

The three electric transportation options target electric buses, fleet vehicles (vans, carts, forklifts), and cars. These options focus on the benefits of electric transportation in urban non-attainment areas. Options would be limited to technologies that could penetrate the market without state or federal mandates. The beneficial electrification options developed for Energy Vision 2020 do not use any direct financial incentives such as rebates or special rates.

FIGURE 8-17. Beneficial Electrification Options Impacts in 2010

Option Name	Units	Millions Kilowatt-Hours	Megawatts
INDUSTRIAL SECTOR			
Process Heating	228	609	87
Melting	29	549	79
Food Processing	29	368	53
Textiles	64	19	3
Chemicals & Metals	49	37	5
Curing and Drying	425	123	18
Environmental Technology	140	227	33
COMMERCIAL SECTOR			
Institutional Facilities	30300	294	21
Cooking & Security Lighting	10917	112	25
RESIDENTIAL SECTOR			
HVAC & Water Heating	101256	374	-119
Security Lighting/Lawn Mowers	236407	51	0
TRANSPORTATION			
Electric Buses	259	9	0
Fleet Vehicles	503	4	0
Electric Autos	1774	6	0
TOTAL		2782	205

Values are the impacts occurring only in the year 2010 for the cumulative participation in the program to that date. The industrial sector options have the most impact in beneficial electrification. Commercial institutional facilities (primarily heating and cooling) and residential heating and cooling are also significant.

Beneficial Electrification Results

Figure 8-17 summarizes the potential impacts of all beneficial electrification options in the year 2010. This figure shows that in 2010, these options would be responsible for more than 2.7 billion kilowatt-hours of increased electricity use and an increase in electricity demand of about 200 megawatts. Industrial electrotechnology options account for 70 percent of the projected increase in electricity use and the need for additional generating capacity.

RATES

The bulk of TVA’s revenue is generated from the wholesale rate that TVA charges the 160 power distributors that purchase power for resale to end-use customers. The wholesale rate structure presumes the wholesale rates for different types of service will be the foundation for the associated retail rates. Each distributor applies retail rates that reflect the appropriate TVA wholesale charges, distributor losses in transmitting power to the end-use customer, and distributor-specific distribution costs.

FIGURE 8-18. Alternative Rate Impacts - Impacts for 2010

Option Name	Summer Megawatts
Time-of-Day Rates	892
Declining Block Rates	169

Time-of-day rates would save 892 megawatts of electricity, while declining block rates would increase sales by 169 megawatts.

In accordance with this principle, TVA has developed a set of wholesale and retail time-of-day rate options. These options have charges that vary according to TVA’s cost of generation and distribution, by time of day and season. The cost of producing electricity is greatest during times of peak demand for TVA electricity, such as summer afternoons, and lower in off-peak periods such as evenings and weekends.

Retail time-of-use rates are designed to give end-use customers price signals to curtail use during peak periods and to shift electricity consumption to off-peak periods. Wholesale time-of-use rates can encourage distributors to offer programs or to participate in TVA programs to shift electricity use from peak to off-peak periods.

A set of declining block rate options was also developed. Declining block rates have higher charges for initial electricity usage with progressively lower charges for higher levels of usage. Declining block rates can encourage the

use of electrical products over competing alternatives. *Figure 8-18* shows the potential impact of these two rate options in 2010.

FIGURE 8-19. Customer Service Options Blocks for Energy Efficiency and Load Management (Impacts for 2010)

Block 1 1,482 Megawatts

PROGRAM

- 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 Financing/Leasing
- Residential Efficiency Products Catalog
- Industrial Technology Rebates – High-Efficiency Motors
- Residential Lighting Products – Retail Component
- Comprehensive Measures Financing
- Residential Ground Source Heat Pump Leasing

Block 2 1,264 Megawatts

PROGRAM

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

Block 3 1,497 Megawatts

PROGRAM

- Residential Load Management – Supervisory Control and Data Acquisition
- Comprehensive Measures Rebates
- Industrial Energy Efficiency – Distributor Serve
- Industrial Energy Efficiency – Direct Serve
- Industrial Technology Rebates – Adjustable Speed Drives
- Energy Efficient Rates
- Residential Heat Pump Water Heating Leasing
- Residential Direct Install
- Commercial HVAC Rebates
- Residential Manufactured Housing Program

Block 4 1,289 Megawatts

PROGRAM

- 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

Summary

For consideration in Energy Vision 2020, TVA has more than 60 customer service options that address all relevant sectors and end uses in the Valley economy. TVA has developed options to smooth system load shape using traditional demand-side management (energy efficiency and load management), self-generation, beneficial electrification, and rate options.

The costs and impacts of the options are interdependent. Option costs depend on the market penetration rate and number of technologies that are required to achieve specific energy and capacity savings.

CUSTOMER SERVICE OPTION BLOCKS

The customer service energy efficiency and load management options were placed into blocks of approximately 1,000 to 1,500 megawatts of capacity savings in the year 2010. Customer service options were placed in these blocks to simplify their integration with supply-side technologies that are generally much larger than any single customer service option. Different numbers of blocks were then incorporated into the strategies that were evaluated in Energy Vision 2020. Options were placed in the blocks, as shown in *Figure 8-19*, based on the following criteria, in order of importance:

- Resource cost
- Impact on rates
- Equity (opportunity for all customers to participate)
- Competitiveness (preservation of long-term customer relationships)
- Other evaluation criteria used in Energy Vision 2020

Thus, programs included in Block 1 are low cost, have minimal effects on TVA rates, and rank high on the other evaluation criteria that have been identified for Energy Vision 2020. For example, program options in Block 1 provide energy savings at an average total resource cost of 2.7 cents per kilowatt-hour and, as discussed later in the chapter on integration, have only a small impact on TVA rates. Programs in Block 1 would be the first to be selected by TVA for implementation in Energy Vision 2020 because of their low cost and low rate impacts.

The energy savings in Block 2 can be obtained at a total resource cost of 2.8 cents per kilowatt-hour, but the constituent programs have a greater impact on TVA rates than those in Block 1. The average total resource cost of ener-

FIGURE 8-20. High and Low Impact Blocks for Beneficial Electrification

High Beneficial Electrification	Low Beneficial Electrification
INDUSTRIAL SECTOR	
Process Heating	Process Heating
Melting	
Food Processing	Food Processing
Textiles	
Chemicals & Metals	
Curing and Drying	Curing and Drying
Environmental Technology	Environmental Technology
COMMERCIAL SECTOR	
Institutional Facilities	
Cooking & Security Lighting	
RESIDENTIAL SECTOR	
HVAC & Water Heating	HVAC & Water Heating
Security Lighting/Lawn Mowers	
TRANSPORTATION	
Electric Buses	
Fleet Vehicles	
Electric Autos	

High beneficial electrification included all options. Low beneficial electrification included those options that had a low total resource cost and reduced rates the most.

gy savings associated with options in Block 3 is 3.9 cents per kilowatt-hour while in Block 4 the average cost is 5.2 cents per kilowatt-hour. Blocks 3 and 4 also have larger impacts on TVA rates than do Blocks 1 and 2.

Peak demand savings potential in the year 2010 from Block 1 represents 4.7 percent of the forecast summer peak demand, and energy savings constitute 2.5 percent of total projected system sales in 2010. For Blocks 1 and 2 combined, the peak demand savings potential in the year 2010 is 8.7 percent of the forecast summer peak demand, and projected energy savings are 6.3 percent of total projected system sales. For all four blocks, peak demand savings potential in the year 2010 is 15.9 percent of forecast summer peak demand, and associated energy savings are 12.8 percent of total projected system sales.

The beneficial electrification options also were separated into two blocks, shown in *Figure 8-20*, according to the criteria discussed previously. Likewise, the self-generation and renewable generation options in *Figure 8-15* were placed in a separate block option. Different combinations of the four blocks of energy efficiency and load management options, one of the blocks of beneficial electrification options, the self-generation options, and rate options can be integrated with various supply options to form different resource strategies for Energy Vision 2020. Each of these different strategies is then evaluated using TVA's multi-attribute trade-off process in order to identify the best strategies for meeting future energy needs. This process is discussed in Chapter 9.