PRESENTING AND APPLYING INDUSTRIAL END-USE METERED DATA

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SUMMARY
Alabama Power Company assessed energy usage and load profiles for electrotechnologies utilized by its industrial customers, with a focus on the primary metals market. The study involved electrotechnologies eligible for tax benefits, as these technologies were easy to identify through the customer account representatives. A survey on the application of the technology and hours of use of each electrotechnology was directed at all industrial customers with tax meters. End-use metering was then implemented on a sample of 19 tax meters, including induction furnaces, arc furnaces, electroplating and autoclaves. This paper presents the approach implemented for this study, presents 3-D load profiles, and discusses the value of the results. The utility is now evaluating the various applications of industrial end-use metered data for its industrial marketing department as well as other areas of the utility. The paper explores the usefulness of industrial end-use profiles in competitive analysis, marketing, forecasting, and rate development.

BACKGROUND
The basis for the study was Alabama Power's tax meter population. There are several industrial processes exempt from the State of Alabama's Gross Receipts Tax. Energy consumption from these processes must be separated from the remainder of the plant or process to claim the exemption. This is typically accomplished through a separate metering arrangement. Electrical energy used in an electrolytic or electromechanical manufacturing or compounding process is eligible for the tax break. Examples are an electrolytic process for making chemicals, an arc furnace, or an induction furnace. In the absence of separate metering for these technologies, this electric use would be taxable.

Information for the complete population of tax-metered industrial customers was obtained from the utility's billing system. The period included was January 1 to December 31, 1991. The target population is described in Table 1. Of the population of 94 tax meters, 61 are in metal-related industries while 33 are not. The nonmetal industries include plastics, chemical, glass, and electronics. The 94 meters represent 50 account numbers and 45 customers. As derived from the BDR data, the 1991 total annual energy usage for these tax meters was 962,250 MWh, with five of the accounts showing zero usage. The 89 accounts with usage had an average annual MWH of 10,812, with minimum and maximum usage of 11 and 142,330 MWh, respectively.

Type of Industry	No. of Customers
Primary Metals/Metal Fabrication	61
Chemical	10
Utilities	8
Plastic	5
Electronics	4
Unknown	4
Glass	2
TOTAL	94

Table B-1: Industrial Tax Meter Population

PURPOSE AND METHODS
The study was conducted by Alabama Power and RLW Analytics, Inc. This section discusses the objectives and the approach applied.

Objectives

The study was aimed at collecting primary data on the use of industrial electrotechnologies in Alabama Power's service territory. In implementing the study, Alabama Power and RLW Analytics, Inc. endeavored to meet the following objectives:

- To obtain load profiles for industrial electrotechnologies under various applications in the Alabama Power service territory.
- To maintain these profiles in a database for future ease of reference.
- To develop end-use information for use in costing, competitive analysis and marketing.

The key elements used to meet these objectives were surveys administered by Industrial Account Managers and fifteen-minute interval data collected from a sample of customers. End-use metering for the project was implemented for approximately a year to determine the loads of sample units. Following collection of the metered data, the data was imported into the Visualize-IT 3-D analysis software. The main results were load profiles for individual tax meters and comparisons of sample loads within categories of electrotechnologies.

Sample Design and Budget Considerations

A limited budget was available for the study, requiring an optimal sample design and careful use of resources. To minimize costs, the bulk of the project was conducted internally at Alabama Power. The team effort involved four departments within the utility as well as RLW Analytics. The Marketing Department assisted in the research of the technologies, the interpretation of profiles, the identification of customers, and the collection of survey data. The Meter Department installed and removed the end-use metering equipment and provided the data to Load Research. Load Research cleaned and analyzed the data and provided load profiles to Economic Analysis and to RLW. Economic Analysis conducted a profitability analysis on the profiles using the utility's PRICEM software. RLW developed the Visualize-It Prints and worked with Marketing and Load Research to develop a report summarizing the industrial tax meter population, the technologies studied, the profiles and the use of results.

Sample designs were developed using the Model-Based Statistical Sampling™ (MBSS™) software developed by RLW. MBSS™ tends to emphasize the importance of larger projects which account for the greater part of the total electrotechnology customer base. Separate designs were developed for Primary Metal and Other applications, with a final sample of 13 Primary Metal customers and 5 other Industrial sites. This paper focuses on the 13 Primary Metal customers included in the sample. The applications metered are described in Table 1.

Table 1: The Electrotechnology Sample

Electrotechnology	Sample
Submerged Arc Smelting Furnace	2
Arc Furnaces	4
Induction Heating	2
Induction Holding	1
Induction Melting	4
TOTAL	13

Data Collection

The first step in the project was to summarize the population of tax meter customers. A survey was conducted in February of 1992 to collect general customer information as well as the technology's connected load and detailed schedule of use. This data was compiled in a database to provide a reference source for customer intelligence information. The database is useful for assessing the predominance of a given technology in a service territory, for determining the applications of that technology for use in marketing to other customers, and for obtaining a preliminary understanding of the load profiles for these technologies. In addition, the data was used to characterize a population for use in sampling and was used to investigate the relevance of the metered results to other customers in the population.

Following the sample design activities, end-use metering was initiated. The data collection employed relatively long-term end-use metering. The majority of the sites were metered for a full year on a fifteen minute interval basis. The metering equipment was installed and removed by Alabama Power's Division Meter Departments.

THE TECHNOLOGIES

This section describes the electrotechnologies investigated in the study.

Electric Arc Furnace Sites

The Electric Arc Furnace is used in the production of both common steels and high alloy steels. In steel production, scrap steel or direct-reduced iron is melted by direct contact with the electric arc. After the scrap steel or direct-reduced iron is placed into the arc furnace bucket, electrodes connected to the roof of the bucket are then lowered to melt the material through direct contact. Once melted, the furnace bucket can be tilted to pour the molten steel into a ladle for casting. This process is becoming more common in the production of steel, as it has several benefits over technologies such as basic oxygen furnaces and open hearth furnaces. Benefits of electric arc furnaces include lower initial investment, economical operation and the ability to utilize scrap material.

The electric arc furnaces of three Primary Metals customers were metered in the study. Two of the three furnaces were submerged arc furnaces used in the production of silicon. The third furnace was an electric arc furnace used to melt steel scrap from a cold start. In addition, three arc furnaces were already being metered by Alabama Power. All of these were electric arc furnaces used to melt steel.

Induction Melting

Induction melting has been widely applied in the Primary Metals Industry for many types of nonferrous metals. There are two types of induction melting technologies currently in use: the coreless furnace and the channel induction furnace. Induction melting in a coreless furnace involves a large refractory envelope or crucible in which the material to be melted is placed. This envelope is surrounded by two coils which induce electromagnetic fields through the material. The current in the coils produces eddy currents of charge which heat and melt the material. Once melted, the metal is continuously stirred by these same eddy currents. Through the manipulation of the frequency and power supplied to the coils, the mixing and melting rates of the molten metal can be precisely controlled. The channel induction furnace may also be utilized for melting, however its more common application is in holding molten metals during the production process. The channel induction furnace is described further under Induction Holding.

Four induction melting customers were metered for the study. These furnaces were utilized in the Primary Metals Industry for the production of brass, aluminum, steel, and stainless steel.

Induction Heating

Like induction melting, induction heating utilizes electric current running through an induction coil to generate heat. Unlike induction melting which has more conventionally shaped crucibles and coils, induction heating takes on as many forms as it has applications. Induction coil design can vary widely from application to application as the induction coils can be shaped to heat specific areas of the material to be worked. It is this adaptability to a wide variety of industrial processes that make it a popular heating process. The most common applications for induction heating are in heating metals prior to metal work, surface hardening, seam welding, extrusion, rolling, forging and annealing.

Induction heating was metered for two customers in the sample.

Induction Holding

The induction holding furnace utilizes the same technology as induction melting to heat material. The main difference is that the induction holding furnace requires molten metal from the initial start up while the induction melting furnace which can utilize scrap material. For this reason, induction holding furnaces are often used in conjunction with other melting technologies. Induction holding is done in a channel induction furnace. The channel induction furnace differs from the coreless induction furnace used for melting in that the molten material is held in a large crucible. The electrical induction causes the molten material to be drawn into the channel where the induction coils are located. Once heated, the natural movement of the induction moves the heated metals back into the crucible and replaces it with colder metal for heating. This type of furnace is utilized in the holding and superheating of molten products in the production process of glass and metals.

The metering sample included one induction holding furnace used to superheat and hold molten iron prior to casting production.

ANALYSIS

Visualize-IT™ Software is a data visualization tool developed by RLW Analytics to analyze and present end-use or total load data. In the Visualize-IT analysis, the first diagnostic tool used was the "EnergyPrint," a 3-D plot of the interval data. The EnergyPrint is a new way of visualizing end-use metered data in which the level of demand is color coded to provide a powerful visual presentation, with darker colors representing lower values and lighter colors representing higher values of demand. In the graph, the date is on the x-axis and the hour of day is on the y-axis. The 3rd dimension is the kW, color-coded using a pre-determined color scale. One can think of the EnergyPrint as being a series of daily load shapes stacked consecutively, color coded as mentioned above, and viewed from above. Each color is tied to a kW value, printed in a legend alongside the graph.

In these prints, horizontal bands represent scheduling, e.g., a transition from black to color at 6:00 a.m. can be the start of the first shift. Upward or downward shifts in these bands represent changes in schedule across the year. Vertical bands represent days or blocks of days, with weekends often appearing as thin black stripes. Darker vertical bands represent lower demand levels or down time for the equipment, such as on the weekend. Often in the EnergyPrints, one is able to discern holidays or long weekends by changes in the patterns of color. In the same fashion, seasonal changes, changes in production, and periods of very high demand can be easily observed.

The analysts used an initial large EnergyPrint to get a big picture understanding of the data. Once the viewer understands the color scheme, the hours of operation and seasonal patterns become readily apparent. The supporting knowledge from the customer survey on the application of the particular end-use technology and its schedule was extremely useful to the analysis at this point as it provided insight into the schedule of operation and application of the technology.

The second diagnostic tool was the 2-D Constant Hour profile. The constant hour plot provides a unique look at the metered data in that the datapoints represent a constant hour throughout the metering period. This constant hour can be selected interactively by the analyst during the analysis. On the computer screen, the Constant Hour chart is positioned above the EnergyPrint so that dates on both charts are aligned. Using this tool, the analyst can identify the actual kW demand of the building at any time and identify any seasonal changes which may occur during the metering period. In addition, the demand across the year can be compared to the maximum demand reported on the customer survey for each site.

In addition to the 2-D and 3-D prints, the Visualize-IT graphic generated for each site also included the average daily profile and the average weekday profile. In addition, an average week profile displays the average load shape for each day of the week, clearly depicting the days of operation per week.

In this study, the Visualize-It Tool was valuable in providing schedules of operation and patterns of use that were not evident from the other graphs developed. The systematic cycling of the induction furnace provided an excellent example of the power of data visualization techniques. The specific results presented here can be beneficial to rate design as well as marketing. The study provided information on how each of the electrotechnologies is used as well as when they are used. These results and graphics can be used in marketing the electrotechnologies and in considering possibilities for load shifting through rate design at sites with these technologies.

RESULTS

This section presents one site for each of the technologies described above and a summary of results across the sample for the given technology. The prints are shown in black and white for discussion purposes in this paper. In the study, color graphics were utilized.

Electric Arc Furnace Sites

All six of the arc furnaces had 24 hour loads on either a five or seven day schedule. The furnaces operated at 57-85% of capacity, with load factors ranging from 55% to 93%. Vacation or holiday shutdowns were evident in all six of the EnergyPrints. The signature arc furnace print for silicon production was a constant load. The two furnaces used for silicon production had highly constant demand across the day and utilized a large portion of the capacity of the furnace. In general, the silicon production furnaces were found to have highly profitable loads for the utility.

The remaining four furnaces were used for melting steel scrap. The first, used for melting steel scraps, was set at three levels during the three shifts of the day, suggesting a mix of melting processes. An additional 3 furnaces used for melting steel also showed differing levels of use for the steel melting process. However, these furnace cycles were not set by shift. Two of these had fairly regular changes in use, at two to three hour intervals. The third was more sporadic, except for a shift up in use to take advantage of a nighttime demand rate rider. It seems possible that this customer could make a further shift in use to achieve additional bill reductions from this rate rider.

The Visualize-It™ prints below present a submerged arc furnace used in the production of silicon. The maximum demand for both the average day profile and the average weekday profile represent 58% of the total capacity as reported in the survey. The load factor for this furnace was 85%. The non-coincident peak for this site occurred at 10:30 P.M. on September 3, 1993. This peak represented 75% of the total capacity of the furnace as reported in the survey. The corresponding non-coincident peak load factor is 76%.

According to the survey data obtained for this customer, the units are operated seven days a week, three shifts per day for a total of 24 hours per day. The average daily, average weekday, and average week load profile prints for this site confirm the operating schedule reported in the survey. The load shapes for this site show a relatively constant demand level throughout the operation of the furnace with small variations occurring throughout the day. Slight decreases in the demand level can be observed at 6:00 A.M., 3:00 P.M., and again at midnight. These decreases could represent changes in the shifts of the facility.

The constant hour plot and energy print for this customer reflect some possible seasonal change in operation that occurs during the 12:00 P.M. constant hour examined. The month of September appears to be a period of high demand for this customer, while the period of December to January appears to have been a less busy period. The metering for this customer did not extend a full year, so it is difficult to ascertain whether or not these changes in demand are regular seasonal shifts, or rather due to changes in production rates caused by economic factors.

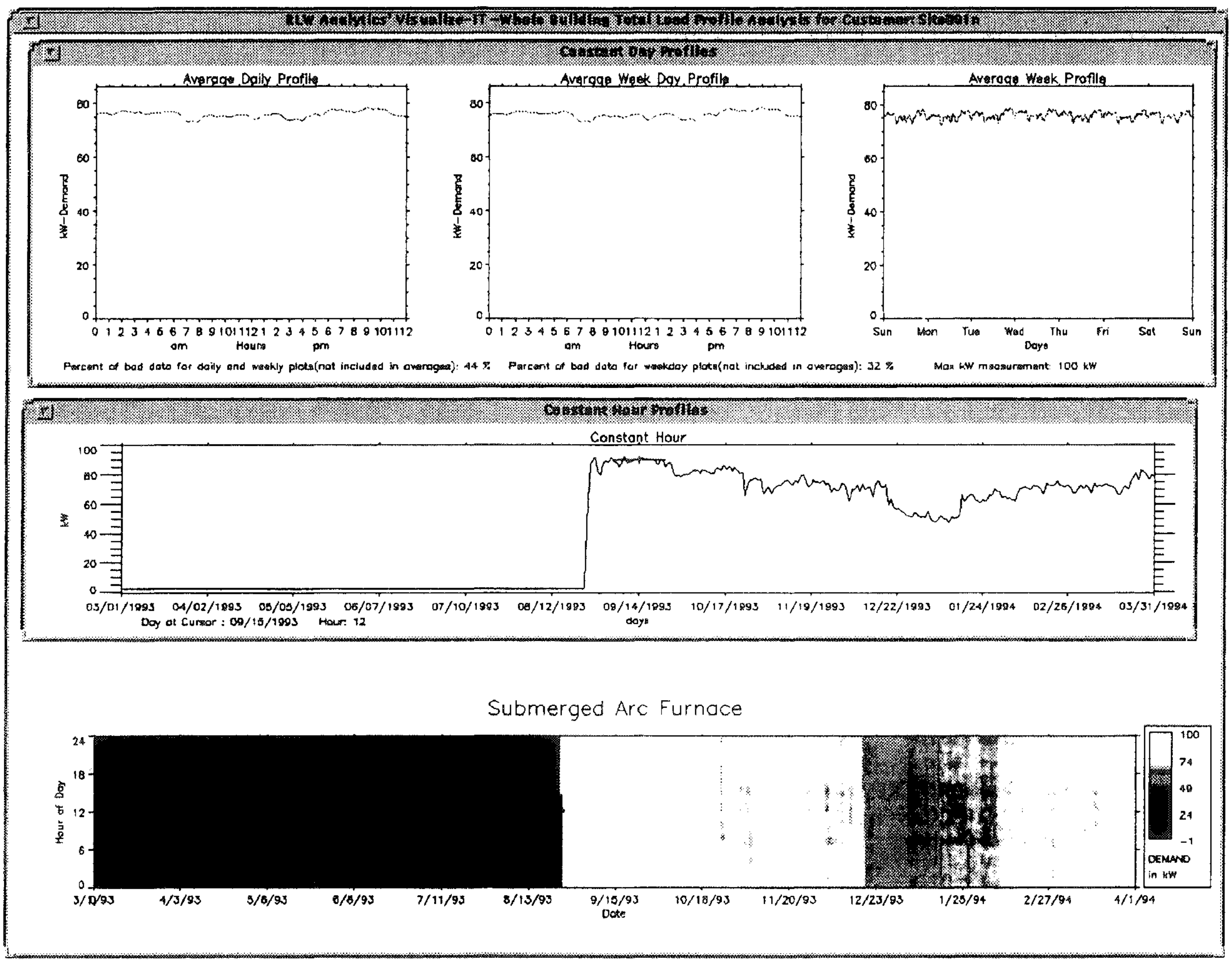
The energy print for this customer clearly displays the constant demand level for this furnace, as is typically seen for submerged arc furnaces. In addition, it underscores the usefulness of Visualize-IT in identifying seasonal patterns in demand levels. The highest demand levels can be see as the white area during the month of September while the demand decrease occurring during the winter can be seen as the darker areas during December and January. The large black spaces on the left side of this energy print represent pre-metering periods.

Induction Melting

All five of the induction furnaces metered in the study were reported to be operating on five days per week, however, two were actually operating during part of the weekend. A characteristic pattern in the load shapes became evident during the analysis of these sites. This pattern is characterized by a period of approximately eight hours in which the demand cycles after which it levels off, or in one case decreases to zero. These cycling peaks are quite evident in the

EnergyPrints and appear as horizontal bands of alternating colors. Two of the meters are on a nighttime demand rate rider, suggesting that this can be an easy load to shift to off-peak hours.

Figure 1: Electric Arc Furnace



The Visualize-It^{TM} print shown below represents 14 induction melting furnaces used to melt brass. The billing account for this meter has a nighttime demand rate rider and a load factor of 54%. According to the survey data obtained for this customer, the furnaces are operated five days a week, two shifts per day for a total of 16 hours per day. The customer reported that the second shift is a partial shift.

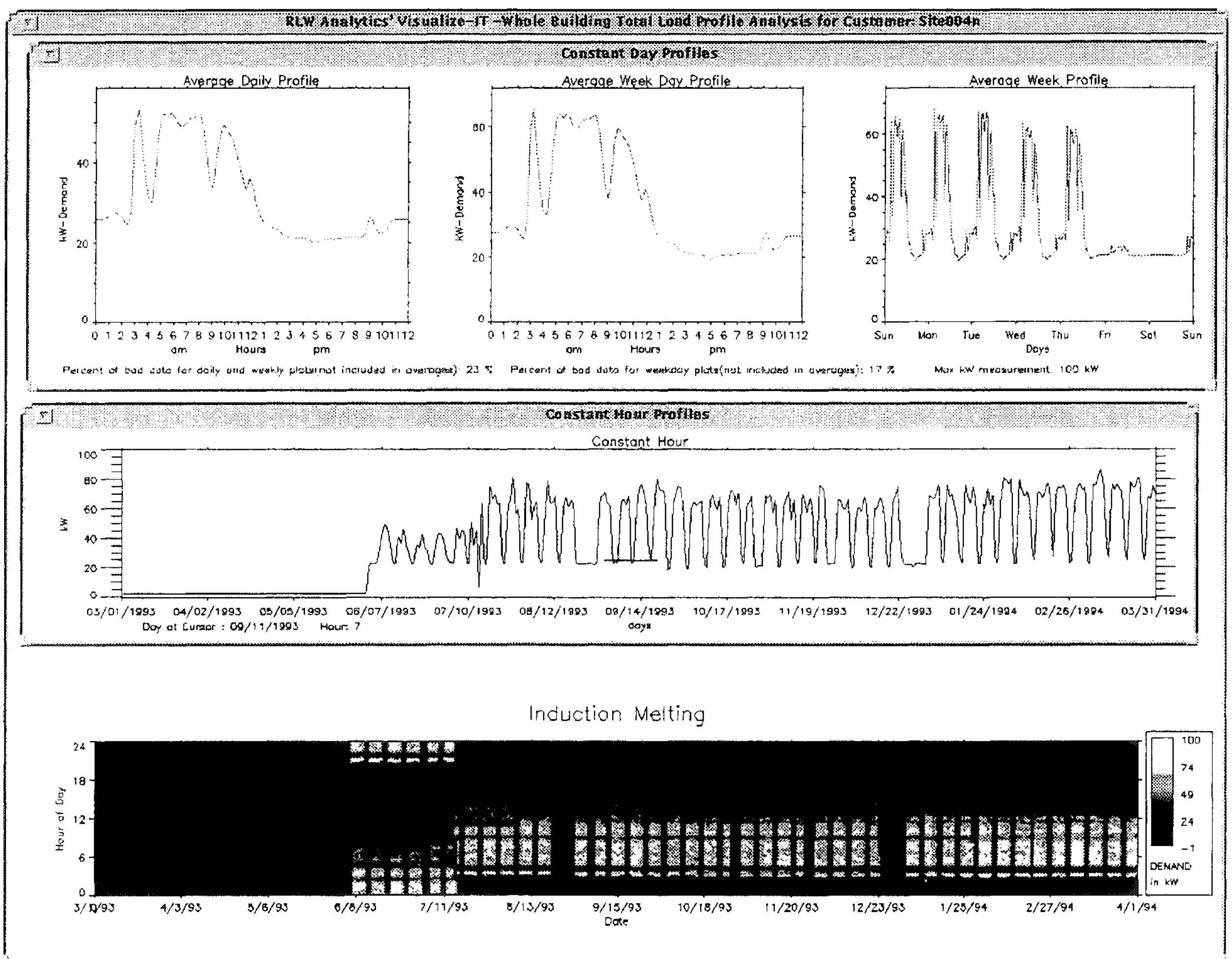
The average daily, average weekday, and average week load profile prints for this site confirm the operation schedule reported in the survey. The maximum demands for the average weekday and average weekly profile represent 38% and 48% of the total capacity as reported in the survey respectively. The non-coincident peak occurred at 9:15 P.M. on June 9, 1993, and represented 72% of the total capacity of the furnace as reported in the survey. The corresponding non-coincident peak load factor is 31%.

In examining the load shapes for this site, the first shift of the operating schedule appears to begin at 2:30 A.M. and continue until 10:00 A.M. or 11:00 A.M. During this shift, four distinct peaks can be observed. At 10:00 A.M., a sharp decrease in demand can be observed. These cycling maximum demand peaks are characteristic of the induction melting process. The second shift appears to have a more constant demand level and is believed to be a period in which the furnaces in operation are used for holding molten brass.

The constant hour plot and energy print for this customer do not reflect any seasonal change in operation during the 8:00 A.M. constant hour. The constant hour plot does reveal a period of decreased demand during the months of June and July. This period is believed to be a change in operating schedule as opposed to a seasonal change. During this period, the customer began the production process during the night, completing most of the melting of the material overnight. Both operating schedules allow this customer to have a preferable nighttime demand rate rider for operating load off peak (7:00 P.M. to 11:00 A.M.).

The energy print for this customer confirms the change in operating schedule which occurred during July of 1993. In addition, the print clearly displays the regular pattern in the demand peaks occurring during the first shift as alternating horizontal bands of color in shades of red and orange. The demand for the second shift also appears to remain constant as evidenced by the few changes in the color shading from approximately 12:00 noon on through the night.

Figure 2: Induction Melting



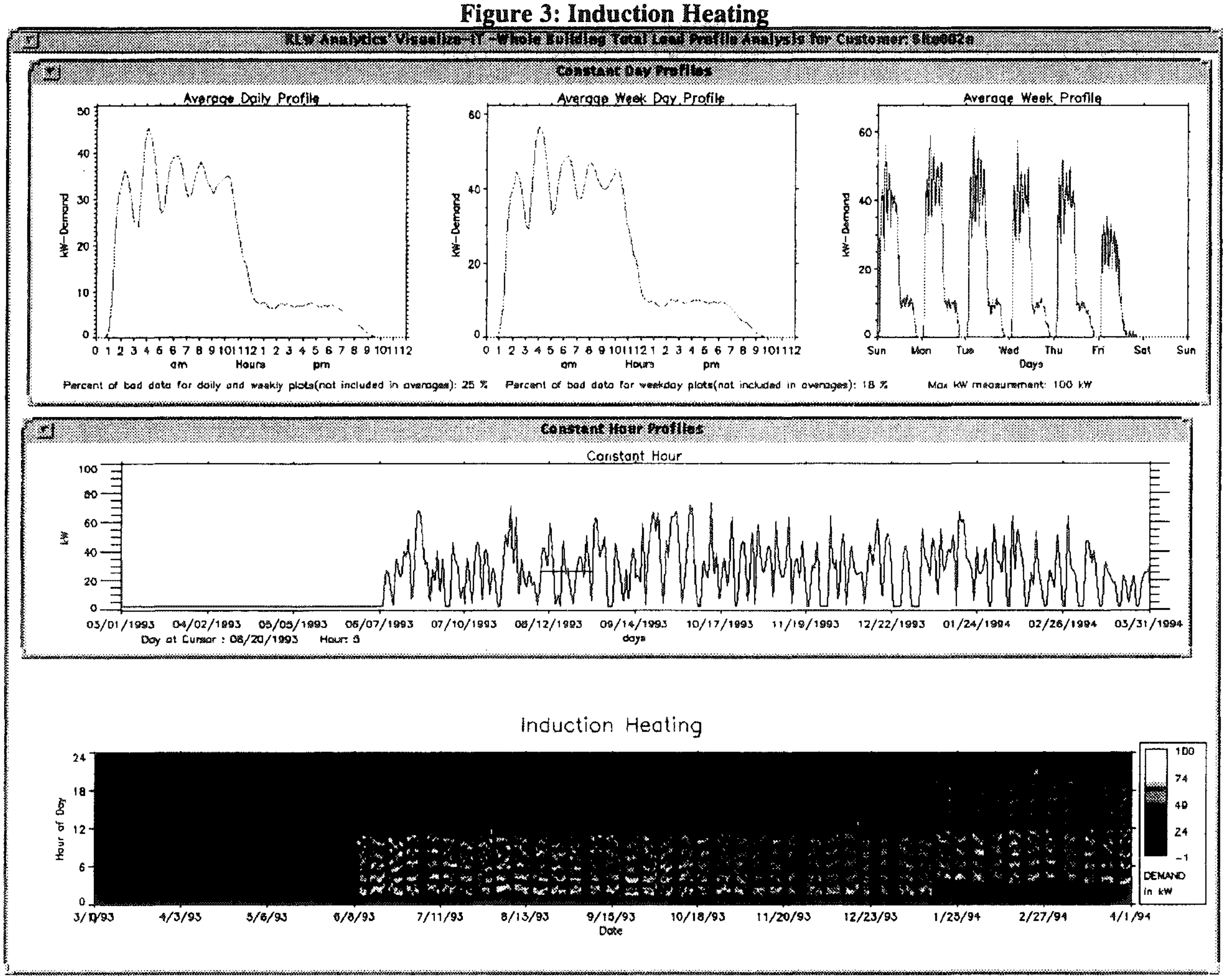
Induction Heating

Two induction heating sites were metered in the study. The Visualize-It™ print shown for this application represent four induction heating units used in forging, heat treating, and brazing processes. According to the survey data obtained for this customer, the units are operated five days a week, two shifts per day for a total of 16 hours per day.

For the 1994 period, the metered data for this site agree with the operating schedule reported during the survey. In examining the EnergyPrint, two eight hour shifts of operation are evident, with a lesser use in the second shift. This is not clear from the average profiles, as they combine two periods with different schedules. In instances such as this, the energy print is particularly valuable. Prior to the beginning of 1994, one shift from 2 A.M. to 10 A.M. is observed.

The non-coincident peak for this site occurred at 2:45 A.M. on August 17, 1993. This peak represents 41% of the total capacity of the furnace as reported in the survey. The corresponding non-coincident peak load factor is 16%.

Figure 3: Induction Heating



Induction Holding

Only one induction holding furnace was included in the study. The Visualize-It^{TM} prints for this site are for an induction holding furnace used for holding and superheating brass. The billing records indicate a load factor of 52% for this furnace. According to the survey data obtained for this customer, the holding furnace is operated five days a week, three shifts per day for a total of 24 hours per day.

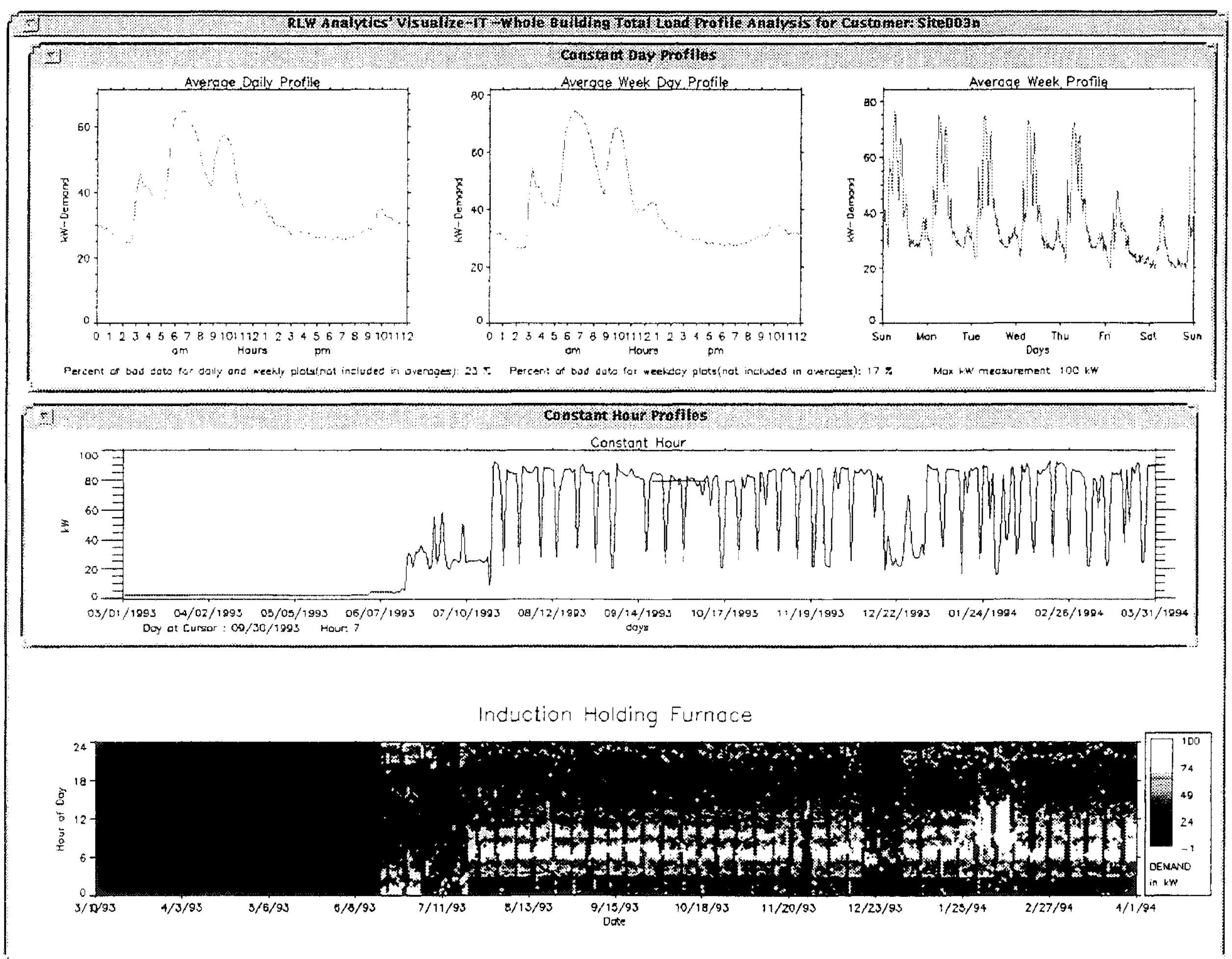
The average daily, average weekday, and average week load profile prints for this site confirm the 24 hour operation schedule reported in the survey. The maximum demand for the average week profile indicates that the furnace operates at two-thirds of capacity. The non-coincident peak occurred at 6:30 A.M. on September 6, 1993, representing 93% of the total capacity of the furnace as reported in the survey. The corresponding non-coincident peak load factor is 36%.

In examining the load shapes for this site, it appears that the superheating of the brass occurs during the hours of 2:30 A.M. to 12:30 P.M. to take advantage of the nighttime demand rate rider. After this period, the load shape appears more constant, indicating the holding period. As with the induction heating site shown above, a very consistent pattern of use can be observed in all of the plots.

The constant hour plot and energy print for this customer do not reflect any seasonal change in operation that occurs during the 9:00 A.M. constant hour. However, the plot does indicate 2 two week periods which may be holiday shut downs or decreases in activity. These periods of decreased demand can be seen During the months of July and December. Additionally, the first month of the metering period shows an operating schedule which is different from the rest of the metering period. This may indicate either a change in the operating schedule, or a seasonal change due to economic factors. It is difficult to determine the cause of this change as data prior to June of 1993 was not available.

The energy print for this customer clearly displays the regular pattern in the demand peaks occurring during the early morning hours as horizontal bands of red and yellow. As can be seen in the legend, the yellow shades represent higher kW readings and therefore represent the maximum demand peaks. The energy print also confirms the operating schedule reported during the survey. In addition, it appears that this facility may have two week vacation periods in July and during the Christmas holidays. These periods appear on the energy print as the wide dark shaded vertical bands, while the weekend periods are represented by the thinner more regularly spaced purple vertical bands.

Figure 4: Induction Holding



USE OF THE RESULTS

Alabama Power wanted to collect specific information on the technologies to inform switching from other energy sources to electricity. The sample plots suggest several potential applications of the study results in the areas of rate development and promotion, customer marketing, cost-to-serve analyses, and competitive analyses.

Rates

The metered data suggest possibility for the addition and promotion of rate rider, e.g., a nighttime demand, rate, to customers with certain metering applications. In addition, the Visualize-IT prints and a companion rate analysis booklet can be a valuable marketing tool for explaining rate opportunities to customers. Many of the customers metered could add shifts or move shifts to lower their cents per kW. The information can be used for rate design, sales evaluation of different pricing options, and the "best" rate options for the customer.

Marketing

The Visualize-It prints can also be used to market the electric technologies to existing and new utility customers. If customers can add supplemental technologies, they can increase load factor and reduce their cost/unit. The data collected can also establish value with customers, to demonstrate that Alabama Power is an expert in the customer's field and that the utility is conducting research to improve the customer's economic and competitive position. One of Alabama Power's key goals is to form a partnership with their customers, and provide quality customer service at competitive prices. Ultimately, the utility wants to provide customers with details on the electrotechnologies including applications, electric costs, and environmental benefits.

Cost-to-Serve

Finally, the end-use metered data allows for precise calculation of the cost to serve the specific technologies. This allows the utility to have improved information for the development of rates, to determine the profitability of various loads, and to estimate loads and cost-to-serve for new electrotechnologies coming into the service territory. In addition, a cost-to-serve graphic can be added to the Visualize-IT print for use in demonstrating to the customers means to reduce the cost-to-serve and their corresponding electric rates.

REFERENCES

1 EPRI Report: The Guide to Industrial Electrotechnologies, Electric Power Research Institute.

2 Managing Electric Services and Costs II - A Guide for Alabama Power Customers, Alabama Power Company Industrial Marketing.