LOAD MANAGEMENT MADE SIMPLE

Kirk Schneider
Project Engineer
Dallas Power & Light
Dallas, Texas

ABSTRACT

Up until the 1970's electric utilities were basically in a supply side management mode,in which enough power plants were built to serve whatever demand customers required. However in the last 10-15 years, many utilities, including Texas Utilities Electric Company have moved to a demand side or load management mode which seeks to influence customers to change electric usage patterns to more efficiently use available generating capacity. Since 1970, the TUEC system peak demand has more than doubled from about 7400 MW to almost 16000 MW projected in 1985. The cost and difficulty of building new power plants to serve this load has caused TUEC to use load management as a tool to slow this demand growth.

Six load management strategies will be discussed:

1. Peak clipping
2. Strategic conservation
3. Valley filling
4. Strategic load growth
5. Load shifting
6. Flexible load shape

Research is required to determine which types of loads or types of customers contribute most heavily to system peak demands and thus should be targeted for load management programs. Furthermore, rates which accurately reflect the cost to serve a customer can be used as a load management tool. Load management has significantly reduced TUEC's need for new power plants over the last 5 years and will continue to create a situation in which both customers and the utility will benefit.

INTRODUCTION

Conservation and Load Management are two terms that we often hear; sometimes used interchangeably. However, the terms are very different. Conservation is a reduction in the total amount of energy used. Electric company customers are driven to conserve because of the cost of energy and because of national interests, while utilities are driven in turn, by the price of fuels. Prior to 1975, utilities operated in a supply side management mode by building as many power plants as were needed to meet the customer demand. The converse is demand side management or load management, which seeks to influence and change customer's electric usage patterns to more efficiently use the generating capacity available. Load Management efforts can be directed at building load, or at reducing load.

The factors that drive an electric utility to be involved in load management can vary. The utility is experiencing peak load growth and much of that growth is at less than the system annual load factor. The system peak demand has grown from about 7400 MW in 1970 to almost 16000 MW projected in 1985. (Fig. 1) Even more important than that is the cost of building new power plants, which has risen dramatically over the last 15 years. Current estimates show Comanche Peak costing over $1900 per kWh. TUEC's demand varies throughout the year, generally peaking in July or August with a smaller peak in December or January. In 1984, the peak and generating demand in August was over 15000 MW while the April peak was only about 9000 MW. (Fig. 2) This shows that the typical system summer peak day normally hitts a maximum between 5 and 6 p.m. (Fig. 3) The winter peak day normally looks like the winter peak in the 1983-84 winter season, with a peak around 8 a.m. and another around 7 p.m. (Fig. 4) On January 31 of this year, there was a new record winter peak of almost 14000 MW at 7 p.m. (Fig. 5) Because the load was nearly constant throughout the day, there was an all-time record for kWh generated that day. TUEC could have been in serious trouble had more businesses not shut down due to the bad weather. This shows the seasonal and daily variations in demand on our system. During the off peak season and night time hours the unused generating capacity just sits idle. One way to reduce the cost per kWh is to raise the system load factor, or the percentage of time that all the generators are running. Since their cost is fixed, if you generate more kWh, the unit cost goes down.

The company's generating situation is shown over the past 15 years. (Fig. 6) In 1970, TUEC generated with 100% gas and oil, and foreseeing higher gas and oil prices, started building lignite plants, the theory being that if lignite plants, with much lower fuel costs, were used to generate all the time (base load) while plants using higher

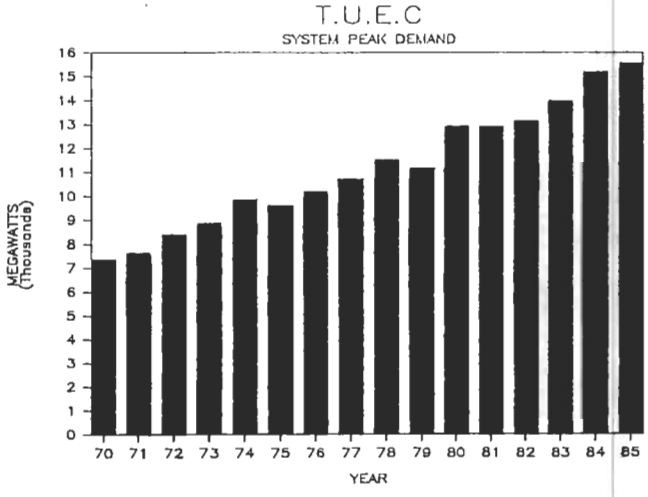

Figure 1

Proceedings of the Second Symposium on Improving Building Systems in Hot and Humid Climates, College Station, TX, September 24-26, 1985

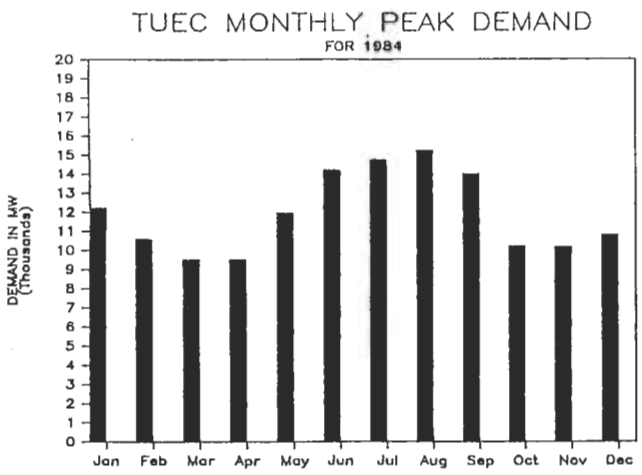

Figure 2

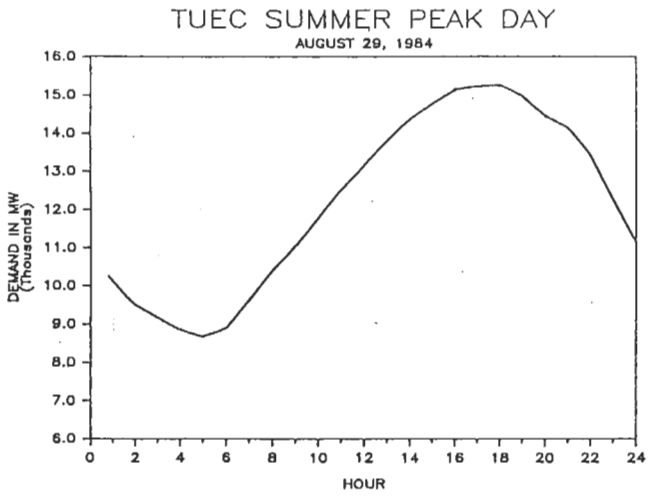

Figure 3

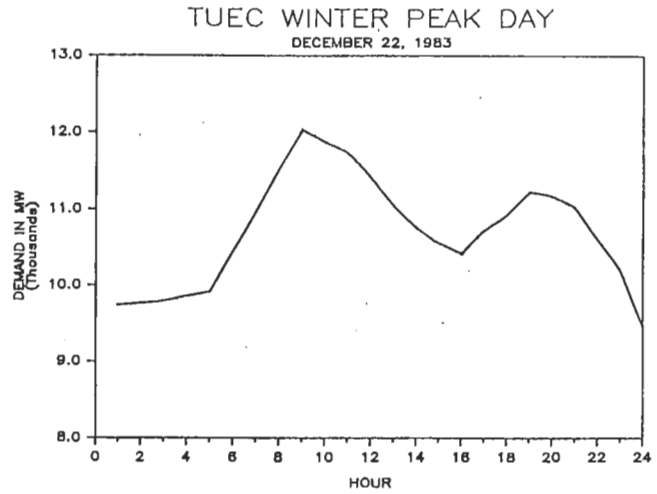

Figure 4

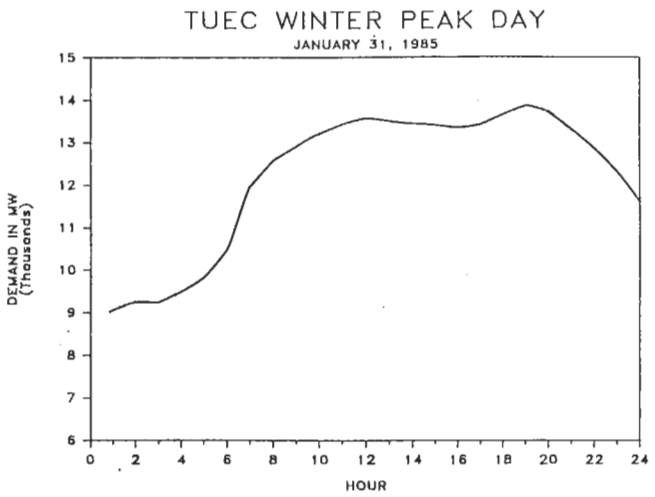

Figure 5

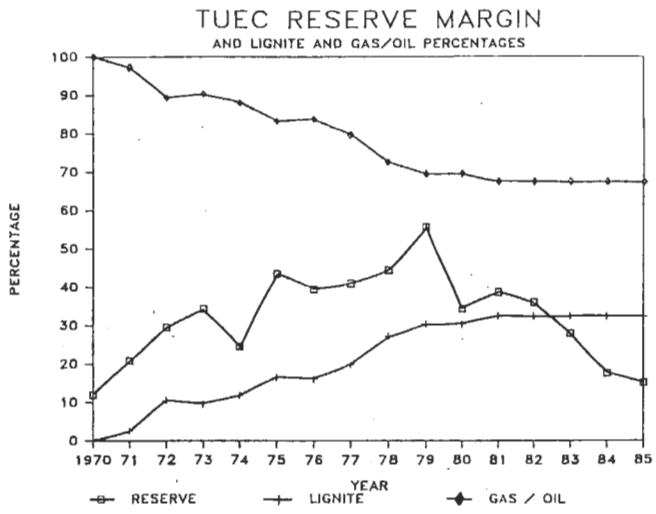

Figure 6

priced gas and oil were used only for peak periods, the savings in fuel would offset the higher cost to build the plants.

Fig. 6 shows how the percentage of lignite generation grew to 33% in 1981 when we last put a power plant on line. One can see that as TUEC began building these lignite plants, the reserve margin grew to a maximium of 56% in 1979. Since 1981, though, this margin has dropped steadily to about 15% at last summer's peak. A few years ago there was criticism that we were unfairly raising the cost of electricity by building unnecessary power plants. However, given the situation that TUEC is in now, those plants were definitely necessary. The industry generally accepts a 20% reserve margin as the minimum reserve for the most reliable system operation.

Load Management is a part of the solution to some of the problems of demand growth. From 1981 though 1985, TUEC's load management program is projected to reduce summer peak demand by 830 MW.

(Fig. 7) Our projected 15% reserve capacity would be less than 10% without our load management programs. (Fig. 8) In February 1985, a System Resource Plan was announced predicting a growth in peak demand of 10,000 MW over the next 10 years. (Fig. 9) The goal is to reduce that by 1734 MW through several load management programs, some that TUEC is currently involved with and some that are yet to be developed. (Fig. 10) There are probably many load management technologies which do not yet exist which will be used in the next 10 years. One of the goals of the new System Conservation and Load Management Group is to identify these technologies and to test their benefits to the Company and to the customer. Over the next 10 years, TUEC will use a combination of load management, new plants, and cogeneration to maintain a reasonable reserve margin.

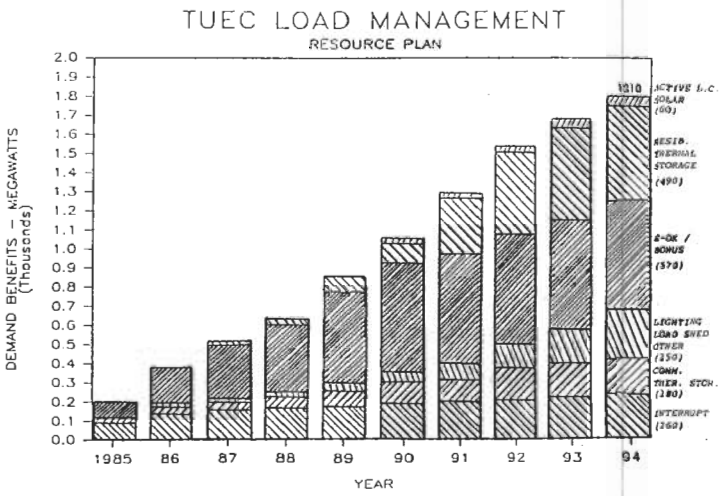

Figure 9

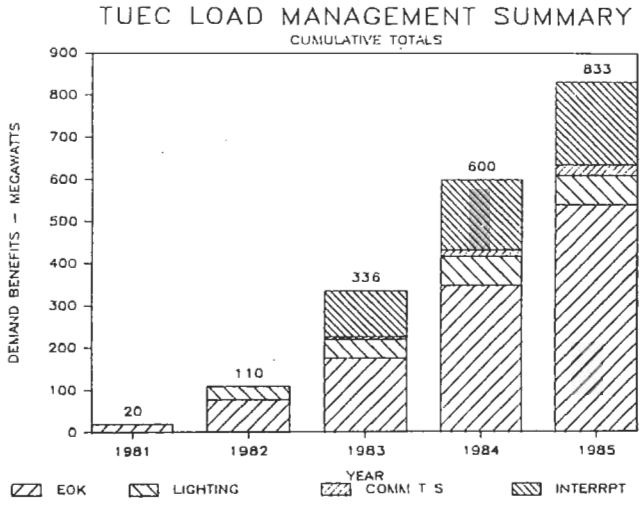

Figure 7

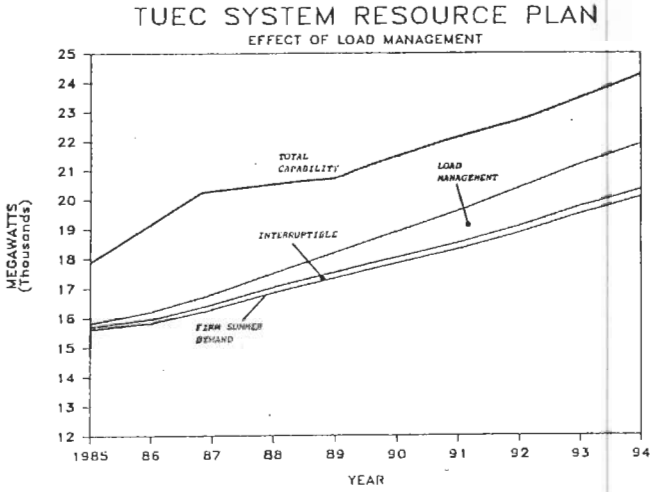

Figure 10

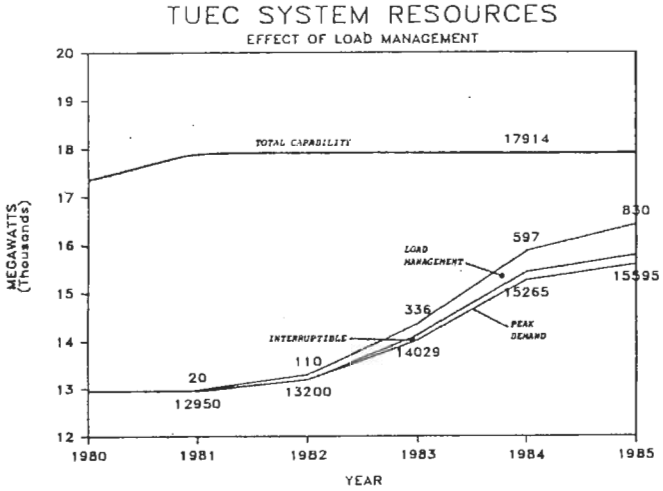

Figure 8

STRATEGIES OF LOAD MANAGEMENT

There are 6 basic load management strategies which are commonly used by electric utilities, any one specific program may be a combination of several of these techniques. (Fig. 11)

The first of these is Peak Clipping. This technique involves using less electricity at peak times only. For example, one research project that TUEC is now working on is direct air conditioning control. TUEC currently has a computer based load management system installed in Richardson which has been cycling 30 air conditioners on and off for the last two summers to determine possible demand reductions and customer acceptance. This shows what each air conditioner typically adds to the system on a hot summer day. (Fig. 12) Notice the jump between 4 and 5 p.m. as people return home from work and turn their thermostats down. Notice how it almost precisely tracts the system peak demand. Fig. 13 shows how that demand is modified by cycling the air conditioning compressor off 25% of the time or 46% of the time from 1 to 9 p.m.

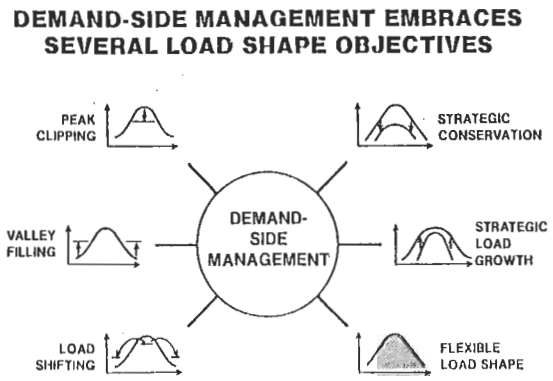

Figure 11

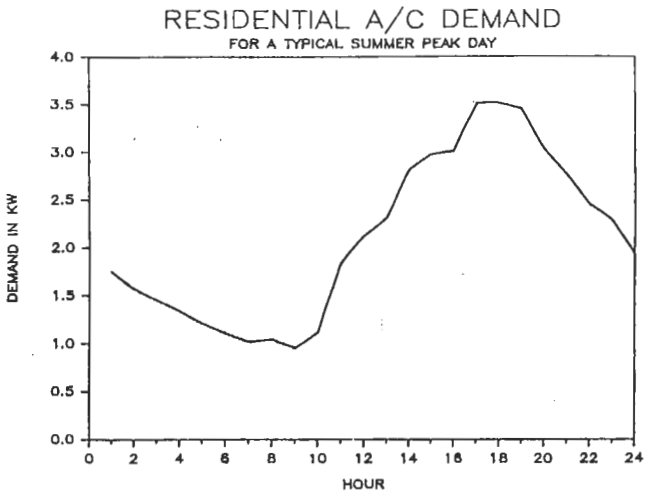

Figure 12

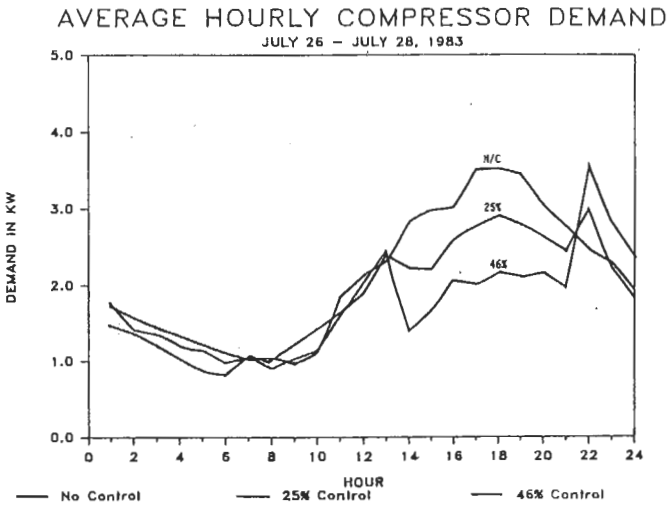

Figure 13

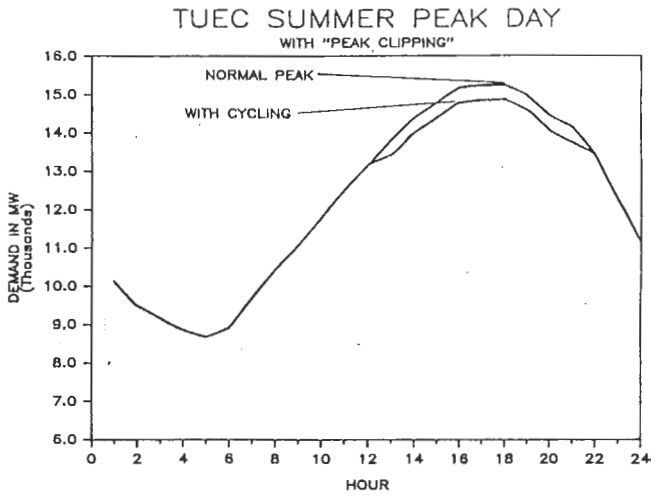

Figure 14

Notice also how the demand soars up when control is released. This is similar to the effect of turning the themostat up during the day and back down in the evening. This hurts the utility, even though it saves the customer money. Figure 14 shows what the peak day might look like with a peak clipping program. This type of load management system is also capable of remote meter reading and distribution automation, which may justify the cost of such a system.

The next area is Strategic Conservation, a general lowering of demand at peak and off-peak times. Examples of this would be the E-OK program areas of energy efficient homes, high EER air conditioners, and efficient commercial lighting. These strategies tend to reduce demand at all times rather than just the peak times. This results in lost revenue in terms of kWh not sold and promotion money paid, but benefits the customer with lower bills and the company with lower peaks. Also things such as proper air conditioner maintenance, insulating water heaters, using microwave ovens rather than electric ovens, and turning the thermostat up could be included in this catagory.

Valley Filling basically involves adding load during off-peak times when excess generating capacity is available. Strategic Load Growth is a general growth in load, with emphasis on adding off-peak load. These two types of load management have been used since the beginning of the electric industry. In the early days, electric utilities primarily served night time lighting loads. Subsequently, the electric companies began actively marketing daytime uses for electricity such as power for industrial operations, street cars, washing machines, and so forth. This marketing, along with improvements in generation and transmission efficiency, caused a steady drop in electricity prices until the 60's.

One company which is actively pursuing "valley filling" today is Duke Power in North Carolina which has over 50% nuclear generating capacity. Nuclear plants are very difficult to cycle on and off (as compared with a gas plant which can be brought on line in a few hours). They are selling off-peak loads just to keep from having to shut the plants off. In fact, they could almost give away these off-peak kWh since the cost of nuclear fuel

is quite small. An example of how TUEC is using "valley filling" is in selling heat pumps. By adding load in off-peak months, the annual load factor is increased. This type of load management, though, has the potential of causing other problems if the valley is filled too much. This winter TUEC reached a winter peak that was 91% of the summer peak. This percentage has been growing steadily the last few years. For example, in 1980, the winter peak was only 67% of the summer peak. (Fig. 15)

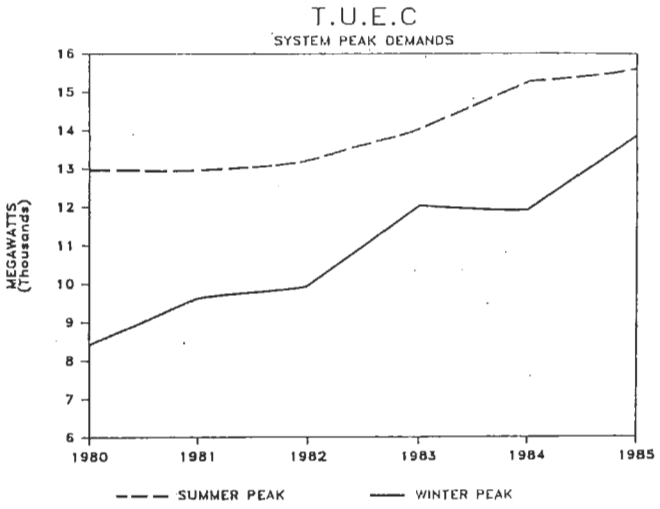

Figure 15

Load Shifting, the next type of load management, is in general the most favorable type of load management for utilities in the sense that peak requirements are reduced while the same number of kWh are sold. An example of this is TUEC's thermal storage program, which is being most actively pursued by DP&L. By storing cooling in the form of ice or chilled water, a smaller cooling unit may be installed and run for more hours.

The last type of load management is termed Flexible Load Shape. The name may be unclear, but basically it refers to a load which the utility may interrupt at any time. In other words, the customer is sacrificing reliability in return for a lower rate or an incentive payment. An example of this is the interruptible industrial contracts which allow TUEC to turn off almost 200 MW. The only problem with this type of load management is that it only works when the load is on. For example, during the peak last January, much of that interruptible capacity was already shut down. From that standpoint, this type of interruptible load may be more valuable in the summer than in the winter.

APPLICATIONS

The first step in determining what effect a program will have on the system's load shape, is to determine what a customer's load shape looks like. For example the load of a typical large office building basically builds up from 6 to 8 a.m. and starts shutting down between 5 and 6 p.m. So there is a lot of opportunity to reduce the peak for commercial buildings on the front end of the summer peak with commercial thermal storage and efficient lighting, but there is not much load to remove after 6 p.m. Thus there must also be a program to take care of the back end of the peak. Another example would be to compare an air conditioner program to a program promoting energy efficient building practices. A high efficiency air conditioner will only reduce summer peaks whereas an energy efficient structure will reduce both summer and winter peaks.

Figure 16 shows what the summer residential load shape looks like, both total load and load due to air conditioning. Notice that it peaks with the summer system peak. In fact residential a/c alone accounts for about 20% of the summer peak. Overall, the residential load accounts for about 45% of the peak, which indicates that one should first concentrate on residential load management, as has TUEC.

Research is important before entering into a load management program. One study which TUEC has worked on for several years is a study on a diary near Sulpher Springs, the largest dairy area in Texas. Figure 17 shows the load shape for one year's data. Two sharp peaks correspond to the 2 milkings; the morning peak corresponding to the normal winter peak and the afternoon peak to the normal summer peak. Certainly customers with these types of load shapes need to be identified and targeted for load management. Another example where prior research would be helpful is before entering into a weatherization program. It might be found that those homes most in need of weatherization have gas heat and no air conditioning. Weatherizing these homes would not decrease system load.

The one factor which drives load management which has not yet been mentioned is the rates. One can discuss load management all day with a customer, but he will not take action unless he sees a financial benefit to him. This may be in the form of a lower monthly bill, a one-time incentive payment, or increased comfort and convenience. Hence, there is a need to develop rates which more accurately reflect the cost to serve a customer at a particular time of the day or season of the year. Education of customers in energy conservation is another valuable load management tool; however, it is more difficult to document the results of this type of program.

The exciting thing about load management is that it creates a situation where everyone wins...both the company and the customers!

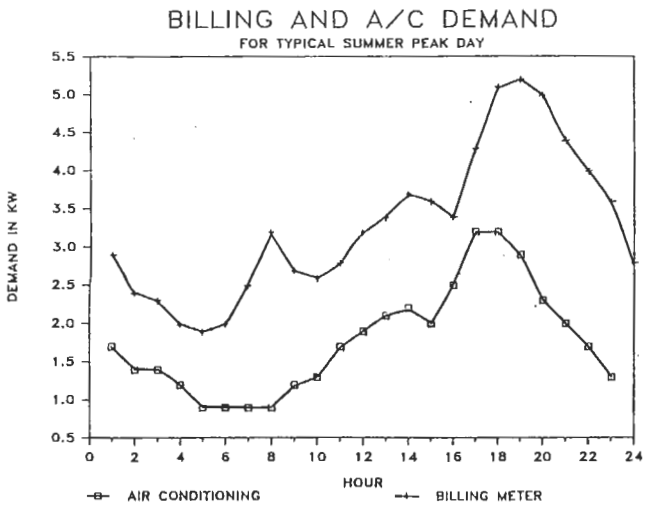

Figure 16

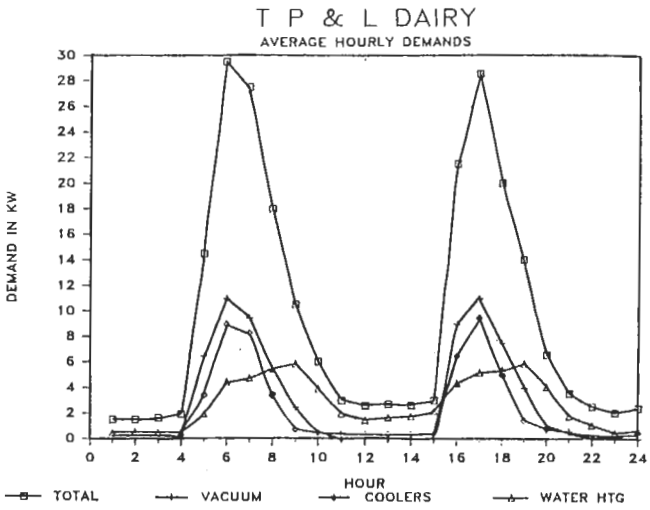

Figure 17