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United States Agency for International Development

# COSTA RICA
# LOAD CONTROL DEMONSTRATION PROJECT

**Final Report**

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## ACRONYMS

| | |
|---|---|
| A.I.D. | U.S. Agency for International Development |
| CNFL | Compania Nacional de Fuerza y Luz |
| DSE | Direccion Sectorial de Energia |
| ECSP | Energy Conservation Services Program |
| EMS | Energy Management System |
| FPL | Florida Power & Light Company |
| ICAA | Instituto Costarricense de Acueductos y Alcantarellados |
| ICAITI | Instituto Centroamericano de Investigacion y Tecnologia Industrial |
| ICE | Instituto Costarricense de Electricidad |
| kVA | kiloVolt Ampere |
| kW | kiloWatt |
| kWh | kiloWatt hour |
| MRNEM | Ministry of Natural Resources, Energy and Mines |
| MW | Megawatt |
| SNE | Servicio Nacional de Electricidad |
| TOU | Time of use |

CURRENCY EQUIVALENTS
(February 1989)

Currency unit = Colon

U.S. dollar = 79.30 Colones

## FOREWORD

The authors wish to thank the following persons for their valuable assistance and guidance in planning, preparing and carrying out the load control demonstration project:

Dr. Alvaro Umana, Minister, Ministerio de Recursos Naturales, Energia y Minas (MRNEM)

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## EXECUTIVE SUMMARY

In recent years, the Costa Rican electric power system has experienced a steady rise in annual peak demand, mainly owing to a burgeoning use of electricity for cooking and lighting. The 1987 expansion plan of the country's principal utility, Instituto Costarricense de Electricidad (ICE), had to be modified because it was based on a projected demand growth rate of 5.5 percent annually. However, 1986-1988 statistics indicate that peak demand is rising much more quickly than the projection -- at an annual rate close to 10 percent.

To meet this demand ICE will have to install six 36 MW gas turbines before the year 2000, and four of the six will be needed before 1992. The capital cost alone of each turbine will be about $15 million in foreign exchange. This investment will hamper the government's efforts to deal with the country's debt situation, as the turbines, replacement parts, and fuel must be imported. ICE is also installing additional geothermal and hydroelectric generating capacity to relieve the situation.

Until the turbines and new geothermal and hydro capacity are on line, ICE must rely on thermal generating units for peaking power when water levels are low in its main dams. However, of a total nameplate capacity of 140 MW, thermal units can only deliver less than half this capacity, mainly because of maintenance problems and lack of spare parts. As a result, when water levels fall substantially in its hydro facilities (as happened in 1987 and early 1988), the system peak demand can come dangerously close to ICE's peak capacity.

To deal with this situation in the near term and reduce investment requirements in the long term, ICE is pursuing two options: the promotion of private power generation[1] and load management. In response to a request from ICE management, the A.I.D. Office of Energy and the USAID Mission in San Jose funded the load management demonstration project described here.

The project was implemented under the direction of RCG/Hagler, Bailly, Inc., through A.I.D.'s Energy Conservation Services Program (ECSP). ECSP is a program of the A.I.D. Office of Energy. FPL Qualtec, a subsidiary of Florida Power & Light, was retained as a subcontractor. Funding was provided by USAID/Costa Rica.

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1 See the ECSP report Non-Utility Power Generation in Costa Rica: Potential, Impediments, and Policy Issues. 4/1/88.

## PROJECT CONCEPT

The project sought to demonstrate how load control measures applied to a selected group of customers can reduce ICE's peak load. The system load curve for a typical day is marked by two peaks, as illustrated in Exhibit i. The morning peak generally occurs between 10:00 a.m. and 12:30 p.m., and the higher evening peak falls between 4:30 p.m. and 8:00 p.m. The principal contributor to both peaks is the widespread use of electricity for cooking in households. After cooking, the main contributors to the evening peak are the household loads (lighting and appliances), street lighting, water pumping, high load factor, multi-shift industrial facilities, and retailing operations.

Reducing the cooking load by means of load management[2] (direct load control, pricing, or even energy storage) is not feasible in the short term. Meal times are dictated by the daily pattern and rhythm of work, and by leisure habits. Most households are unlikely to change this pattern significantly; consequently, the commercial and industrial sectors were chosen as the target of the load control demonstration project because they, unlike residential customers, offer a significant potential for immediate or short-term load reductions during peak hours.

The project targeted customers with monthly consumption levels of at least 20,000 kWh or a maximum demand exceeding 100 kW. The target population consists of about 425 accounts with an estimated aggregate coincidental demand of 122.5 MW, or 22 percent of the system peak load. In order to demonstrate whether or not load management could be technically, economically, and financially viable in Costa Rica, a limited pilot project was agreed on in early 1987, and an initial design phase was carried out in the fall of 1987.

The project's final objective was to demonstrate that the aggregate coincidental peak demand of a representative sample of industrial and commercial enterprises can be reduced by 10 percent at a cost acceptable to both the users and the utility.

## PROJECT COMPONENTS

The load control demonstration project consisted of six components:

- Selection of participants
- Implementation of load control measures
- Tariff modifications

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2 Load management is the deliberate control or influencing of customer electrical loads, including load levels and time-of-use patterns. There are two classes of strategies for applying load management in customers' homes or facilities: direct load control and indirect load control. Direct load control involves the physical switching on and off of end-use devices by the utility, while indirect load control involves customer controls of loads in response to price signals.

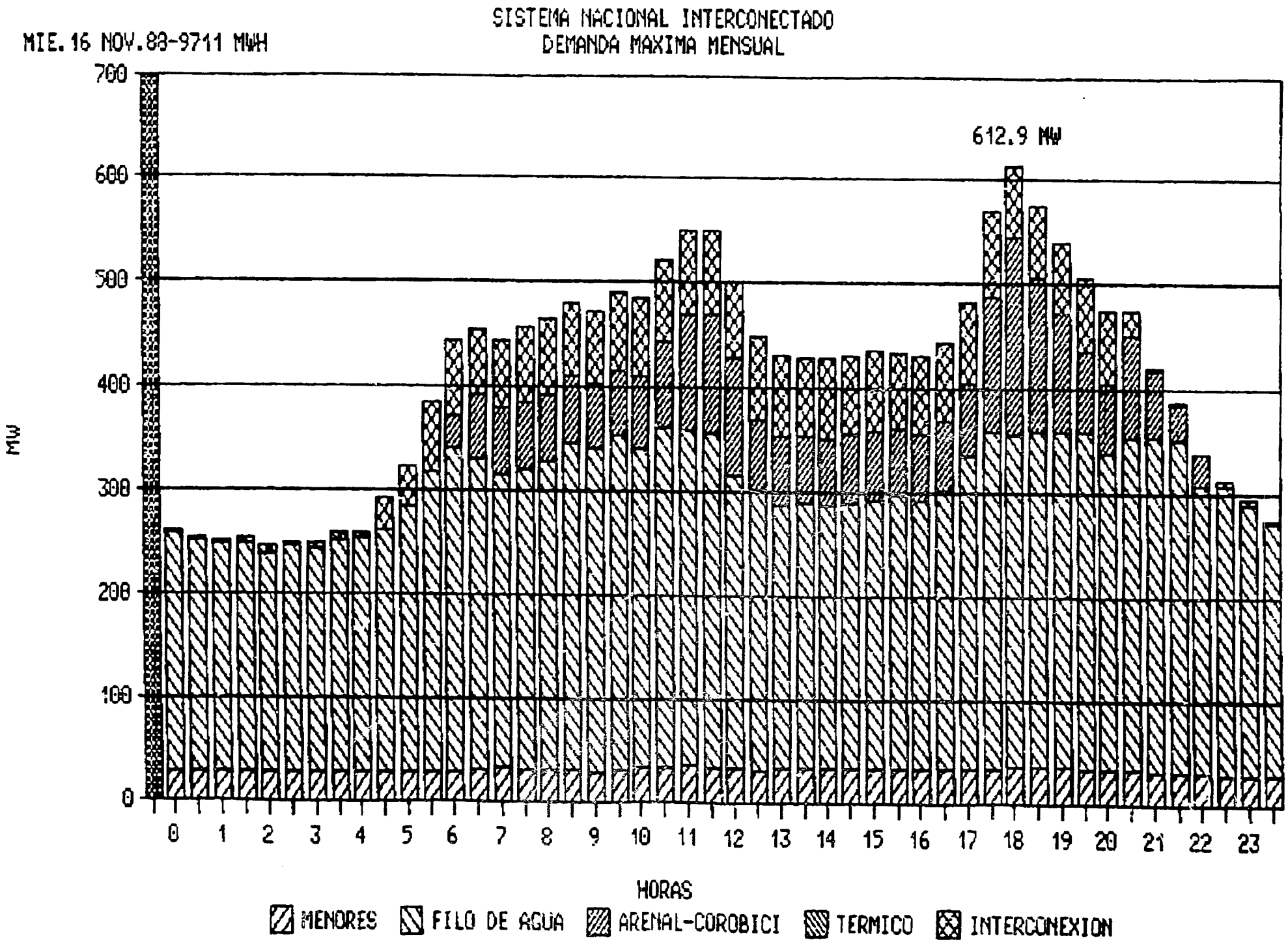


Exhibit i: Typical System Load Curve in Costa Rica

- Training
- Information dissemination and promotion
- Data collection and analysis

**Selection of Participants:** The ICE project team tracked the interest and participation in the project of 75 candidate facilities preselected on the basis of their load patterns and metering capabilities. Of these, 24 were finally selected for participation in the pilot project[3] (see Exhibit ii).

**Load Control Activities:** The project introduced procedures to reduce demand for electricity during the peak hours of the national system. The measures ranged from simple, manual routines, such as switching off high-load machinery during peak hours, to sophisticated energy management systems. With a view toward developing a continuing in-country capability in load management and control, the use of local consulting engineers was promoted.

In several facilities implementation activities actually commenced shortly after initial visits of the survey team in October-November 1987. These visits acquainted electricity users with the potential for cost savings and identified specific energy management measures that could be applied in the short term. Several customers then began controlling loads on a trial basis in the subsequent months. On the other hand, some customers contacted ICE as late as October 1988 to express an interest in joining the demonstration and began load control efforts in early 1989; consequently, at the project's end participating facilities were in various stages of implementation.

Local consulting engineers were assigned a key role in the demonstration project. They were to conduct audits and feasibility studies for participating customers, advise on energy management equipment selection, and assist in project implementation. They also were to monitor progress in the application of energy management in customers' facilities and recommend corrective action as required.

**Tariff Modifications:** To provide incentives for load management, electricity tariffs must be formulated carefully to balance the utility's need to improve the system load profile and the customers' desire to minimize disruption of their operations in a way that is financially attractive or acceptable to all parties. Although ICE offers a time-of-use tariff and an interruptible tariff (which has no subscribers), both require changes to serve as effective tools for promoting load management to the fullest extent under current conditions in Costa Rica. As a result the project team analyzed the present tariffs and their relationship to the current system load profile and customers' operating requirements.

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3 Candidates were chosen based on the following criteria: 1) Expressed an interest in the program and indicated that they had begun to implement load management measures; 2) had functioning demand meters (measuring demand on the quarter hour) for October and November of 1987 and 1988.

- V'

## Exhibit ii

## Participants

| | | Demand[1] 1987 (kW) | Activity |
|---|---|---|---|
| 1. | Alunasa | 1,692 | Aluminum rolling mill |
| 2. | Arrocera Los Sauces | 211 | Rice processor |
| 3. | Carnes de Centroamerica (El Arreo) | 704 | Slaughterhouse |
| 4. | Cartago Beef Packing | 805 | Slaughterhouse |
| 5. | CNP Montecillos (Coopemontecillos-Alejuela) | 443 | Slaughterhouse |
| 6. | Conducen | 840 | Electric cable manufacturer |
| 7. | Coopeagri el General (Beneficio) | 486 | Coffee processor |
| 8. | Coopeatenas | 166 | Coffee processor |
| 9. | Coopevictoria - Beneficio | 311 | Coffee processor |
| 10. | El Gallito Industrial | 579 | Chocolate candy maker |
| 11. | Empacadora de Carnes (Coopemontecillos-Barranca) | 884 | Slaughterhouse |
| 12. | Fabrica Nacional de Licores | 506 | Distillery |
| 13. | Fertica | 4,258 | Fertilizer manufacturer |
| 14. | Hacienda Atirro Ltda (Beneficio) | 202 | Coffee processor |
| 15. | ICAA Puente de Mulas | 2,501 | Potable water supplier |
| 16. | ICAA San Rafael de Escazu | 2,434 | Potable water supplier |
| 17. | Industrias Akron de Costa Rica (formerly Firestone) | 1,814 | Tire & tube manufacturer |
| 18. | Ingenio Taboga | 166 | Sugar mill |
| 19. | Punto Rojo | 271 | Toilet soaps |
| 20. | Rafytica | 295 | Woven polypropylene bags |
| 21. | Ricalit | 669 | Building materials |
| 22. | Scott Paper de Costa Rica | 4,635 | Paper mill |
| 23. | Ticatex | 2,337 | Textile mill |
| 24. | Urgelles y Penon | 174 | Furniture manufacturer |
| TOTAL | | 27,383 | |

1 Average maximum coincidental peak demand.

**Training:** To develop an indigenous capability for developing load management nationwide, ICE counterparts were trained on-the-job in all aspects of industrial and commercial load management. Three ICE engineers also attended a five-day load management course organized by the Florida Power & Light Company in Miami.

**Information Dissemination and Promotion:** Information dissemination and promotion activities were integrated in most of the project activities, beginning with the kickoff workshop for the managers of candidate facilities held on April 20, 1988 and attended by more than 60 interested customers. During this workshop, the purpose and content of the demonstration project and its objectives and conditions were explained. During on-site meetings at customers' facilities and in numerous phone conversations, project staff explained through one-to-one contact the benefits of load control and encouraged participation in the demonstration project. The project staff also worked with the consulting engineers to encourage them to become involved in promoting the project and disseminating information on energy management techniques and hardware. Finally, the project staff drafted a load control brochure and a load control dissemination plan for ICE.

**Data Collection and Analysis:** ICE uses magnetic tape recorders and new electronic recorders installed at their customers' sites for measuring demand (kW) and energy consumption (kWh) in 15-minute increments. Data from these recorders are transferred to two computers at ICE for analysis and billing. In order to establish as clearly as possible the effects of the program, direct load data were extracted from the ICE computers for the project participants, converted to LOTUS for use on PCs, and changes over the course of the project were monitored and analyzed.

## RESULTS

By and large, the project participants relied on manual load control for achieving their demand savings. Typically, they used their own technical staff to study load reduction possibilities and conduct trials with manual controls and little or no equipment. Some companies proceeded to a second manual control stage by installing simple systems, such as signal lights and alarms, to remind plant staff to implement load control procedures. In a small number of cases, a limited degree of automatic load control equipment was installed.

The primary goal of this project was to reduce the total peak demand from the participating companies. As a result, the primary measure of the effectiveness of the project is the total reduction of coincidental demand for power from the participants. Three methods of analyzing the participants' demand were chosen: (1) comparing aggregate load curves on the day of the 1987 system peak (without load control) with the aggregate load curves on the day of the 1988 system peak (with load control); (2) comparing the average of the aggregate maximum peak demand for the two years for October and November; and (3) examining load curves for each customer for the two

years for October and November to compare average on-peak demand with average off-peak demand. These three analyses together are believed to provide an accurate indication of the demand reduced as a result of the pilot project.

Of the 24 selected companies, only 18 could be analyzed with a sufficient degree of reliability, as problems with metering or the baseline definition for six companies precluded their inclusion in the final analysis.

Comparing demand on November 12, 1987 with demand on November 18, 1988 (the two system peak days for each year) indicated that the 18 companies reduced their maximum demand by 3.4 MW during the evening peak hours. Because these 18 companies had an aggregate demand of 20.1 MW in 1987, they reduced their demand by 17 percent (see Exhibit iii). The second analysis, comparing the average of the aggregate maximum peak demand for the two years, produced results on the same order of magnitude, showing 4.1 MW of savings for October and 3.8 MW for November, for a total reduction of 19 percent.

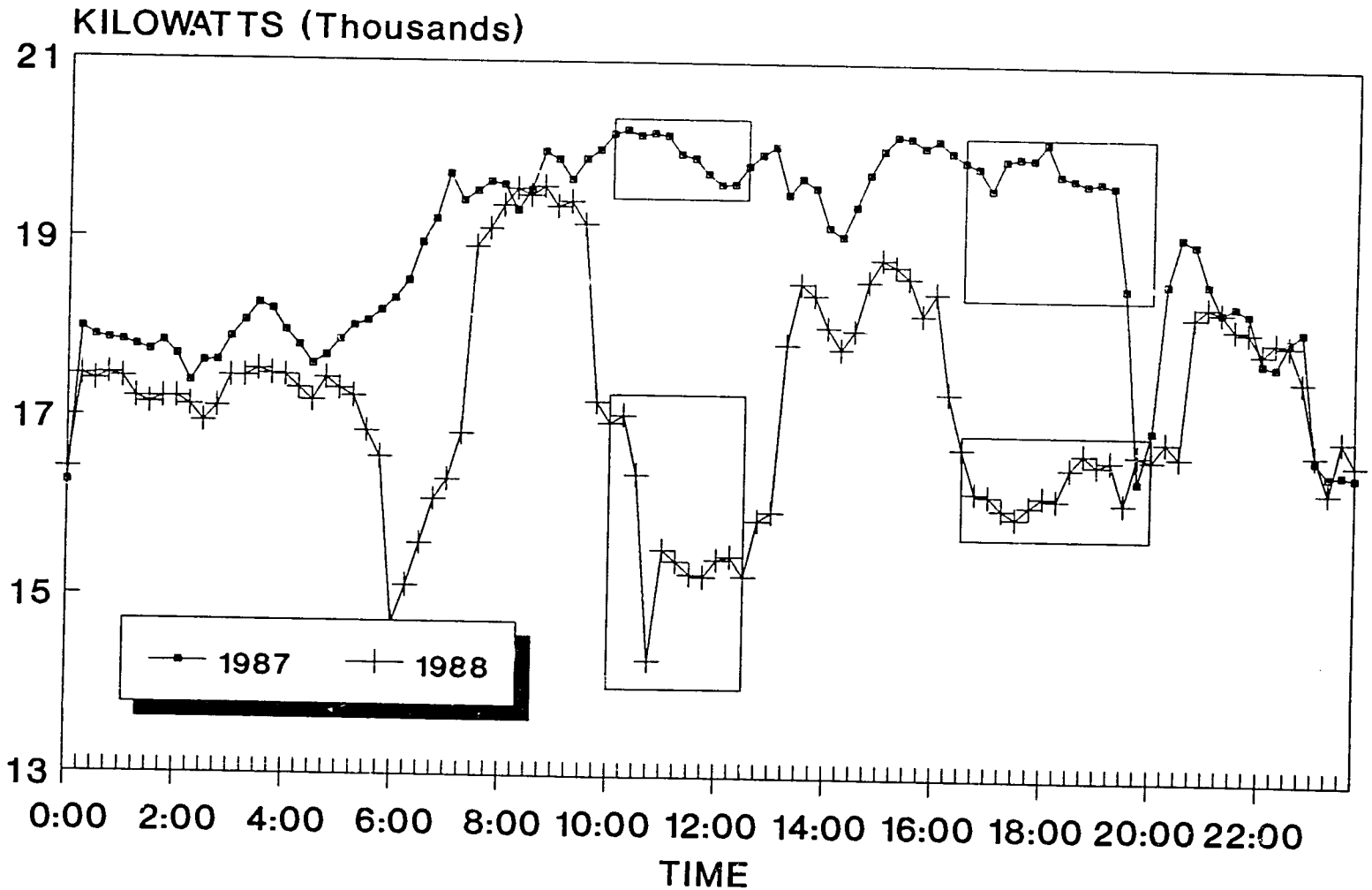
The third analysis measured the difference between demand on-peak and off-peak by examining changes in the shape of the daily load curve. Its results provide a lower-bound estimate for demand reduction of 2.1 MW during the evening peak hours. An examination of the aggregate average demand curves for 1987 and 1988 (aggregating average load curves for 24 companies) shows that together the participants have significantly changed their requirements for power during the peak hours (Exhibit iv). Also of note is the fact that during the on-peak hours, the total average demand curve in 1988 is strikingly "V" shaped instead of being "U" shaped, indicating that the participants are able to reduce demand but are not being successful at maintaining their maximum reduction throughout the entire peak demand period. If the customers were able to maintain their maximum demand reduction throughout the peak hours, this analysis would also show savings in the 3 to 5 MW range.

No one analysis can adequately account for the many variables that affect industrial demand for electric power. As a result, each of the analyses above is valid for only a portion of the sample. Conservatively calculated, the 24 companies included in the analysis reduced their evening peak demand by 3 MW. Because these 24 companies together had a demand of 21 MW during peak hours in 1987, they achieved a total savings of 14 percent. If the participants succeed in extending their efforts and achieve their savings on a consistent basis throughout the peak hours, they will reduce their evening peak demand by over 5.8 MW for a savings exceeding 27 percent.

In summary, the initial goal of the program -- to reduce the participants' peak demand for power by at least 10 percent -- was met: the 24 companies in the analysis reduced their demand by 14 percent. The 18 participants for which reliable data could be obtained on average reduced their demand for power during the evening peak hours by 3.8 MW, and reduced their demand on the day of maximum system peak demand by 3 MW.

Exhibit iii

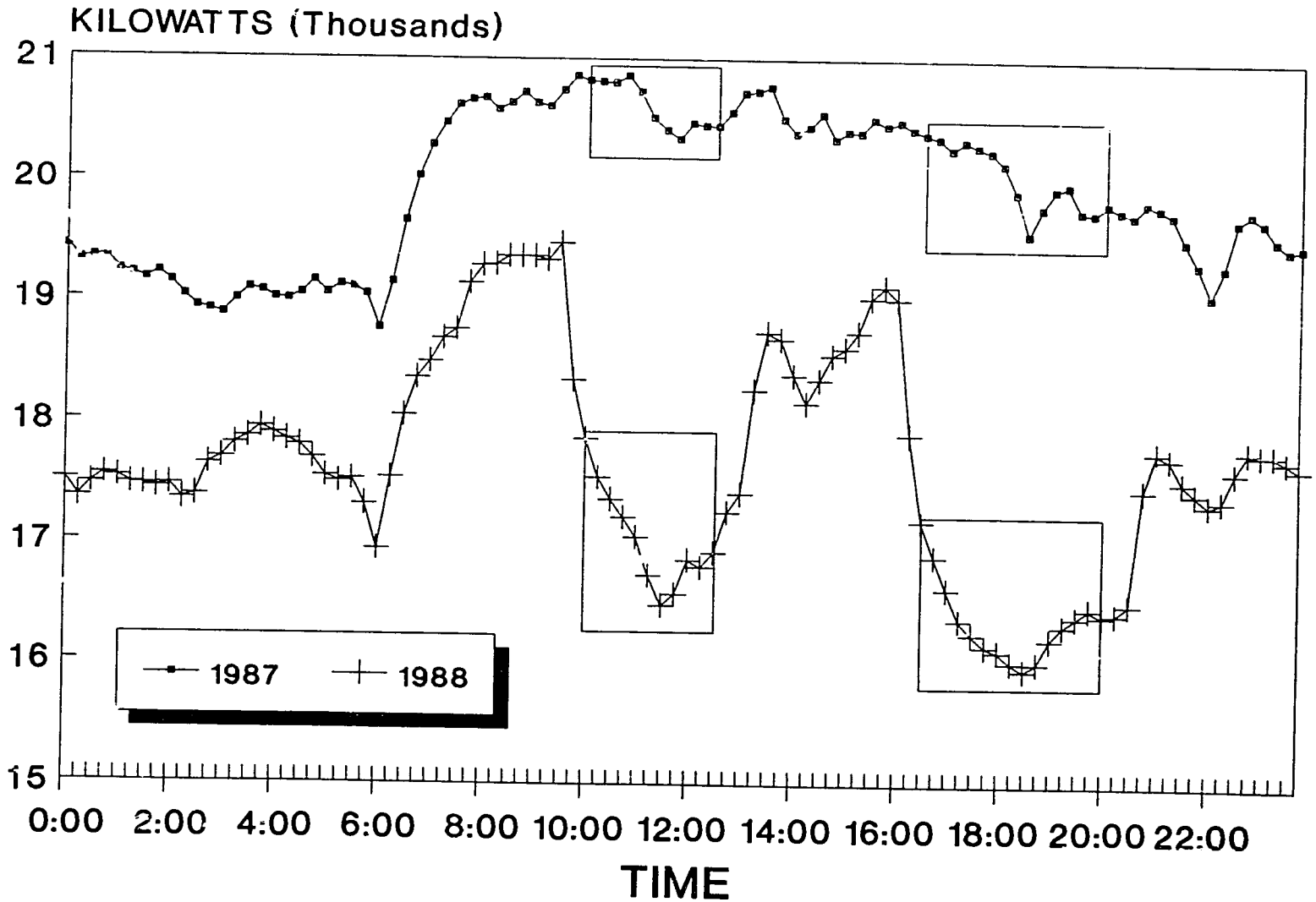
# TOTAL PARTICIPANT DEMAND
## ON SYSTEM PEAK DAYS




Boxed region represents peak hours.

Exhibit iv

# TOTAL AVERAGE DEMAND




Boxed region represents peak hours.

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## COSTS AND BENEFITS

On the whole, load management projects yield better cost/benefit ratios than any other power sector improvement project in Costa Rica and are the most effective way to "add" capacity. Of the 24 demonstration participants whose results were analyzed, 18 incurred no cost at all, and 6 reported low to moderate costs ranging from $1,210 to $29,445 depending on the size of their demand and the approach taken, i.e., manual vs. automatic control. Costs were low because customers relied largely on their own technical personnel to plan and implement load control, and because in all cases load was controlled manually as of the close of the project. The 24 customers analyzed reduced their total demand charge by about $26,000 per month at a total cost of approximately $52,000, resulting in an overall payback period of two months for the group. For individual customers the payback period ranged from zero (in the case of manual control) to 10.9 months.

The value to ICE of the load reduction of 3,015 kW is almost $200,000 annually net of their revenue reduction (lower demand charges). This saving was achieved with an outlay of only $11,100; therefore, the payback period is less than one month.

## CONCLUSIONS

The conclusions drawn from this project are divided into sections on the impact of the load control measures and the problems encountered in implementing the project.

### Participants achieved target savings.

This project has demonstrated that peak load coincidental with the system annual peak can be reduced by 14 percent, or 3 MW, in a representative sample of 24 industrial facilities at a cost acceptable to both the customers and the electric utility. The results exceed the project goal of a 10 percent reduction.

### Savings could exceed 5.8 MW from demonstration participants.

The peak reduction demonstrated was measured as of November 1988 (the system peak month); however, it does not reflect the full results of the program and the results presented in this report must be considered as conservative. Most of the facilities analyzed had not yet completed their application of load control at that point in time and, in fact, many were still in early stages of implementation. When the 24 participants in the statistical analysis refine their load management procedures and achieve their potential reduction on a consistent basis, their total reduction in on-peak demand will reach an estimated 5.8 MW for a total decrease of 27 percent.

**The entire commercial and industrial sector could reduce demand by 17.2 MW.**

Based on the 14 percent demand reduction demonstrated, there is a potential for trimming coincidental peak demand in the rest of Costa Rica's similar commercial and industrial facilities alone by approximately 17.2 MW, or almost 3 percent of the integrated system peak of 613 MW. (The aggregate coincidental demand of the sector is estimated at 122.5 MW.)

**The project proves to be very cost effective.**

The approach taken to improve the load profiles of the sample of 24 customers was very cost effective. The group achieved monthly demand charge savings of 2.1 million colones ($26,294), with project-related expenditures of 4.1 million colones ($51,702), comprising mainly purchased equipment and services. Overall, the simple payback period for costs incurred by customers was two months.

ICE also benefitted in terms of deferred costs of generation and transmission capacity, estimated to have an annualized value of $154,656 net of reduced revenue from lower demand billing.

**Problems reduced the achievements of the demonstration project.**

Several problems were encountered in the course of the demonstration project that served to hamper its implementation and reduce its effectiveness due to the fact that the project budget only allowed for U.S. consultants to visit for a few weeks every six months. The information dissemination activities and contact among project staff, consulting engineers, and participants was not sufficient to overcome the participants' reluctance to implement new measures quickly and invest in new load control equipment. The limited technical information available on potential manageable loads at each plant and the limited technical assistance available to each customer added to the difficulty in encouraging participants to implement load control activities. Several institutional barriers also hampered the effectiveness of the project, including lack of an organizational framework and manpower to implement the program; limited availability of load curves and other information for use in educating the customers and informing them of their progress; and difficulty in obtaining full participation of the distribution companies in the program. Finally, several tariff-related barriers were identified, including: excessively long peak periods in the time-of-use tariffs offered by the utilities; lack of load management tariffs that would give the utilities a positive control over a known portion of the demand; and lack of time-of-use and interruptible tariffs in the offerings of most distribution companies.

## RECOMMENDATIONS

The recommendations are divided into three parts: (1) general recommendations and recommendations to ICE; (2) recommendations related to other Costa Rican organizations; and (3) recommendations for the development community.

### General Recommendations and Recommendations to ICE

**Use the momentum developed by the demonstration project to expand the project to the whole target population.**

ICE should exploit fully the visibility, interest, and momentum generated by the pilot project; therefore, a larger scale, multi-year load management program should be established without delay to achieve an optimum national demand curve. Such a program would cost about $2.5 million for the next 5 years and lead to a peak reduction of about 15-25 MW by 1992 (phase 2).

**Create a department within ICE to coordinate load management and end-use efficiency improvements.**

A permanent group at the department level should be created within ICE with the explicit mandate to coordinate programs to bring about load management and end use efficiency improvements. The sole responsibility of this group should be to implement a load control program and/or end-use programs.

**Prepare and implement an information dissemination plan.**

The draft information dissemination plan should be completed and implemented to distribute information on the benefits of load management, encourage customers to participate in a continuing load control program, enroll more customers in load management tariffs, and generally raise the awareness and understanding of the need for and benefits of load management.

**Educate utility personnel on the results of the project and the benefits of load control.**

The management at ICE, CNFL, and the distribution companies should be shown how the benefits of load management can be calculated.

**Improve the existing tariffs to encourage participation.**

Several measures should be taken to improve the effectiveness of the current tariffs and create additional tariffs that will encourage customers to implement energy management measures:

1. The existing time-of-use and interruptible tariffs should be amended to make them more attractive to industrial and commercial customers, consistent with the utilities' interests. All utilities should offer tariffs that promote energy management.

2. A special load management tariff should be developed and offered by all Costa Rican utilities.

3. ICE should develop criteria for dispatching load control on the interruptible rates (and any new load management rates). This should provide a systematic procedure to be followed by the system control center dispatchers in order to initiate load management.

4. Existing and new time-of-use, load control, and interruptible tariffs should be publicized widely.

**Create additional incentives for customers to implement energy management procedures.**

These incentives should include the following:

1. Audits and advisory services by consulting engineers with specialized energy management knowledge should be initially subsidized to promote their widespread use.

2. At the same time, a complete electrical energy rationalization service should be promoted to increase customers' energy cost savings and thereby facilitate justification of energy management systems.

3. A simple, low-cost energy monitoring system should be designed and made available to customers who cannot justify investing in an energy management system.

4. Because more technical assistance is needed for commercial customers than for industrial, assistance to the former should be subsidized.

## Recommendations Related to Other Costa Rican Organizations

1. The distribution companies should be drawn into the program by training their key personnel in load management and encouraging them to establish load management functions in their own organizations.

2. The contract between ICE and the distribution companies should be changed to increase the incentives for them to encourage their customers to implement load control measures.

3. Because ICE is facing budgetary constraints that make it difficult to provide manpower fully dedicated to load management development in the medium term, other sources of manpower must be found. DSE and ICAITI should be considered as a source of interim staff until ICE can organize and staff the function adequately. Alternatively, private consulting/engineering companies could be brought under contract to ICE to carry out the related activities, as is often done in the United States. The respective merits of each option should be analyzed both in terms of institutional feasibility and economic and financial merit.

**Recommendations for the Development Community**

1. The development community, including the Agency for International Development, the World Bank, the Interamerican Development Bank, and CEPAL, should provide support for the development of a division or department within ICE that will be dedicated to implementing and supervising a load control program.

2. The development community should provide financial support in the form of technical assistance and funding for specialized equipment for a full-scale load control program in Costa Rica. When such a program is in full swing, consideration should be given to further expanding the program to include the residential sector. Preliminary estimates indicate that reductions of up to 5 percent of the integrated system peak demand (35 MW) could be obtained from a full scale program in the mid 1990s. The total cost of such a program is estimated to be around $4-5 million (phase 3).

# INTRODUCTION

## BACKGROUND

Costa Rica's national electrical load curve is characterized by two daily peaks (generally 10:00 a.m. to 12:30 p.m. and 4:30 p.m. to 8 p.m.) that coincide with the preparation of the midday and evening meals. Typically, the evening peak is the higher of the two. These characteristics are illustrated by Exhibit 1, which shows the system load curve for the peak day of 1988 (November 16), during which the system peaked at 612.9 MW.

In recent years, Costa Rica has experienced a steady growth in annual peak demand, mainly because of rising electricity consumption for cooking and lighting in both urban and rural areas. Also, the construction of dwellings by the current administration has contributed to the increase in peak demand. Statistics from 1986-1988 indicate that peak demand is rising by close to 10 percent annually.

The Instituto Costarricense de Electricidad (ICE), the nation's principal electric utility, is responsible for power generation, transmission, and distribution. During 1988, ICE increased its electricity tariffs and undertook an ambitious conservation campaign. Combined with a generally sluggish economy, these measures led to a slowing of demand growth in 1988. Exhibit 2 shows the trends in demand growth, by comparing peak demand, by week, for the years 1986-88. The rising demand reflects the parallel trend for electricity consumption, which is plotted over the same period in Exhibit 3.

To meet expected demand, ICE will have to install six 36 MW gas turbines before the year 2000. The capital cost of each will be some $15 million in foreign exchange. This investment will hamper the government's efforts to deal with the country's debt situation, as the turbines, replacement parts, and the fuel they use must be imported. ICE is also installing additional geothermal and hydroelectric generating capacity to relieve the situation.

The rapid growth in demand prompted the Government of Costa Rica and ICE to consider load management as a means of stabilizing and shrinking peak demand to relieve mounting pressure for new generation and transmission investments. Load management can be broadly defined as the deliberate control or influencing of customer electrical loads in order to achieve the most efficient configuration of the utility's load profile. ICE's need to avoid or defer capital investment and to improve its low annual load factor (currently 59-60 percent) have led the utility to embark on a

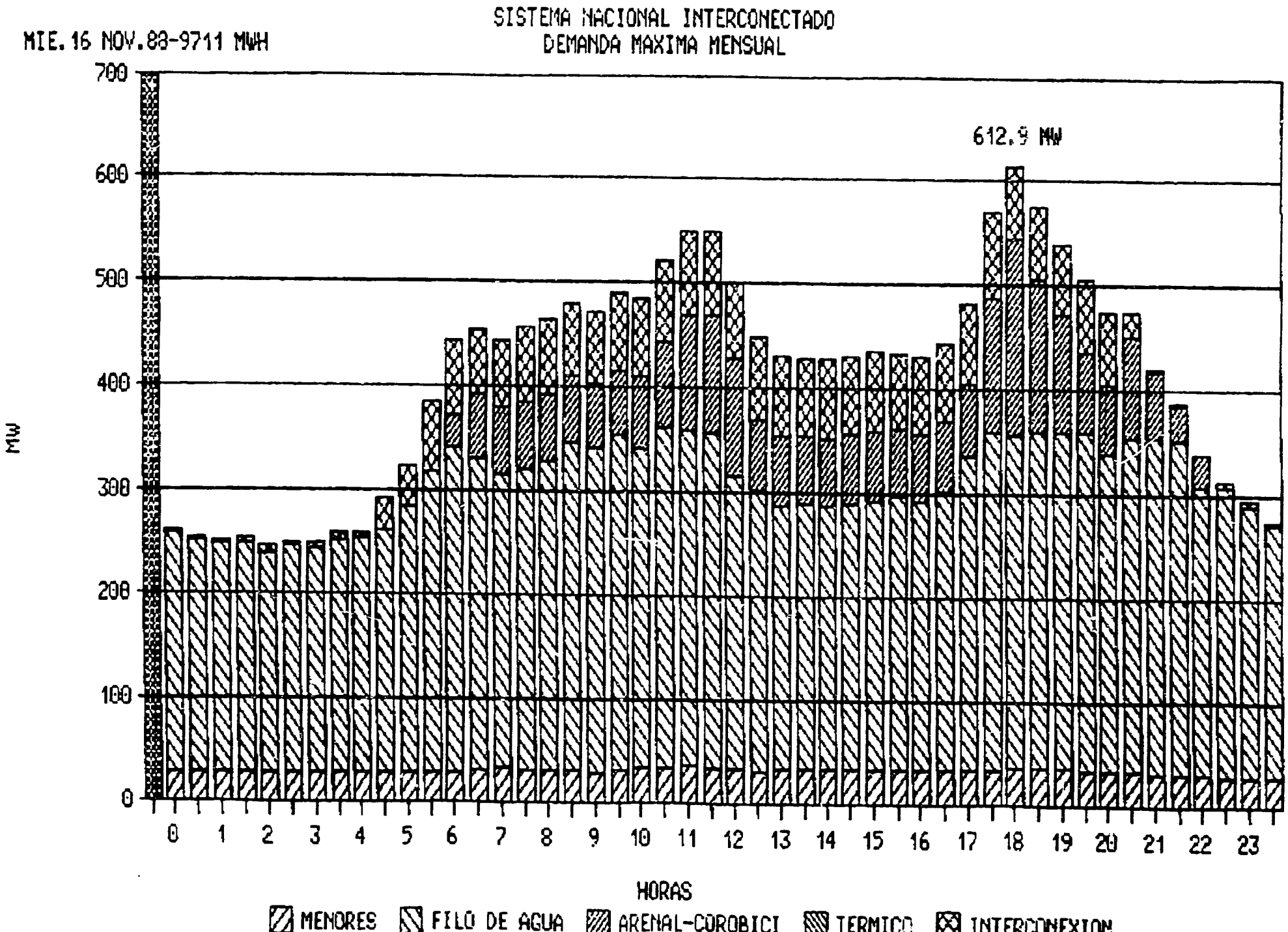



Exhibit 1: Typical System Load Curve in Costa Rica

2

Exhibit 2

# System Peak Demand
## (Weekly)

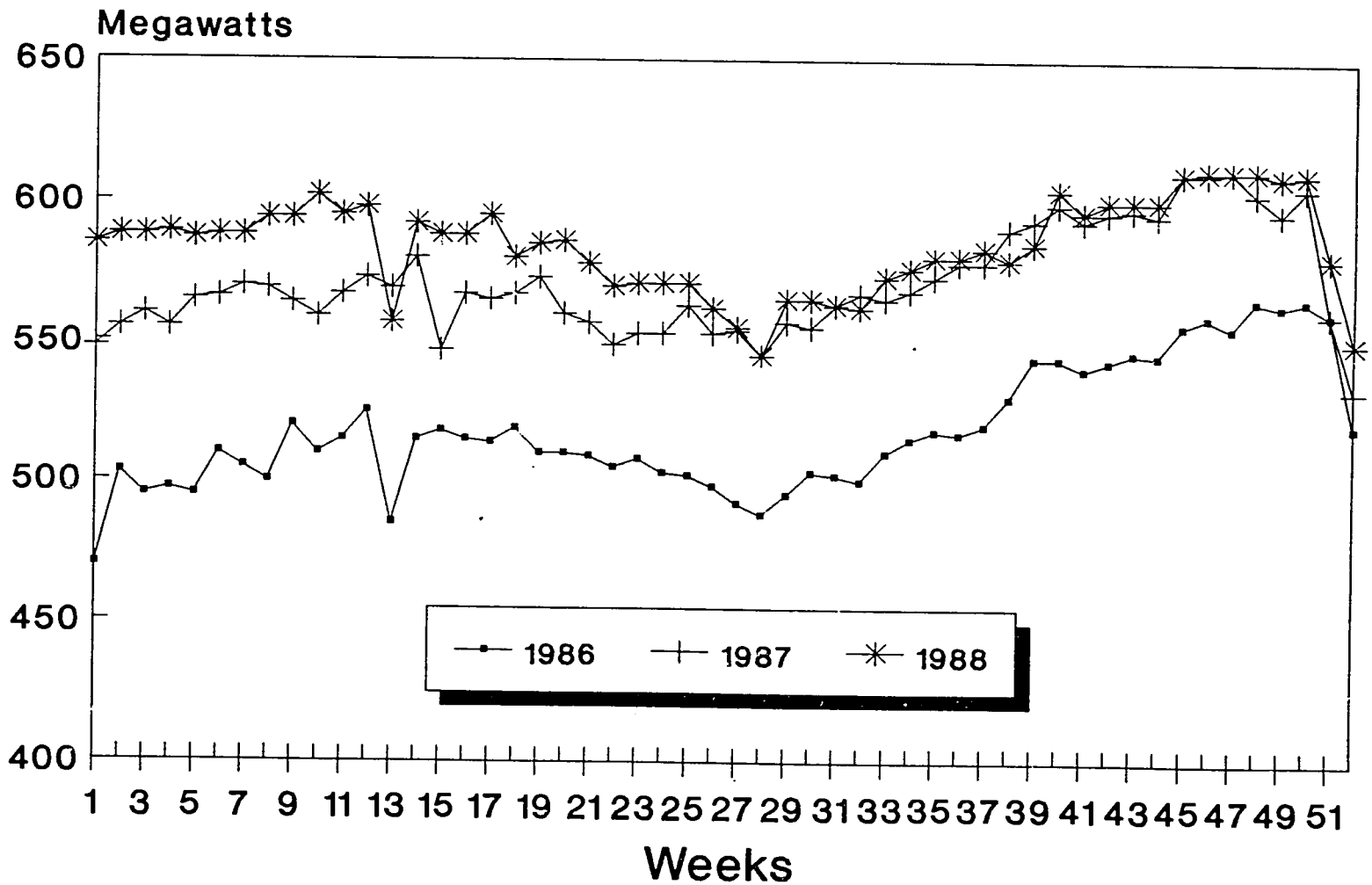
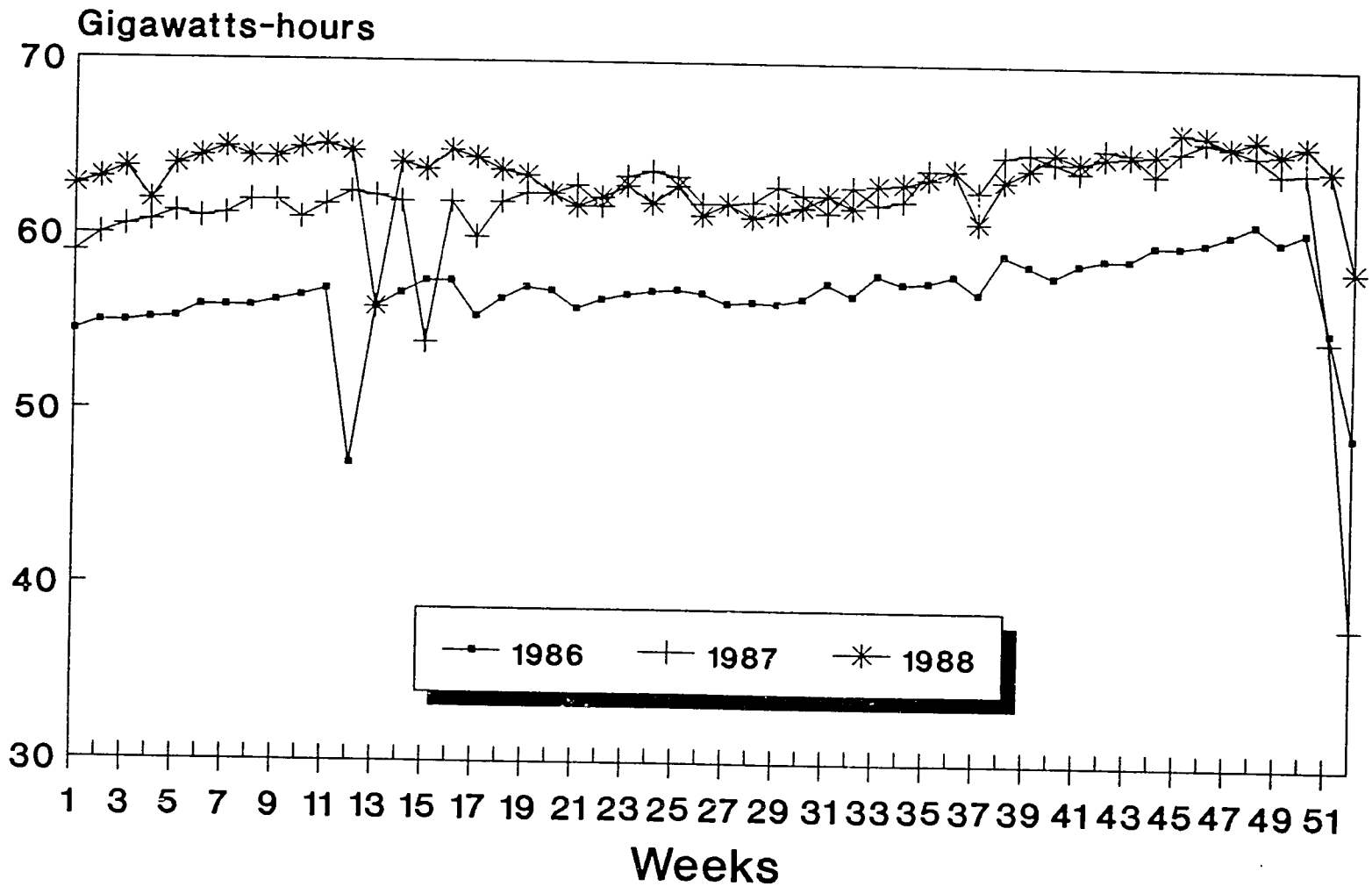


Exhibit 3

# System Electricity Consumption
## (Weekly)



short-term load management/control program aimed at reducing the coincidental peak loads of the industrial and commercial customer classes. (ICE is also looking to purchase power from independent or private sources.)[1]

The first step was a load control demonstration project aimed at approximately 30 large industrial and commercial customers of ICE and the distribution companies. In response to a request from ICE management, the A.I.D. Office of Energy and the USAID Mission in San Jose funded the load management demonstration project, which is the subject of this report.

The project was implemented under the direction of RCG/Hagler, Bailly, Inc. through the Energy Conservation Services Program (ECSP) with FPL Qualtec, a subsidiary of Florida Power & Light, as subcontractor. ECSP is a program of the A.I.D. Office of Energy. Alain Streicher, Robert Kowalski, Arun Sanghvi, and Jeff Erickson of RCG/Hagler, Bailly and Juan Gonzalez and Jorge Cano of FPL Qualtec provided direction, training and analysis for the project. ICE personnel working on the project included Ing. Jose F. Carballo, Ing. Felipe Corriols M., and Ing. Arnoldo Arias C., under the supervision of Ing. Jose Manuel Fernandez and Ing. Hernan Robles V. Several local engineering/consulting companies, including SOC 2000 and Disenos Electricos, provided technical assistance to the users.

With support from ECSP, ICE promoted the application of current load management and control techniques by participating customers, with the objective of reducing their aggregate coincidental peak demand by at least 10 percent. Further objectives were to demonstrate the cost-effectiveness of load control and to disseminate widely the results of the pilot program with a view toward multiplying its effect through replication. The scope of work for the project is presented in Appendix A.

## LOAD MANAGEMENT: IMPROVING THE UTILITY'S LOAD SHAPE

The project draws on the load management experience of utilities in the United States, where power plant construction and operation costs have been rising sharply since the mid-1970s. The principal factors pushing up the costs of generating power are increases in fuel costs, unreliable supplies of fuels, high capital cost, and increased regulatory and environmental restrictions. Faced with these constraints on power supply, utilities have been forced to find new ways to reduce the cost of electricity. Instead of building expensive power plants to meet customers' demand for electricity, utilities have found that they can reduce their peak loads by influencing the load shape, or "managing" their peaks/loads. By reducing system peaks, utilities are able to defer or avoid the construction of expensive power plants.

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1 See the ECSP report Non-Utility Power Generation in Costa Rica: Potential, Impediments, and Policy Issues. 4/1/88.

Load management is defined as utility activities designed to influence the timing and magnitude of their customers' use of electricity. The traditional load shape objectives include peak clipping, valley filling and load shifting, as illustrated in Exhibit 4.

Some of the objectives of load management are:

- Reduce peak load growth
- Avoid or defer construction of power plants
- Increase overall system utilization
- Improve utility load factor
- Reduce use of expensive fuels
- Reduce electricity cost to customers
- Reduce combustion emissions (from peaking units)

Accomplishing these objectives through load management improves profits for the utility and will simultaneously reduce customers' electricity costs. Effective rates are reduced immediately through incentives for customers to choose specific load management rates, and are reduced in the long term through improved system utilization and deferral or avoidance of new generation capacity.

Strategies, technologies and techniques for improving load profiles are described in Appendix B.

## PROJECT HISTORY

The need for a load management and control program was identified through a fact-finding survey conducted by RCG/Hagler, Bailly, Inc. during the summer of 1986 and funded by AID's ECSP. This survey had been requested by the Ministry of Natural Resources, Energy and Mines (MNREM) and the USAID Mission in San Jose, Costa Rica.

Following this visit, a report and a subsequent proposal were submitted to MNREM and USAID. The proposal was granted official approval in the summer of 1987, and the planning phase of the program started in October 1987. The implementation phase began in April 1988 with a kickoff workshop for medium and large industrial and commercial customers of ICE and the major distribution company, Compania Nacional de Fuerza y Luz (CNFL). Implementation activities under the pilot project continued through February 1989, after which ICE continued to offer assistance to interested customers using its own limited resources.

The Minister of MNREM had recognized the value of demand management very early on, and assigned it high priority. His strong support was a key element in the development and success of the pilot project. In particular, he was very helpful in providing the institutional framework for the project and in encouraging ICE to undertake the project.

# DEMAND MANAGEMENT CAN HAVE MANY DIMENSIONS

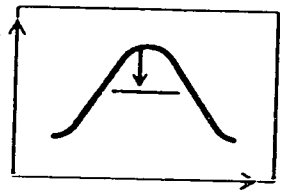
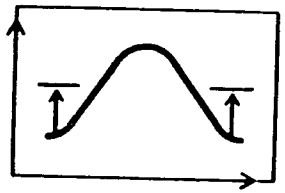
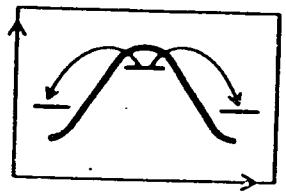
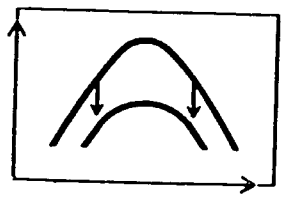
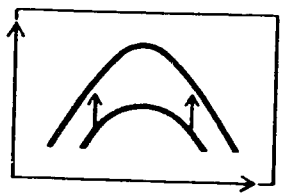
| | | Residential | Commercial | Industrial |
|---|---|---|---|---|
| **Peaking clipping,** or reduction of load during peak periods, is generally achieved by directly controlling customers' appliances. This direct control can be used to reduce capacity requirements, operating costs, and dependence on critical fuels. |  | • Accept direct control of air conditioners | • Accept direct control of water heaters | • Subscribe to interruptible rates |
| **Valley filling,** or building load during off-peak periods, is particularly desirable when the long-run incremental cost is less than the average price of electricity. Adding properly priced off-peak load under those circumstances can decrease the average price. |  | • Use off-peak water heating | • Store hot water to augment space heating | • Add nighttime operations |
| **Load shifting,** which accomplishes many of the goals of both peak clipping and valley filling, involves shifting load from on-peak to off-peak periods, allowing the most efficient use of capacity. |  | • Subscribe to time-of-use rates | • Install cool-storage equipment | • Shift operations from daytime to nighttime |
| **Strategic conservation** involves a reduction in sales, often including a change in the pattern of use. The utility planner must consider what conservation actions would occur naturally and than evaluate the cost-effectiveness of utility programs intended to accelerate or stimulate conservation actions. |  | • Supplement home insulation | • Reduce lighting use | • Install more-efficient processes |
| **Strategic load growth,** a targeted increase in sales, may involve increased market share of loads that are or can be served by competing fuels, as well as development of new markets. In the future, load growth will include greater electrification—electric vehicles, automation, and industrial process heating. |  | • Switch from gas to electric water heating | • Install heat pumps | • Convert from gas to electric process heating |

Exhibit 4: The Dimensions of Load Management

## DEMONSTRATION PROJECT DESCRIPTION

The project targeted large commercial and industrial customers because they represent a high potential for immediate or short-term load reduction. Residential customers, on the other hand, are the major contributors to the peak, but have demand patterns governed by social factors that are difficult to alter in the near term. Target customers were those with monthly consumption levels of at least 20,000 kWh, or maximum demand exceeding 100 kW. The target population was estimated at 425 accounts with an estimated aggregate coincidental demand of 122.5 MW.

The project work plan consisted of three steps: preparation or start-up, demonstration, and dissemination. The detailed schedule of activities is shown in Exhibit 5.

The plan called for the enrollment of a representative group of about 30 customers with a large load reduction potential and a strong interest in load control. The goal was a total coincidental peak load reduction of not less than 10 percent.

The participating customers were to be provided with technical assistance by ICE, ECSP staff and local consulting engineers. The consulting engineers were to be contracted by the customers to perform audits, assess load reduction potential, and to formulate plant-level programs, including recommendations for and justification of equipment.

ICE was to provide and install electronic demand recorders on participating customers' premises, with provision for remote interrogation by a central computer station operated by ICE. Customers' load profiles were to be collected before and after the initiation of load control, to permit determination of its impact on coincidental peak demand.

ECSP staff were then to analyze the load data and conduct a cost/benefit analysis to assess the financial viability of the pilot program. In addition, they were to prepare overall conclusions and recommendations.

Based on the results of the ECSP analyses, ICE was to estimate the long-term impact of the demonstration on the participants' load profiles and the potential benefit from expanding the program to a larger segment of the industrial and commercial customer classes. Also, ICE was to develop a plan for disseminating the information gathered during the pilot project to a wide audience.

In parallel with the above activities, ICE was to take steps to amend its time-of-use tariff and to provide a new load control tariff--both with a view toward encouraging customers to exercise effective demand control. Also, the existing interruptible tariff can be used to reduce peak demand in a similar fashion to the load control tariff.

# Exhibit 5: Detailed Work Plan, Load Control Demonstration Project

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MONTH

1 | 2 | 3 | 4 | 5 | 6 | 7 - 9 | 10 | 11

## A. START UP

### ICE

1. Organize initial workshop (opening seminar)
2. Finalize selection of target facilities
3. Assign staff roles
4. Finalize metering and monitoring procedures
5. Install meters at selected sites
6. Install computer/test
7. Develop sample output

### PARTICIPATING INDUSTRIES

1. Finalize arrangement/agreement
2. Identify/select control system
3. Order equipment
4. Set up internal organization

### SUPPLIERS/CONSULTANTS

1. Assist industries select equip/def specs

### HBC/FPL

1. Draft typical letter of agreement for indu.
2. Provide tech. assistance to participants
3. Train ICE/industry engineers/counterparts
4. Draft interim report

### DSE

1. Participate in initial workshop/meetings

## B. DEMONSTRATION

### ICE

1. Collect data/monitor progress at each site
2. Visit sites (at random)
3. Track impact on peak load

### PARTICIPATE INDUSTRIES

1. Install equipment
2. Implement load management project (gradually)

### HBC/FPL

1. Collect cost/benefit data and provide ad hoc T.A.

## C. DISSEMINATION

### ICE

1. Fine tune cost/benefit data
2. Identify impact of demos over long term (seasons)
3. Estimate replicability (list of candidate facilities)
4. Develop dissemination plan
5. Prepare pamphlets and campaign for specialized magazines

### PARTICIPATING INDUSTRIES

1. Prepare short report documenting experience
2. Allow site visits
3. Prepare programs for further steps

### HBC/FPL

1. Analyze load data
2. Conduct detailed cost/benefit analysis
3. Prepare overall conclusions and recommendations
4. Prepare final report

CLOSING WORKSHOP (ICE & HBC/FPL)

## REPORT ORGANIZATION

This report presents a brief history of the project, describes the activities undertaken, analyzes the impact of the project, and makes recommendations for the future. In Chapter 1 the many activities that set the stage for the demonstration are described and the field activities and monitoring that characterized the implementation, or demonstration, stage are presented. Chapter 2 explains the analysis procedure, presents the results achieved by the demonstration, and examines the project's cost-effectiveness. Finally, Chapter 3 presents conclusions drawn from the project and recommendations for further action.

Appendices A through P present additional information in support of the body of the report.

# CHAPTER 1: PREPARATION AND IMPLEMENTATION

This chapter describes the work undertaken to provide the resources, enroll participants, and collect data, and other elements necessary for implementing the demonstration. It also describes the measures undertaken in the implementation stage of the project. Many interviews and visits to customer facilities were held in the process of designing and implementing this project; they are listed in Appendix C.

## OPENING SEMINAR

On April 20, 1988, ICE held a workshop for the managers of candidate facilities to explain the purpose and content of the demonstration project and its objectives and conditions. More than 60 persons, mostly from industry, attended the seminar. The agenda is presented as Exhibit 1.1.

Two very convincing case studies of load management systems in a small coffee processing plant and a large cement plant were presented. Both plants experienced actual payback periods of two months after their systems were implemented. The event was a success, as a large number of candidate facilities decided to participate in the demonstration.

## STAFFING AND ORGANIZATION

On May 16, 1988, ICE announced the appointment of a counterpart staff, assigning the bulk of the work to three quality control managers on a part-time basis. The project staff then consisted of:

| | |
|---|---|
| Liaison Officer: | Ing. Mario Hidalgo, Manager of the Electrical System |
| Project Director: | Ing. Jose Manuel Fernandez, Head of the Electrical Distribution Directorate |
| Principal Counterpart: | Ing. Jose Carballo A., Regional Head of Quality Control, Central Pacific and Guanacaste (40 percent of his time) |
| Counterpart: | Ing. Felipe Corriols M., Regional Head of Quality Control, Atlantic and South (25 percent of his time) |
| Counterpart: | Arnoldo Arias C., Regional Head of Quality Control, Central Region (25 percent of his time) |

**Exhibit 1.1**

**Agenda of Opening Seminar**

**AGENDA PARA REUNION INAUGURAL**
**PLAN PILOTO PARA EL MANEJO DE CARGA**

**APRIL 20, 1988**

| HORA | TEMA | EXPOSITOR | |
|---|---|---|---|
| 8:30-8:45 | Bienvenida | Mario Hidalgo P. | I.C.E. |
| 8:45-9:00 | Presentacion General del Proyecto. | Jose M1. Fernandez | I.C.E. |
| | Importancia del Manejo carga | Fernando Moya M. | I.C.E. |
| 9:00-9:30 | Detalle de las actividades que involucra el proyecto | Alain Streicher<br>Juan Gonzalez | RCG/HBI<br>F.P.L. |
| 9:30-10:00 | Tarifas disponibles en el ICE y CNFL | Federico Zuniga M.<br>Oficina de Facturacion | I.C.E. |
| 10:00-10:30 | Dos casos interesantes | Gerardo Amador<br>Industria Nacional Cemento<br>Sr. Roberto Kooper<br>Cafetalera Pilas | |
| 10:30-10:45 | Descanso | | |
| 10:45-12:00 | Sesion de preguntas y respuestas. Finalizacion del Seminario y puesta en marcha del proyecto | Participantes | |

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Thus, responsibility for day-to-day activities rested with members of ICE's regional quality control offices. Messrs. Carballo and Corriols have offices in the ICE headquarters building, while Mr. Arias is based in Alajuela (17 km from San Jose). A map of the three quality control regions is presented in Appendix D.

The regional quality control offices are responsible for monitoring the services provided to customers and the condition of the distribution system. Their responsibilities include inspection of customer services; installation of demand meters; load management; system reliability; analysis of distribution load, voltage and losses; and customer complaint management. Their situation in the organization is shown in Exhibit 1.2.

## ENROLLMENT OF CUSTOMERS

The initial round of plant visits in October-November 1987 yielded 15 good candidates for the demonstration project based on their maximum demand, potential for load reduction, degree of interest in load control, and estimated cost effectiveness of energy management measures. Analysis of customer lists and records, and plant visits resumed in June 1988 with a view toward identifying and enrolling about 30 suitable candidates for the project. These activities continued through December 1988 and resulted in a target list of 77 facilities as shown in Appendix E.

Potential candidates were screened on the basis of the following criteria:

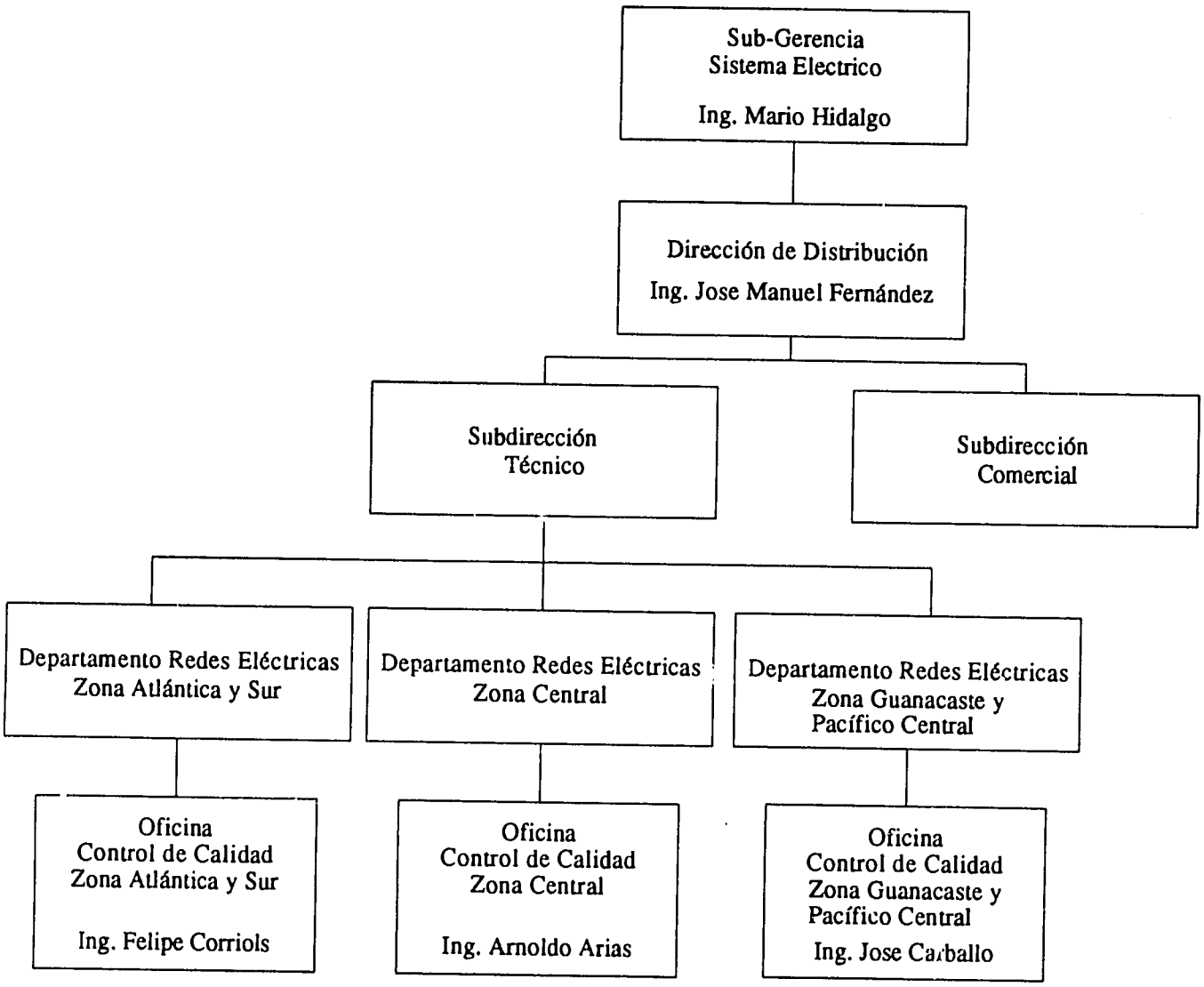
- Lack of load control, indicated by poor load profiles
- Presence and size of controllable loads
- Degree of management interest in implementing energy management.

The question of cost effectiveness was eliminated as an important factor in candidate selection when it became apparent that most customers were choosing manual energy management options -- at least in the initial stage of trials and feasibility testing. This approach entails little or no investment in control equipment and therefore obtains very good cost effectiveness.

Many of the customers on the target list did not satisfy the above criteria. Mainly, they lacked controllable load or, in a few cases, showed insufficient interest. Also, several of the targeted customers had already initiated energy management programs prior to the project and were already controlling loads. Thus, they were not likely to demonstrate a further significant reduction of coincidental peak demand as a result of the project.

The candidates deemed most suitable for the project were then requested to sign a letter of intent (shown in Appendix F). The letter was intended to formalize both parties' agreement to the terms of the project and to strengthen the customer's

**Exhibit 1.2: ICE Quality Control Organization**

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commitment to the project. Although the commitments established are not legally binding, the letter of intent proved to be a barrier (or cause of delay) in securing some candidates' agreement to join the demonstration.

In general, two or more site visits were required to secure customers' formal agreement because the letter of intent tended to raise questions at top management levels. Also, in some cases it was necessary to reconcile conflicting views of plant engineering and production personnel in regard to rescheduling equipment operations. Engineers are interested in providing electricity to the plant at lowest cost, while production personnel give priority to meeting production commitments.

The efforts of the project team resulted in the enrollment of 34 customers. A subset of these companies was chosen for the analysis of the impact of the project[1] (Exhibit 1.3).

## MONITORING OF CUSTOMER LOADS AND DATA COLLECTION

A key element of the demonstration was the monitoring of customers' load profiles to evaluate the impact of the project and to provide feedback to guide the energy management efforts of participating customers. This was to be accomplished by means of Sangamo DataStar electronic pulse recorders linked by telephone lines to a central computer situated in the ICE meter laboratory in Colima (near San Jose). The recorders can be interrogated centrally, and hard copy demand data, including graphics, can subsequently be generated by the computer. ICE allocated 35 DataStar recorders to the project, and most of them were installed in participating facilities during the second half of 1988. Earlier data, required for establishing a baseline for the analysis of project results, were to be taken from equipment that was already in place in most facilities and were being used for billing purposes. This equipment consisted of meters with a capability to record daily load data on a magnetic tape cartridge. Both types of recording equipment and their data processing arrangements are described in detail in Appendix N. Fortunately, all recorded daily load data (in 15 minute intervals) for both ICE and CNFL customers were available from a single source within ICE. The Meter Laboratory at Colima was responsible for collecting, processing, and storing daily load data, as well as determining maximum monthly demand for billing purposes.

## LOCAL CONSULTING ENGINEERS

Local consulting engineers were assigned a key role in the demonstration project. They were to contract with customers to provide load management expertise and technical assistance. Specifically, they were to conduct audits and feasibility studies for participating customers, advise on energy management equipment selection, and assist

[1] Firms were chosen based on the following criteria: 1) Expressed an interest in the program and indicated that they had begun to implement load management measures; 2) had functioning demand meters (measuring demand on the quarter hour) for October and November of 1987 and 1988.



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## Exhibit 1.3

## Participants

| | | Demand[1] 1987 (kW) | Activity |
|---|---|---|---|
| 1. | Alunasa | 1,692 | Aluminum rolling mill |
| 2. | Arrocera Los Sauces | 211 | Rice processor |
| 3. | Carnes de Centroamerica (El Arreo) | 704 | Slaughterhouse |
| 4. | Cartago Beef Packing | 805 | Slaughterhouse |
| 5. | CNP Montecillos (Coopemontecillos-Alejuela) | 443 | Slaughterhouse |
| 6. | Conducen | 840 | Electric cable manufacturer |
| 7. | Coopeagri el General (Beneficio) | 486 | Coffee processor |
| 8. | Coopeatenas | 166 | Coffee processor |
| 9. | Coopevictoria - Beneficio | 311 | Coffee processor |
| 10. | El Gallito Industrial | 579 | Chocolate candy maker |
| 11. | Empacadora de Carnes (Coopemontecillos-Barranca) | 884 | Slaughterhouse |
| 12. | Fabrica Nacional de Licores | 506 | Distillery |
| 13. | Fertica | 4,258 | Fertilizer manufacturer |
| 14. | Hacienda Atirro Ltda (Beneficio) | 202 | Coffee processor |
| 15. | ICAA Puente de Mulas | 2,501 | Potable water supplier |
| 16. | ICAA San Rafael de Escazu | 2,434 | Potable water supplier |
| 17. | Industrias Akron de Costa Rica (formerly Firestone) | 1,814 | Tire & tube manufacturer |
| 18. | Ingenio Taboga | 166 | Sugar mill |
| 19. | Punto Rojo | 271 | Toilet soaps |
| 20. | Rafytica | 295 | Woven polypropylene bags |
| 21. | Ricalit | 669 | Building materials |
| 22. | Scott Paper de Costa Rica | 4,635 | Paper mill |
| 23. | Ticatex | 2,337 | Textile mill |
| 24. | Urgelles y Penon | 174 | Furniture manufacturer |
| TOTAL | | 27,383 | |

1 Average maximum peak demand during peak hours.

in project implementation. They would monitor progress in the application of load management in customers' facilities and would recommend corrective action as required.

The intent of the program is to apply the most advanced energy management technology that could be justified, including sophisticated energy management systems. This approach would produce a maximum demand reduction on a permanent basis. It supposes a systematic, informed and thorough engineering approach to the problem, as illustrated in Exhibit 1.4. The considerable resources required to carry out this work would be provided by qualified consulting engineers who, in many cases, were already familiar with the facilities in question.

Several local consulting engineers were contacted and interviewed, and four were selected to support the demonstration program. Three of them had extensive experience with ICE or CNFL, and one had many years' experience in rationalizing energy use in sugar, coffee and rice processing facilities. They would market their services to participants, who would bear the cost of the services. Their names were then given to participating customers who required technical assistance.

## TRAINING OF ICE PERSONNEL

Because ICE personnel had limited qualifications in load management, it was essential that they be trained in all aspects of the subject. This training was necessary not only to provide qualified personnel for implementing the demonstration project but also to form a core of trained personnel on which to build a permanent load management organization within ICE.

RCG/Hagler, Bailly and FPL Qualtec trained the ICE counterpart team in all aspects of industrial and commercial load management, as well as in project management techniques. Joint visits to customers' facilities provided excellent opportunities to demonstrate how to identify controllable loads and measures for controlling them. The ICE counterparts were also trained in interpreting load curves, selecting target customers and their subsequent screening, drafting a load management tariff, and preparing promotional material.

A key element of the training was a 5-day load management course presented by FPL Qualtec in Miami, comprising both classroom and field training. Three ICE engineers (the counterpart team) attended the course, where they studied the experience of FPL in influencing customer loads. With the exception of an equipment vendor, all instructors were Spanish-speaking FPL employees experienced in various aspects of load management and energy management. The course program is presented as Appendix G.



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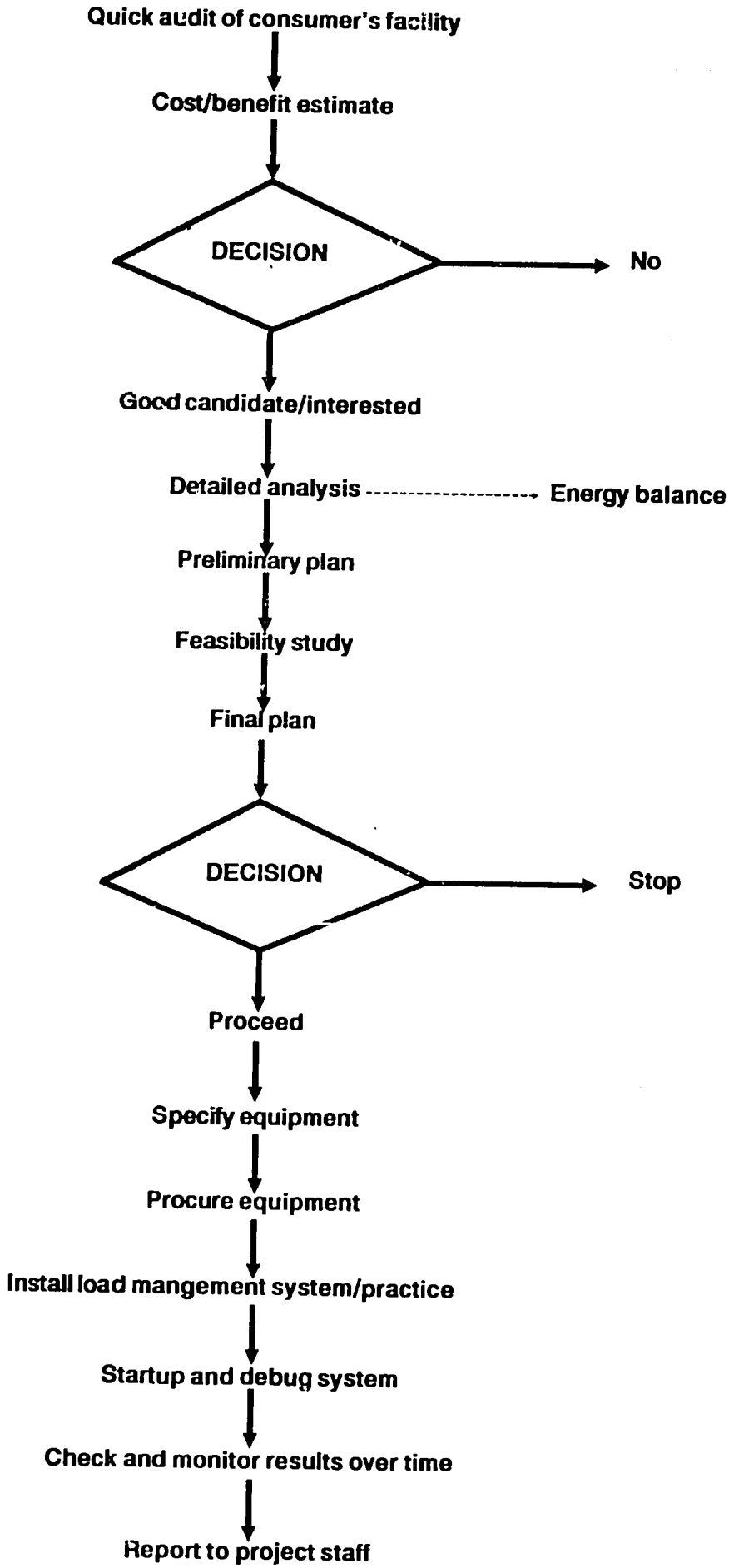
Exhibit 1.4
Load Management Implementation Procedure



## TARIFF AMENDMENTS/MODIFICATIONS

To provide an incentive for implementing load management measures, electricity tariffs must be formulated carefully to balance the utility's need to reduce peak demand and the customers' desire to avoid disrupting their operations. An examination of the tariffs offered by ICE and CNFL indicated that none of them was optimal for promoting load management efforts under current conditions in Costa Rican industry.

The present ICE and CNFL time-of-use (TOU) tariffs, which are outlined in Appendix H, have excessively long peak periods, i.e., 6 hours daily during the 5-day workweek (see below). Many customers cannot limit demand throughout the entire peak period without adversely affecting production. Also, the TOU tariffs fail to focus load control on the evening peak, which is the higher of the two, and therefore the heart of the problem. Finally, the existing interruptible tariff (offered only by ICE), does not provide an optimum balance of load control events for ICE and industrial customers. The tariff permits up to 300 hours of interruption, which appears to be an unacceptably high risk exposure for most customers. This view likely accounts for the fact that no customers have subscribed to this tariff. Also, the general lack of knowledge of this tariff among customers is another reason for their lack of participation.

An additional obstacle to subscription to these tariffs is the fact that ICE normally asks customers who wish to change tariffs to provide a substantially larger security deposit. This results in many customers changing their mind about the tariff change.

These problems led the contractors to work with ICE personnel to examine possible amendments to the existing TOU and interruptible tariffs. Also, FPL Qualtec provided ICE with a draft load control tariff based on one established by FPL for its current experimental load control project. In November 1988 the ICE project team completed a detailed tariff study with a view toward providing tariffs that are beneficial to both the utility and its customers, while simultaneously being workable for customers' operations. The team produced a report recommending the following changes:

TOU Tariffs T-8 and T-16[2]

1. Applies to customers consuming over 20,000 kWh per month or 240,000 kWh per year (now over 3,000 kWh per month).

2. Morning peak period reduced to two hours (now 2-1/2 hours); evening peak period reduced to two hours, except 2-1/2 hours October-December (now 3-1/2 hours).

[2] Tariffs T-8 and T-16 have demand charges based on energy use during coincidental peak hours. Energy charges for T-8 are based on the changes in seasonal demand and are not sensitive to time of use. Energy charges for T-16 are based on the time of use, with on-peak energy costing more.



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Interruptible Tariff T-11

1. Interruptible load of 300 kW or more (now 500 kW or more).
2. Up to 40 control days per year; one control event per day of three hours maximum (now up to 100 control days per year; limit of two control events per day of three hours maximum; limit of 300 control hours per year).
3. A penalty for non-compliance (now no penalty is specified).

The report is currently under review by ICE management. Any proposed tariff modifications must also be approved by the Servicio Nacional de Electricidad (SNE), a regulatory body.

## CUSTOMER DATA BASE

Each of the participants in the load control demonstration project was guided through a sequence of events and milestones that would lead to an optimum demand management effort -- manual, decentralized automatic or central microprocessor-controlled -- and measurement of results.

This complex task was accomplished with the assistance of a computerized data base that was capable of storing and retrieving a large quantity of information and producing progress tracking tables. Such a data base was developed by the project team based on D:Base III software. Data entry, data base maintenance, and generation of monitoring reports were carried out by the ICE Regional Quality Control Office, Atlantic and South. An example of a project monitoring report is presented as Appendix E.

## PROGRAM PROMOTION BROCHURE

A demonstration project promotion brochure using a question and answer format was drafted by the project team. When it could not be produced in time to be of use in the demonstration program, it was revised for use in the utility's continuing load management program. The revised draft is presented as Appendix I.

## LOAD CONTROL DISSEMINATION PLAN FOR ICE

The ultimate goal of this load control demonstration project is to enroll the majority of establishments in the industrial and commercial sectors in a load control program and expand load control efforts to include the residential sector. By replicating the success of the pilot program throughout the country, ICE can hope to reduce its system peak significantly and thereby improve the efficiency of its entire system and avoid or delay

new generation and transmission investments. In order to ensure that the efforts of the pilot project are continued, a draft dissemination plan was developed. The plan presents a variety of activities that ICE and other Costa Rican organizations can pursue to distribute information on the benefits of load management, encourage customers to participate in a continuing load control program, enroll more customers in load management tariffs, and generally raise the awareness and understanding of the need for and benefits of load management. The draft plan is presented in Appendix P.

## PROBLEMS ENCOUNTERED

Several problems emerged in the course of the project to hinder its progress and reduc its impact, preventing the project from realizing its full potential for demand reduction.

### Resources

The level of staffing was a problem throughout the course of the project. In order to achieve the maximum benefits and ensure that the program achieved a lasting impact, it was planned that two people would be assigned to the project on a full-time basis. However, due to legislated manpower limitations, ICE was not able to place anyone in charge of day-to-day project management until mid-May 1988, and the project was never assigned full-time staff. Because the project activities were superimposed on the normal work of the ICE staff, they were unable to devote their full attention to the project. This situation, by its nature, limited the interaction among ICE, the consulting engineers, and the participants. Limitations on clerical support, transportation, and computer manpower also served to retard project activities.

The limited interaction between ICE project staff and the participants reduced the anticipated information transfer and may, in part, explain why fewer companies than planned were actively managing their load at the end of the demonstration phase. Without the dedication of full-time personnel to load management activities, the full achievement of the potential of load management will be slow in coming.

### Data Monitoring and Collection

Several problems emerged during metering, monitoring, and data collection for the project:

1. Most plants could not provide the required direct telephone line to the electronic recorder. (Remote interrogation is not possible through a telephone switchboard.) As a result, most data for the demonstration were collected from the magnetic tape recorders.

2. Twenty-one of the target facilities were customers of the major distribution company Compania Nacional de Fuerza y Luz (CNFL), and many of them did not have pulse initiating meters which are required to provide pulses to the DataStar recorder. An attempt was made to provide the necessary meters from the stock at the ICE Meter Laboratory, but the effort was not successful.

3. The manpower available at the Meter Laboratory was insufficient to cope with the extra work load caused by the demonstration project. This resulted in delays, both in providing customers with timely demand data, and in providing project management with data for the analysis of results.

4. In many cases customer load data were not available for the baseline period, October-November 1987, because magnetic tape recording meters had not yet been installed (because the customers were not on time-of-day tariffs at the time) or because the facilities were not operating at the time.

5. In some cases the baseline data were not available owing to recording failure or loss of the file.

### Training

To achieve continuing success in managing system demand it was essential to develop qualified personnel within ICE who would implement the pilot project, disseminate the techniques widely among all customer classes, and create and maintain a permanent load management initiative.

Toward this end, it was necessary to train ICE counterparts (three engineers) at the Florida Power & Light Company, Miami, in August 1988. Unfortunately, ICE had already exhausted its training quota for 1988, which prevented approval of the travel to Miami. However, with the support of the Minister of MNREM, this obstacle was overcome and the training was conducted.

### Load Control Approach

The project envisioned deploying some of the most automated energy management technology that could be justified to obtain an optimal, permanent demand reduction. (An EMS, or Energy Management System, eliminates the factor of human error in managing demand, thus giving consistent results.) It was felt that local consulting engineers were in the best position to analyze the demand structure of each facility and to counsel customers on energy management equipment selection and justification.

In fact, however, customers tended to use their own technical personnel (usually plant engineering and maintenance) for the analysis, planning, and implementation of load management. Moreover, they tended to initiate manual load control as a first step, based on a relatively superficial analysis and incomplete information. Their desire to avoid or defer capital expenditure in energy management equipment was also a factor. While this approach produces quick results at low cost, it fails to provide an optimum reduction of all controllable load, and does not ensure permanent, reliable load control (only one mistake for a few seconds during peak hours can ruin the efforts and achievements of a full month).

Several customers achieved model daily demand curves averaged over a month, but failed to reduce demand consistently in the peak hours, as seen in significantly higher demand curves showing monthly peak demand.

A notable exception to the above procedure was the water utility, ICAA, whose engineers conducted a detailed analysis of the controllable load in their pumping stations and well fields, and documented their findings and recommendations. Their report on the study is presented as Appendix J.

### Consultants

The load control demonstration project relied on consulting engineers to provide most of the technical assistance to customers. They were to market their services strongly, offering a free preliminary demand audit as an incentive. A steady flow of information from the project staff would support their selling efforts, and later their load reduction work with customers.

In reality, however, they were slow to initiate their marketing efforts and to follow through with preliminary audits and formal project proposals. Of the 13 customers visited by the project staff in February 1989 (Appendix C), none was able to show a consultant's report or proposal. Therefore, on the whole, the participating customers did not benefit significantly from the consultants' expertise and resources.

### Role of CNFL

CNFL is the major distribution utility, and operates in San Jose and the surrounding area; therefore, many of the target facilities were CNFL customers. It was hoped that CNFL would be closely involved in the project; however, communication with the utility proved to be very difficult. This gave rise to problems in obtaining demand data on CFNL customers, equipping their facilities with demand recorders and in arranging for the participation of CNFL personnel in the demonstration project activities.

### Tariffs

Economic motivation of customers by means of well designed tariffs is a powerful tool for load management; however, the TOU tariffs offered by ICE and CNFL have not been tuned to attract all potential customers, while focusing more narrowly on actual demand peaks. While plant engineers are generally enthusiastic about reducing coincident peak demand (and electricity cost), the long peak periods in the tariffs give rise to resistance from production managers, who are more concerned about output than about utility costs.

### Program Promotion Brochure

Initial plans called for the creation of a Program Promotion Brochure to invite participation in the load control demonstration project and to educate customers on the benefits of load control. Unfortunately, the draft produced by the project staff was not finished in time to be of use in the demonstration project.

## IMPLEMENTATION

In several facilities implementation activities commenced shortly after the survey team's initial visits in October-November 1987. These visits acquainted electricity users with the potential for cost savings and identified specific energy management measures that could be applied in the short term. Several customers then began controlling loads on a trial basis in subsequent months. On the other hand, some customers contacted ICE as late as October 1988 to express an interest in joining the demonstration and began load control efforts in early 1989; consequently, at the project's end participating facilities were in various stages of implementation.

The central activities in the implementation stage were load control planning and trials, selection and installation of equipment, and implementation of control on a permanent basis. Data collection and analysis proceeded in parallel with the central activities.

### Load Control Planning and Trials

Most of the initial planning activities and trials were carried out by customers' in-house technical staffs, with intermittent support from consultants in some cases. Load profiles were provided by ICE to allow customers to judge the effectiveness of their actions. Only one participant (ICAA, the water utility) produced a documented analysis of load control potential and a project plan (Appendix J). As a rule, trials were conducted using manual load control, and most participants decided to continue manual control in the medium term to gain experience before considering the use of automatic controls.

### Energy Management Equipment

Application of automatic energy management equipment in the project was limited. Several customers installed electronic demand registers with limited control capability. Others installed demand controllers and time switches that activated flashing lights and alarms to alert operators to shut down equipment. Consulting engineers tended to specify simple controls of their own design, reflecting customers' wishes to minimize investment. In no case was automatic load-shedding equipment installed, although one customer (El Gallito Industrial, a chocolate candy maker) was preparing to install a sophisticated energy management system designed by its own staff.

### Demonstration

The demonstration period -- during which peak loads were routinely controlled according to plan -- proved that the measures implemented could consistently maintain the optimum load profile in each facility. Plant personnel became familiar with the new operating routines and equipment, and adjusted their activities and habits accordingly. Meanwhile, the project staff and the contracted consulting engineers provided assistance as required. Results were monitored and problems were identified by means of the daily load curves generated for each facility from data provided by the on-site demand recorders.

### Data Collection

Apart from gathering daily load data captured by the demand recorder system, it was necessary to collect production data, equipment cost data, and other information. This was accomplished largely through visits to customers' facilities and facsimile communications with customers.

Two types of visits were carried out: progress monitoring visits and final visits. Monitoring visits revealed the status of the customer's load control preparation or demonstration activities, problems encountered, experience with consulting engineers and information or assistance required. The questionnaire used in the monitoring visits is presented as Appendix K.

The purpose of the final visit was to gather missing data required for the analysis of results, to learn what was done and to determine the customer's reaction to the project. Specifically, production data for the baseline period and the demonstration period were requested, together with details of the costs incurred by the customer in connection with the project. Other subjects covered were details of actions taken and planned, major equipment or capacity changes since the baseline period, contributions of local consultants, estimated peak demand reduction, and the customer's subjective evaluation of the load control effort.

The information provided by the final visit was recorded on the questionnaire presented in Appendix L, and was a factor in deciding if the facility would be included in the demonstration analysis. The experience of the customers selected for the analysis of results, as determined primarily from the above-mentioned interviews, is summarized in Appendix M.

### Analysis

The analysis of the daily load profiles and monthly production data gathered in the course of the demonstration project was carried out mainly in the Washington, DC offices of RCG/Hagler, Bailly, Inc. The analysis process and the project's impact on peak demand are described in Chapter 2 and Appendix N.

Based on the peak demand reduction achieved, the savings obtained by customers were determined and compared with project costs incurred by customers, ICE and RCG/Hagler, Bailly, Inc. The cost/benefit analysis process and results are also described in Chapter 2.

## CHAPTER 2: LOAD DATA AND COST/BENEFIT ANALYSIS

The primary measure of the success of this program is the change in the coincidental peak demand[1] of the participants. To establish as clearly as possible the program's effects, direct load data were gathered from the demand meters at participating industries and changes over the course of the project were calculated. This chapter describes the assumptions and procedures used for calculating the effect of the project and will present the results of that effort. A complete discussion of the analysis procedures is given in Appendix N. To complete the examination of the project, a cost-benefit analysis was performed and is presented at the end of this chapter.

### HYPOTHESIS AND METHODOLOGY

Because the primary goal of this project was to reduce the total peak demand from the participating companies, the primary measure of the project's effectiveness is the participants' total reduction of coincidental demand for power. The hypothesis of this analysis is that comparing daily load curves from October and November (peak months of the year) of 1987 and 1988 will show that participating customers' demand has been reduced during the utility's peak hours. Several methodologies are available for making this comparison, some quite complex -- requiring data on many aspects of the economy, weather, and industry -- and others fairly simple. Based on discussions with experts in evaluating demand management programs, three methods were chosen that provide a good balance between accuracy and feasibility, considering the time, data, and computer resources available. These three methods of analyzing the participants' demand are: (1) comparing aggregate load curves on the day of the system peak for 1987 (without load control) with the aggregate load curves for 1988 (with load control); (2) comparing the daily average of the aggregate maximum peak demand for the two years for October and November; and (3) examining monthly average load curves for each customer for the two years for October and November to compare average on-peak demand with average off-peak demand. These three analyses together provide an accurate indication of the demand reduced as a result of the pilot project.

Dates for Analysis: Data were processed for each quarter hour for October and November of 1987 and 1988 for each company in the analysis. These two months were chosen as the study months for four reasons:

1. They correspond to the dates of the annual maximum system demand in recent years.

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1 That is, the sum of all participant demands during any 15-minute interval, during on-peak hours.

2. October and November 1987 provide good baseline data, being before the demonstration phase of the project.

3. Data were available from ICE's computer files for these months.

4. Production equipment has not changed significantly since 1987 for most companies in the analysis.

## PARTICIPANTS

The ICE project team tracked the interest and participation in the project of 77 facilities in a database designed for this project. In order to perform a statistical analysis of the impact of the project, a subset of these companies was chosen that fit the following criteria:

- Expressed an interest in the program and indicated that they had begun to implement load management measures
- Had functioning demand meters (measuring demand on the quarter hour) for October and November of 1987 and 1988.

Based on these criteria the following 24 companies were chosen for the final analysis (Exhibit 2.1).

To take into account companies that have made serious efforts at load management but did not have functioning demand meters in 1987, estimates, based on load curves and site visits, were made for 4 of those 24 companies (see Exhibit 2.2).

## ANALYSIS PROCEDURES

ICE uses two types of recorders and their associated computers to measure demand (kW) and energy consumption (kWh) in 15 minute intervals: a Hewlett Packard 1000 minicomputer (HP) with magnetic tape readers from Sangamo, a U.S. company; and an IBM-compatible personal computer (PC) and DataStar pulse recorders, also from Sangamo. For this project, the data were translated from these two computers to a format compatible with Lotus 123 to analyze the change in demand. These steps are outlined here and explained in detail in Appendix N.

Data collected from the demand recorders are in a proprietary format on the HP and PC. The analysis options available using the Sangamo software on the Hewlett Packard 1000 and IBM-compatible PC are limited,[2] which prohibited analyzing the data using

[2] Sangamo, however, makes other packages for these computers that provide additional analysis options.

## Exhibit 2.1

### Participants

| | | Demand[1] 1987 (kW) | Activity |
|---|---|---|---|
| 1. | Alunasa | 1,692 | Aluminum rolling mill |
| 2. | Arrocera Los Sauces | 211 | Rice processor |
| 3. | Carnes de Centroamerica (El Arreo) | 704 | Slaughterhouse |
| 4. | Cartago Beef Packing | 805 | Slaughterhouse |
| 5. | CNP Montecillos (Coopemontecillos-Alejuela) | 443 | Slaughterhouse |
| 6. | Conducen | 840 | Electric cable manufacturer |
| 7. | Coopeagri el General (Beneficio) | 486 | Coffee processor |
| 8. | Coopeatenas | 166 | Coffee processor |
| 9. | Coopevictoria - Beneficio | 311 | Coffee processor |
| 10. | El Gallito Industrial | 579 | Chocolate candy maker |
| 11. | Empacadora de Carnes (Coopemontecillos-Barranca) | 884 | Slaughterhouse |
| 12. | Fabrica Nacional de Licores | 506 | Distillery |
| 13. | Fertica | 4,258 | Fertilizer manufacturer |
| 14. | Hacienda Atirro Ltda (Beneficio) | 202 | Coffee processor |
| 15. | ICAA Puente de Mulas | 2,501 | Potable water supplier |
| 16. | ICAA San Rafael de Escazu | 2,434 | Potable water supplier |
| 17. | Industrias Akron de Costa Rica (formerly Firestone) | 1,814 | Tire & tube manufacturer |
| 18. | Ingenio Taboga | 356 | Sugar mill |
| 19. | Punto Rojo | 271 | Toilet soaps |
| 20. | Rafytica | 295 | Woven polypropylene bags |
| 21. | Ricalit | 669 | Building materials |
| 22. | Scott Paper de Costa Rica | 4,635 | Paper mill |
| 23. | Ticatex | 2,337 | Textile mill |
| 24. | Urgelles y Penon | 174 | Furniture manufacturer |
| TOTAL | | 27,383 | |

## Exhibit 2.2

### Participants for which Demand Reduction was Estimated

| | | Demand 1987 (kW) | Activity |
|---|---|---|---|
| 1. | Alunasa | 1,692 | Aluminum rolling mill |
| 2. | Arrocera Los Sauces | 211 | Rice processor |
| 3. | Hacienda Atirro Ltda (Beneficio) | 202 | Coffee processor |
| 4. | Urgelles y Penon | 174 | Furniture manufacturer |

[1] Average maximum coincidental peak demand.

ICE's computers and software. It was thus necessary to translate the data and import them into Lotus 123 for analysis.

Once the data were imported into Lotus 123, they were organized into a format that facilitated the analysis of daily coincidental peak demand (see Exhibit 2.3). The maximum daily coincidental peak demand was calculated for each day, and the average demand and maximum demand for the entire month were calculated for each quarter hour. Data from all companies were combined to create a composite daily load curve for the day of maximum system peak demand in 1987 and 1988. And finally, average before and after demand curves were created for each participant to enable the comparison of changes in the shape of demand over the course of the project.

Three separate procedures were used for calculating the results: (1) comparing the aggregate load curve on the day of the system peak for 1987 (without load control) with the aggregate load curve for 1988 (with load control); (2) comparing the aggregate maximum peak demand for the two years for October and November; and (3) examining average load curves for each customer to compare average on-peak demand with average off-peak demand. In addition, estimates were prepared for additional companies when complete data were not available, but the project team members knew that savings had been achieved. Each procedure is sensitive to a different set of variables and, as a consequence, each produces somewhat different results. Project team members drew from their knowledge of each company and the limitations of the analysis to formulate conclusions about actual savings.

## RESULTS

Results from each of the three different calculation methodologies are discussed below, followed by the project team members' estimates and conclusions.

### Day of System Peak Demand Analysis

ICE's maximum system peak demand in 1987 reached 612 MW on the 12th of November and in 1988 it reached 612.9 MW on the 18th of November. The maximum evening peak aggregate demand for 18 of the participants (for which reliable data were available) on November 12, 1987 was 20.1 MW, on November 18, 1988 it was 16.7 MW, representing a reduction in demand of 3.4 MW (see Exhibit 2.4).[3]

[3] Reliable demand data from both peak days was not available for the complete set of participants in the analysis.

# Exhibit 2.3 Sample Month of Demand Data for Analysis

CARTAGO BEEF PACKING
NOV 87

| TIME/DATE | Sun 1 | Mon 2 | Tue 3 | Wed 4 | ThursFri 5 | 6 | Sat 7 | Sun 8 | Mon 9 | Tue 10 | Wed 11 | ThursFri 12 | 13 | Sat 14 | Sun 15 | Mon 16 | Tue 17 | Wed 18 | ThursFri 19 | 20 | Sat 21 | Sun 22 | Mon 23 | Tue 24 | Wed 25 | ThursFri 26 | 27 | Sat 28 | Sun 29 | Mon 30 | AVERAGE | MAXIMUM |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 00:15 | 517 | 445 | 591 | 659 | 603 | 696 | 725 | 581 | 437 | 720 | 640 | 702 | 617 | 599 | 555 | 413 | 656 | 692 | 593 | 510 | 534 | 647 | 419 | 677 | 628 | 736 | 707 | 684 | 581 | 314 | 596 | 736 |
| 00:30 | 594 | 468 | 615 | 629 | 611 | 690 | 700 | 580 | 446 | 672 | 627 | 703 | 645 | 597 | 563 | 413 | 657 | 700 | 573 | 400 | 546 | 637 | 419 | 678 | 619 | 722 | 704 | 690 | 582 | 376 | 595 | 722 |
| 00:45 | 565 | 447 | 646 | 637 | 592 | 685 | 705 | 547 | 449 | 655 | 683 | 715 | 708 | 621 | 521 | 415 | 625 | 692 | 534 | 407 | 535 | 654 | 410 | 683 | 606 | 700 | 684 | 673 | 600 | 477 | 596 | 715 |
| 01:00 | 568 | 436 | 654 | 617 | 619 | 680 | 723 | 482 | 436 | 596 | 673 | 697 | 692 | 629 | 513 | 357 | 475 | 668 | 533 | 402 | 535 | 664 | 415 | 684 | 577 | 660 | 661 | 669 | 609 | 443 | 579 | 723 |
| 01:15 | 546 | 434 | 618 | 610 | 582 | 700 | 724 | 526 | 434 | 553 | 634 | 691 | 681 | 620 | 509 | 346 | 481 | 666 | 577 | 390 | 529 | 661 | 411 | 675 | 608 | 641 | 663 | 646 | 623 | 445 | 574 | 724 |
| 01:30 | 540 | 426 | 563 | 628 | 597 | 680 | 715 | 518 | 436 | 575 | 649 | 646 | 678 | 639 | 518 | 345 | 481 | 673 | 617 | 438 | 538 | 641 | 404 | 684 | 646 | 627 | 610 | 643 | 589 | 448 | 573 | 715 |
| 01:45 | 421 | 424 | 560 | 600 | 586 | 672 | 721 | 515 | 460 | 549 | 664 | 645 | 675 | 648 | 509 | 341 | 476 | 668 | 629 | 365 | 553 | 653 | 407 | 672 | 642 | 633 | 596 | 631 | 561 | 473 | 565 | 721 |
| 02:00 | 414 | 423 | 559 | 634 | 651 | 666 | 747 | 473 | 436 | 558 | 664 | 623 | 674 | 647 | 557 | 342 | 476 | 657 | 643 | 565 | 534 | 642 | 401 | 654 | 637 | 625 | 601 | 644 | 598 | 470 | 574 | 747 |
| 02:15 | 424 | 417 | 560 | 616 | 653 | 643 | 727 | 493 | 443 | 559 | 663 | 609 | 667 | 631 | 572 | 359 | 486 | 647 | 612 | 610 | 555 | 599 | 403 | 653 | 685 | 626 | 597 | 597 | 570 | 468 | 571 | 727 |
| 02:30 | 413 | 421 | 561 | 622 | 643 | 612 | 723 | 499 | 444 | 526 | 666 | 536 | 659 | 621 | 558 | 410 | 570 | 612 | 588 | 617 | 573 | 556 | 398 | 653 | 701 | 607 | 675 | 586 | 557 | 540 | 572 | 723 |
| 02:45 | 480 | 415 | 563 | 594 | 635 | 604 | 665 | 496 | 448 | 521 | 689 | 600 | 651 | 610 | 576 | 503 | 569 | 590 | 581 | 663 | 560 | 552 | 400 | 656 | 692 | 646 | 681 | 591 | 555 | 601 | 580 | 692 |
| 03:00 | 449 | 412 | 644 | 565 | 541 | 600 | 680 | 498 | 449 | 495 | 704 | 680 | 646 | 604 | 548 | 511 | 560 | 547 | 577 | 692 | 552 | 550 | 400 | 654 | 685 | 663 | 751 | 568 | 509 | 596 | 578 | 751 |
| 03:15 | 451 | 415 | 643 | 617 | 522 | 602 | 680 | 476 | 434 | 534 | 703 | 674 | 643 | 621 | 511 | 502 | 547 | 501 | 647 | 625 | 537 | 547 | 394 | 652 | 654 | 620 | 742 | 566 | 491 | 592 | 572 | 742 |
| 03:30 | 488 | 404 | 677 | 656 | 563 | 606 | 706 | 461 | 504 | 558 | 729 | 653 | 655 | 664 | 490 | 473 | 535 | 532 | 617 | 625 | 554 | 532 | 462 | 670 | 627 | 559 | 736 | 561 | 494 | 562 | 579 | 736 |
| 03:45 | 479 | 459 | 647 | 654 | 605 | 682 | 720 | 459 | 500 | 608 | 743 | 650 | 742 | 666 | 499 | 445 | 556 | 534 | 609 | 615 | 564 | 506 | 416 | 697 | 706 | 552 | 736 | 602 | 486 | 526 | 589 | 743 |
| 04:00 | 500 | 484 | 613 | 639 | 622 | 711 | 694 | 448 | 492 | 590 | 730 | 659 | 731 | 647 | 488 | 437 | 537 | 494 | 597 | 582 | 579 | 481 | 356 | 683 | 702 | 559 | 714 | 601 | 476 | 517 | 579 | 731 |
| 04:15 | 486 | 461 | 562 | 588 | 605 | 713 | 691 | 446 | 489 | 641 | 667 | 650 | 734 | 616 | 485 | 442 | 549 | 460 | 611 | 559 | 565 | 492 | 358 | 667 | 632 | 636 | 698 | 584 | 522 | 518 | 571 | 734 |
| 04:30 | 485 | 484 | 506 | 546 | 595 | 707 | 679 | 442 | 470 | 669 | 641 | 643 | 737 | 598 | 520 | 450 | 565 | 465 | 575 | 551 | 560 | 480 | 351 | 643 | 618 | 634 | 692 | 524 | 549 | 518 | 563 | 737 |
| 04:45 | 491 | 482 | 470 | 607 | 562 | 699 | 666 | 443 | 482 | 658 | 645 | 642 | 720 | 590 | 525 | 451 | 548 | 581 | 560 | 547 | 563 | 480 | 351 | 636 | 628 | 589 | 655 | 560 | 552 | 546 | 564 | 720 |
| 05:00 | 486 | 478 | 466 | 624 | 539 | 676 | 650 | 440 | 475 | 662 | 642 | 645 | 679 | 643 | 500 | 480 | 544 | 596 | 582 | 545 | 572 | 472 | 345 | 636 | 703 | 605 | 653 | 622 | 519 | 493 | 566 | 703 |
| 05:15 | 488 | 475 | 469 | 616 | 556 | 641 | 614 | 452 | 469 | 658 | 539 | 648 | 652 | 610 | 500 | 458 | 531 | 595 | 555 | 606 | 574 | 478 | 349 | 651 | 687 | 562 | 645 | 597 | 510 | 509 | 560 | 687 |
| 05:30 | 490 | 437 | 505 | 612 | 558 | 639 | 551 | 508 | 459 | 629 | 654 | 666 | 628 | 638 | 511 | 430 | 589 | 601 | 556 | 646 | 549 | 501 | 377 | 613 | 651 | 566 | 630 | 561 | 608 | 521 | 563 | 666 |
| 05:45 | 482 | 430 | 505 | 588 | 590 | 637 | 593 | 510 | 459 | 667 | 657 | 660 | 580 | 633 | 536 | 434 | 589 | 616 | 595 | 612 | 542 | 532 | 387 | 605 | 661 | 631 | 624 | 585 | 582 | 522 | 568 | 667 |
| 06:00 | 485 | 437 | 636 | 586 | 594 | 629 | 630 | 499 | 437 | 680 | 657 | 691 | 637 | 659 | 568 | 419 | 600 | 624 | 589 | 564 | 574 | 532 | 400 | 552 | 692 | 640 | 615 | 630 | 588 | 486 | 578 | 692 |
| 06:15 | 491 | 462 | 605 | 611 | 619 | 654 | 638 | 504 | 468 | 673 | 686 | 644 | 710 | 684 | 557 | 436 | 636 | 651 | 581 | 572 | 565 | 532 | 416 | 595 | 651 | 667 | 579 | 645 | 568 | 505 | 587 | 710 |
| 06:30 | 476 | 451 | 605 | 629 | 587 | 645 | 675 | 506 | 487 | 651 | 679 | 632 | 700 | 689 | 558 | 405 | 604 | 573 | 589 | 562 | 566 | 343 | 420 | 581 | 604 | 599 | 602 | 653 | 558 | 549 | 573 | 700 |
| 06:45 | 481 | 453 | 593 | 622 | 589 | 589 | 678 | 503 | 474 | 640 | 688 | 667 | 686 | 687 | 559 | 421 | 607 | 594 | 595 | 564 | 578 | 504 | 431 | 576 | 622 | 457 | 659 | 671 | 563 | 597 | 578 | 688 |
| 07:00 | 469 | 474 | 597 | 612 | 505 | 585 | 672 | 500 | 481 | 638 | 677 | 653 | 705 | 665 | 530 | 484 | 602 | 705 | 617 | 573 | 576 | 528 | 437 | 565 | 661 | 658 | 684 | 680 | 513 | 587 | 588 | 705 |
| 07:15 | 491 | 471 | 587 | 638 | 553 | 613 | 681 | 514 | 483 | 640 | 658 | 626 | 719 | 697 | 482 | 448 | 625 | 702 | 618 | 622 | 594 | 527 | 434 | 557 | 648 | 646 | 662 | 699 | 509 | 554 | 590 | 719 |
| 07:30 | 490 | 470 | 602 | 621 | 575 | 631 | 705 | 448 | 489 | 652 | 644 | 616 | 712 | 724 | 481 | 427 | 636 | 676 | 613 | 766 | 606 | 492 | 416 | 546 | 683 | 661 | 686 | 726 | 506 | 555 | 595 | 766 |
| 07:45 | 505 | 511 | 544 | 624 | 633 | 627 | 716 | 440 | 516 | 668 | 631 | 625 | 720 | 730 | 402 | 507 | 650 | 665 | 617 | 765 | 635 | 480 | 435 | 610 | 701 | 596 | 682 | 744 | 514 | 552 | 602 | 765 |
| 08:00 | 497 | 515 | 549 | 688 | 672 | 629 | 755 | 440 | 499 | 698 | 654 | 656 | 722 | 731 | 399 | 500 | 720 | 669 | 613 | 775 | 660 | 462 | 436 | 611 | 720 | 576 | 672 | 738 | 516 | 572 | 611 | 775 |
| 08:15 | 479 | 530 | 569 | 681 | 703 | 623 | 756 | 459 | 554 | 703 | 671 | 703 | 769 | 715 | 392 | 559 | 729 | 744 | 621 | 780 | 690 | 446 | 478 | 650 | 743 | 703 | 675 | 752 | 507 | 606 | 633 | 780 |
| 08:30 | 471 | 560 | 599 | 688 | 747 | 635 | 762 | 463 | 654 | 722 | 706 | 687 | 755 | 742 | 387 | 496 | 769 | 765 | 651 | 860 | 678 | 433 | 555 | 683 | 747 | 723 | 663 | 709 | 490 | 622 | 647 | 860 |
| 08:45 | 482 | 601 | 603 | 682 | 735 | 642 | 752 | 530 | 653 | 715 | 575 | 710 | 741 | 764 | 389 | 545 | 725 | 813 | 666 | 848 | 679 | 438 | 532 | 697 | 769 | 717 | 599 | 699 | 529 | 649 | 649 | 848 |
| 09:00 | 488 | 639 | 624 | 677 | 662 | 669 | 746 | 519 | 648 | 739 | 572 | 707 | 734 | 752 | 381 | 559 | 735 | 775 | 719 | 775 | 683 | 435 | 497 | 700 | 776 | 672 | 589 | 700 | 546 | 614 | 644 | 776 |
| 09:15 | 482 | 586 | 630 | 695 | 554 | 665 | 730 | 525 | 666 | 745 | 597 | 736 | 778 | 723 | 397 | 608 | 722 | 751 | 701 | 805 | 680 | 437 | 475 | 708 | 773 | 678 | 606 | 773 | 542 | 606 | 646 | 805 |
| 09:30 | 492 | 601 | 679 | 718 | 709 | 681 | 757 | 469 | 682 | 741 | 779 | 739 | 809 | 688 | 464 | 657 | 748 | 760 | 685 | 833 | 678 | 442 | 484 | 710 | 786 | 674 | 624 | 802 | 541 | 630 | 669 | 833 |
| 09:45 | 473 | 603 | 729 | 725 | 686 | 727 | 766 | 529 | 681 | 727 | 815 | 720 | 790 | 685 | 458 | 684 | 723 | 746 | 706 | 792 | 691 | 437 | 514 | 722 | 781 | 651 | 647 | 809 | 539 | | 674 | 815 |
| 10:00 | 446 | 590 | 715 | 732 | 695 | 715 | 780 | 519 | 684 | 741 | 825 | 747 | 790 | 674 | 461 | 708 | 770 | 768 | 702 | 807 | 709 | 421 | 515 | 709 | 761 | 782 | 712 | 821 | 540 | | 684 | 825 |
| 10:15 | 406 | 587 | 710 | 703 | 539 | 721 | 797 | 513 | 703 | 781 | 827 | 780 | 774 | 718 | 454 | 720 | 811 | 787 | 689 | 756 | 719 | 386 | 598 | 715 | 774 | 831 | 725 | 792 | 531 | | 684 | 831 |
| 10:30 | 495 | 617 | 705 | 731 | 595 | 742 | 821 | 508 | 721 | 618 | 839 | 796 | 790 | 703 | 380 | 730 | 804 | 766 | 739 | 831 | 732 | 432 | 576 | 720 | 778 | 855 | 777 | 779 | 525 | | 693 | 855 |
| 10:45 | 518 | 611 | 698 | 732 | 723 | 739 | 821 | 508 | 723 | 840 | 812 | 797 | 764 | 699 | 373 | 723 | 822 | 662 | 735 | 771 | 750 | 440 | 632 | 722 | 778 | 793 | 808 | 749 | 535 | | 699 | 840 |
| 11:00 | 552 | 666 | 685 | 714 | 727 | 733 | 828 | 523 | 718 | 838 | 790 | 776 | 789 | 736 | 381 | 751 | 785 | 666 | 758 | 571 | 820 | 433 | 679 | 720 | 785 | 777 | 805 | 753 | 515 | | 699 | 838 |
| 11:15 | 586 | 611 | 671 | 650 | 696 | 721 | 820 | 563 | 713 | 829 | 808 | 694 | 687 | 772 | 383 | 784 | 738 | 645 | 705 | 705 | 764 | 440 | 675 | 710 | 741 | 830 | 788 | 765 | 492 | | 689 | 830 |
| 11:30 | 550 | 629 | 686 | 663 | 651 | 716 | 820 | 590 | 724 | 823 | 780 | 705 | 741 | 773 | 382 | 747 | 757 | 608 | 688 | 702 | 754 | 439 | 712 | 714 | 791 | 828 | 809 | 750 | 509 | | 691 | 828 |
| 11:45 | 517 | 646 | 703 | 737 | 639 | 704 | 748 | 650 | 726 | 812 | 789 | 671 | 758 | 731 | 381 | 713 | 804 | 646 | 706 | 722 | 756 | 448 | 687 | 719 | 769 | 830 | 797 | 688 | 489 | | 689 | 830 |
| 12:00 | 517 | 690 | 697 | 674 | 627 | 694 | 732 | 650 | 698 | 628 | 749 | 684 | 738 | 717 | 383 | 703 | 752 | 655 | 674 | 729 | 821 | 440 | 641 | 694 | 764 | 744 | 724 | 661 | 497 | | 668 | 821 |
| 12:15 | 450 | 705 | 681 | 599 | 596 | 681 | 771 | 658 | 661 | 783 | 729 | 689 | 724 | 715 | 451 | 694 | 571 | 651 | 674 | 709 | 771 | 429 | 629 | 685 | 714 | 718 | 731 | 695 | 511 | | 658 | 783 |
| 12:30 | 430 | 663 | 724 | 731 | 605 | 694 | 832 | 656 | 677 | 723 | 737 | 727 | 722 | 737 | 518 | 690 | 786 | 719 | 695 | 718 | 776 | 423 | 670 | 692 | 753 | 724 | 735 | 753 | 491 | | 683 | 832 |
| 12:45 | 486 | 580 | 802 | 731 | 616 | 689 | 830 | 628 | 728 | 733 | 763 | 707 | 112 | 746 | 515 | 713 | 806 | 700 | 586 | 724 | 768 | 420 | 714 | 713 | 710 | 739 | 588 | 743 | 502 | | 658 | 830 |
| 13:00 | 481 | 629 | 799 | 738 | 591 | 713 | 818 | 578 | 739 | 765 | 757 | 752 | 11 | 753 | 512 | 798 | 817 | 703 | 586 | 756 | 791 | 420 | 691 | 727 | 723 | 754 | 762 | 703 | 496 | | 668 | 818 |
| 13:15 | 528 | 742 | 794 | 746 | 756 | 711 | 787 | 586 | 750 | 775 | 761 | 760 | 642 | 744 | 506 | 795 | 823 | 706 | 592 | 778 | 776 | 423 | 692 | 734 | 729 | 678 | 765 | 710 | 502 | | 700 | 823 |
| 13:30 | 502 | 759 | 800 | 730 | 811 | 725 | 801 | 549 | 734 | 778 | 765 | 806 | 830 | 804 | 398 | 783 | 825 | 691 | 610 | 773 | 830 | 422 | 692 | 734 | 731 | 425 | 766 | 705 | 474 | | 698 | 830 |

# Exhibit 2.3 Sample Month of Demand Data for Analysis (cont)

CARTAGO BEEF PACKING

| NOV 87 TIME/DATE | Sun 1 | Mon 2 | Tue 3 | Wed 4 | ThursFri 5 | 6 | Sat 7 | Sun 8 | Mon 9 | Tue 10 | Wed 11 | ThursFri 12 | 13 | Sat 14 | Sun 15 | Mon 16 | Tue 17 | Wed 18 | ThursFri 19 | 20 | Sat 21 | Sun 22 | Mon 23 | Tue 24 | Wed 25 | ThursFri 26 | 27 | Sat 28 | Sun 29 | Mon 30 | AVERAGE | MAXIMUM |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 13:45 | 483 | 733 | 793 | 715 | 835 | 735 | 806 | 604 | 760 | 784 | 811 | 825 | 765 | 808 | 384 | 754 | 827 | 668 | 643 | 771 | 833 | 490 | 705 | 764 | 721 | 608 | 765 | 768 | 560 | | 714 | 835 |
| 14:00 | 499 | 736 | 792 | 691 | 790 | 723 | 811 | 564 | 769 | 870 | 789 | 816 | 681 | 774 | 389 | 743 | 818 | 691 | 584 | 752 | 669 | 472 | 746 | 644 | 712 | 660 | 757 | 780 | 593 | | 701 | 870 |
| 14:15 | 506 | 749 | 776 | 839 | 746 | 735 | 836 | 559 | 785 | 650 | 786 | 803 | 672 | 753 | 382 | 732 | 823 | 692 | 605 | 780 | 757 | 437 | 707 | 650 | 734 | 787 | 736 | 722 | 577 | | 701 | 839 |
| 14:30 | 515 | 747 | 758 | 806 | 762 | 735 | 861 | 551 | 751 | 753 | 821 | 780 | 679 | 784 | 382 | 699 | 828 | 680 | 597 | 774 | 774 | 414 | 721 | 642 | 725 | 813 | 756 | 710 | 543 | | 702 | 861 |
| 14:45 | 504 | 725 | 737 | 790 | 805 | 608 | 526 | 554 | 760 | 836 | 789 | 777 | 672 | 846 | 393 | 709 | 824 | 713 | 601 | 754 | 741 | 403 | 716 | 673 | 752 | 797 | 669 | 707 | 497 | | 685 | 846 |
| 15:00 | 506 | 725 | 745 | 789 | 800 | 612 | 825 | 549 | 751 | 822 | 777 | 771 | 728 | 830 | 458 | 842 | 822 | 654 | 584 | 739 | 781 | 401 | 742 | 672 | 736 | 722 | 734 | 677 | 501 | | 700 | 842 |
| 15:15 | 525 | 726 | 717 | 771 | 796 | 747 | 733 | 537 | 793 | 809 | 807 | 749 | 710 | 731 | 462 | 779 | 770 | 631 | 601 | 735 | 774 | 374 | 721 | 680 | 822 | 758 | 711 | 637 | 516 | | 694 | 822 |
| 15:30 | 505 | 733 | 699 | 774 | 806 | 778 | 843 | 538 | 770 | 820 | 813 | 749 | 635 | 778 | 479 | 721 | 771 | 612 | 581 | 775 | 699 | 433 | 699 | 742 | 817 | 741 | 731 | 686 | 526 | | 699 | 843 |
| 15:45 | 490 | 710 | 695 | 817 | 822 | 778 | 585 | 525 | 689 | 837 | 795 | 756 | 642 | 790 | 461 | 699 | 806 | 651 | 622 | 710 | 688 | 362 | 642 | 742 | 836 | 795 | 723 | 719 | 513 | | 686 | 837 |
| 16:00 | 495 | 697 | 719 | 830 | 698 | 777 | 869 | 509 | 622 | 809 | 813 | 784 | 701 | 839 | 459 | 697 | 814 | 689 | 642 | 753 | 711 | 328 | 680 | 747 | 852 | 751 | 775 | 722 | 509 | | 700 | 869 |
| 16:15 | 489 | 763 | 736 | 838 | 597 | 795 | 829 | 538 | 767 | 807 | 827 | 789 | 724 | 799 | 493 | 633 | 834 | 674 | 640 | 747 | 707 | 379 | 719 | 734 | 817 | 739 | 779 | 727 | 479 | | 703 | 838 |
| 16:30 | 488 | 815 | 733 | 800 | 762 | 800 | 802 | 528 | 768 | 822 | 838 | 785 | 685 | 817 | 503 | 627 | 840 | 701 | 676 | 759 | 789 | 404 | 801 | 760 | 747 | 737 | 786 | 622 | 497 | | 714 | 840 |
| 16:45 | 485 | 820 | 727 | 757 | 758 | 800 | 800 | 525 | 806 | 834 | 855 | 762 | 748 | 727 | 499 | 619 | 843 | 705 | 636 | 755 | 687 | 472 | 763 | 784 | 752 | 747 | 713 | 740 | 518 | | 712 | 855 |
| 17:00 | 566 | 797 | 717 | 731 | 742 | 796 | 791 | 524 | 698 | 820 | 853 | 765 | 769 | 715 | 498 | 680 | 852 | 744 | 734 | 738 | 700 | 520 | 738 | 798 | 749 | 720 | 689 | 752 | 471 | | 713 | 853 |
| 17:15 | 552 | 765 | 719 | 765 | 737 | 794 | 765 | 523 | 496 | 834 | 846 | 757 | 691 | 759 | 498 | 674 | 853 | 736 | 721 | 748 | 707 | 507 | 707 | 767 | 778 | 822 | 728 | 602 | 497 | | 702 | 853 |
| 17:30 | 534 | 760 | 721 | 782 | 712 | 791 | 765 | 466 | 553 | 848 | 810 | 760 | 642 | 778 | 471 | 652 | 854 | 721 | 701 | 747 | 705 | 465 | 734 | 750 | 802 | 720 | 759 | 651 | 495 | | 695 | 854 |
| 17:45 | 507 | 705 | 715 | 749 | 726 | 785 | 743 | 447 | 657 | 817 | 815 | 766 | 696 | 755 | 459 | 702 | 815 | 684 | 704 | 744 | 762 | 513 | 798 | 731 | 814 | 751 | 778 | 709 | 492 | | 701 | 817 |
| 18:00 | 465 | 701 | 754 | 777 | 753 | 791 | 749 | 469 | 859 | 829 | 827 | 789 | 655 | 808 | 462 | 723 | 741 | 647 | 679 | 749 | 706 | 488 | 770 | 748 | 846 | 671 | 843 | 687 | 501 | | 706 | 859 |
| 18:15 | 503 | 723 | 714 | 780 | 719 | 817 | 741 | 469 | 706 | 812 | 812 | 801 | 656 | 801 | 451 | 728 | 848 | 674 | 674 | 731 | 688 | 446 | 753 | 757 | 843 | 750 | 768 | 678 | 481 | | 701 | 848 |
| 18:30 | 503 | 734 | 708 | 726 | 710 | 750 | 715 | 464 | 632 | 816 | 800 | 797 | 663 | 771 | 448 | 725 | 847 | 680 | 701 | 735 | 680 | 443 | 793 | 756 | 831 | 607 | 724 | 663 | 506 | | 687 | 847 |
| 18:45 | 397 | 755 | 738 | 748 | 689 | 811 | 690 | 438 | 659 | 797 | 786 | 801 | 675 | 746 | 452 | 715 | 828 | 719 | 750 | 719 | 668 | 435 | 797 | 759 | 822 | 717 | 749 | 669 | 477 | | 690 | 828 |
| 19:00 | 347 | 740 | 753 | 754 | 765 | 806 | 715 | 471 | 661 | 780 | 772 | 801 | 683 | 741 | 448 | 675 | 810 | 709 | 709 | 702 | 655 | 435 | 785 | 755 | 830 | 612 | 663 | 649 | 491 | | 680 | 830 |
| 19:15 | 339 | 686 | 733 | 751 | 768 | 820 | 724 | 525 | 613 | 767 | 768 | 825 | 683 | 736 | 448 | 641 | 790 | 695 | 675 | 695 | 651 | 425 | 893 | 750 | 835 | 730 | 781 | 651 | 505 | | 686 | 893 |
| 19:30 | 354 | 645 | 700 | 719 | 763 | 813 | 712 | 533 | 608 | 738 | 774 | 818 | 666 | 726 | 448 | 665 | 785 | 696 | 664 | 697 | 641 | 417 | 892 | 675 | 804 | 675 | 756 | 639 | 478 | | 672 | 892 |
| 19:45 | 343 | 639 | 735 | 684 | 751 | 800 | 706 | 471 | 597 | 734 | 783 | 802 | 711 | 715 | 443 | 655 | 782 | 698 | 636 | 721 | 629 | 377 | 868 | 612 | 793 | 685 | 754 | 645 | 492 | | 664 | 868 |
| 20:00 | 386 | 725 | 708 | 729 | 690 | 761 | 708 | 462 | 690 | 726 | 739 | 790 | 773 | 714 | 446 | 601 | 552 | 702 | 678 | 692 | 694 | 377 | 774 | 595 | 769 | 686 | 743 | 659 | 500 | | 658 | 790 |
| 20:15 | 413 | 708 | 710 | 758 | 646 | 738 | 707 | 458 | 721 | 734 | 747 | 764 | 755 | 711 | 443 | 586 | 742 | 707 | 670 | 676 | 658 | 373 | 794 | 613 | 749 | 622 | 742 | 721 | 484 | | 660 | 794 |
| 20:30 | 413 | 691 | 643 | 753 | 673 | 725 | 689 | 457 | 746 | 716 | 753 | 786 | 716 | 704 | 442 | 577 | 704 | 726 | 670 | 649 | 619 | 378 | 817 | 619 | 762 | 683 | 675 | 715 | 485 | | 655 | 817 |
| 20:45 | 423 | 660 | 651 | 696 | 687 | 733 | 636 | 452 | 681 | 675 | 742 | 738 | 702 | 704 | 435 | 580 | 651 | 556 | 668 | 624 | 626 | 393 | 798 | 630 | 717 | 659 | 712 | 707 | 450 | | 637 | 798 |
| 21:00 | 421 | 672 | 566 | 644 | 698 | 796 | 596 | 455 | 692 | 680 | 758 | 732 | 697 | 702 | 433 | 608 | 641 | 673 | 663 | 618 | 694 | 399 | 764 | 611 | 649 | 650 | 739 | 698 | 447 | | 634 | 796 |
| 21:15 | 417 | 652 | 634 | 683 | 524 | 816 | 655 | 489 | 716 | 690 | 764 | 766 | 698 | 697 | 417 | 562 | 698 | 680 | 654 | 615 | 634 | 274 | 763 | 514 | 622 | 656 | 732 | 680 | 478 | | 627 | 816 |
| 21:30 | 424 | 647 | 673 | 658 | 588 | 788 | 644 | 490 | 656 | 708 | 765 | 750 | 706 | 695 | 419 | 563 | 799 | 680 | 650 | 599 | 619 | 301 | 753 | 521 | 607 | 731 | 715 | 702 | 463 | | 632 | 799 |
| 21:45 | 423 | 627 | 642 | 684 | 756 | 732 | 628 | 453 | 728 | 746 | 751 | 734 | 690 | 686 | 417 | 564 | 799 | 674 | 639 | 583 | 594 | 447 | 750 | 534 | 620 | 753 | 681 | 698 | 498 | | 639 | 799 |
| 22:00 | 420 | 608 | 523 | 700 | 756 | 710 | 625 | 444 | 760 | 733 | 751 | 725 | 672 | 673 | 415 | 608 | 794 | 662 | 634 | 579 | 571 | 439 | 754 | 574 | 639 | 742 | 675 | 663 | 479 | | 632 | 794 |
| 22:15 | 420 | 596 | 664 | 681 | 745 | 717 | 626 | 443 | 750 | 732 | 750 | 758 | 658 | 662 | 418 | 651 | 761 | 654 | 638 | 579 | 580 | 436 | 735 | 707 | 708 | 733 | 698 | 681 | 439 | | 642 | 761 |
| 22:30 | 419 | 583 | 670 | 672 | 741 | 763 | 649 | 439 | 750 | 722 | 732 | 746 | 643 | 649 | 414 | 647 | 729 | 649 | 638 | 578 | 657 | 436 | 725 | 647 | 710 | 731 | 690 | 647 | 425 | | 638 | 763 |
| 22:45 | 424 | 591 | 645 | 675 | 715 | 769 | 673 | 448 | 754 | 713 | 734 | 730 | 659 | 598 | 415 | 641 | 702 | 637 | 634 | 575 | 647 | 432 | 728 | 646 | 725 | 729 | 692 | 672 | 421 | | 635 | 769 |
| 23:00 | 453 | 592 | 626 | 676 | 705 | 762 | 647 | 449 | 747 | 704 | 741 | 719 | 711 | 562 | 414 | 637 | 692 | 622 | 633 | 564 | 638 | 433 | 726 | 707 | 723 | 728 | 671 | 651 | 413 | | 633 | 762 |
| 23:15 | 444 | 580 | 602 | 647 | 687 | 730 | 648 | 426 | 750 | 685 | 734 | 692 | 708 | 569 | 415 | 638 | 682 | 616 | 629 | 556 | 650 | 431 | 730 | 666 | 718 | 725 | 675 | 644 | 408 | | 624 | 750 |
| 23:30 | 444 | 597 | 628 | 631 | 683 | 721 | 651 | 423 | 744 | 676 | 726 | 663 | 659 | 552 | 412 | 678 | 667 | 614 | 630 | 547 | 620 | 433 | 723 | 619 | 741 | 722 | 666 | 644 | 402 | | 618 | 744 |
| 23:45 | 446 | 595 | 633 | 662 | 685 | 731 | 625 | 439 | 745 | 680 | 719 | 636 | 662 | 549 | 413 | 676 | 673 | 606 | 661 | 622 | 594 | 417 | 711 | 607 | 745 | 717 | 688 | 595 | 388 | | 618 | 745 |
| 00:00 | 446 | 592 | 677 | 657 | 686 | 729 | 594 | 448 | 726 | 639 | 700 | 663 | 647 | 542 | 411 | 652 | 687 | 593 | 579 | 550 | 608 | 416 | 700 | 619 | 737 | 714 | 670 | 592 | 362 | | 608 | 737 |
| MAXAM | 586 | 705 | 724 | 737 | 727 | 742 | 832 | 658 | 726 | 840 | 839 | 797 | 790 | 773 | 518 | 784 | 822 | 787 | 758 | 831 | 821 | 448 | 712 | 722 | 791 | 855 | 809 | 821 | 540 | | | |
| MAXPM | 566 | 820 | 754 | 800 | 768 | 820 | 802 | 533 | 859 | 848 | 855 | 825 | 773 | 817 | 503 | 728 | 854 | 744 | 750 | 759 | 789 | 520 | 893 | 798 | 846 | 822 | 843 | 752 | 518 | | | |

**Exhibit 2.4**

Total Participant Demand on System Peak Days (18 participants)
(kW)

| TIME | Thursday 12 Nov 87 | Friday 18 Nov 88 | Change 1988-1987 Kilowatts | Percent |
|---|---|---|---|---|
| On-Peak Average (AM) | 19,990 | 15,672 | (4,318) | 21.6 |
| On-Peak Average (PM) | 19,321 | 16,351 | (2,970) | 15.4 |
| On-Peak Maximum (AM) | 20,244 | 17,057 | (3,187) | 15.7 |
| On-Peak Maximum (PM) | 20,135 | 16,710 | (3,425) | 17.0 |

Comparing the aggregate load curves from 1987 and 1988 shows a striking drop in demand during the peak hours (Exhibit 2.5).

The average evening peak aggregate demand on system peak days for the same 18 companies was 19.3 MW in 1987 and 16.4 MW in 1988, or 3 MW less. The actual savings were concentrated in few companies and some companies showed an increase in demand primarily due to the higher levels of activity (see Exhibit 2.6). The ten companies with a reduced average peak demand together reduced their demand by 4.7 MW in the evening peak.[4]

### Aggregate Maximum Peak Demand

This analysis also compares real demand data; but by examining an entire month's worth of data, it eliminates potential inaccuracies encountered by examining only one day. Briefly stated, this analysis calculates maximum daily peak demand during on-peak hours for each customer, aggregates those data for all participants, and calculates average work-week changes in demand from October and November 1987 to 1988.

The average change in the evening peak demand (during on-peak hours) for the work week (Monday through Friday) for October was 4.1 MW for the 18 companies and for November it was 3.8 MW (see Exhibit 2.7).

The average total demand during evening peak hours in 1987 for the 18 companies in the October data were 21.7 MW; thus, these participants reduced their peak demand by 19 percent.

As mentioned earlier, some companies in the analysis experienced an increase in their average monthly peak demand. Taking these companies out of the analysis produced a total reduction in peak demand of 5.3 MW for October and 4.8 MW for November.

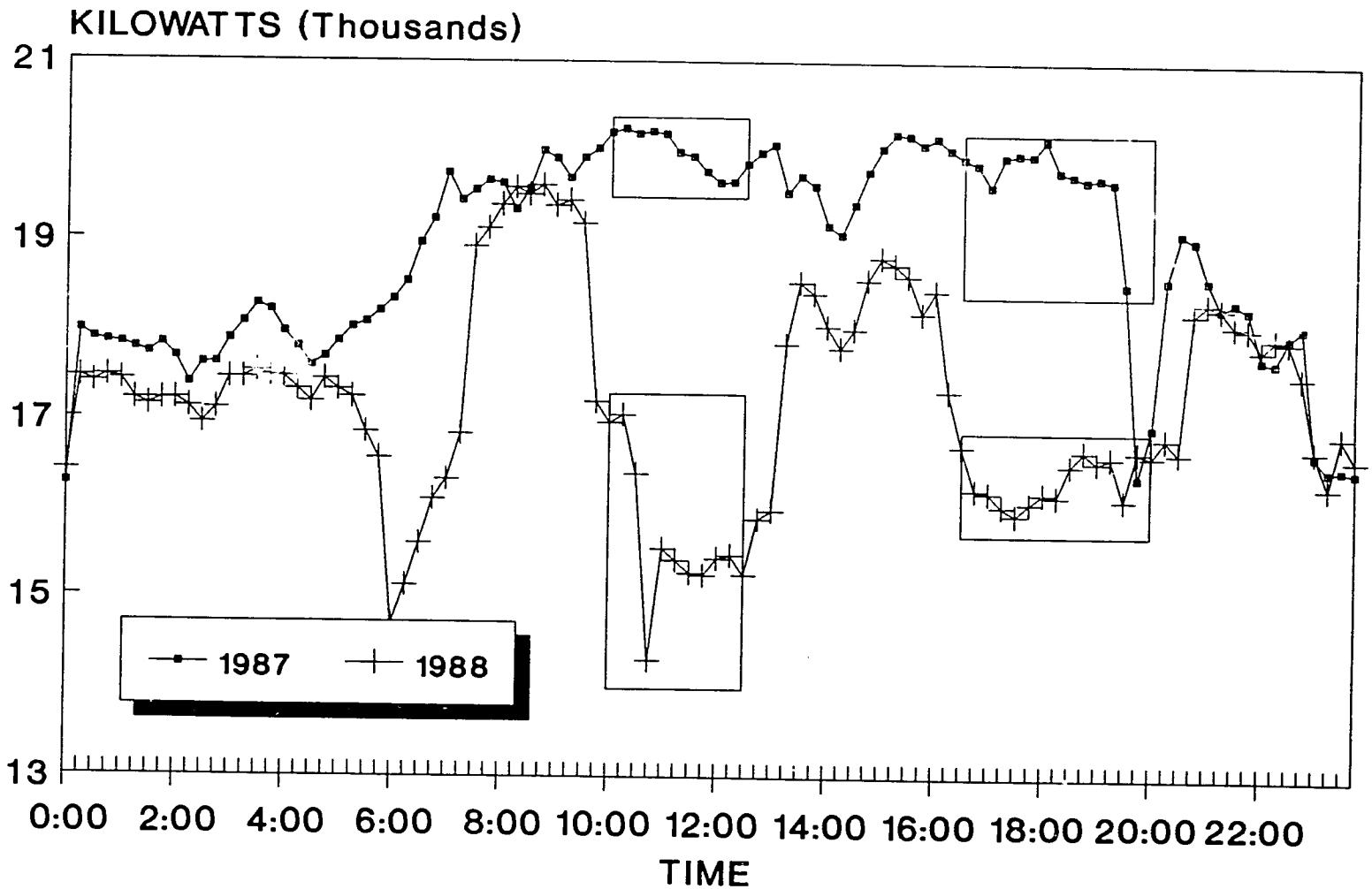
[4] However, since a new pumping station was brought on-line, demand reduction at the ICAA facilities is not entirely due to load control measures.



37

Exhibit 2.5

# TOTAL PARTICIPANT DEMAND
## ON SYSTEM PEAK DAYS




Boxed region represents peak hours.

**Exhibit 2.6**

**Change in Average Demand During On-Peak Hours on System Peak Days[1] (kW)**

| | AM | PM |
|---|---|---|
| Carnes de C.A. | (4) | (12) |
| Cartago Beef Packing | (238) | (286) |
| CNP Montecillos | 107 | 164 |
| Conducen | (108) | (54) |
| Coopeagri el General (Beneficio) | 362 | 135 |
| Coopeatenas | (23) | (61) |
| Coopevictoria Beneficio | 241 | 372 |
| El Gallito | (64) | 60 |
| Empacadora de Carnes | (366) | (82) |
| Fertica | 559 | 864 |
| ICAA Puente de Mulas | (1,712) | (1,706) |
| ICAA San Rafael de Escazu | (1,700) | (1,693) |
| Ingenio Taboga | (221) | (149) |
| Punto Rojo | (44) | 21 |
| Rafytica | 52 | 34 |
| Ricalit | (578) | (599) |
| Scott Paper | (733) | 103 |
| Ticatex | 153 | (82) |
| TOTAL | (4,318) | (2,970) |

[1] The average peak demand numbers have to be used to indicate savings on a company-by-company basis because the maximum peak demand numbers for each of these participants will not present an accurate picture. Each company experiences its maximum peak demand at a different time; thus their sum would exceed the true aggregate peak demand.

**Exhibit 2.7**

**Change in Maximum Average Work-Week Evening Peak Demand During On-Peak Hours**[1]
(kW)

| | October | November |
|---|---|---|
| Carnes de C.A. | 145 | 23 |
| Cartago Beef Packing | (146) | (281) |
| CNP Montecillos | 86 | 85 |
| Conducen | (15) | (72) |
| Coopeagri el General (Beneficio) | | 229 |
| Coopeatenas | | (62) |
| Coopevictoria Beneficio | (41) | 23 |
| El Gallito | 57 | 61 |
| Empacadora de Carnes | (198) | (119) |
| Fabrica Nacional de Licores | (44) | |
| Fertica | (837) | 321 |
| Hacienda Atirro Beneficio | 861 | |
| ICAA Puente de Mulas | (1,920) | (1,802) |
| ICAA San Rafael de Escazu | (1,855) | (1,684) |
| Industrias Akron de C.R. (Firestone) | (12) | |
| Ingenio Taboga | (156) | (195) |
| Punto Rojo | (3) | (37) |
| Rafytica | (19) | (54) |
| Ricalit | | (581) |
| Scott Paper | 67 | 305 |
| Ticatex | (55) | 17 |
| TOTAL | (4,084) | (3,821) |

1 1987 data subtracted from 1988.

### Average Change On-Peak to Off-Peak

Successful load management efforts are reflected in changes in the shape of the daily load curve through reductions in peak demand during on-peak hours. Measuring the difference between demand on-peak and off-peak can give a measure of the demand savings as a result of load control efforts.

When a company has reduced its on-peak demand to below its off-peak demand, a lower-bound estimate for its demand savings can be calculated by comparing the average on-peak demand with the average off-peak demand.[5] Using the average daily demand curves for the participants, an analysis of the off- to on-peak demand indicates that for 23 of the companies in the analysis, savings amount to 2.1 MW during the evening peak hours (see Exhibit 2.8). The 17 companies that showed positive results achieved a total savings of 2.2 MW during the evening peak hours.

An examination of the aggregate average demand curves for 1987 and 1988 (aggregating average load curves for 23 companies) shows that together the participants have significantly changed their requirements for power during the peak hours (Exhibit 2.9). Also of note is the fact that during the on-peak hours, the total average demand curve in 1988 is strikingly "V" shaped instead of being "U" shaped, indicating that the participants are able to reduce demand but are not being successful at maintaining their maximum reduction throughout the entire peak demand period. This characteristic of the load curve may indicate that the manual demand measures being undertaken are not as effective as they could be, indicating a need for more training and, perhaps, for automatic demand management systems. This characteristic may also indicate that, for production reasons, the participants are not willing to hold demand down for the length of the on-peak period. Project team members recommended to ICE management that the length of the peak demand hours be reduced to make it easier for participants to maintain a low level of demand throughout the entire period.

Regardless of the method of analysis, the majority of the reduction in peak demand for power was achieved by a small number of companies. Alunasa reduced its demand by approximately 200 kW by placing two 660 kW foil annealing furnaces under manual load control (see Exhibit 2.10). Ingenio Taboga reduced its demand by approximately 150 kW by using a 550 kVa diesel generator to supply power during peak times. It also replaced 31 electric ranges in employee housing with gas ranges (see Exhibit 2.11). ICAA, at its Puente de Mulas and San Rafael de Escazu pumping stations, achieved the largest savings of the group by shutting down selected pumps during peak load periods (see Exhibits 2.12 and 2.13). (An additional pumping station was opened in 1988, reducing the total demand on both Puente Mulas and San Rafael de Escazu, thus explaining the significant total drop in maximum demand from 1987.)

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5 When a company has reduced its level of on-peak demand but its on-peak demand still remains above off-peak demand, this method of analysis will not indicate the true savings.

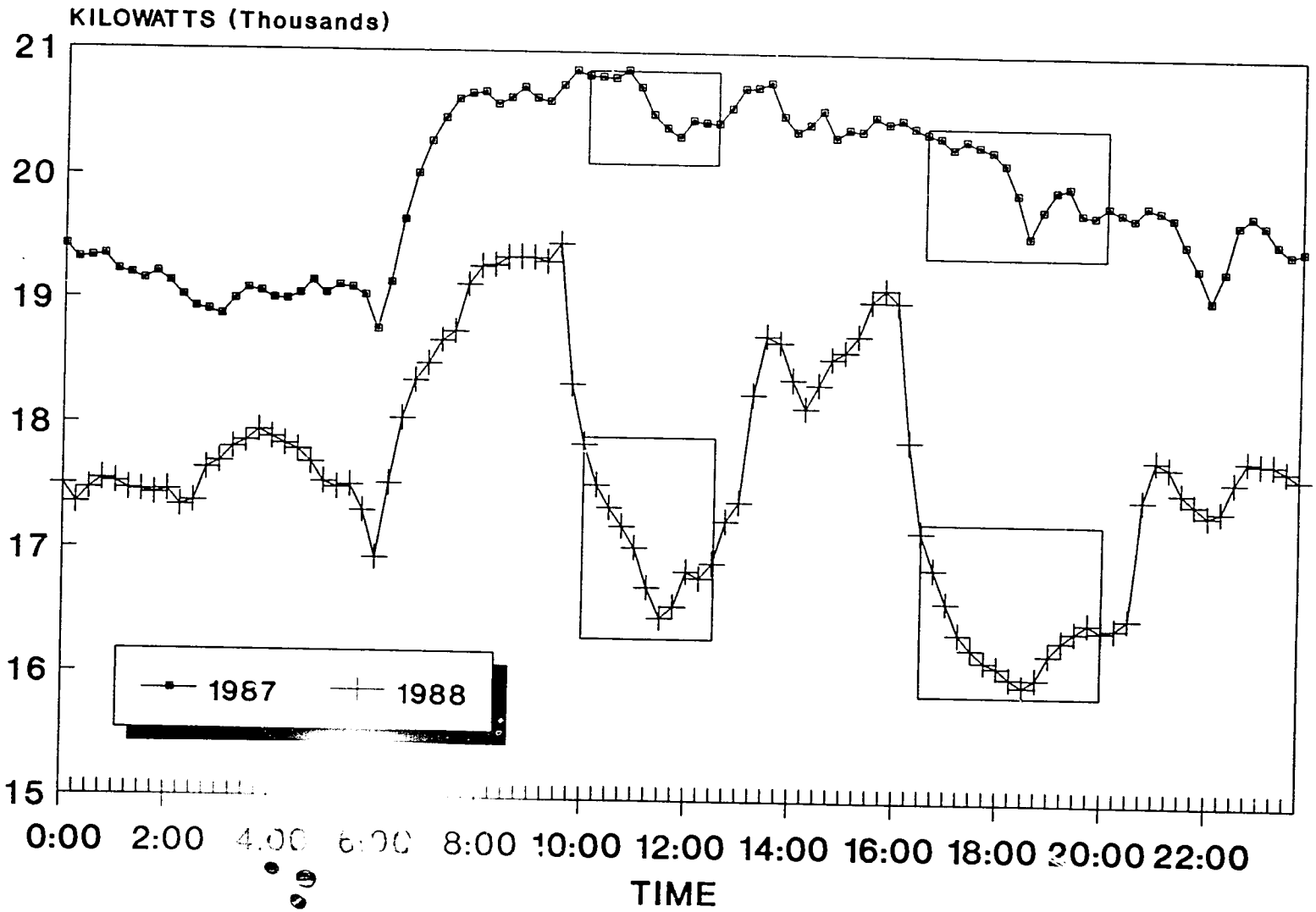
**Exhibit 2.8**

**Average Change Off-Peak to On-Peak**
(kW)

| | AM | PM |
|---|---|---|
| Conducen | 12 | 26 |
| Urgelles y Penon | (64) | 23 |
| El Gallito | 12 | 17 |
| Ticatex | (19) | 15 |
| Punto Rojo | (9) | 12 |
| Rafytica | (3) | 8 |
| Coopeatenas | 2 | 4 |
| Ricalit | (11) | (4) |
| Coopevictoria Beneficio | (15) | (9) |
| Fabrica Nacional de Licores | (2) | (13) |
| CNP Montecillos | 25 | (18) |
| Empacadora de Carnes | (7) | (25) |
| Cartago Beef Packing | (40) | (40) |
| Arrocero Los Sauces | (31) | (54) |
| Hacienda Atirro Beneficio | (101) | (73) |
| Carnes de C.A. | (6) | (84) |
| Ingenio Taboga | (126) | (92) |
| Industrias Akron de C.R. (Firestone) | (119) | (96) |
| Scott Paper | (148) | (98) |
| Coopeagri el General (Beneficio) | (83) | (125) |
| Fertica | (287) | (182) |
| Alunasa | (313) | (193) |
| ICAA San Rafael de Escazu | (646) | (522) |
| ICAA Puente de Mulas | (638) | (537) |
| TOTAL | (2,616) | (2,060) |
| TOTAL PM NEGATIVE ONLY | (2,547) | (2,165) |

Exhibit 2.9

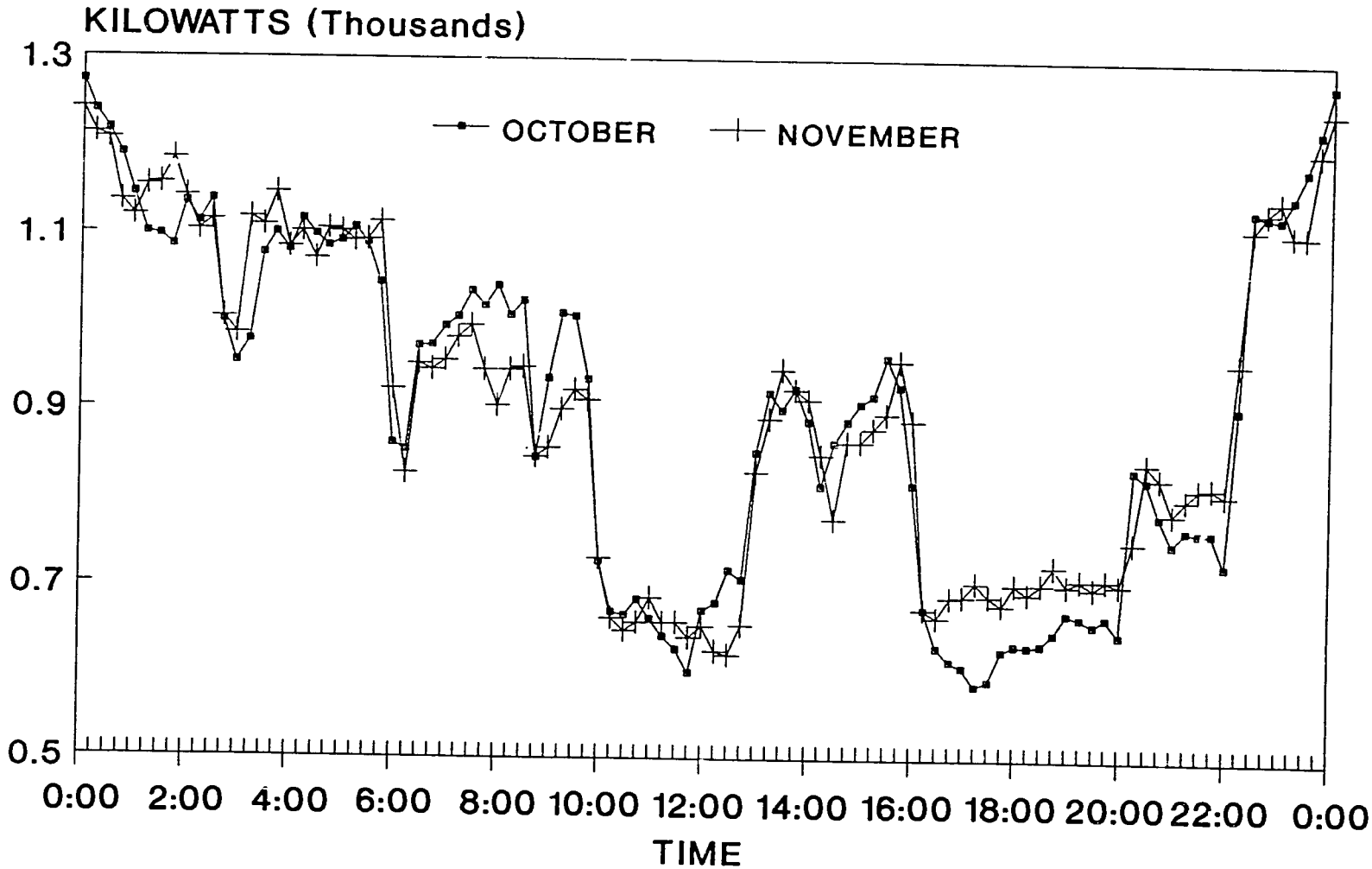
# TOTAL AVERAGE DEMAND




Boxed region represents peak hours.

Exhibit 2.10

# ALUNASA
## AVERAGE DEMAND -- 1988




40.

Exhibit 2.11

# INGENIO TABOGA
## AVERAGE DEMAND -- NOVEMBER

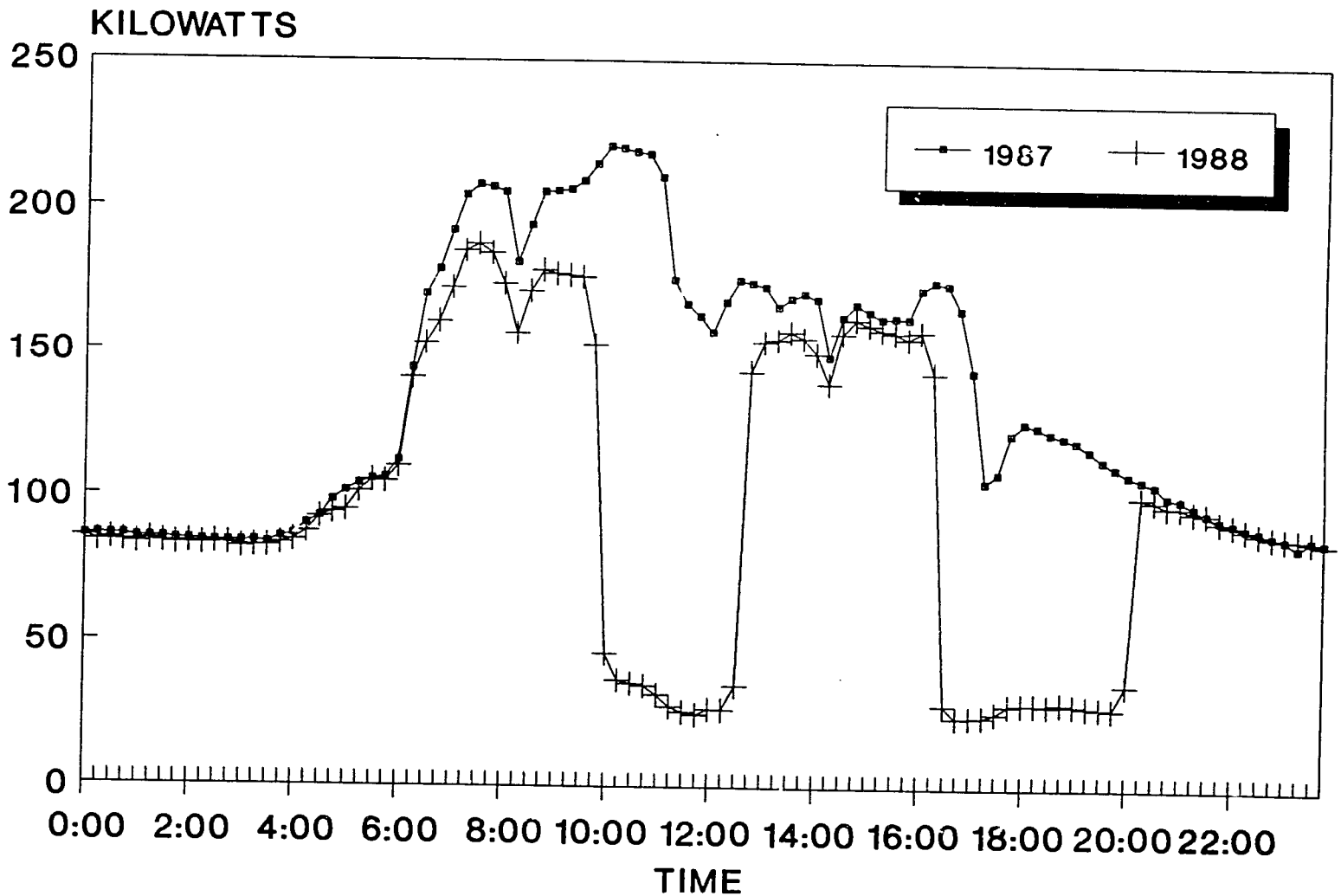
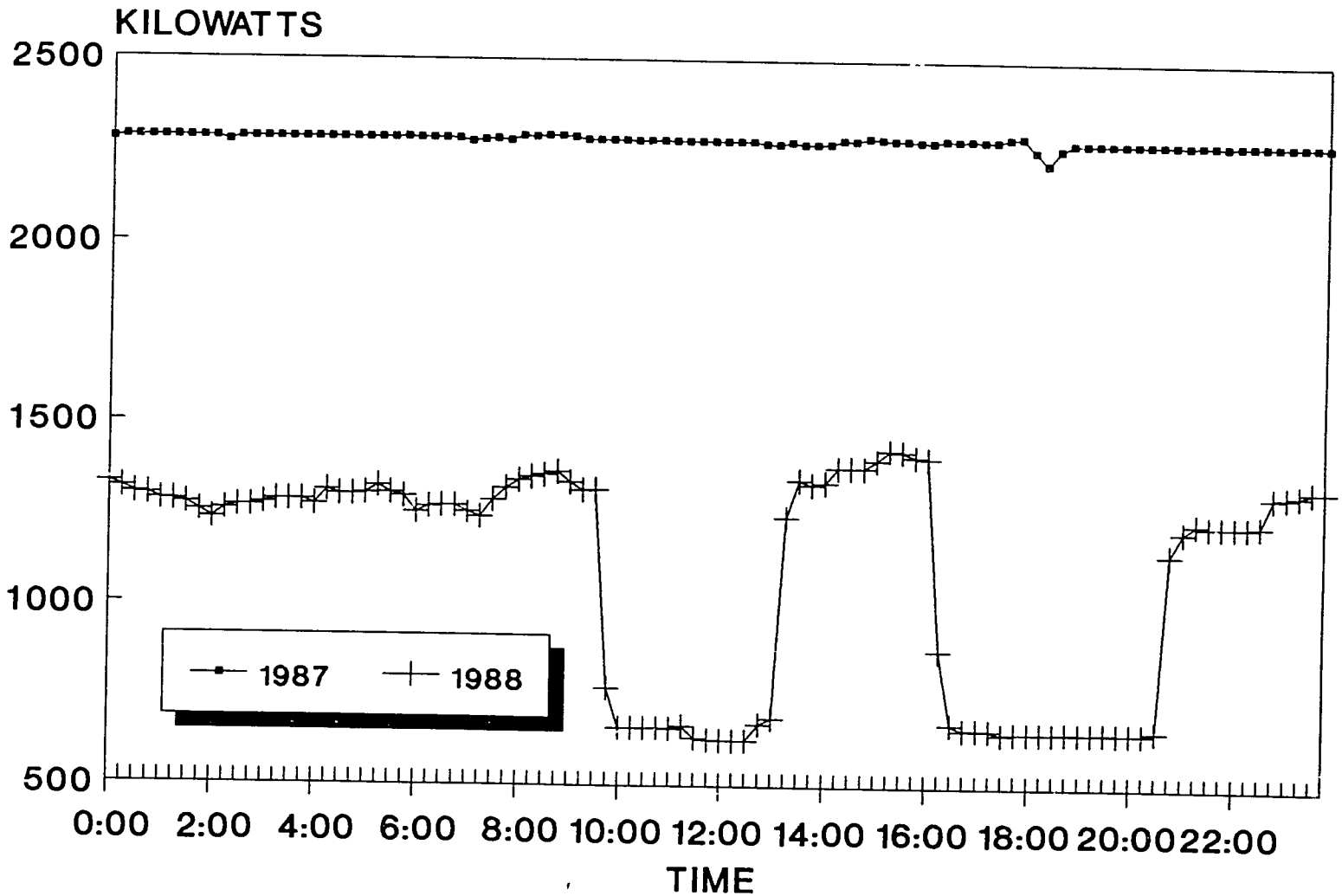


Exhibit 2.12

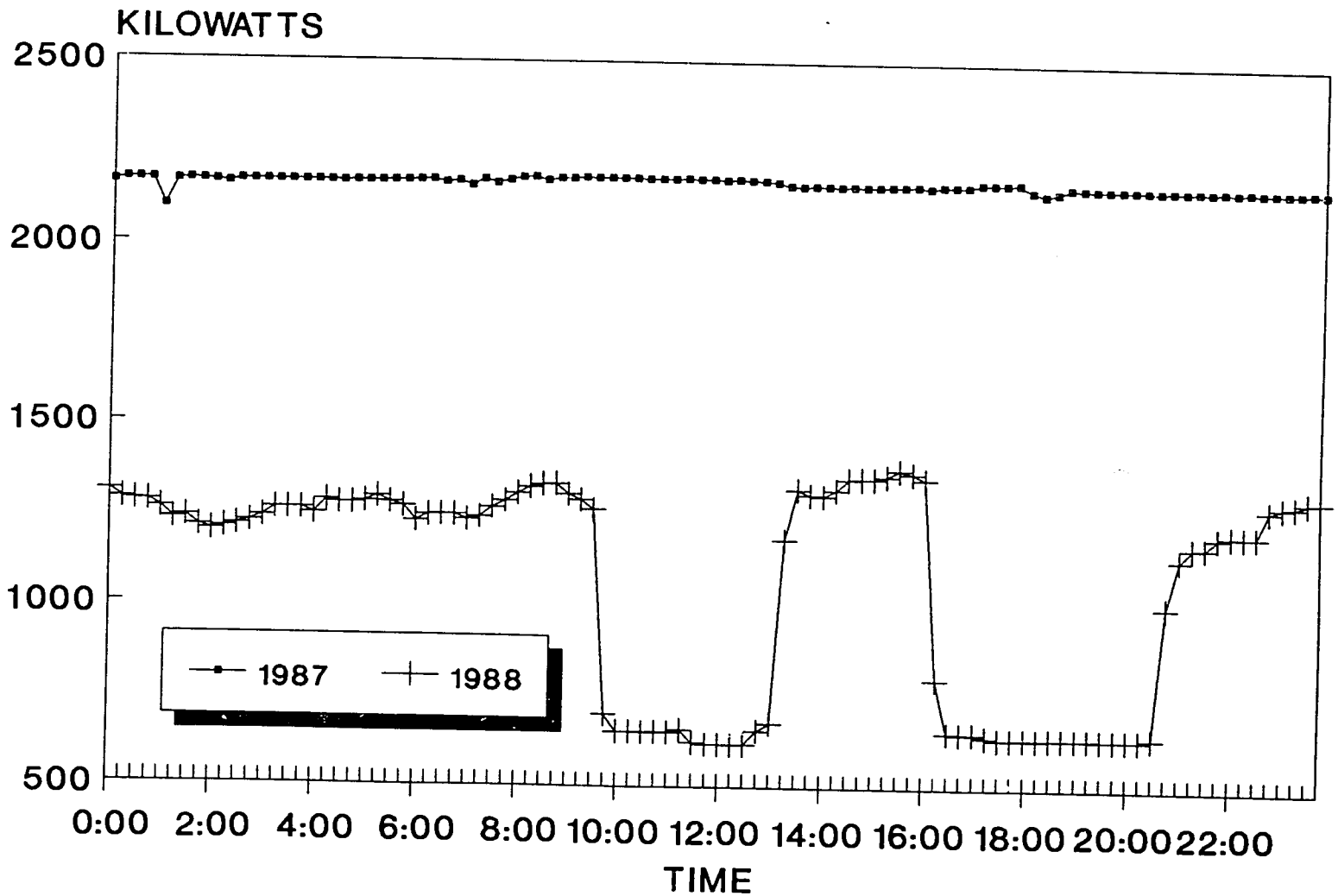
# ICAA PUENTE DE MULAS
## AVERAGE DEMAND -- NOVEMBER




42

Exhibit 2.13

# ICAA SAN RAFAEL DE ESCAZU
## AVERAGE DEMAND -- NOVEMBER



### Participants' Estimates

In on-site interviews held during training and information sessions, eleven of the participants estimated the demand reduction they had achieved to date. Together these participants estimate they have achieved savings of 5.4 MW (see Exhibit 2.14).

**Exhibit 2.14**

Customer Estimates
of Reduced Coincidental Peak Demand
(kW)

| | |
|---|---|
| Alunasa | 1,120 |
| Conducen | 500 |
| Coopevictoria Beneficio | 150 |
| El Gallito | 150 |
| Fertica | 750 |
| ICAA Puente de Mulas | 1,000 |
| ICAA San Rafael de Escazu | 1,000 |
| Industrias Akron de C.R. (Firestone) | 220 |
| Punto Rojo | 50 |
| Ricalit | 300 |
| Urgelles y Penon | 150 |
| TOTAL | 5,390 |

### Combined Results

No one analysis can adequately account for the many variables that affect industrial demand for electric power. As a result, each of the above analyses is valid for only a portion of the sample. The project team members drew upon their knowledge of the individual companies and the strengths and weaknesses of the analyses to prepare the following estimates. The "conservative" calculations represent the most likely true load reduction achieved on a consistent basis by the participants. The "potential" calculations include savings that were achieved sporadically, but not consistently throughout the months under study, and savings calculated using the known nameplate ratings on equipment that is currently being controlled during on-peak hours.

Conservatively calculated, the 24 companies included in the analysis reduced their evening peak demand by 3 MW (see Exhibit 2.15). Because these 24 companies together had a coincidental peak demand in 1987 of 21 MW, they achieved a total demand reduction of 14 percent.

**Exhibit 2.15**

**Estimated Combined Demand Reduction**
(kW)

| | Conservative | Potential |
|---|---|---|
| Alunasa | 200 | 1,120 |
| Arrocera los Sauces | 50 | 60 |
| Carnes de C.A. | 0 | 0 |
| Cartago Beef Packing | 100 | 200 |
| CNP Montecillos | 0 | 0 |
| Conducen | 0 | 100 |
| Coopeagri el General (Beneficio) | 80 | 125 |
| Coopeatenas | 60 | 60 |
| Coopevictoria el General (Beneficio) | 0 | 50 |
| El Gallito | 0 | 0 |
| Empacadora de Carnes | 100 | 150 |
| Fabrica Nacional de Licores | 10 | 20 |
| Fertica | 200 | 400 |
| Hacienda Atirro Beneficio | 70 | 80 |
| ICAA Puente de Mulas | 700 | 1,000 |
| ICAA San Rafael de Escazu | 700 | 1,000 |
| Industrias Akron de C.R. (Firestone) | 75 | 200 |
| Ingenio Taboga | 150 | 200 |
| Punto Rojo | 40 | 70 |
| Rafytica | 0 | 10 |
| Ricalit | 300 | 500 |
| Scott Paper | 100 | 200 |
| Ticatex | 0 | 100 |
| Urgelles y Penon | 80 | 149 |
| TOTAL | 3,015 | 5,794 |

If the participants succeed in extending their efforts and achieve their reductions on a consistent basis throughout the peak hours, they could reduce their evening peak demand by over 5.8 MW, for a savings exceeding 27 percent.

## DISCUSSION

The second analysis (aggregate maximum peak demand) produced the largest reduction in evening peak demand (3,821 kW). It represents an accurate portrayal of the actual reduction for those companies involved as reflected in their bills, and therefore measures the financial savings to the customer. By using two months worth of data, it is also a more accurate portrayal of the real change in demand than the one-day analysis on the system peak day (the first analysis). However, the second analysis may overstate the savings attributable to load management efforts because some companies (e.g, ICAA) reduced their entire operations (and thus demand) during 1988 for reasons other than load control. For several companies, the entire average demand curve for 1988 was significantly below the corresponding curve for 1987. The most conservative assumption from such a situation is that there was an overall reduction in activity in the plant unrelated to load management efforts. Variables such as weather, economic climate, labor relations, and world prices for inputs and outputs affect the total level of activity in industrial enterprises. In this limited study, it was not possible to include these variables in the analyses. Attempts were made to create indices based on total energy consumption and industrial production to adjust the demand numbers for changes in level of activity; however, limitations with this methodology prevented the project team from drawing conclusions based on that analysis (see Appendix N for a complete discussion).

The third analysis (average change off-peak to on-peak) avoids the problem of changes from year to year by measuring the changes from hour to hour. It presents a very accurate calculation for some companies and presents an accurate calculation of the minimum amount of load management being achieved. However, the third analysis understates the actual achievements. In cases where load management efforts change a demand curve that shows a significant daily peak demand during peak hours to one that shows a flat curve during the peak hours, the third analysis will underestimate the true load reduction. (The average demand curves for Coopeatenas provide a good example, Exhibit 2.16.)

Time and resources were not available for an exhaustive analysis that would include adjustments for all the factors that contribute to changing peak demand for each company. It was thus necessary to examine each participant on a case-by-case basis, drawing upon the project team members' knowledge of the participating industries, to determine which analysis most accurately reflected the true impact of the project and to draw necessarily subjective conclusions as to the actual savings achieved. Every effort was made to be conservative in the final analysis, using each analysis as a check against the other. The final analysis is liberal only in the sense that some participating compa-



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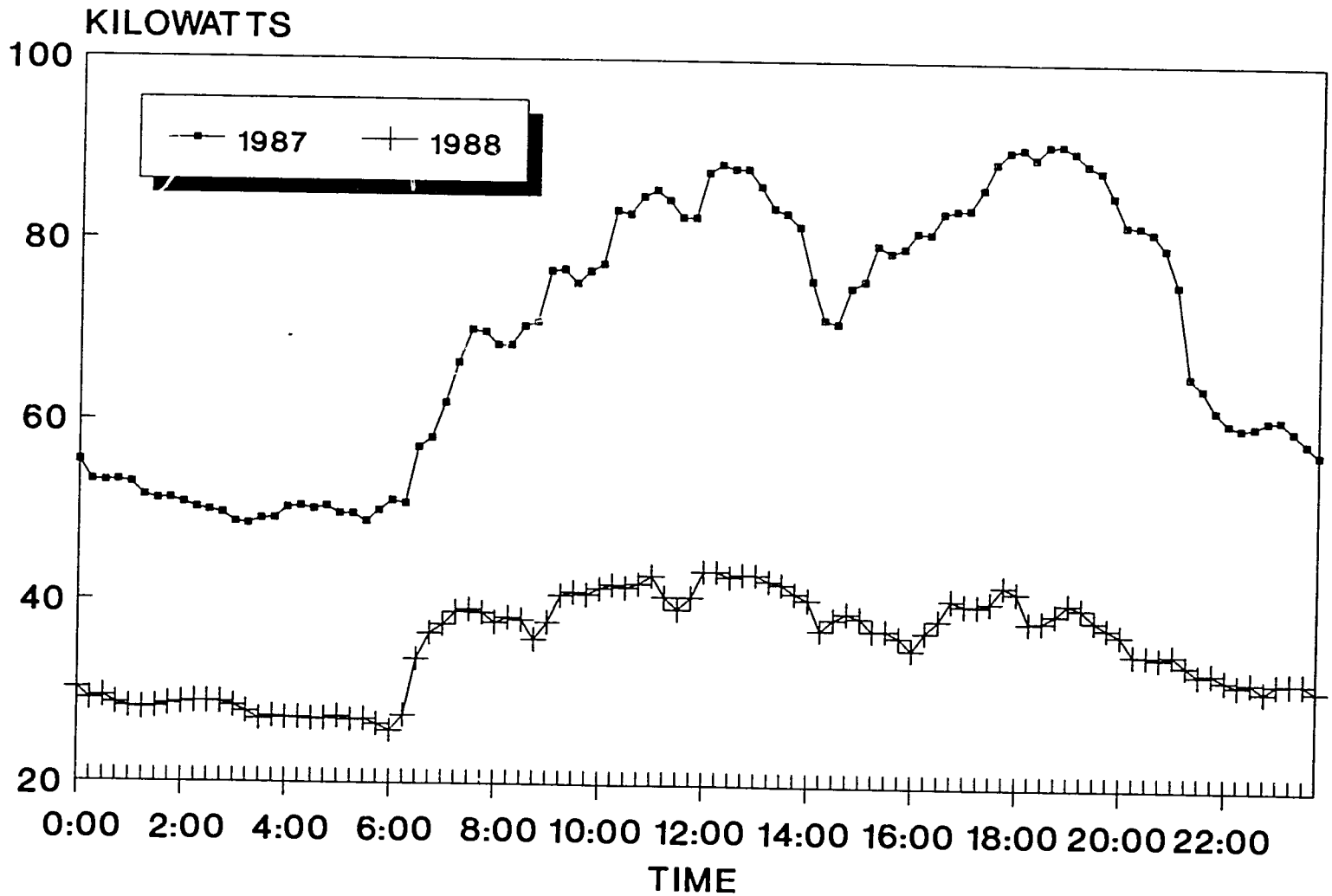
Exhibit 2.16

# COOPEATENAS
## AVERAGE DEMAND -- NOVEMBER



nies may not have succeeded in maintaining the indicated level of savings throughout the entire peak period.

In summary, the initial goal of the program to reduce the participants' peak demand for power by at least 10 percent was met: the 24 companies included in the analysis reduced their demand by 14 percent. The goal of the program was also to reduce the peak demand for power by 3.5 MW from a total sample of 35 companies. Of the more than 75 facilities identified as possible participants in the project, 18 for which reliable data could be obtained on average reduced their demand for power during the evening peak hours by 3.8 MW, and reduced their demand on the day of maximum system peak demand by 3 MW. When final estimates for savings were prepared for 24 of the participants, the total savings, based on conservative calculations, were 3 MW. When 35 participants will be actively involved in the program, their combined demand reductions will far exceed the original target of 3.5 MW.

Several companies were just beginning to implement significant load management programs at the end of 1988 and the first quarter of 1989. As these companies implement their strategies, as other companies join the program, and as all the participants learn more about measures for reducing their coincidental peak demand, significant additional savings are expected. An additional five companies are officially participants, but began controlling their loads before the beginning of the program: Cempa, Gerber, El Angel, Canera San Ramon, and Miller Hermanos. Their peak demand savings were not included in the analysis, but they are nonetheless helping to reduce the system peak demand. Cempa alone is saving approximately 1.4 MW during the evening peak hours.

## COST/BENEFIT ANALYSIS

Technical and economic analyses of load management projects indicate that, on the whole, they offer better cost-benefit ratios than any other power sector improvement project in developing countries. Utilities around the world have proven that investment in demand management programs is the most effective way to "add" capacity: The cost of adding a kilowatt of capacity is almost always higher than the cost of saving a kilowatt by means of a load management program. In addition, load management programs present essentially no technological risks because there is a considerable wealth of worldwide experience in load management methods, procedures and technologies.

The financial advantage obtained by the parties involved in a load control initiative is measured in terms of the relationship of their respective costs and benefits. This value is conveniently expressed by the simple payback period:

$$\frac{\text{Total cost}}{\text{Monthly savings}} = \text{Payback period in months}$$

This calculation ignores the time value of money, but has the advantage of being easily calculated and understood.

The costs and benefits of load control can be analyzed at three levels or perspectives:

- The perspective of the user
- The perspective of the utility
- The national perspective

All three viewpoints will be examined in this chapter.

### Costs

The project participants incurred several categories of costs in introducing load control to their facilities, including:

- Energy management systems (EMS)
- Load control devices
- Demand measuring devices
- Diesel-electric generators
- Installation
- Consulting fees
- Awareness-raising
- Loss of production.

In practice, however, most participating customers who used in-house resources and manual control considered that they had introduced load control at no cost. Those who reported costs confined themselves largely to major purchases of equipment and services (electronic demand registers and consulting engineers' fees). There was no investment in energy management systems, as such actions would only follow a period of testing to confirm the potential for load reduction. Because as of the closing date of the demonstration, none of the participants had purchased an EMS, the costs reported were low to moderate (in the range of $1,210 - $29,445) or no cost at all.

From its perspective, ICE reported a project cost of $11,100, consisting of labor and equipment, and finally, there was the cost of the technical assistance and equipment funded by USAID in the amount of $213,000.

### Benefits

The benefits of the project derive, of course, from the reduction in coincidental peak demand, and are interpreted differently by each of the parties involved. To the customer the reduction in his electricity bill is of greatest interest. To ICE the present value of deferring investment in generating capacity is of primary importance; however, this is partly offset by a loss of revenue owing to lower billable demand. At the national level any aspect of load control that will avoid increasing the public debt and will reduce foreign expenditures is seen as an advantage.

### User's Perspective

The elements and results of the cost/benefit analysis are shown in Exhibit 2.17. The benefit calculation is based on ICE's monthly incentive of 736.17 colones ($9.28) per kW reduced during the system peak periods. CNFL customers received a slightly lower incentive of 646.55 colones ($8.15) per kW reduction of coincidental peak demand. For the 24 customers who were most interested and active in controlling load, this yielded a monthly saving of $26,294 based on their October/November 1988 load profiles. For individual customers the payback period ranged from zero (with no cost) to 10.9 months. In industry, payback periods of up to 18 months are considered to be attractive. This is particularly true when technical risks are low, as is the case with load control (see Exhibit 2.17).

Coopevictoria Beneficio, a coffee processor, registered no demand reduction as of November 1988, although they had spent 132,000 colones ($1,665) in consulting fees for overall rationalization of electricity use. They are currently procuring energy management equipment with a view toward reducing their load in 1989.

The total monthly saving of $26,294 was achieved at a total cost of $51,702, which results in an overall payback period of two months for the group of 24 customers and demonstrates the cost-effectiveness of load control (see Exhibit 2.17).

### ICE's Perspective

During the system peak period each kW saved avoids adding capacity at the margin. Because ICE is considering installing peaking gas turbines at $508/kW, one could argue that the value to ICE of each kW saved through load control is the annualized value of the new generating capacity. This value is about $111/kW which, together with transmission costs, amounts to approximately $156/kW.

On this basis, the economic value to ICE of the load reduction of 3,015 kW is $470,340 per year, or $154,812 net of the revenue reduction. Since the cost to ICE of implementing the demonstration project was only $11,100, the payback period is less than one month.

## Exhibit 2.17

## Cost/Benefit Analysis of Selected[a] Utility Customers

| | | COINCIDENTAL PEAK DEMAND REDUCTION (kW) | MONTHLY DEMAND[b] CHARGE SAVING (COLONES) | PROJECT COST INCURRED (COLONES) | SIMPLE PAYBACK (MONTHS) |
|---|---|---|---|---|---|
| 1. | Alunasa | 200 | 147,234 | 205,000 | 1.4 |
| 2. | Arrocera los Sauces | 50 | 36,809 | 0 Est. | 0 |
| 3. | Carnes de C.A. | 0 | 0 | 0 | d |
| 4. | Cartago Beef Packing | 100 | 73,617 | 0 Est. | 0 |
| 5. | CNP Montecillos | 0 | 0 | 0 | d |
| 6. | Conducen | 0 | 0 | 0 | d |
| 7. | Coopeagri el General (Beneficio) | 80 | 58,894 | 132,000 | 2.2 |
| 8. | Coopeatenas | 60 | 44,170 | 0 Est. | 0 |
| 9. | Coopevictoria el General (Beneficio) | 0 | 0 | 132,000 | d |
| 10. | El Gallito | 0 | 0 | 0 | c |
| 11. | Empacadora de Carnes | 100 | 73,617 | 0 | 0 |
| 12. | Fabrica Nacional de Licores | 10 | 7,362 | 0 | 0 |
| 13. | Fertica | 200 | 147,234 | 0 | 0 |
| 14. | Hacienda Atirro Benefico | 70 | 51,532 | 0 Est. | 0 |
| 15. | ICAA Puente de Mulas | 700 | 452,585[c] | 0 | 0 |
| 16. | ICAA San Rafael de Escazu | 700 | 452,585[c] | 0 | 0 |
| 17. | Industrias Akron de C.R. (Firestone) | 75 | 55,213 | 0 | 0 |
| 18. | Ingenio Taboga | 150 | 110,426 | 1,200,000 | 10.9 |
| 19. | Punto Rojo | 40 | 29,447 | 96,000 | 3.3 |
| 20. | Rafytica | 0 | 0 | 0 | d |
| 21. | Ricalit | 300 | 220,851 | 2,335,000 | 10.6 |
| 22. | Scott Paper | 100 | 64,655[c] | 0 | 0 |
| 23. | Ticatex | 0 | 0 | 0 | c |
| 24. | Urgelles y Penon | 80 | 58,894 | 0 | 0 |
| TOTAL (colones) | | 3,015 kw | ¢ 2,085,125 | ¢ 4,100 | 2.0 |
| TOTAL (dollars) | | 3,015 kw | $ 26,294 | $ 51,702 | 2.0 |

a. Most interested and most active.
b. At 736.17 colones/kW, except as noted
c. At 646.55 colones/kW (CNFL rate)
d. Not applicable

Source: RCG/Hagler, Bailly, Inc.

Taking a broader view, and adding to ICE's cost the $213,000 of foreign technical assistance and training funded by USAID, the payback period increases to 19.7 months -- still an attractive undertaking, especially for a pilot/demonstration project.

### National Perspective

The national perspective in regard to this load control demonstration is very close to that of ICE, because the bulk of the outlay for the new generating capacity would be in foreign exchange and because there are almost no additional costs (e.g., taxes or actual costs) to be borne by the government. Moreover, less oil would have to be imported for thermal power plants (peaking capacity). Thus, the project proved to be very beneficial to Costa Rica's economy.

# CHAPTER 3: CONCLUSIONS AND RECOMMENDATIONS

## CONCLUSIONS

The conclusions drawn from this project are divided into those on the impact of the load control measures and the problems encountered in implementing the project. This will be followed by a section on the recommendations of the project team.

### Participants achieved target savings.

This project has demonstrated that peak load coincidental with the system annual peak can be reduced by 14 percent, or 3 MW, in a representative sample of 24 industrial facilities at a cost acceptable to both the customers and the electric utility. The results exceed the project goal of a 10 percent reduction, or not less than 3.5 MW for a larger sample of 35 sites.

### Savings could exceed 5.8 MW from demonstration participants.

The peak reduction demonstrated was measured as of November 1988 (the system peak month); however, it does not reflect the full results of the program. Most of the facilities analyzed had not completed their application of load control at that point in time and, in fact, many were still in early stages of implementation. When the 24 participants in the statistical analysis refine their load management procedures and achieve their potential reduction on a consistent basis, their total reduction in on-peak demand will reach an estimated 5.8 MW for a total decrease of 27 percent.

### The entire commercial and industrial sector could reduce demand by 17.2 MW.

Based on the 14 percent demand reduction demonstrated, there is a potential for trimming coincidental peak demand in the rest of the Costa Rican commercial and industrial sector by approximately 17.2 MW. Because the aggregate coincidental demand of the sector is estimated at 122.5 MW, this reduction amounts to almost 3 percent of the integrated system peak.

**The project proves to be very cost effective.**

The approach taken to improve the load profiles of the sample of 24 customers was very cost effective. The group achieved monthly demand charge savings of 2.1 million colones ($26,294), with project-related expenditures of 4.1 million colones ($51,702), comprising mainly purchased equipment and services. Overall, the simple payback period for costs incurred by customers was two months.

ICE also benefitted in terms of deferred costs of generation and transmission capacity, estimated to have an annualized value of $154,656 net of reduced revenue from lower demand billing.

**Participants largely relied on manual load control methods.**

By and large, the participants in the project relied on manual load control for achieving their demand savings. Typically they used their own technical staff to study load reduction possibilities and conduct trials with manual controls and little or no equipment. Some companies proceeded to a second manual control stage by installing simple equipment, such as signal lights and alarms, to remind plant staff to implement load control procedures. In a small number of cases, a limited degree of automatic energy management equipment was installed. Customers were reluctant to install sophisticated energy management systems that entail a large investment. It appears that without increased encouragement, only customers with large facilities or complex operations are likely to consider the ultimate installation of sophisticated energy management systems.

A key element in the success of customers' load management programs was a high level of interest on the part of general management or plant management. Equally important to program success was the availability of excess equipment capacity and in-process storage capacity in customers' facilities, both of which provide operational flexibility.

**Problems reduced the achievements of the demonstration project.**

At most participating facilities the complete load management process (analysis, planning, implementation) appears to take from 1.5 to two years, but more intensive effort would accelerate the process and yield greater load reduction. Given the level of effort, the implementation period of the project (under five months) was too short to allow participating customers to implement load control fully; therefore, the results of the quantitative analysis reflect, to a large extent, awareness-raising, trial and error efforts, and manual load control -- all of which are subject to human error, potentially resulting in the loss of the month's demand billing gains. A demonstration period of one year would have produced a much greater achievement.

The principal barriers to load management that emerged from the pilot project are:

Barriers Relating to Customers and Consulting Engineers

- Lack of awareness of load management potential and available tariff options
- Lack of reliable information on the potential manageable load of each customer owing to the lack of documented professional assessments with energy balances
- Reluctance to contract consulting engineers with specialized load management knowledge and to invest in automatic energy management equipment
- Lack of initiative on the part of the consulting engineers in pursuing potential work in the participating facilities
- Difficulty of arranging for dedicated telephone lines for remote interrogation of the electronic demand recorders installed in customers' facilities
- Lack of data and smaller in-house technical staffs at commercial customers (hotels, hospitals, and office buildings) make them more difficult to evaluate and there was only limited success in bringing them into the program.

Institutional Barriers

- Lack of an organizational framework and manpower to implement the program
- Limited availability of load curves and other information for use in educating the customers and informing them of their progress
- Difficulty of obtaining full participation of the distribution companies in the program

Tariff-Related Barriers

- Excessively long peak periods in the time-of-use tariffs offered by the utilities
- Lack of load management tariffs that would give the utilities a positive control over a known portion of the demand
- Lack of time-of-use and interruptible tariffs in the offerings of most distribution companies.

## RECOMMENDATIONS

The recommendations are divided into three parts: (1) general recommendations and recommendations to ICE; (2) recommendations related to other Costa Rican organizations; and (3) recommendations for the development community.

### General Recommendations and Recommendations to ICE

**Use the momentum developed by the demonstration project to expand the project to the whole target population.**

ICE should exploit fully the visibility, interest, and momentum generated by the pilot project; therefore, a larger scale, multi-year load management program should be established without delay to achieve an optimum national demand curve. The program should first address the industrial and commercial customer classes, and subsequently be extended to the residential class. Such an expanded program would cost about $2.5 million and lead to a demand reduction of 15 - 25 MW by 1992 (Phase 2). The necessary institutional and policy frameworks should be provided to assure the program's success. Draft terms of reference for an expanded program are presented in Appendix O.

**Create a permanent unit (at the department level) within ICE to coordinate load management and end-use efficiency improvements.**

A permanent unit should be created within ICE at the department level with the explicit mandate to coordinate a program to bring about load management and end-use efficiency improvements. The sole responsibility of this department should be to implement a load control program. This group should be given the necessary manpower and resources (including software and computers) to carry out a comprehensive program.

One responsibility of such a department would be to perform more load research to determine load contribution to the system peak by rate class. This will help to identify the types of customers to target for each type of rate. The load control unit should also study the current tariffs with an eye toward improving their effectiveness (see specific recommendations later). The new department should also take the following recommendations into account when it devises its work plan in order to improve its effectiveness:

1. The design of future projects should take into account the long load management development cycle at the plant level, and should attempt to reduce it by means of subsidized technical assistance and incentives, and a greatly increased frequency of contacts between the utility and the participating consulting engineers.

2. Load curves should be provided to all customers with a demand in excess of 200 kW or to those who express an interest in load management. Also, they might be provided with multi-tariff meters.

3. Special arrangements should be made with ICE's telecommunications group to provide the telephone links with electronic demand recorders installed in customers' facilities.

This department could also be responsible for the coordination of other energy efficiency improvement activities of ICE. CNFC should also encourage the establishment of a similar department for its own benefit.

**Prepare and implement an information dissemination plan.**

A draft information dissemination plan has been prepared (see Appendix P). This plan should be completed and implemented to distribute information on the benefits of load management, encourage customers to participate in a continuing load control program, enroll more customers in load management tariffs, and generally raise the awareness and understanding of the need for and benefits of load management. Awareness campaigns should target general management as well as technical personnel, because the interest of the former is a key factor in achieving the desired results at the plant or facility level.

**Educate utility personnel on the results of the project and the benefits of load control.**

The management at ICE, CNFL, and the distribution companies should be shown how the benefits of load management can be calculated. This could be done by means of a seminar. It is essential that utility managers and planners fully understand the concept of load management and how the benefits are derived and maintained. Without this information, many executives and planners will remain skeptical and will not provide the support needed to make a load management program a success.

**Improve the existing tariffs to encourage participation.**

Several measures should be taken to improve the effectiveness of the current tariffs and create additional tariffs that will encourage customers to implement load control measures:

1. The existing time-of-use and interruptible tariffs should be amended to make them more attractive to industrial and commercial customers, consistent with the utilities' interests. ICE and all the distribution utilities should offer tariffs that promote load management.

2. A special load management tariff should be developed and offered by all Costa Rican utilities. Such a tariff would include a firm demand level for each customer with an agreement from the customer to reduce demand to that level on a signal from ICE. Customers that can easily bring their production lines down once a day but have great difficulty shutting down twice a day (for the TOU tariff) could benefit from such a tariff while ICE achieves a greater ability to reduce demand when its total demand approaches designated ceilings.

3. ICE should develop criteria dispatching load control on the interruptible rates (and any new load management rates). This should provide a systematic procedure to be followed by the system control center dispatchers in order to initiate load management. If the dispatching of load management is left to the dispatchers' discretion, it could lead to inefficient use of the total allowed number of control periods.

   To provide the greatest benefit to Costa Rica, the criteria developed should be based on the total national system peak and not on peaks created by the different distribution companies; however, this does not preclude some load management at the distribution company level.

4. Customers changing to a load management, TOU, or interruptible tariff must not be required to provide an additional security deposit. This has been a barrier to many of the customers who were interested in the TOU rates, but owing to various reasons were unable to participate in the demonstration project.

5. Existing and new time-of-use, load control, and interruptible tariffs should be publicized widely. Promotion activities should include industry sector-specific meetings, plant visits, and promotional materials. A promotional brochure should be sent to every commercial and industrial customer with a demand of 50 kW or more with an invitation to change to a preferential tariff without an increase in the security deposit.

**Create additional incentives for customers to implement load control procedures.**

These incentives should include the following:

1. Audits and advisory services by consulting engineers with specialized load management knowledge should be subsidized to promote their widespread use.

2. At the same time, a complete electrical energy rationalization service should be promoted to increase customers' energy cost savings and thereby facilitate justification of energy management systems.

3. A simple, low-cost energy monitoring system should be designed and made available to customers who cannot justify investing in an energy management system. It should include an audible alarm to signal excessive demand during peak periods. Without such a system the customer does not know when a specified demand level is exceeded; therefore, he cannot maintain his demand below that level. Load profiles from an electronic demand recorder furnish after-the-fact demand data which are received too late to permit timely corrective action to curb demand; however, the profiles are useful for planning operations in the coming months.

4. Because more technical assistance is needed for commercial customers than for industrial, assistance to the former should be subsidized.

## Recommendations Related to Other Costa Rican Organizations

1. The distribution companies should be drawn into the program by training their key personnel in load management and encouraging them to establish load management functions in their own organizations.

2. The contract between ICE and the distribution companies should be changed to increase the incentives for encouraging customers of the distribution companies to implement load control measures. Currently the distribution companies are charged a flat rate for all power they receive from ICE. Even though they are closely connected to ICE, it may be desirable to adjust their costs of energy to match the load management tariffs.

3. Because ICE is facing budgetary constraints that make it difficult to provide manpower fully dedicated to load management development in the medium term, other sources of manpower must be found. DSE and ICAITI could be considered as a source of interim staff until ICE can organize and staff the function adequately. Contracting outside with local or foreign specialized consulting/engineering firms could also be considered as a possible alternative. The respective merits of each option should be analyzed both in terms of economic and financial merit and institutional feasibility.

**Recommendations for the Development Community**

1. The development community, including the Agency for International Development, the World Bank, the Interamerican Development Bank, and CEPAL, should provide support for the development of a division or department within ICE that will be dedicated to implementing and supervising a load control program.

2. The development community should provide financial support for a full-scale load control program in Costa Rica. The community could join forces in this effort to provide financial support and technical assistance to a major project. When such a program is in full swing, consideration should be given to expanding the program to include the residential sector. Preliminary estimates indicate that reductions of up to 5 percent of the system peak demand could be obtained from a full-scale program (35 MW) by the mid-1990s. The total cost of such a program would be $4-5 million (Phase 3).

# APPENDICES

Order No. 02
DHR-5728-Z-02-7014-00

**Objective**

This project will seek to demonstrate that peak load can be reduced by 10 percent in a representative sample of medium-sized users (i.e., 20-100 kW) at a cost acceptable to both the users and the electric utility. To put this project in perspective, a 5 percent reduction in peak demand at the national level by 1990 would contribute as much to the system as the addition of one 55 MW geothermal unit. This would save roughly $15 million in foreign exchange by delaying construction of that power plant by about two years.

Three phases are proposed for the pilot project:

**Phase 1: Design**

An analysis of the structure of current peaks indicates that they derive from two sectors, the domestic and the commercial sectors, and that cooking accounts for the major use of electricity. Because typical household demand is low by international standards of 400-500 W average peak[1] and 200 kWh/month, it is unlikely to be technically or economically practical to initiate the project in the domestic sector. The commercial sector is thus the most suitable candidate for the project, together with some medium-scale industries contributing to the peak. In both cases, typical loads are likely to be in the 20-200 kW range and can justify sizable investments. In addition, each participant in these groups, e.g., hotels, supermarkets, hospitals, medium-size industries, has a full-time trained technician that will be a great asset for the project's day-to-day operation. Moreover, each establishment is -- or can easily be -- equipped with adequate metering systems.

This phase will consist of the following tasks:

Task 1: Finalize ICE and GOCR commitment to the project.

Task 2: Select, with ICE, the optimal sample of participating establishments to maximize chances of success for Phase 2 and replicability, probably around 40, of which 20 are in the commercial sector (5 hotels, 5 hospitals, 5 office buildings, and 5 "other") and the other 20 in small/medium industries around San Jose.

Task 3: Define detailed organization arrangements, i.e., role of DSE, ICE, participants, equipment suppliers, and consultants.

Task 4: Develop detailed budget for Phase 2.

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[1] Which is about 10 times the average LDC figure (50 W).

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Task 5: Conduct preliminary cost-benefit analysis for Phase 2. The goal should be not less than a 10 percent peak load reduction in Phase 2.

Task 6: Get final agreement and commitments from all parties involved in the project.

**Phase 2: Demonstration**

This phase, which will be defined in detail at the end of Phase 1, is likely to consist of the following tasks:

Task 1: Preparation. In this task, the Contractor and the counterparts will revisit the participating establishments to make arrangements (e.g., data, staff requirements) for installing the LMT equipment and associated metering instruments. At this time, it is difficult to anticipate exactly what type of "hardware" will be needed, but one can assume that there will be two categories of equipment: (1) direct load management devices and associated meters (at each participating location) and (2) the data transmission and analysis (including software) components.

The Contractor will also develop ICE's monitoring system, which will probably be computerized. For example, direct communication between ICE's counterpart team and the participating establishments may be required. Detailed hour-by-hour baseline load curves will need to be developed for not less than one month in each establishment to allow accurate measurement of peak reduction during the demonstration and after, correcting for seasonal factors. During this task, all training, e.g., for ICE and participating technicians will be carried out. This step is likely to take about two months for two consultants, one with direct experience of one U.S. electric utility programs.

Task 2: Demonstration. This task will consist of the implementation of the LMTs during a period of not less than three months, with on-the-job training for the ICE team. During this period, no more than two man months of consultant time are expected to be needed to oversee ICE activities.

Task 3: Evaluation and preparation of final report. In this task, quantitative data collected during the previous task, together with a survey of reactions from participating establishments, will be analyzed to estimate project costs and benefits and recommend next tasks. This task is likely to require three man months of consultant time, including report preparation.

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**Phase 3: Dissemination (Prepare Nationwide Implementation Program)**

This phase can only be designed and costed after completion of Phase 2. However, it is likely to result in a multiyear, multimillion dollar program submitted to international lending organizations such as the World Bank and the Inter-American Development Bank for funding. Possible savings resulting from such a phase would be in the order of $10-20 million (rough estimate).

Counterpart. Two agencies would be involved as counterparts: ICE must be the implementing agency with day-to-day responsibility for all aspects, especially technical, of the project and to a lesser extent DSE, because of its overall energy planning responsibilities. The exact definition of the counterpart role, including personnel and equipment, will be part of Phase 1.

This program could delay large public investments by several years and has the potential to save considerable foreign exchange for Costa Rica in the future. And most importantly, the project will develop a local capability within ICE to expand and continue using more and more efficient load management techniques and thereby make ICE a leader in Central America in this field. This project must therefore be seen as an ambitious technology and know-how transfer effort at the conclusion of which load management activities in Costa Rica will be handled mostly by local staff with minimum outside consultancy support.

## APPENDIX B: IMPROVING UTILITY LOAD PROFILES

### Strategy

U.S. experience suggests a variety of load management strategies to modify a utility load curve. These strategies can be divided into two types: direct load control and indirect load control.

Direct Load Control refers to programs in which the utility is able to take actions to modify the daily load curve at desired times. The simplest forms of direct load control entail the use of fuses, time switches, appliance interlocks, and other types of demand limiters that do not involve remote activation by the utility. In contrast, appliance cycling programs are activated and controlled by the utility. The most common of these involve the on-and-off cycling of residential water heaters and air conditioners and commercial and industrial central air conditioning systems during times of generation (or network) deficiencies.

Indirect Load Control refers to utility programs involving customer control of loads in response to price signals. The most common examples of indirect load control are:

- Demand charge tariffs where billing demand is measured coincident with system peak
- Time-of-use (TOU) tariffs
- Water heater off-peak rates
- Dynamic tariffs
- Dynamic curtailable tariffs
- Demand subscription service
- Real time/spot-price-based tariffs.

Coincident demand metered tariffs and TOU tariffs require special metering equipment. However, no communication link is needed between the utility and the customer, as the peak periods and prices are specified well in advance.

Most utilities prefer direct load control or a combination of direct and indirect control. However, each utility must analyze its needs, identify its specific objectives for load management, and then select the method or combination of methods that is most appropriate.

## Load Control Technologies and Techniques

A wide variety of load control technologies are available for load management applications. Two types of control systems are addressed here: remote load control systems and local control systems.

Remote Load Control Systems require a load controller at the customer's premises that can switch the loads off as required, and a communications system linking the utility dispatcher and the load controller.

Four basic media are used for transmitting the signal, and all remote control systems use some variation or a combination of them:

- Radio: These systems use FM transmitters to transmit control signals to radio receiver switches at the point of control. Widely used and with predictable performance, the cost per control point tends to be less than for other communication and control systems.
  - FM-VHF
  - AM broadcast
  - FM broadcast (FM-SCA)
- *Power Lines*

  Ripple Control: These systems transmit low frequency signals using the utility's transmission and distribution network as a medium. The impulses are received by ripple control receivers at the point of control.

  Power Line Carrier: These systems transmit high frequency signals using the utility's transmission and distribution network as a medium. For bi-directional communications, transponders are used at the point of control, adding monitoring capabilities. The economics of such a system become more favorable with applications involving large numbers of control points.

  Power Frequency Carrier: These systems modify the 60 cycle sine wave at the sub-transmission or distribution network level. The modifications are decoded by the equipment at the customer's site. For bi-directional communications, current pulses are created at the customer's site, which are detected by the substation communications equipment and transmitted to the central controller.

- Telephone: Having load control capabilities similar to the power line carrier system, this system uses a telephone interface to achieve load control using a central computer at the utility.

- Cable TV (CATV): These systems use existing cable television networks to transmit and receive signals to and from a controller at the customer's site.

  The advantage of cable is its capacity to transmit at high data rates. However, the disadvantage is the limited coverage in some utility areas.

- Local Control Systems are normally used by customers and some utilities to control the customer's loads. Some examples of local control systems are:

- Interlock (priority relay): These current sensing devices prevent the simultaneous operation of two or more high loads.

- Time Controllers: These are electronic devices used to turn off or duty cycle loads such as compressors, HVAC, pumps, motors, refrigeration systems, and lighting at pre-determined times.

- Demand Limiters: These range in size from small microprocessors to larger computer-controlled energy management systems and can be used to limit demand by deferring or duty cycling loads in a pre-programmed manner.

- Energy Management Systems (EMS): These systems are microprocessor-based and are used to provide a variety of control functions for loads in a facility. The functions include: time-of-day scheduling, demand control, duty cycling of equipment, priority scheduling, and automatic temperature setback/set-up. Because of the wide diversity of EMS product offerings, an in-depth study is needed to determine the compatibility of the system with the needs of the facility.

The major disadvantage of local control systems is that the utility does not have discretion over these systems' activation, timing, or degree of control. For this reason, utilities more often select remote load control systems than local control ones. In addition, local control systems are more likely to fall out of synchronization and thus fail to function when they are needed by the utility, as in the case of time clocks after long power outages.

## APPENDIX C: LIST OF CONTACTS

**Thursday, June 9, 1988**

**ICE**
San Jose

Ing. Jose Manuel Fernandez, Head of Distribution Directorate
Ing. Arnoldo Arias, Head of Quality Control Office, Central Region
Ing. Jose Fco. Carballo, Head of Quality Control Office, Guanacaste and Pacific Central Region
Ing. Felipe Corriols, Head of Quality Control, Atlantic Region and South
Ing. Hernan Robles, Technical Consultant to Management
AS, RK, JG*

**Friday, June 10, 1988**

**HOTEL CARIARI**
Alejuela

German Berna, Assistant Manager
Rafael A. Jara, Technical Maintenance Manager
AS, JG, RK, JC

**RAFYTICA**
El Coyol Alajuela

Lic. Arturo Quiroz, General Manager
AS, RK, JG, JC

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* Hagler, Bailly, FPL Qualtec and ICE staff members:

| | | | |
|---|---|---|---|
| AS: | Alain Streicher | JC: Jose Carballo | MT: Manuel Triqueros |
| RK: | Robert Kowalski | FC: Felipe Corriols | LA: Luis Acuna |
| JE: | Jeff Erickson | | |
| JG: | Juan Gonzalez | AA: Arnoldo Arias | |

Monday, June 13, 1988

**CONDUCEN**
San Antonio de Belen

Ing. Jose Luis Ulate, Head of Plant Engineering and Maintenance
Ing. Clodoveo Gonzalez, Production
Ing. Rodrigo Calderon, Production Programming & Control
Jorge Jimenez, Technician
RK, JG, AA

**COMPANIA NUMAR**
San Jose

Ing. Saverio Altamura, Manager of Production and Maintenance
AS, FC

**TICATEX**
La Asencion

Ing. Luis Lanzoni, Maintenance
Ing. Tako Wanatabe, Production Manager
JG, AA

**URGELLES Y PENON**
Alajuela

Ing. Eugenio Penon, General Manager
Ing. Rafael Aguero, Technical Consultant
JG, AA, RK

**SCOTT PAPER DE COSTA RICA**
San Antonio de Belen

Ing. Joaquin Lizano, Vice President, Development & Engineering
AS, RK, JG, FC, AA

**SOL 2000**
San Jose

Ing. Juan Rojas, Manager
Ing. Ismael Mazon, Consulting Engineer
AS, RK, JG

**Tuesday, June 14, 1988**

**FABRICA NACIONAL DE LICORES**
Grecia, Alajuela

Ing. Jose Mendes, Head of the Alcohol Distillery
RK, JG, JC

**ICE**
San Jose

Ing. Jose Manuel Fernandez, Head of Distribution Directorate
AS, RK, JG, JC, FC, AA

**INDUSTRIA AKRON (FIRESTONE)**
Alajuela

Ing. Mario Crespo, Head of Production Department
Ing. Jesus Hernandez, Plant Engineering
RK, JG, JC

**I.C.A.A. (Water Utility)**
San Jose

Herbert Farrer, General Manager
RK, JG, JC

**Thursday, June 16, 1988**

**MINAS MONCADA**
San Ramon

Gonzalo Moncada, President
RK, JC

**ALUNASA**
Esparza, Puntarenas

Ing. Osvaldo Gonzalez, Head of Maintenance Department
RK, JC

**DISENOS ELECTRICOS (Consulting engineers)**
San Jose

Ing. Fernando Moya, Electrical Engineer

**Tuesday, June 21, 1988**

**EL ANGEL**
Cinchona, Alajuela

Jose Luis Kutscheraurer, Vice President
Joan Clark, President and Administration
RK, JC, AA, Uriel Cespes (ICE)

**CNFL**
San Jose

Ing. Gerardo Sarraga, Head of Office of Control of Measurement and Energy
RK, JC

**Thursday, June 23, 1988**

**ALUNASA**
Esparza, Puntarenas

Ing. Rodrigo Martinez, Operations Manager
Ing Osvaldo Gonzalez, Head of Maintenance Department
Ing. Carlos Sosa, Production Manager
RK, F. Moya (Disenos Electricos)

**COOPEMONTECILLOS, Barranca Division**
Barranca

Ing. Juan Sequeira, Manager
Jorge I. Franceschi, Maintenance Supervisor
Victor Venegas, Electrician
RK, F. Moya

**FERTICA**
Barranca, Puntarenas

Walter Blanco, Plant Manager
Felix A. Bolanos, Production Superintendent
Wilber Sosa, Maintenance Superintendent
RK, F. Moya

**CEMPA**
Abangares, Guanacaste

Ing. Enrique Acosta, Technical Manager
Ing. Arnoldo Alonso, Head of Electricity Conservation
RK, F. Moya

**Monday, June 27, 1988**

**SCOTT PAPER DE COSTA RICA**
San Antonio de Belen

Ing. Joaquin Lizano, Vice President, Development & Engineering
JC, FC

**Tuesday, June 28, 1988**

**SOL 2000**
San Jose

Ing. Juan Rojas, Manager
RK, JC

**Thursday, June 30, 1988**

**ICAITI**
San Jose

Ing. Luis Fdo. Arce, Assistant
Ing. Agustin Rodriguez, Assistant
RK, JC, FC

**Friday, July 1, 1988**

**REPRESENTACIONES MARIO CANTILLO**
San Jose

Mario Cantillo, President
RK, FC

Tuesday, August 16, 1989

**AGECOSA**
San Jose

Oscar Garcia Pinto, General Manager
RK

Wednesday, August 17, 1989

**DISENOS ELECTRICOS (Consulting engineers)**
San Jose

Ing. Fernando Moya, Electrical Engineer
RK, JC

**SOL 2000 (Consulting engineers)**
San Jose

Ing. Juan Rojas
RK, JC

Thursday, August 18 and Friday, August 19, 1989

**CIA. ERIC MURRAY**
San Jose

Ing. Bernardo Mendez, Technical Manager
RK

Tuesday, August 23, 1989

**ICE**
San Jose

Ing. Hernan Robles, Technical Consultant to Management
RK

**Wednesday, August 24, 1989**

**ICE**
San Jose

Ing. Jose Manuel Fernandez, Head of Distribution Directorate
RK, JC, FC, AA

**SOL 2000**
San Jose

Ing. Juan Rojas, Manager
RK, JC

**Thursday, August 25, 1989**

**INGENIO TABOGA**
Heredia

Fabio A. Robelo, Vice President
RK, JC

**ICE METER LABORATORY, COMPUTER SECTION**
Colima

Jorge Duran, Computer Specialist
Jorge Rojas, Computer Specialist
RK, JC, FC

**Friday, August 26, 1989**

**CNFL**
San Jose

Ing. Gerardo Sarraga, Head of Metering Control & Energy
RK, JC, FC

Monday, August 29, 1989

**CARNES DE CENTRO AMERICA**
La Ribera, Belen

Harry Valverde, Plant Manager
RK, JG, AA



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**Tuesday, August 30, 1988**

**ICE**
San Jose

Agustin Rodriguez, Head of Electrical Planning Directorate
Luis Soto Rodriguez, Head of Tariff Department
RK, JG, JC, FC

**Wednesday, August 31, 1988**

**EL GALLITO INDUSTRIAL**
San Jose

Ing. Luis P. Lopez, Head of Electrical Maintenance
RK, FC, JC, Alonso Valverde and Fernando Monto (CNFL)

**RAFYTICA**
El Coyol Alajuela

Lic. Arturo Quiroz Mercado, General Manager
Ronald Arias, Head of Maintenance
RK, FC, JC

**COOPEMONTECILLOS, R.L., Slaughterhouse**
Alajuela

Ing. Alberto Romero R., Maintenance Department
RK, AA

**INDUSTRIA AKRON DE COSTA RICA (Firestone)**
Alajuela

Ing. Jesus Hernandez, Head of Maintenance,
Metropolitan Aqueduct
RK, AA

**Thursday, September 1, 1988**

**DISENOS ELECTRICOS (Consulting engineers)**
San Jose

Ing. Fernando Moya
RK

**I.C.A.A. (Water utility)**
San Jose

Ing. Isidro Solis Blanco, Operations Department
Metropolitan Aqeduct
RK, FC, JC

**Friday, September 2, 1988**

**CONDUCEN**
San Antonio de Belen

Ing. Jose Luis Ulate, Head of Plant Engineering & Maintenance
RK, JC, FC

**ALIMENTOS JACK'S**
San Jose

Ing. Luis Solis, Head of Plant Engineering & Maintenance
RK, FC, JC

**Tuesday, September 6, 1988**

**URGELLES Y PENON**
Alajuela

Dipl. Ing. Eugenio Penon, General Manager
RK, AA

**Thursday, September 8, 1988**

**ROMA PRINCE, S.A.**
Alajuela

Benjamin Nunez, Head of Maintenance
Ing. Armando Gutierrez, Consultant
Antonio Guadamuz, Plant Supervisor
Carlos Luis Mendez, Head of Production
RK, AA



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**PUNTO ROJO**
Alajuela

Bernal Soto Ch., General Manager
Ing. Arnoldo Garcia, Head of Maintenance
RK, AA

Monday, September 12, 1988

**CERVECERIA COSTA RICA**
Alajuela

Ing. Rafael A. Ferraro, Production Manager
RK, JE, JC

**ICE METER LABORATORY, COMPUTER SECTION**
Colima

Ing. Aguilar, Head of Computer Section
Jorge Duran, Computer Specialist
Jorge Rojas, Computer Specialist
RK, JE, FC

Tuesday, September 13, 1988

**DISENOS Y MONTAJES (Consulting engineers)**
San Jose

Ing. Edgar Alexis Maldonado, General Manager
RK, FC

**ICE ELECTRONIC COMPUTATION DEPARTMENT**
San Jose

Pablo Rojas, Department Head
Ivan Gano, Assistant to Department Head
RK, JE

**Wednesday, September 14, 1988**

**ELVATRON, S.A.**
San Jose

Ing. Rafael Araya
RK

**Thursday, September 15, 1988**

**SOL 2000 S.A.**
San Jose

Ing. Juan Rojas
RK, JE

**Friday, September 16, 1988**

**DIRECCION SECTORIAL DE ENERGIA**
San Jose

Jacqueline Wing Chin Jones, Computer Section
RK

**Monday, September 19, 1988**

**GARCIA Y MAURO (Consulting engineers)**

Ing. Carlos Manuel Garcia, Consulting Engineer
RK, JC, FC

**Tuesday, January 31, 1989**

FABRICA NACIONAL DE LICORES
Grecia, Alajuela

Ing. Eugenio Alpizar, Head of Electrical-Mechanical Systems Section
RK, AA, MT

Thursday, February 2, 1989

**COOPEVICTORIA (Beneficio)**
Grecia, Alajuela

Ing. Franklin Montero Mora, Head of Central Electrical Department
Abel Antonio Monge B., Head of Production
RK, AA, MT

**COOPEMONTECILLOS, R.L., Leather Division (Curtidos)**
Alajuela

Ing. Carlos Herrera, Maintenance Department
RK, AA, MT

Friday, February 3, 1989

**COOPEMONTECILLOS, R.L., Meat Division (Matadero)**
Alajuela

Ing. Alberto Romero R., Maintenance Department
Lic. Carlos Rojas Ramirez, Head of Administration
RK, AA, MT

**INDUSTRIA AKRON DE COSTA RICA (Firestone)**
Alajuela

Ing. Jesus Hernandez, Head of Maintenance
RK, AA, MT

**TICATEX**
La Asuncion, Belen

Ing. Luis A. Fernandez, Head of Electrical Section, Plant Engineering
RK, AA, MT

Monday, February 6, 1989

**EL GALLITO INDUSTRIAL**
Guadalupe

Ing. Alejandro Odio, Director of Maintenance
Ing. Luis P. Lopez, Head of Electrical Maintenance
RK, FC

**I.C.A.A.**
San Jose

Ing. Jose Carlos Solano Rodrigues, Director of Operations
Ing. Isidro Solis, Operations Department
Ing. Walter Soto Murillo, Head of Pumping Department
Ing. German Araya Montezuma, Systems Optimization Department
Ing. Saul Trejos, Systems Optimization Department
RK, FC

**CARNES DE CENTROAMERICA**
La l ɔera, Belen

Harry Valverde, Gerente de Planta
RK, AA, MT

**URGELLES Y PENON**
Alajuela

Dipl. Ing. Eugenio Penon, General Manager
AA, MT

**Tuesday, February 7, 1989**

**CONDUCEN**
San Antonio de Belen

Ing. Jose Luis Ulate, Head of Plant Engineering & Maintenance
RK, AA, MT

**Wednesday, February 8, 1989**

**SCOTT PAPER DE COSTA RICA**
San Antonio de Belen

Ing. Eduardo Diaz, Head of Electrical Maintenance
RK, FC, LA

**RAFYTICA**
El Coyol Alajuela

Lic. Arturo Quiroz Mercado, General Manager
RK, FC, LA

**Monday, February 13, 1989**

**DISENOS Y MONTAJES S.A.**
San Jose

Ing. Edgar Alexis Maldonado, General Manager
RK, FC

**Tuesday, February 14, 1989**

**INGENIO TABOGA, S.A.**
Heredia

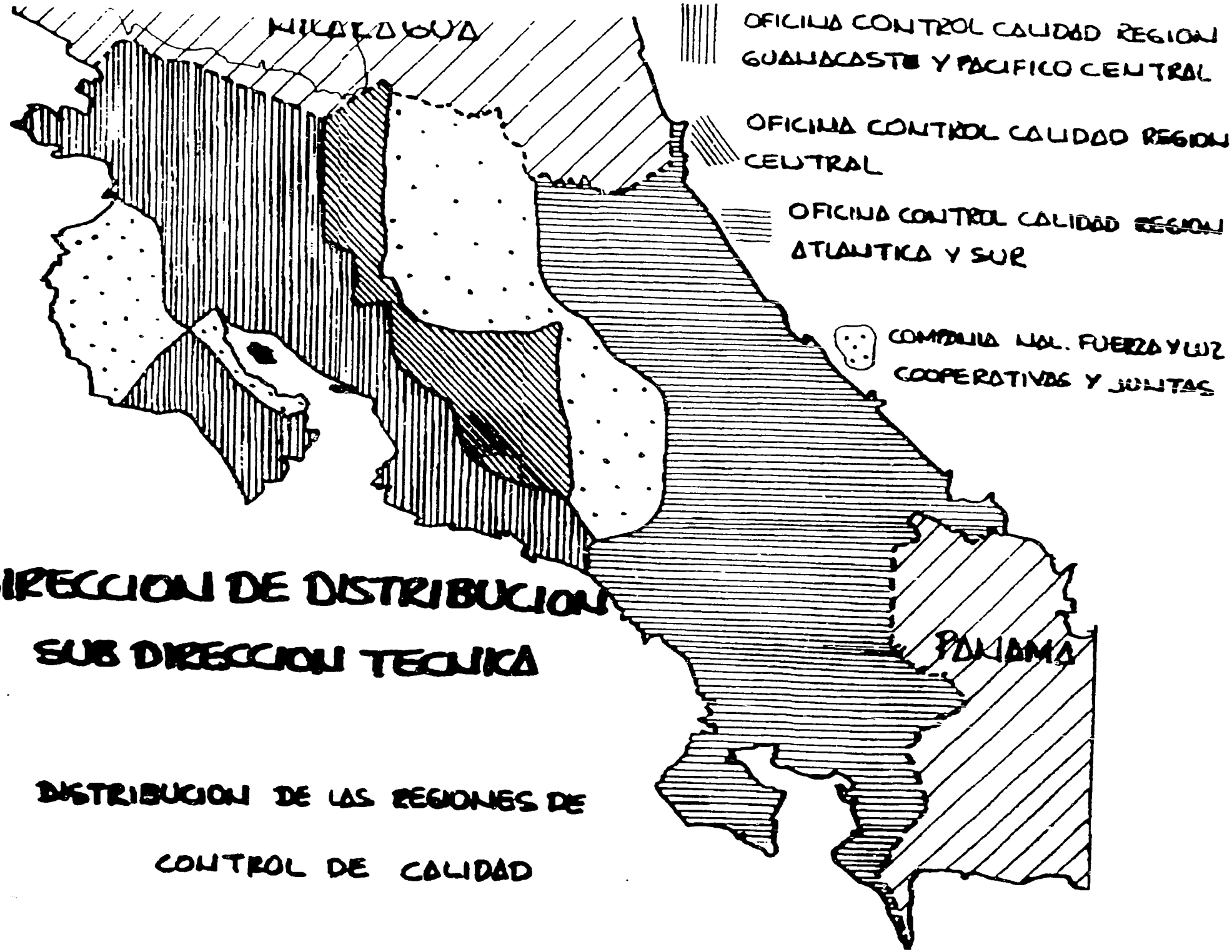
Fabio A. Robelo, Vice President
RK, JC

**Friday, February 17, 1989**

**ICE**
San Jose

Ing. Jose Manuel Fernandez, Head of Distribution Directorate
RK, JC, FC

## APPENDIX D: MAP OF ICE QUALITY CONTROL OFFICE REGIONS



# APPENDIX E: PROJECT MONITORING TABLE

Page No 1
02/19/89

DEPARTAMENTO REDES ELECTRICAS REGION ATLANTICA Y SUR
OFICINA CONTROL DE CALIDAD
ESTUDIO SOBRE MANEJO DE CARGA

| CODIGO | NOMBRE DE EMPRESA | APDO. POST. | NUMERO TELEF. | DIRECCION | TIPO DE INDUSTRIA | TAMANO EMPRESA | PERIODO OPERAC | CAPACIDOCIOSA % | PERSONA ENCARGADA | FECHA VISITA | ASISTENTE A REUNION | CARTA FIRMADA |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | TICATEX | 0 | 39-0011 | SAN JOSE,COSTA RICA | TEXTIL | | 0 | 0 | ING LUIS A.FERNANDEZ | 02/03/89 | | |
| 2 | CONDUCEN | 0 | 39-1222 | AUTOPISTA GRAL.CAPAS | CABLES | GRANDE | 12 | 20 | ING. JOSE L. ULATE | 02/06/89 | ING. JOSE L. ULATE | |
| 3 | HOTEL CARIARI | 737 | 39-0022 | AUTOPISTA GRAL.CAPAS | HOTELERA | | 0 | 0 | ING. CARLOS ROESCH | 06/10/88 | SR. GERMAN BERNA | SI |
| 4 | CIA KUMAR | 0 | 23-9666 | BARRIO CUBA,SAN JOSE | ALIMENTICIA | | 0 | 0 | ING.GUSTAVO BODAN V | 06/13/88 | | |
| 5 | CERVECERIA C R | 0 | 41-0222 | RIO SEGUNDO,ALAJUELA | CERVEZA | GRANDE | 12 | 0 | SR. RAFAEL FERRARO | 09/12/88 | | |
| 6 | FAB NACIONAL LICORES | 5015 | 44-5458 | GRECIA | LICORES | | 0 | 0 | ING EUGENIO ALPIZAR | 01/31/89 | | |
| 7 | FERTICA | 5350 | 63-0080 | BARRANCA,PUNTARENAS | ABONOS | GRANDE | 0 | 0 | SR.FELIX BOLAPOS A. | 06/23/88 | | SI |
| 8 | FAB HIELO GUTIERREZ | 0 | 61-0904 | PUNTARENAS | HIELO | | 0 | 0 | | 11/05/87 | | |
| 9 | EL ARREO | 0 | 39-0655 | SAN ANTONIO DE BELEN | PROC.CARNES | | 0 | 0 | SR. HARRY VALVERDE | 02/03/89 | | SI |
| 10 | HOTEL TAMARINDO | 0 | 60-0652 | TAMARINDO,GUANACASTE | HOTELERA | | 0 | 0 | | 11/06/87 | | |
| 11 | PRODUCTOS GERBER | 0 | 25-8411 | BO.ESCALANTE,SN.JOSE | ALIMENTICIA | | 0 | 0 | SR.ROY D. ARAGON | 04/21/88 | | SI |
| 12 | EL GALLITO INDUSTRIA | 623 | 24-2424 | GUADALUPE | CONFITERIA | GRANDE | 0 | 0 | ING.ALEJANDRO ODIO | 02/06/89 | ING. LUIS P. LOPEZ | SI |
| 13 | COOPEVICTORIA(INGEN) | 0 | 44-5638 | GRECIA | AZUCAR | | 0 | 0 | ING.RAFAEL CARTIN | 10/11/87 | | SI |
| 14 | RICALIT | 3482 | 51-0866 | CARTAGO | MAT.CONSTRUC | | 0 | 0 | ING HARALD LULING | 11/10/87 | | SI |
| 15 | SCOTT PAPER CIA CR | 10271 | 24-2222 | SAN ANTONIO BELEN | PROC. PAPEL | GRANDE | 0 | 0 | ING. EDUARDO DIAZ | 02/08/89 | | SI |
| 16 | CEMPA | 6558 | 68-5469 | COLORADO,GUANACASTE | CEMENTO | GRANDE | 8 | 0 | ING.ENRIQUE ACOSTA | 06/23/88 | ING. ARNOLDO ALONSO | SI |
| 17 | HACIENDA LA LUISA SA | 0 | 45-4011 | SARCHI | | | 0 | 0 | | / / | | |
| 18 | AVICOLA LA GARITA | 0 | 48-7676 | LA GARITA,ALAJUELA | CARNES(AVES) | | 0 | 0 | LIC. SERGIO VENEGAS | 03/17/88 | | |
| 19 | CARTAGO BEEF PACKING | 0 | 0 | CARTAGO | PROC.CARNES | | 0 | 0 | DR. MAX FIGUEROA | / / | | |
| 20 | CIA MINERA ESPERANZA | 0 | 0 | | | | 0 | 0 | | / / | | |
| 21 | INGENIO TABOGA S A | 0 | 37-3582 | CAPAS,GUANACASTE | AZUCARERA | | 0 | 0 | SR. FABIO A. ROBELO | 02/14/89 | | SI |
| 22 | COOPEAGRI FL GENERAL | 0 | 71-0593 | S ISIDRO DEL GNRAL. | CAFETALERA | | 0 | 0 | ING.RICARDO CASTRO R | / / | | SI |
| 23 | CIA BANANERA DE C.R | 0 | 0 | PALO VERDE | BANANO | | 0 | 0 | ING.CARLOS MATAMOROS | 06/10/88 | | |
| 24 | CIA BANANERA DE C R | 0 | 0 | NARANJOS | BANANO | | 0 | 0 | | / / | | |
| 25 | ENVACO MED #1 | 0 | 53-1035 | SAN JOSE | ENVASES | | 0 | 0 | | / / | | |
| 26 | FLORENCIA COFFEE CO | 0 | 56-0308 | FLORENCIA, TURRIALBA | CAFETALERA | | 0 | 0 | SR. RODRIGO HIDALGO | 03/23/88 | | |
| 27 | HACIENDA ATIRRO LTDA | 0 | 56-1002 | ATIRRO, TURRIALBA | CAFETALERA | | 4 | 0 | SR. CARLOS CARTIN | / / | | |
| 28 | CTL AZUCAR TURRIALBA | 0 | 56-1002 | TURRIALBA | AZUCARERA | | 0 | 0 | ING. ARTURO ROJAS V | 03/23/88 | SR. CARLOS CARTIN | SI |
| 29 | TALMANA S A | 0 | 61-0719 | PUNTARENAS | | GRANDE | 12 | 0 | ING. AGUILAR,OERENTE | 03/22/88 | | |
| 30 | AZUCARERA EL PALMAR | 0 | 68-3903 | MIRAMAR,PUNTARENAS | AZUCARERA | GRANDE | 0 | 0 | SR. ADRIAN DOBLES | 03/22/88 | | |
| 31 | COOPEMONTECILLOS (A) | 0 | 41-3233 | ALAJUELA | PROC CARNES | | 12 | 0 | ING. ALBERTO ROMERO | 02/03/89 | SR. CARLOS RODRIGUEZ | SI |
| 32 | COOPEMONTECILLOS (B) | 4105 | 73-0766 | BARRANCA,PUNTARENAS | PROC.CARNES | | 9 | 0 | SR. JUAN SEQUEIRA | 03/22/88 | | SI |
| 33 | CROWN CORK, S A | 0 | 41-6255 | AUTOPISTA GRAL.CAPAS | | GRANDE | 0 | 0 | SR. MAXIMO LAU | 03/17/88 | | |
| 34 | KAM LUNG | 0 | 28-7044 | SANTA ANA | | | 0 | 0 | ING. RANDALL JIMENEZ | 03/16/88 | | |
| 35 | PRODUC. DE CONCRETO | 0 | 39-1622 | SAN RAFAEL,ALAJUELA | MATER CONST | | 0 | 0 | ING. M. VILLARREAL | 03/10/88 | | |
| 37 | I C A A (P MULAS) | 5120 | 55-0439 | PUENTE MULAS | AGUA | | 0 | 0 | ING. HERBERT FARRER | 09/01/88 | ING. WALTER SOTO | |
| 38 | I C A A (ESCAZU) | 5120 | 55-0439 | ESCAZU | AGUA | | 0 | 0 | ING. HERBERT FARRER | 09/01/88 | ING. WALTER SOTO | |
| 39 | PUNTO ROJO | 160 | 41-5833 | ALAJUELA | JABONES | GRANDE | 12 | 45 | SR. BERNAL SOTO | 09/09/88 | | SI |
| 40 | ICE | 0 | 20-7875 | SABANA NORTE | | | 0 | 0 | ING JOSE CARBALLO | 11/02/87 | | SI |
| 41 | ARROCERA LOS SAUCES | 0 | 77-9019 | PARRITA | ARROCERA | MEDIANA | 0 | 0 | SR. ORLANDO HEILBRON | / / | | SI |
| 42 | URGELLES Y PENON | 0 | 42-1091 | ALAJUELA | MUEBLES | MEDIANA | 12 | 0 | ING. EUGENIO PENON | 02/06/89 | | SI |
| 43 | IND AKRON DE C R | 4018 | 39-0188 | | LLANTAS | GRANDE | 0 | 0 | ING JESUS HERNANDEZ | 02/03/89 | | |
| 44 | PORTICO | 71730 | 37-2550 | | PUERTAS | GRANDE | 0 | 0 | ARQ BARRENECHEA | 12/11/87 | | |
| 45 | ALUNASA | 21 | 63-5522 | ESPARZA,PUNTARENAS | PR ALUMINIO | GRANDE | 0 | 0 | ING OSVALDO GONZALEZ | 06/23/88 | ING. CLAUDIO VOLIO P | SI |
| 46 | EL ANGEL S A | 7775 | 47-2078 | CINCHONA,ALAJUELA | ALIMENTICIA | MEDIANA | 12 | 0 | SR JOSE KUTSCHERAVER | 06/21/88 | SR. RICARDO DIAZ | SI |
| 47 | LAMINADORA COSTARRIC | 2007 | 33-1861 | SAN JOSE | | | 0 | 0 | | 11/11/87 | | |
| 48 | INDUST. NAC. CEMENTO | 0 | 51-0922 | CARTAGO | CEMENTO | | 0 | 0 | | 03/11/87 | | |
| 49 | HOSPITAL MEXICO | 0 | 0 | LA URUCA,SAN JOSE | SERV MEDICOS | | 0 | 0 | | 11/04/87 | | |
| 50 | CAFETALERA PILAS | 3997 | 22-6722 | NARANJO | CAFETALERA | | 0 | 0 | SR ROBERTO KOPPER O | 04/11/87 | | |
| 51 | MOLINOS DE C R | 0 | 41-1414 | ALAJUELA | ALIMENTICIA | | 0 | 0 | SR ENZO PRDARA | 11/09/87 | | |
| 52 | HOTEL AURORA | 0 | 33-7233 | SAN JOSE | HOTELERA | | 0 | 0 | | 11/11/87 | | |
| 53 | CAPERA SAN RAMON | 0 | 0 | SAN RAMON | CAFETALERA | | 0 | 0 | | / / | | SI |
| 54 | HOTEL EUROPA | 0 | 22-1222 | SAN JOSE | HOTELERA | | 0 | 0 | | / / | | |
| 55 | BORDA AZUL | 5400 | 0 | PUNTARENAS | | | 0 | 0 | | / / | | |
| 56 | MILLER HERMANOS | 0 | 22-4244 | SAN JOSE | OXIGENO | | 0 | 0 | HANS MILLER | 11/10/87 | SR. CARLOS MILLER | SI |
| 57 | RAFITICA, S A | 714 | 43-8511 | COYOL DE ALAJUELA | FABR. SACOS | | 12 | 30 | LIC. ARTURO QUIROS | 02/08/89 | | SI |
| 58 | ICE-SAN PEDRO | 0 | 0 | SAN PEDRO,SAN JOSE | | | 0 | 0 | | / / | | SI |
| 59 | ICE-PAVAS | 0 | 0 | PAVAS, SAN JOSE | | | 0 | 0 | | / / | | SI |
| 60 | MINAS MONCADA | 3694 | 45-6038 | SAN RAMON | | | 0 | 0 | SR. GONZALO MONCADA | 06/16/80 | | |
| 61 | HOTEL COROBICI | 0 | 32-8122 | SAN JOSE | HOTELERA | | 0 | 0 | | / / | | |
| 62 | ALIMENTOS JACKS | 0 | 32-0483 | PAVAS | ALIMENTICIA | GRANDE | 12 | 0 | SR. LUIS SOLIS R | 09/02/88 | | |
| 63 | INCOFER | 0 | 0 | SAN JOSE | SERV TRENES | | 0 | 0 | | / / | | |
| 64 | ARROCERA EL CEIBO | 0 | 75-0316 | GOLFITO | ARROCERA | | 0 | 0 | SR. ORLANDO HEILBRON | / / | | SI |
| 65 | BENEFICIO SN ANTONIO | 0 | 26-0315 | SN ANTONIO,DESAMPAR | CAFETALERA | | 0 | 0 | SR. RICARDO SEEVES F | / / | | SI |
| 66 | COOPESANJUANILLO | 0 | | | CAFETALERA | | 0 | 0 | SR. LUIS G ROJAS V | / / | | SI |
| 67 | COOPESABALITO | 0 | 77-3331 | SABALITO | CAFETALERA | | 0 | 0 | SR. BOLIVAR FONSECA | / / | | SI |
| 68 | COOPROSANVITO | 0 | | | CAFETALERA | | 0 | 0 | SR. CLAUDIO ESQUIVEL | / / | | SI |
| 69 | COOPEATENAS | 0 | 46-8350 | | AGROPECUARIA | | 0 | 0 | LIC. LEONIDAS LOPEZ | / / | | SI |
| 70 | COOPEPALMARES | 0 | | | CAFETALERA | | 0 | 0 | SR. LUIS C. CASTILLO | / / | | SI |
| 71 | COOPEVICTORIA | 0 | | | CAFETALERA | | 0 | 0 | ING FRANKLIN MONTERO | 02/02/89 | | SI |
| 72 | COMPANIA BANANERA CR | 0 | 75-3269 | CORREDORES,COTO 54 | PALMA AFRIC | | 0 | 0 | ING. MANUEL SERRANO | 07/05/88 | ING. MANUEL SERRANO | SI |
| 73 | EL ALAMO S A | 0 | 37-0366 | | | | 0 | 0 | SR. JORGE E. KOPPER | / / | | |
| 74 | I C A A | 5120 | 55-0439 | LA VALENCIA,HEREDIA | AGUA | | 12 | 0 | ING. HERBERT FARRER | 09/01/88 | ING. WALTER SOTO | |
| 75 | I C A A | 5120 | 55-0439 | LA URUCA SUR | AGUA | | 12 | 0 | ING. HERBERT FARRER | 09/01/88 | ING. WALTER SOTO | |
| 76 | COOPECAFIRA R L | 0 | | | | | 0 | 0 | ING. ALVARO RAMIREZ | / / | | |
| 77 | YAMBER | 0 | 23-7333 | SAN JOSE,AV 10 C.28 | POLIETILENO | | 0 | 0 | ING HERNAN ECHEVERR | / / | | |

E.2.

ESTUDIO SOBRE MANEJO DE CARGA
PAG No 2

| CO DI GO | NOMBRE DE EMPRESA | TA RI FA | MAXIMA DEMANDA KW | DEMANDA COINCID KW | REDUCC DEMANDA KW | CONSUMO MENSUAL KWH | DATA STAR INSTAL | CINTA MAGNET INSTAL | CONTROL MANUAL | MANEJO CARGA FUNCION | RED CONS | PARTIC PROGRAM | OBSERVACIONES | FECHA DATOS | ZONA |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | TICATEX | B | 2477 | 2310 | 164 | 1191607 00 | SI | SI | | / / | | | | | |
| 2 | CONDUCEN | B | 606 | 340 | 148 | 151500 00 | SI | SI | | / / | SI | | CARTA INTENC PENDIEN | 06/26/88 | CENTRAL |
| 3 | HOTEL CARIARI | 2/3 | 110 | 0 | 0 | 35377 00 | | | | / / | | SI | ETAPA DE PRUEBAS | 09/02/88 | CENTRAL |
| 4 | CIA NUMAR | 6 | 960 | 600 | 100 | 579406 00 | SI | SI | | / / | SI | | PENDIENTE INSTALAC | 06/26/88 | CNFL |
| 5 | CERVECERIA C R | 3 | 1600 | 1600 | 0 | 672000 00 | | | | / / | | | CARTA INTENC PENDIEN | 06/26/88 | CNFL |
| 6 | FAB NACIONAL LICORES | B | 576 | 475 | 0 | 23337 00 | | SI | | / / | | | HACEN ESTUDIO PRELIM | 09/12/88 | CNFL |
| 7 | FERTICA | B | 5493 | 3850 | 1700 | 2574326 00 | SI | SI | SI | / / | | SI | CARTA INTENC PENDIEN | 06/26/88 | CENTRAL |
| 8 | FAB HIELO GUTIERREZ | B | 182 | 156 | 0 | 110160 00 | | | | / / | | | PRUEBAS CONTR CARGA | 06/23/88 | PACIFICO |
| 9 | FL ARREO | 6 | 1316 | 505 | 375 | 601922 00 | SI | SI | | / / | | | | 06/26/88 | PACIFICO |
| 10 | HOTEL TAMARINDO | | 300 | 0 | 0 | 0 00 | | | | / / | | SI | PRUEBAS CONTR CARGA | 06/26/88 | CNFL |
| 11 | PRODUCTOS GERBER | 6 | 500 | 0 | 0 | 187160 00 | | | | / / | | | NO ES BUEN CANDIDATO | 06/26/88 | PACIFICO |
| 12 | EL GALLITO INDUSTRIA | 6 | 806 | 560 | 150 | 233624 00 | SI | SI | | / / | | SI | | 06/26/88 | CNFL |
| 13 | COOPEVICTORIA(INGEN) | B | 704 | 525 | 50 | 228920 00 | SI | SI | | 08/05/88 | SI | SI | EN ETAPA DE PRUEBA | 08/31/88 | CNFL |
| 14 | RICALIT | B | 856 | 630 | 324 | 295400 00 | SI | SI | | / / | | SI | CARGA ESTACIONAL | 06/28/88 | CENTRAL |
| 15 | SCOTT PAPER CIA CR | 6 | 6000 | 4050 | 400 | 8200 00 | SI | SI | | / / | | SI | | 06/26/88 | ATLANTIC |
| 16 | CEMPA | 16 | 8668 | 400 | 200 | 3999089 00 | SI | SI | SI | 06/20/88 | | SI | CON LINEA TELEFONICA | 06/26/88 | CNFL |
| 17 | HACIENDA LA LUISA SA | 3C | 398 | 14 | 0 | 114257 00 | | SI | | / / | | SI | PEND INST DATASTAR | 06/23/88 | PACIFICO |
| 18 | AVICOLA LA GARITA | 3C | 261 | 0 | 19 | 117136 00 | | | | / / | | | | 06/26/88 | CENTRAL |
| 19 | CARTAGO BEEF PACKING | 3C | 855 | 0 | 0 | 384450 00 | | SI | | / / | | | | / / | CENTRAL |
| 20 | CTL MADERA ESPECIALES | | 342 | 0 | 0 | 497335 00 | | | | / / | | | MEDIANO INTERES | 06/26/88 | ATLANTIC |
| 21 | INGENIO TABOGA S A | 3C | 1447 | 140 | 0 | 378386 00 | | SI | | / / | | | | 06/26/88 | |
| 22 | COOPEAGRI EL GENERAL | | 451 | 0 | 0 | 13087 00 | | SI | | / / | | | FALTA LINEA TELEF | 08/25/88 | PACIFICO |
| 23 | CIA BANANERA DE C R | B | 403 | 0 | 0 | 156916 00 | | | | / / | | | | 06/26/88 | SUR |
| 24 | CIA BANANERA DE C R | | 335 | 0 | 0 | 97000 00 | | | | / / | | | TIENEN COGENERACION | 06/26/88 | |
| 25 | FUVACO MED #1 | | 438 | 0 | 0 | 212400 00 | | | | / / | | | TIENEN COGENERACION | 06/26/88 | |
| 26 | FLORENCIA COFFEE CO | | 531 | 0 | 0 | 194890 00 | | SI | | / / | | | | 06/26/88 | CNFL |
| 27 | HACIENDA ATIRRO LTDA | | 250 | 0 | 0 | 55000 00 | | SI | | / / | | | | 06/26/88 | ATLANTIC |
| 28 | CTL AZUCAR TURRIALBA | | 428 | 75 | 0 | 84700 00 | | SI | | / / | | | | 06/26/88 | ATLANTIC |
| 29 | TALMANA S A | 16 | 265 | 0 | 30 | 126316 00 | | SI | | / / | | | CONTROL DE CARGA | 06/26/88 | ATLANTIC |
| 30 | AZUCARERA EL PALMAR | | 1063 | 0 | 0 | 701750 00 | | SI | | / / | | SI | MEDIDOR CON CINTA | 06/26/88 | PACIFICO |
| 31 | COOPEMONTECILLOS (A) | B | 640 | 0 | 150 | 241746 00 | SI | SI | | / / | | | PREVISTO COGENERAC | 06/26/88 | PACIFICO |
| 32 | COOPEMONTECILLOS (B) | B | 1253 | 1000 | 150 | 596545 00 | SI | SI | | / / | | SI | 3 PUNTOS DE MEDICION | 06/26/88 | CENTRAL |
| 33 | CROWN CORK S A | 3 | 546 | 240 | 0 | 149100 00 | | SI | | / / | | SI | INICIAN EN SETIEMB | 06/23/88 | PACIFICO |
| 34 | FAM LUNG | | 400 | 0 | 70 | 75000 00 | | | | / / | | | POSIBLE CANDIDATO | 06/23/88 | CENTRAL |
| 35 | PRODUC DE CONCRETO | 6 | 525 | 0 | 0 | 150000 00 | | | | / / | | | | 06/30/88 | CNFL |
| 37 | I C A A (P MULAS) | 4B | 2736 | 2210 | 900 | 1689870 00 | SI | SI | | / / | | | OTRA CON MAS DEMANDA | 06/30/88 | CNFL |
| 38 | I C A A (ESCAZU) | 4B | 2700 | 2200 | 900 | 1504470 00 | SI | SI | | / / | | | CARTA INTENC PENDIEN | 06/30/88 | CNFL |
| 39 | PUNTO ROJO | B | 457 | 210 | 100 | 105264 00 | | SI | SI | 07/04/88 | NO | SI | CARTA INTENC PENDIEN | 06/30/88 | CNFL |
| 40 | ICE | | 600 | 0 | 0 | 170400 00 | | SI | | / / | NO | SI | EN ETAPA DE PRUEBA | 09/08/88 | CENTRAL |
| 41 | APRICERA LOS SAUCES | | 17 | 11 | 0 | 1713 00 | | SI | | / / | | SI | | 06/30/88 | CNFL |
| 42 | URGELLES Y PENON | B | 266 | 172 | 150 | 0 00 | SI | SI | SI | 08/02/88 | SI | SI | INICIAN EN AGOSTO | 06/30/88 | PACIFICO |
| 43 | IND ALFON DE C R | B | 2200 | 0 | 200 | 920248 00 | SI | SI | | / / | | | INTERES COGENERAC | 09/06/88 | CENTRAL |
| 44 | PORTICO | | 157 | 0 | 0 | 42267 00 | | | | / / | | | CARTA INTENC PENDIEN | 09/06/88 | CENTRAL |
| 45 | ALUMAFA | B | 1730 | 225 | 0 | 536312 00 | | SI | | / / | | | PREVISTO COGENERAC | 06/30/88 | |
| 46 | EL ANGEL S A | B | 1260 | 0 | 0 | 117220 00 | | SI | SI | / / | | | MEDIDOR CON CINTA | 06/23/88 | PACIFICO |
| 47 | LAMINADORA COSTARRIC | 6 | 2000 | 0 | 0 | 337400 00 | | | | / / | | | MEDIDOR CON CINTA | 06/21/88 | CENTRAL |
| 48 | INDUST NAC CEMENTO | 6 | 9400 | 0 | 0 | 43574 00 | | SI | | / / | | | BAJA PRIORIDAD | 06/30/88 | CNFL |
| 49 | HOSPITAL MEXICO | | 816 | 0 | 0 | 362000 00 | | | | / / | | | BAJA PRIORIDAD | 06/30/88 | ATLANTIC |
| 50 | CAFETALERA PILAS | B | 397 | 0 | 0 | 140560 00 | | SI | | / / | | | MAL CANDIDATO | 06/30/88 | CNFL |
| 51 | MOLINOS DE C R | B | 1674 | 0 | 0 | 688737 00 | | SI | | / / | | | MAL CANDIDATO | 06/30/88 | CENTRAL |
| 52 | HOTEL AURORA | | 503 | 0 | 0 | 215360 00 | | | | / / | | | MAL CANDIDATO | 06/30/88 | CENTRAL |
| 53 | CAPERA SAN RAMON | | 394 | 5 | 0 | 57952 00 | | SI | | / / | | | MAL CANDIDATO | 06/30/88 | CNFL |
| 54 | HOTEL EUROPA | | 60 | 0 | 0 | 16279 00 | | | | / / | | | TIENEN CONTROL CARGA | 06/30/88 | CENTRAL |
| 55 | BORDA AZUL | 16 | 182 | 11 | 0 | 40800 00 | | SI | | / / | | | | 06/30/88 | CNFL |
| 56 | MILLER HERMANOS | | 332 | 19 | 0 | 0 00 | SI | SI | | / / | | SI | MISMO GEREN TALMANA | 06/30/88 | PACIFICO |
| 57 | RAFITICA, S A | B | 329 | 290 | 0 | 105257 00 | SI | SI | | / / | | | TIENEN PLANTA HIDROE | 06/30/88 | CNFL |
| 58 | ICE-SAN PEDRO | | 144 | 0 | 200 | 62995 00 | | | | / / | | | INICIAN EN SETIEMBRE | 08/31/88 | CENTRAL |
| 59 | ICE-PAVAS | | 152 | 0 | 0 | 50872 00 | | | | / / | | | | 06/30/88 | |
| 60 | MINAS MONCADA | 3B | 465 | 0 | 0 | 50310 00 | | | | / / | | | | 06/30/88 | |
| 61 | HOTEL COROBICI | | 390 | 0 | 0 | 135800 00 | | | | / / | | | | 06/30/88 | CENTRAL |
| 62 | ALIMENTOS JACKS | 3 | 364 | 0 | 0 | 26601 00 | | | | / / | SI | | PROGRAMAR VISITA | 06/30/88 | CNFL |
| 63 | INCOFER | | 157 | 0 | 0 | 43468 00 | | | | / / | | | PROGRAMAR VISITA | 09/02/88 | CNFL |
| 64 | ARROCERA EL CEIBO | | 120 | 0 | 0 | 44308 00 | | | | / / | | | | 06/30/88 | |
| 65 | BENEFICIO SN ANTONIO | | 386 | 0 | 0 | 175680 00 | | | | / / | | | | / / | SUR |
| 66 | COOPESANJUANILLO | | 203 | 0 | 0 | 63000 00 | | | | / / | | | | / / | CNFL |
| 67 | COOPESABALITO | | 227 | 0 | 0 | 33537 00 | | SI | | / / | | | | / / | |
| 68 | COOPROSANVITO | | 359 | 0 | 0 | 153612 00 | | SI | | / / | | | | / / | SUR |
| 69 | COOPEATENAS | | 299 | 0 | 0 | 101792 00 | | | | / / | | | | / / | |
| 70 | COOPEPALMARES | | 74 | 0 | 0 | 12250 00 | | | | / / | | | | / / | |
| 71 | COOPEVICTORIA | | 205 | 400 | 0 | 44880 00 | | | | / / | | | | / / | |
| 72 | COMPANIA BANANERA CR | | 608 | 0 | 0 | 233539 00 | | SI | | / / | | | | / / | |
| 73 | EL ALAMO S A | | 0 | 0 | 0 | 0 00 | SI | | 1 | / / | | | TIENEN COGENERACION | 07/05/88 | ATLANTIC |
| 74 | I C A A | 3 | 2511 | 2511 | 0 | 0 00 | | | | / / | | | | / / | |
| 75 | I C A A | 3 | 732 | 732 | 0 | 0 00 | | | | / / | NO | | PASARON A T-6 | 09/01/88 | |
| 76 | COOPECAFIRA R L | | 0 | 0 | 0 | 0 00 | | | | / / | NO | | PASARON A T-6 | 09/01/88 | |
| 77 | YAMBER | 3 | 1000 | 0 | 200 | 0 00 | | | | / / | | | | / / | |
| | | | | | | | | | | | | | SE PROP CAMBIO TARIF | / / | |

## APPENDIX F: CANDIDATE'S LETTER OF INTENT

INSTITUTO COSTARRICENSE DE ELECTRICIDA

PROGRAMA DE CONTROL DE CARGA

CARTA DE INTENCION

Nosotros, la empresa: _____

_____

representada en este acto por _____

_____

en adelante denominada la Empresa, luego de analizar los beneficios que nos representa el racional manejo de la carga eléctrica, acordamos:

Formar parte del programa piloto dirigido a controlar el consumo de energía y potencia asumiendo las siguientes responsabilidades:

1) Adquirir e instalar (corriendo los gastos por cuenta de la Empresa) los equipos necesarios de control de carga recomendados y aprobados por el ICE.

2) Autorizar la divulgación de los resultados obtenidos mediante este programa, para promoverlo al expandir su cobertura al resto del país.

3) Acogernos (o mantenernos) en la tarifa T-8 o T-6 (aplicable a la reducción de demanda).

4) Tomar las previsiones del caso para que la instalación de los equipos de control de carga que nos corresponderá instalar sea concluida antes del _____

_____, pues de lo contrario no podríamos estar en capacidad de beneficiarnos oportunamente con este programa.

5) Autorizar la instalación de los equipos de control de carga en la zona aledaña a los medidores existentes. Asimismo, brindar el acceso necesario todo el tiempo que sea razonable para que el ICE proceda a la instalación, mantenimiento, prueba, etc., de los equipos de control de carga.

Por su parte el ICE:

1) Instalará los equipos necesarios para la medición y control de carga en el edificio de la Empresa _____

_____

no más tarde de _____

2) Aplicará la tarifa (T-8 o T-6 según corresponda) acreditándole a la Empresa la bonificación que le corresponda por la reducción en demanda que haya obtenido.

Aceptamos que bajo las siguientes condiciones este acuerdo pueda quedar sin efecto:

INSTITUTO COSTARRICENSE DE ELECTRICIO.

a- En el caso de que por circunstancias especiales la Empresa no quisiera continuar aprovechando los beneficios que le brinda el mismo, siempre y cuando así lo notifique por escrito al ICE con 30 días de anticipación.

b- Cuando de común acuerdo entre la Empresa y el ICE se decida dejarlo sin efecto.

c- Cuando se compruebe que la Empresa no cumple las condiciones estipuladas en la tarifa (T-8 o T-6). En tal caso, el ICE notificará, por escrito, tal resolución a la Empresa, 90 días por anticipado a la fecha de terminación indicandole sus razones. El acuerdo quedará sin efecto a los 90 días de la notificación, a menos que la Empresa tome medidas para eliminar, a satisfacción del ICE, las razones que motivaron tal acción.

Atentamente,

.....

por la Empresa

Sincerely,

Ing. Hernán Robles V.
ASESOR TECNICO

cc: Archivo Central
Asesoría Sistema Eléctrico

# COMMERCIAL/INDUSTRIAL LOAD MANAGEMENT AND ENERGY MANAGEMENT
## TRAINING AGENDA
## AUGUST 8-12, 1988

| | | |
|---|---|---|
| **MONDAY, AUG. 8** | **LOAD MANAGEMENT** | |
| 8:30 a.m. | Introduction | JuanGonzalez |
| 8:45 a.m. | History of Load Management | Juan Gonzalez |
| 9:00 a.m. | Load Management Objectives | Juan Gonzalez |
| 9:30 a.m. | Evaluation of Load Management Alternatives | Mike Whalin |
| 9:50 a.m. | How to Select Load Management Methods to solve problem | Mike Whalin |
| 10:10 a.m. | Florida Power & Light's Commercial/Industrial Load Management | Mike Whalin |
| 10:30 a.m. | FPL's Load Control Programs | Mike Whalin |
| 10:45 a.m. | Criteria for Selection of Control Days | Mike Whalin |
| 11:15 a.m. | FPL's Commercial/Industrial Load Control Equipment | Mike Whalin |
| 12:00 noon | Lunch | |
| 1:00 p.m. | Load Management In The United States | Juan Gonzalez |
| 2:00 p.m. | Load Management Technologies & Applications | Juan Gonzalez |
| 3:00 p.m. | FPL's Residential Load Control Program | Juan Gonzalez |
| 5:00 p.m. | Adjourn | |
| **TUESDAY, AUG. 9** | **ENERGY MANAGEMENT & CONSERVATION** | |
| 8:00 a.m. | Energy Efficient Design Considerations | Marina Blanco Pape |
| 10:30 a.m. | Energy Conservation Programs | |
| 12:00 noon | Lunch | |
| 1:00 p.m. | Energy Management & Control Systems | Steven Diggs |
| 3:00 p.m. | Energy Management Planning | Andover Controls |

| | | |
|---|---|---|
| **WEDNESDAY, AUG. 10** | **ENERGY ANALYSES & NEW TECHNOLOGIES** | |
| 8:00 a.m. | Energy Conservation Opportunities | Oscar Gans |
| 9:00 a.m. | How to Perform an Energy Audit | |
| 11:00 a.m. | Energy Efficient Air Conditioning | |
| 12:00 noon | Lunch | |
| 1:00 p.m. | Energy Efficient Lighting Technologies | |
| 2:30 p.m. | Energy Efficient Water Heating | |
| 3:30 p.m. | Energy Efficient Motors | |
| 4:00 p.m. | Pre-Survey Preparations | |
| **THURSDAY, AUG. 11** | **BELCHER OIL BUILDING ENERGY SURVEY** | |
| 8:30 a.m. | Field Survey | |
| 12:00 noon | Lunch | |
| 1:00 p.m. | Energy Balance | |
| 2:30 p.m. | Operation & Maintenance Opportunities | |
| 3:30 p.m. | Energy Conservation Opportunities | |
| **FRIDAY, AUG. 12** | **DATA ANALYSIS & EVALUATION** | |
| 8:00 a.m. | Analyzing Load Profiles | Juan Gonzalez |
| 10:00 a.m. | Evaluation of Demand Reductions | |
| 11:00 a.m. | Quality Power Conditioning | Richard Lopez |
| 12:00 noon | Lunch | |
| 1:00 p.m. | FPL's Experience with Time-of-Use Rates | Juan Gonzalez |
| 3:00 p.m. | Tour of FPL's C/I Load Management System | Juan Gonzalez |
| 4:30 p.m. | Adjourn | |

# INSTITUTO COSTARRICENSE DE ELECTRICIDAD

## TARIFA 08

(Para consumos mayores de 20000 KWH - mes)

| | INDUSTRIAL | GENERAL |
|---|---|---|
| Cargo por energia | | |
| Primeros 20000 KWH | ¢63 109,30 | ¢73 620,10 |
| Cada KWH adicional | 2,28 | 2,68 |

ENERGIA DE EXCESO: Para industria y general

Se definen dos periodos

1- Verano: Del 1 de febrero al 31 de mayo

2- Invierno: Del 1 de junio al 31 de enero siguiente año

Durante el Invierno, lo que se consuma de EXCESO sobre el promedio mensual de verano vale ¢1.07 por cada KWH.

# INSTITUTO COSTARRICENSE DE ELECTRICIDAD

## TARIFA 08

(Para consumos mayores de 20000 KWH - mes)

| | INDUSTRIAL | GENERAL |
|---|---|---|
| Cargo por demanda: | | |
| (De 10:00 a 12:30 hrs y de 16:30 a 20:00 hrs) | | |
| Primeros 27 KW o menos | ₡13 077,20 | ₡15 258,45 |
| Siguientes 60 KW | 484,34 c/u | 565,13 c/u |
| Cada KW adicional | 736,17 | 859,80 |

En el período del 1 de junio al 31 de enero siguiente año, no se tomaran en cuenta para efectos de facturación las demandas registradas los sábados, domingos y feriados de ley.

# INSTITUTO COSTARRICENSE DE ELECTRICIDAD

## TARIFA 16
(Para consumos mayores de 3000 KwH)

| | INDUSTRIAL | GENERAL |
|---|---|---|
| **Cargo por energía:** | | |
| Cargo mínimo | ₡9 442,80 | ₡10 980,00 |
| **Energía nocturna : de 20:00 a 10:00 hrs** | | |
| Primeros 20000 KwH | 3,03 c/u | 3,50 c/u |
| Cada KwH adicional | 2,12 | 2,52 |
| **Energía hora pico: de 10:00 a 12:30 y 16:30 a 20:00 hrs** | | |
| Primeros 20000 KwH | 3,20 c/u | 3,72 c/u |
| Cada KwH adicional | 2,34 | 2,74 |
| **Energía de la tarde: de 12:30 a 16:30 hrs** | | |
| Primeros 20000 KwH | 3,15 c/u | 3.66 c/u |
| Cada KwH adicional | 2,28 | 2,68 |

**ENERGIA DE EXCESO:**

Igual a la T-08, tomando en consideración los 3 bloques de horas antes definidos.

INSTITUTO COSTARRICENSE DE ELECTRICIDAD

TARIFA 16

(Para consumos mayores de 3000 KwH)

| | INDUSTRIAL | GENERAL |
|---|---|---|
| **Cargo por demanda:** | | |
| (De 10:00 a 12:30 hrs y de 16:30 a 20:00 hrs) | | |
| Primero 10 Kw o menos: | ₡ 4 916,00 | ₡ 5 736,00 |
| Siguientes 57 Kw | 491,60 c/u | 573,60 c/u |
| Cada Kw adicional | 747,20 | 872,73 |

En el período del 1 de junio al 31 de enero siguiente año, no se tomaran en cuenta para efectos de facturación las demandas registradas los sábados, domingos y feriados de ley.

COMPANIA NACIONAL DE FUERZA Y LUZ S A

TARIFA 06

(Para consumos mayores de 20000 KWH/mes)

| | INDUSTRIAL | GENERAL |
|---|---|---|
| Cargo por energía | | |
| Primeros 20000 KWH | 052 460,30 | 060 325,75 |
| Cada KWH adicional | 2,12 | 2,48 |

ENERGIA DE EXCESO:

Durante el invierno, lo que se consumo de exceso sobre el promedio mensual de verano vale:

| | | |
|---|---|---|
| Exceso diurno: | 1,12 c/kwh | 1,36 c/kwh |
| Exceso nocturno: | 0,98 c/kwh | 1,07 c/kwh |

Se considera diurno: de 10:00 a 20:00 horas del día

Se considera nocturno: de 20:00 a 10:00 horas siguiente día.

# COMPANIA NACIONAL DE FUERZA Y LUZ S A

## TARIFA 06

(Para consumos mayores de 20000 KWH/mes)

| | INDUSTRIAL | GENERAL |
|---|---|---|
| **Cargo por demanda:** | | |
| (De 10:00 a 12:30 hrs y de 16:30 a 20:00 hrs) | | |
| Primeros 27 KW | 427,90 c/u | 461,82 c/u |
| Siguientes 40 KW | 427,90 c/u | 461,82 c/u |
| Cada KW adicional | 646,55 | 769,72 |

En el período del 1 de junio al 31 de enero siguiente año, no se tomaran en cuenta para efectos de facturación las demandas registradas los sábados, domingos y feriados de ley.

## APPENDIX I: INSTITUTO COSTARRICENSE DE ELECTRICIDAD FOLLETO DE PROMOCION PROGRAMA PILOTO DE MANEJO DE CARGA INDUSTRIAL

### INSTITUTO COSTARRICENSE DE ELECTRICIDAD PREGUNTAS Y RESPUESTAS SOBRE EL PROGRAMA PILOTO DE MANEJO DE CARGA

En los últimos años, Costa Rica ha experimentado un fuerte crecimiento en su demanda, especificamente al incremento de la electrificación rural, por el uso de las cocinas eléctricas, y el alumbrado.

En 1967, los planes de expansión se vieron afectados por el incremento de la demanda, provocando que los mismos se modificaran, al pasar de 5.5% a caso 10% anual.

La curva de carga típica del sistema nacional interconectada con los dos picos característicos de las horas de la mañana y la tarde, se muestra en el anexo No. 1.

Para enfrentar ésta situación y reducir la inversión en nuevas plantas de generación, el ICE ha implementado en un período corto de un año un programa de manejo de carga, incentivos para proyectos de cogeneración, y campañas de conservación de energía.

Dado que los patrones de consumo de los abonados residenciales (que representan el 45% del total de la demanda) no cambiaron significativamente, los sectores comerciales e industriales fueron escogidos como el punto clave del proyecto del programa piloto de manejo de carga. A diferencia de los clientes residenciales la cantidad es mínima y tienen un significativo para la reducción de carga inmediata.

**¿Qué es el manejo de carga?**

El manejo de carga consiste en aplicar medidas para reducir la carga durante las horas de máxima demanda del sistema nacional. Estas medidas pueden realizarse con un control manual sencillo, como apagar equipo de alta demanda durante las horas de máxima demanda, o con equipo más sofisticado, como un sistema de control automático.

El procedimiento para establecer el manejo de carga en la industria, hoteles, bancos, hospitales u otro comercio es:

- ACCION RAPIDA
- ESTIMACION DEL COSTO BENEFICIO
- DECISION
- AUDITORIA ENERGETICA
- PLAN PRELIMINAR
- ESTUDIO DE FACTIBILIDAD
- PLAN FINAL
- DECISION
- ESPECIFICAR EL EQUIPO
- INSTALAR EL SISTEMA DE MANEJO DE CARGA
- INICIAR Y DEPURAR EL SISTEMA

Un caso actual donde se usa el manejo de carga para reducir la demanda durante períodos de máxima demanda y que aprovecha una tarifa durante un año se encuentra ilustrado en el anexo.

**¿Por qué está promoviendo el manejo de carga el I.C.E.?**

Enfrentando el incremento en el costo de la construcción y operación de plantas de suministro energético y los problemas presupuestarios, el I.C.E. se ha visto obligado a nuevas formas para abastecer la demanda de los clientes y reducir el costo de la electricidad. En vez de construir nuevas plantas térmicas de suministro eléctrico para satistacer la demanda de energía de los abonados, se debe reducir la carga de máxima demanda, influyendo la forma de la curva de carga, reduciendo el costo de la electricidad a los abonados, y mejorando la situación financiera del ICE y del país.

## BENEFICIOS PARA EL ICE

- Reducir la necesidad de inversión de capital
- Reducir el consumo de combustibles
- Mejorar el factor de carga del sistema
- Factor térmico
- Aumentar la flexibilidad operativa y la confiabilidad del sistema
- Proveer a los clientes opciones que ofrezcan una medidad de control para su consumo eléctrico
- Mejorar la relación entre el ICE y sus abonados.

## BENEFICIOS PARA EL CLIENTE

- Reducir el costo de facturción a los clientes que participan en el programa, disminuyendo su demanda en horas pico.

- Ayudar a reducir los aumentos en las tarifas futuras y cargas por combustibles.

**¿En qué consiste el programa piloto control de carga?**

El programa piloto consiste en 4 componentes:

- Recolección de datos y análisis
- Control de manejo de carga
- Estudio de tarifas
- Promoción y diseminación de la información.

## RECOLECCION DE DATOS Y ANALISIS

Un elemento clave del programa es la colocación de medidores de grandes consumidores de control remoto en las instalaciones de los abonados para controlar el uso de la electricidad. suministrar datos en el sistema computarizado del programa de control de carga y preveer datos sobre la efectividad de los esfuerzos del manejo de carga.

En el transcurso del proyecto, estas curvas serán controladas para cuantificar los efectos del proyecto.

## CONTROL DE MANEJO DE CARGA

El núcleo del programa piloto es la puesta en ejecución de ciertos controles de manejo de carga, haciendo participantes a los abanados.

Las acciones serán planeadas e implementadas por el personal de las empresas con asistencia técnica de ingenieros consultores del ICE especializados en el manerio energético. Varias firmas consultoras con experiencia en la selección e instalación de equipo de manejo de control energético, están disponibles para ayudar a los clientes participantes en el programa. Los estudios han demostrado que los abonados participantes pueden disminuir la máxima demanda en un 15% o más.

## INFORMACION, DISEMINACION Y PROMOCION

Los resultados y avances del programa piloto serán difundidos a todos los abonados comerciales e industriales que se benefician del manejo de carga, con el fin de mantener un contacto estrecho entre las empresas de suministro eléctrico y abonados con la expectativa de seguir promocionando programas de control de carga.

### ¿Que ofrece el programa piloto a los abonados participantes?

El programa ofrece una oportunidad única a los abonados para aprovechar las siguientes ventajas:

- Curvas de máxima demanda en el mes
- Ahorros en gastos de electricidad
- Cambio de tarifa rápida (si es necesario efectuarlas)
- Instalación del equipo de medición
- Asistencia técnica del ICE sin costo alguna.

Los ingenieros consultores con especialidad en la conservación energética son:

- Diseños Eléctricos, Teléfono 41-64-86
- Sol 2000, Teléfono 24-79-44/24-87-37
- Diseños y Montajes, Teléfono 27-56-16
- Carlos Manuel Garcia y Mauro, Teléfono 37-25-12
- Baltazar Chaverri

**¿Qué tiene que hacer un abonado para aprovechar el programa?**

Si usted tiene interés en participar en el Programa de Manejo de Carga Industrial, por favor llame a la Oficina Control de Calidad del ICE, de su Zona Regional con el fin de coordinar una visita a su empresa y evacuar cúal consulta que tenga bien indicarnos.

Los telefonos disponibes son los siguientes:

| | |
|---|---|
| - Ing. Arnoldo Arias Chavarria | - Región Central<br>Tei. 42-08-15 |
| - Ing. Felipe Corriols Morales | - Región Atlántica y Sur<br>Tel. 20-72-81 |
| - Ing. José A. Carballo Alvarez | - Región Guanacaste y Pac. Ctrl.<br>Tel. 20-28-75 |

Para participar en el programa, se debe proceder de la siguiente forma:

- Solicitar cambio de tarifa (si es necesario electuarla a la Tarifa T-8 del ICE o la T-6 de la C.N.F.L. (veáse anexo 4)

- Enviar al ICE o a la C.N.F.L. una carta de intención, para participar en el Programa (veáse anexo 3)

- Elaborar y llevar a cabo su propio Programa de Manejo de Carga y eventualmente con asistencia técnica del ICE y de ingenieros consultores.

**¿Cuales son los gastos del programa a cargo de los abonados participantes?**

EI abonado participante se encargará sólo:

- De los honorarios de los ingenieros consultores (eventualmente)

- De los costos de equipo de medición (¢40 000,00)

**¿Cuánto puede ahorrar un abonado aprovechando el Programa Piloto?**

Basado en la Tarifa T-8 vigente del ICE, un Abonado ahorraría ¢1,004 por kW consumido sobre un exceso de 87 kW. Normalmente la inversión del abonado se recupera en menos de un año. La Tabla Financiera adjunta (en el anexo 5) indica el tamaño del ahorro y período de recuperación de la inversión del abonado, según la reducción de la máxima demanda lograda y el costo de algunos equipos del manejo de carga.

**¿Cómo se puede recibir información adicional?**

Llamando a los ingenieros especialistas en conservación de energia anotados en la página No. 4.

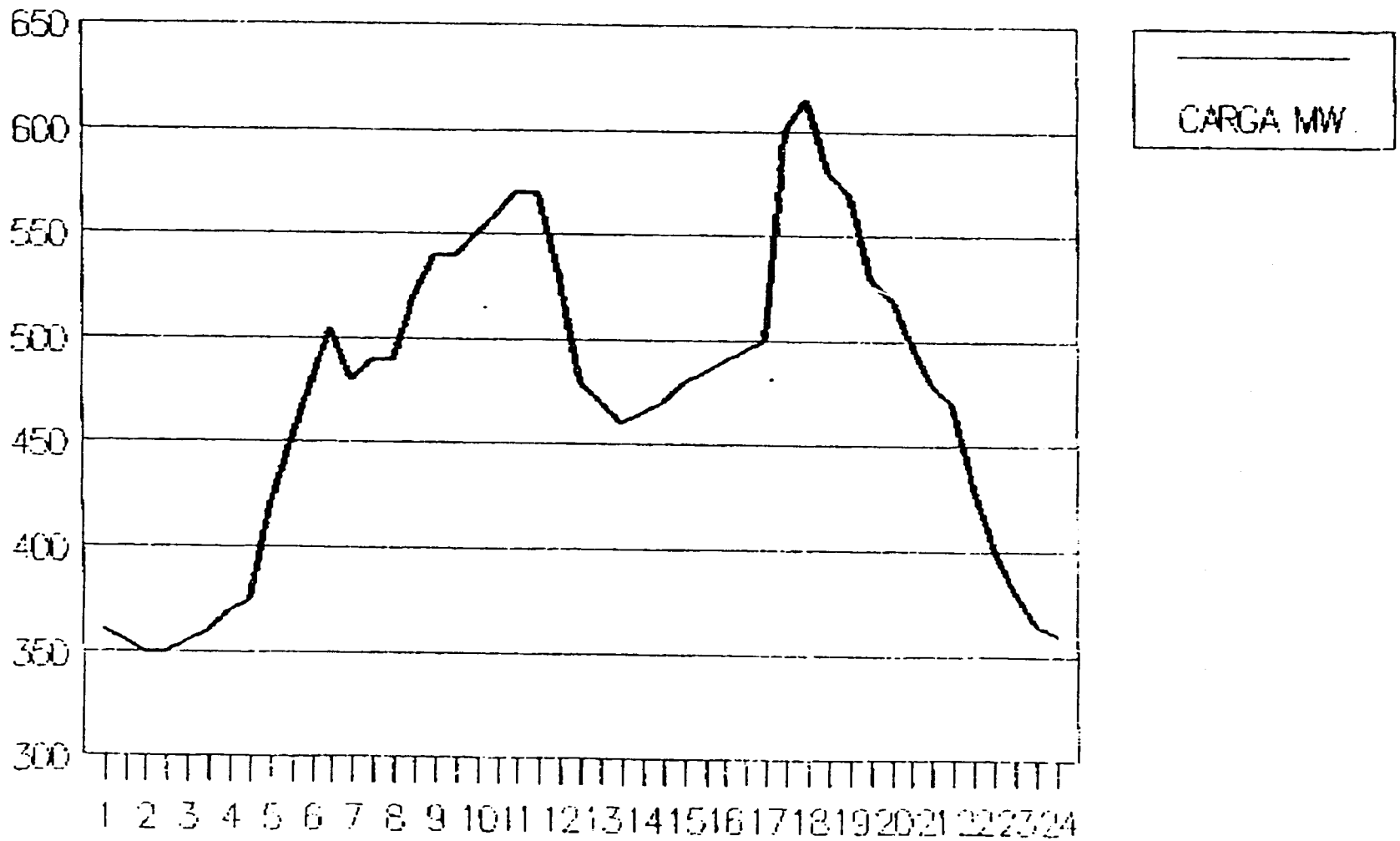
# ANEXO N. 1

# CURVA TIPICA DE DEMANDA

# EN COSTA RICA

# CURVA TIPICA DEMANDA EN COSTA RICA

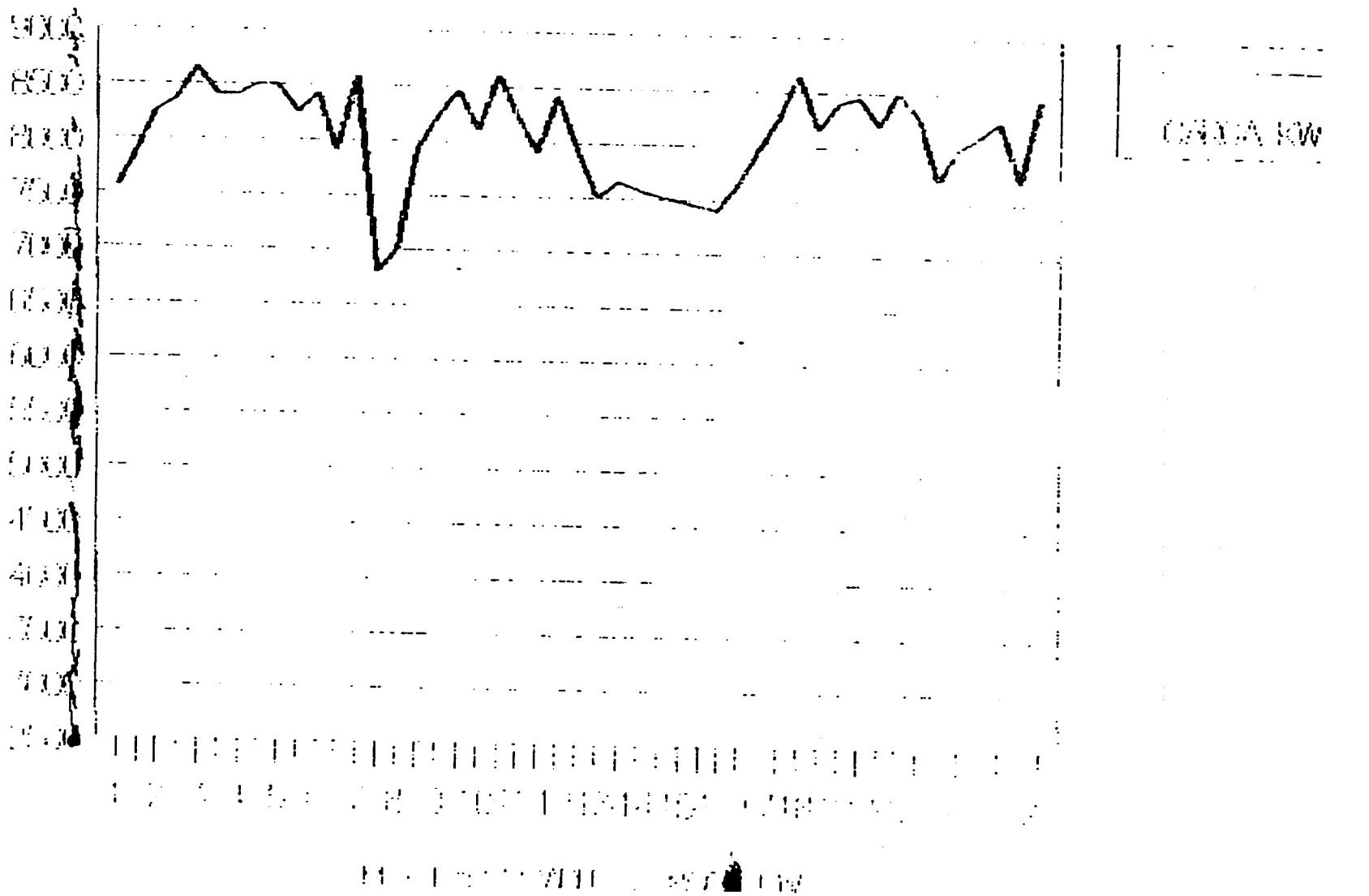
# DIA DE PICO: 24 NOVIEMBRE 1987



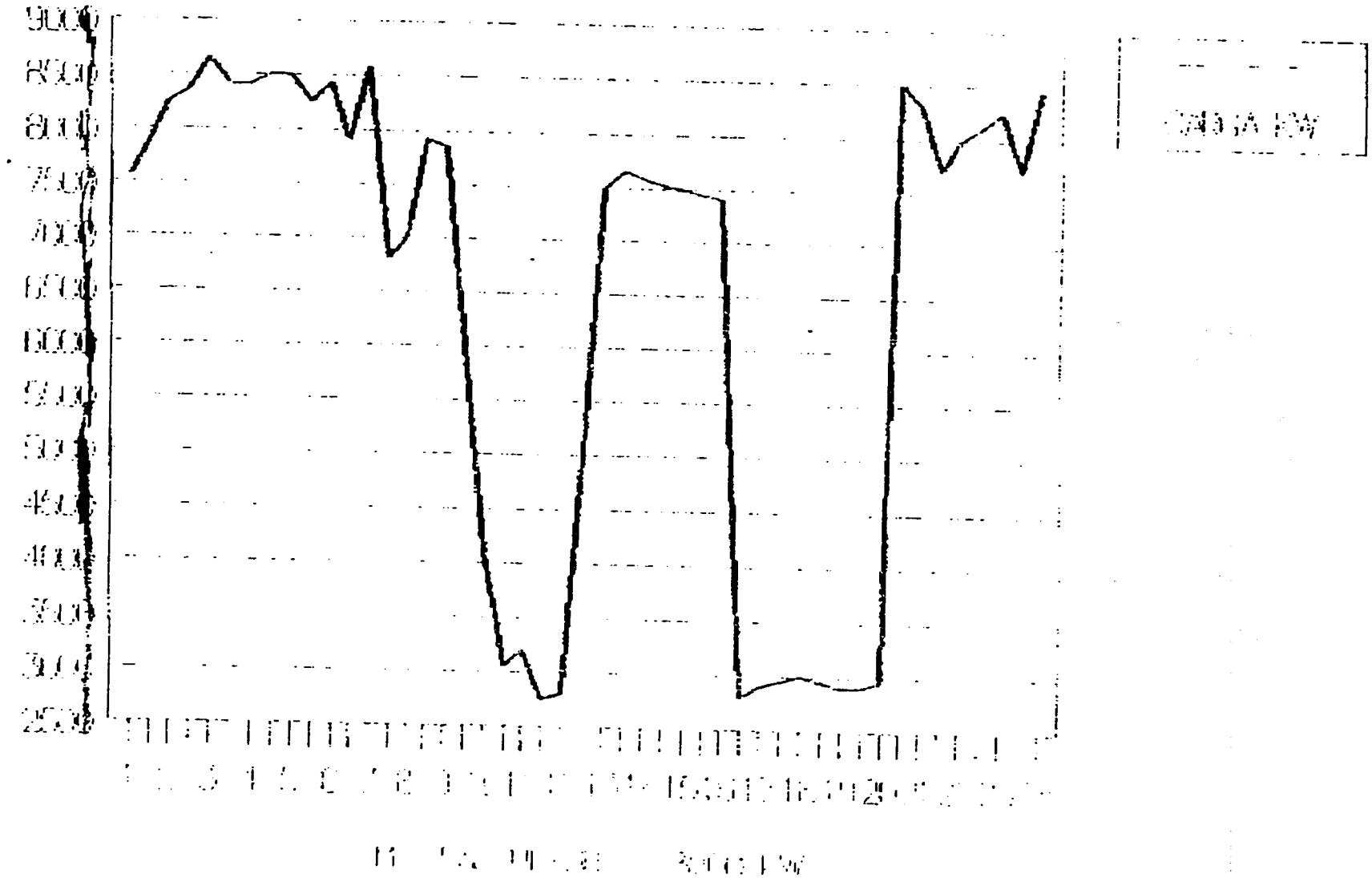
# ANEXO N. 2

## COMPARACION DE CURVAS TIPICAS EN EMPRESAS QUE NO EFECTUAN CONTROL VS. CONTROL DE CARGA

# CURVA TIPICA SIN CONTROL DE MANEJO DE CARGA INDUSTRIAL



# CURVA TIPICA CON CONTROL DE MANEJO DE CARGA INDUSTRIAL



# ANEXO N. 3

# CARTA DE INTENCION PARA INGRESO AL PROGRAMA PILOTO DE CONTROL DE CARGA INDUSTRIAL

PROGRAMA DE CONTROL DE CARGA

CARTA DE INTENCION

Nosotros, la empresa: _____
_____
representada en este acto por _____
_____,
en adelante denominada la Empresa, luego de analizar los beneficios que nos representa el racional manejo de la carga eléctrica, acordamos:

Formar parte del programa piloto dirigido a controlar el consumo de energía y potencia asumiendo las siguientes responsabilidades:

1) Adquirir e instalar (corriendo los gastos por cuenta de la Empresa) los equipos necesarios de control de carga recomendados y aprobados por el ICE.

2) Autorizar la divulgación de los resultados obtenidos mediante este programa, para promoverlo al expander su cobertura al resto del país.

3) Acogernos (o mantenernos) en la tarifa .....(aplicable a la reducción de demanda).

4) Tomar las previsiones del caso para que la instalación de los equipos de control de carga que nos corresponderá instalar sea concluida antes del _____
_____, pues de lo contrario no podríamos estar en capacidad de beneficiarnos oportunamente con este programa.

5) Autorizar la instalación de los equipos de control de carga en la zona aledaña a los medidores existentes. Asimismo, brindar el acceso necesario todo el tiempo que sea razonable para que ..... proceda a la instalación, mantenimiento, prueba, etc., de los equipos de control de carga.

Por su parte.....

1) Instalará los equipos necesarios para la medición y control de carga en el edificio de la Empresa _____
_____
no más tarde de _____

2) Aplicará la tarifa....., acreditándole a la Empresa la bonificación que le corresponda por la reducción en demanda que haya obtenido.

Aceptamos que bajo las siguientes condiciones este acuerdo pueda quedar sin efecto:

a- En el caso de que por circunstancias especiales la Empresa no quisiera continuar aprovechando los beneficios que le brinda el mismo, siempre y cuando así lo notifique por escrito a ..... con 30 días de anticipación.

b- Cuando de común acuerdo entre la Empresa y ..... se decida dejarlo sin efecto.

c- Cuando se compruebe que la Empresa no cumple las condiciones estipuladas en la tarifa acordada. En tal caso, ..... notificará, por escrito, tal resolución a la Empresa, 90 días por anticipado a la fecha de terminación indicándole sus razones. El acuerdo quedará sin efecto a los 90 días de la notificación, a menos que la Empresa tome medidas para eliminar, a satisfacción.....las razones que motivaron tal acción.

Atentamente,

.....

por la Empresa

# ANEXO N. 5

## TABLA FINANCIERA SOBRE TIEMPO DE RECUPERACION, DE ACUERDO A LA REDUCCION EN KW LOGRADA, Y A LA INVERSION EFECTUADA

INSTITUTO COSTARRICENSE DE ELECTRICIDAD

ANALISIS FINANCIERO DE UN PROGRAMA DE CONTROL DE CARGA

| REBAJO DE DEMANDA MAXIMA EN KW | 50.0 | 100.0 | 200.0 | 300.0 | 400.0 | 500.0 | 1000.0 | 2000.0 |
|---|---|---|---|---|---|---|---|---|
| AHORRO COLONES POR AÑO | 602400.0 | 1204800.0 | 2409600.0 | 3614400.0 | 4819200.0 | 6024000.0 | 12048000.0 | 24096000.0 |
| COSTO DE LOS EQUIPOS | PERIODO DE RECUPERACION DE LA INVERSION EN MESES | | | | | | | |
| 150000.0 | 3 | 2 | - | - | - | - | - | - |
| 250000.0 | 5 | 3 | 1 | - | - | - | - | - |
| 500000.0 | 10 | 5 | 3 | 2 | 1 | - | - | - |
| 750000.0 | 15 | 7 | 4 | 3 | 2 | 2 | - | - |
| 1000000.0 | 20 | 10 | 5 | 3 | 3 | 2 | - | - |

1 BASADO EN LA TARIFA " T-8 " DEL ICE.(1004.0 COLONES POR KW DEMANDA)

# INSTITUTO COSTARRICENSE DE ELECTRICIDAD

## TARIFA 8

(Para consumos mayores de 3001 y 20.000 kw-hr-mes)

| | INDUSTRIAL | GENERAL |
|---|---|---|
| Cargo por demanda: (De 10:00 a 12:30 hrs y de 16:30 a 20:00 hrs) | ¢ 10 022,00 | ¢ 15 253,45 |
| Primeros 13 kw o menos | | |
| Cada kw adicional | 770,93 | 650,55 |

En el período del 1 de junio al 31 de enero del siguiente año, no se tomarán en cuenta para efectos de facturación las demandas registradas los sábados, domingos y feriados de ley.



110.

# INCORPORACION DE LOS SISTEMAS DE BOMBEO DE A Y A AL PLAN PILOTO DE CONTROL DE CARGA ICE - AID

El A y A en el proceso de abastecer de agua potable y la extración de la misma ha desarrollado una serie de sistemas de bombeo, los cuales la fuente principal de energía es la electricidad, en el caso específico del Acueducto Metropolitano actualmente se cuenta con las estaciones de bombeo principales en operación que se muestran en el cuadro No.1.

El Plan Piloto de Control de Carga ICE - AID, cuyo propósito es disminuir la demanda de energía en las horas pico y así evitar la implementación de nuevas plantas de generación eléctrica, pone a disposición la tarifa (T-8) promocional para consumos mayores de 3000 KWh/mes:

## TARIFA T-8

### A) Aplicación:

Para contratos especiales con clientes de consumos mensuales mayores a 3000 KWH. Los contratos tendrán una duración mínima de un año, que se considera renovado a su vencimiento por períodos iguales, excepto que una de las partes haga indicación, de lo contrario, tres meses antes de su vencimiento.

### B) Precios mensuales:

#### Carga por demanda:

La demanda máxima que se facturará será la carga promedio más alta en KW, para cualquier intervalo de quince minutos durante el mes, que se registre entre las 10:00 y las 12:30 horas o entre las 16:00 y las 20:00 horas.

La demanda máxima, así establecida, se facturará de acuerdo con la que corresponde al abonado según su tarifa correspondiente.

En el período de época lluviosa (junio a enero), no se tomarán en cuenta para efectos de facturación, las demandas registradas los días sábados, domingos o días feriados por ley.

#### Cargo por energía:

El exceso del consumo promedio mensual en la época lluviosa (junio a enero), sobre el consumo promedio mensual en la época seca (1 de

febrero al 31 de mayo], se facturará a ¢1,07/KWh. La energía restante se facturará de acuerdo con la tarifa que corresponda al abonado.

Para los nuevos abonados, esta tarifa se aplicará, cuando se cuente con el registro de la época [febrero a mayo].

C] Depósito de garantía:

El abonado deberá cubrir un depósito de ¢40.000,00 como garantía por el equipo especial de medición que deberá instalarse.

En el caso de A y A la tarifa correspondiente a los sistemas de bombeo es la [T-9]: cuando el suministro es directamente del ICE y la tarifa [T-7]: cuando el suministro de energía la da CNFL.

TARIFA [T-9]: Bombeo de agua potable para servicio público [ICE]

A] Aplicación:

Aplicación al consumo de energía en el bombeo de agua potable para servicio público, por parte de las instituciones del Estado o asociaciones de desarrollo comunal que cumplan con el fin indicado.

B] Precios mensuales:

A] Para consumos hasta 3000 KWh/mes:
Primeros 30 KWh o menos: ¢75,60.
Exceso a: ¢2,52/KWh.

B] Para consumos mayores a 3000 KWh/mes:

Cargo por potencia:

Primeros 10 KW o menos: ¢2.075,00.
Siguientes 57 KW a: ¢207,50/KW.
Exceso a: ¢344,04/KW.

Cargo por energía:

Primeros 3000 KWh o menos ¢4.871,15.
Siguientes 17000 KWh a: ¢1,56/Kwh.

TARIFA [T-7]: CNFL

A] Aplicación:

Para consumos de servicio público exclusivamente para el bombeo de agua potable en todos aquellos lugares en donde esté tendida la red al voltaje correspondiente.

B) Precios mensuales:

i) Cargo por demanda:

Primeros 10 KW o menos: ¢1.969,50.
Siguientes 57 KW, a: ¢196,95/KW.
Exceso de KW, a: ¢326,50/KW.

ii) Cargo por energía:

Primeros 3000 KWh o menos: ¢4.622,30
Siguientes 20.000 KWh, a: ¢1,52/KWh.
Excesó de KWh, a: ¢1,07/KWh.

AyA se puede beneficiar en gran medida acogiendose la promoción del plan piloto reduciendo el pago por concepto de demanda en energía.

En este estudio se analizará los beneficios que se pueden obtener aplicando el plan a los sistemas de Puente Mulas No.1 y No.2, campo de pozos La Valencia y los rebombeos La Uruca - Del Sur y La Uruca - Tibás.

En los demás sistemas no es aplicable, debido que en algunos casos son consumidores de menos de 3000 KWh/mes y en otros no se puede prescindir de su funcionamiento en el horario que contempla el Plan Piloto.

A continuación se presenta el estudio para cada uno de los sistemas factibles al plan.

## SISTEMAS PUENTE DE MULAS No.1 Y No.2

Para incorporar estos sistemas al plan piloto se le debe asignar al tanque de Bello Horizonte una zona de abastecimiento específica y aislada con el propósito de que el tanque sirva de regulador de caudal debido a la variación horario del consumo y a los horarios y caudales a bombear desde Puente de Mulas hacia este tanque.

Esta zona comprenderá los sectores de Escazú actualmente abastecidos por A y A, Alajuelita, San Rafael Abajo y San Juan de Dios de Desamparados.

En caso de que se requiera una extracción de agua en Puente de Mulas mayor a la que requiera la zona a abastecer, este exceso puede ser evacuado hacia la zona de San José, de manera que el Acueducto Metropolitano no se vea afectado en cuanto a la interconexión entre los diferentes sistemas de abastecimiento.

La demanda promedio diaria de la zona de Bello Horizonte se estima al año en unos 185 l/s para un volumen diario de 15980 $m^3$, el cual puede ser abastecido con dos bombas grandes y una pequeña en Puente de Mulas No.1 y No.2 y bombas en Puente de Mulas No.2 durante un período de 13 horas por día.

En estas condiciones los sistemas de Puente de Mulas No.1 y No.2 tienen una alta factibilidad para la aplicación de la tarifa T-8 en donde el cargo por demanda de energía se puede reducir a un 10% de la máxima de operación.

El cuadro No.2 muestra los calculos de ahorro por concepto de demanda de energía aplicable a los sistemas de Puente de Mulas.

## SISTEMA POZOS LA VALENCIA Y REBOMBEO LA URUCA

En este sistema particularmente en el campo de pozos La Valencia, se debe mantener un suministro mínimo de bombeo, ya que la zona de Pavas, que actualmente tiene una demanda promedio de 320 l/s aproximadamente se abastece unicamente desde el campo de pozos, y de las fuentes de La Libertad: por lo tanto la producción restante de 750 l/s disponible en el sistema da cabida a la aplicación de la tarifa T-8 apagando pozos en La Valencia y reduciendo el bombeo en la estación de La Uruca.

En el caso del campo de pozos, para efecto de medición y control de suministro de energía es recomendable la instalación de un equipo de control de carga en donde se contemple la operación de varios pozos en forma conjunta. En este caso los pozos que se deben integrar al programa deben ser los de mayor potencia y de fácil acceso para la operación; se proponen así los siguientes: pozos W1, pozo W2, pozo W3. pozo W4, pozo W7, pozo W12, pozo W13, pozo W14, los cuales dan una producción global de aproximadamente 600 l/s, adicional al resto de los pozos que deben operar en forma permanente para suplir la demanda de la zona de Pavas.

En el rebombeo La Uruca el equipo de Control de Carga servirá para el bombeo hacia los tanques Oel Sur y hacia la zona de Tibás.

El cuadro No.3 muestra los cálculos del ahorro posible al aplicar este plan al sistema de pozos de La Valencia y en el cuadro No.4 del sistema de rebombeo de La Uruca.

Con base en la información presentada en los cuadros anteriores se

observa que el A y A puede lograr una sustancial economia en el pago de energía eléctrica que puede llegar a ser hasta cerca de ₡1,750,000 mensuales, en el caso más favorable con una reducción en la produ - cción que no supera los 275 l/s en promedio en caso de que fuera ne- cesario la operación en su máxima capacidad de los sistemas a inte - grar al plan, por lo tanto se recomienda la opción del Plan Piloto de Control de Carga ICE - AID a los sistemas de Puente de Mulas y la Valencia - Uruca.

CUADRO No 1

SISTEMAS DE BOMBEO DEL ACUEDUCTO METROPOLITANO EN OPERACION (1988)

| NOMBRE DEL SISTEMA | EQUIPOS DE BOMBEO (maxima operacion actual) | POTENCIA REQUERIDA (Kilowats) | CAUDAL BOMBEADO (maxima operacion actual) |
|---|---|---|---|
| FUENTE DE MULAS No 1 | 3 Bombas de 600 HP<br>1 Bomba de 350 HP | 1527 | 600 l/s |
| FUENTE DE MULAS No 2 | 3 Bombas de 600 HP | 1341 | 500 l/s |
| CAMPO DE POZOS LA VALENCIA | 10 Pozos de 250 HP<br>3 Pozos de 190 HP<br>2 Pozos de 150 HP | 2511 | 1000 l/s |
| REBOMBEO LA URUCA-DEL SUR | 3 Bombas de 300 HP | 732 | 600 l/s |
| REBOMBEO LA URUCA-TIBAS | 2 Bombas de 175 HP | 262 | 200 l/s |
| IPIS | 1 Bomba de 75 HP | 56 | 75 l/s |
| POZOS DE SAN PABLO | 2 Pozos de 100 HP | 149 | 40 l/s |
| BOOSTER LA VALENCIA-SAN PABLO | 2 Bombas de 75 HP | 112 | 30 l/s |
| REBOMBEO SAN PABLO | 2 Bombas de 50 HP | 75 | 25 l/s |
| LA LIBERTAD | 2 Bombas de 75 HP | 112 | 80 l/s |
| | TOTAL = | 6876 | |



1/6

CUADRO No.2

REDUCCION DEL CARGO POR DEMANDA DE POTENCIA ELECTRICA
SISTEMA DE PUENTE DE MULAS

| CONDICION DE OPERACION | | DEMANDA DE POTENCIA (Kilowats) | CARGO POR POTENCIA TARIFA T-9 (colones mensuales) | AHORRO POR APLICACION DE TARIFA T-8 (1) (colones mensuales) |
|---|---|---|---|---|
| BOMBEO No1 | BOMBEO No2 | | | |
| 3x600 HP<br>1x350 HP | 3X600 HP | 2963 | 1,001,094.16 | 0.00 |
| 2x600 HP<br>1x350 HP | 2X600 HP | 2063 | 691,458.16 | 309,636.00 |
| 1x600 HP<br>1x350 HP | 1X600 HP | 1163 | 381,822.16 | 619,272.00 |
| 1X350 HP | | 263 | 72,186.16 | 928,908.00 |

(1) Con respecto a la máxima demanda

CUADRO No 3

REDUCCION DEL CARGO POR DEMANDA DE POTENCIA ELECTRICA
SISTEMA DE POZOS LA VALENCIA

| CONDICION DE OPERACION | | | | |
|---|---|---|---|---|
| POZOS NO INTEGRADOS AL PLAN (1) | POZOS INTEGRADOS AL PLAN | DEMANDA DE POTENCIA (Kilowats) | CARGO POR POTENCIA TARIFA T-9 (colones mensuales) | AHORRO POR APLICACION DE TARIFA T-8 (2) (colones mensuales) |
| 2*250 HP<br>3*190 HP<br>2*150 HP | 8*250 HP | 2528 | 732,510.42 | 0.00 |
| 2*250 HP<br>3*190 HP<br>2*150 HP | 6*250 HP | 2152 | 603,151.38 | 129,359.04 |
| 2*250 HP<br>3*190 HP<br>2*150 HP | 4*250 HP | 1778 | 474,480.42 | 258,030.00 |
| 2*250 HP<br>3*190 HP<br>2*150 HP | 2*250 HP | 1402 | 345,121.38 | 387,389.04 |
| 2*250 HP<br>3*190 HP<br>2*150 HP | | 1028 | 216,450.42 | 516,060.00 |

(1) Minimo requerido
(2) Con respecto a la máxima demanda

CUADRO No 4

REDUCCION DEL CARGO POR DEMANDA DE POTENCIA ELECTRICA
SISTEMA DE REBOMBEO LA URUCA

| CONDICION DE OPERACION (%) (1) | DEMANDA DE POTENCIA (Kilowats) | CARGO POR POTENCIA TARIFA T-9 (colones mensuales) | AHORRO POR APLICACION DE TARIFA T-8 (3) (colones mensuales) |
|---|---|---|---|
| 3*300 HP 2*175 HP (100%) | 934 | 312,185.18 | 0.00 |
| 1000 HP (80%) | 747 | 247,849.70 | 64,335.48 |
| 750 HP (60%) | 560 | 183,514.22 | 128,670.96 |
| 500 HP (40%) | 374 | 119,522.78 | 192,662.40 |
| 250 HP (20%) | 187 | 55,187.30 | 256,997.88 |
| (00%) | 0 | 13,902.50 | 298,282.68 |

(1) Respecto a la máxima operación (1250 HP)
(2) Con respecto a la máxima demanda

## APPENDIX K: MONITORING VISIT QUESTIONNAIRE

## INFORME DE VISITA

I-DATOS BASICOS

CODIGO:

NOMBRE DE ABONADO:

ASISTENTES (NOMBRE, CARGO)

ASISTENTES ICE:

CARTA INTENCION FIRMADA SI NO

DEMANDA PICO:
COINCIDENTE (KW): NO COINCIDENTE (kw):

TARIFA/FECHA:

CIA DE SERVICIO: ICE CNFL

PUNTOS DE MEDICION: UNO VARIOS

TIPO DE MEDIDOR: CINTA MAG. DATASTAR

PUNTO (1) PUNTO (2) PUNTO (3)

DATOS VISITA

PROGRESO DESDE VISITA ANTERIOR DEL (FECHA):

MEDIDAS PROGRAMADAS (CON FECHAS) INCLUSO CAMBIO DE TARIFA:

| | | |
|---|---|---|
| TIENEN CONTROL DE CARGA MANUAL? | SI (FECHA) | NO |
| PRECISAN ASISTENCIA TECNICA? | SI | NO |
| TIENEN CONSULTORES? | SI | NO |

QUIEN-CUALES?

ESTADO DEL TRABAJO DE LOS CONSULTORES:

PROBLEMAS QUE HAN SURGIDO

REDUCCION DEMANDA COINCIDENTE (LOGRADA) (KW):

REDUCCION DEMANDA COINCIDENTE (META) (KW):

AHORRO ANUAL CORRESPONDIENTE A LA REDUCCION PREVISTA

NIVEL DE INTERES: BAJO REGULAR FUERTE

COMPROMISOS DE DATOS:

SE HAN RECOGIDO DATOS DE PRODUCCION (FORMULARIO)? SI NO

SE HA PUESTO AL DIA LA HOJO DE BASE DE DATOS? SI NO

III-SE ENTREGARON RESUMEN TARIFAS SI NO

CUALES?

CURVAS SI NO

CUALES?

IV-LLEVAR EN VISITA

1) CONTROL DE ABONADOS (HISTORIAL) 3) HOJA BASE DATOS

2) CURVAS DE CARGA 4) TARIFAS (LIBRETA Y RESUMEN)

# APPENDIX L: FINAL VISIT QUESTIONNAIRE

**INSTITUTO COSTARRICENSE DE ELECTRICIDA**

ICE. Manejo de Carga

RESULTADOS DE LA DEMOSTRACION — Fecha informe

Abonado: — Codigo.

Fecha ultima visita:

Facilitaron datos para analisis?

| | | | | | | |
|---|---|---|---|---|---|---|
| Historial carga: | Oct 87 | SI | NO | Nov 87 | SI | NO |
| | Oct 88 | SI | NO | Nov 88 | SI | NO |
| Produccion: | Oct 87 | SI | NO | Nov 87 | SI | NO |
| | Oct 88 | SI | NO | Nov 88 | SI | NO |
| Consumo, KWh: | Oct 87 | SI | NO | Nov 87 | SI | NO |
| | Oct 88 | SI | NO | Nov 88 | SI | NO |
| Facturacion: | Oct 87 | SI | NO | Nov 87 | SI | NO |
| | Oct 88 | SI | NO | Nov 88 | SI | NO |

Practican control manual? SI NO — Automatico? SI NO

Medidas implementadas (con Fechas):

Cambios de equipos de produccion o ampliaciones:

Estimado del abonado de la reduccion de demanda coincidente.

Manana _____ KW — Tarde _____ KW

Detalles del costo del proyecto al abonado.

| | |
|---|---|
| Equipos | Asesoria |
| Medidores | Mano de obra |
| Instalacion | Promocion |

INSTITUTO COSTARRICENSE DE ELECTRICIDAD

Comentario del abonado sobre horario de carga en su empresa:

Medidas programadas (con fechas)

Contribuciones de consultores (cuales?):

Otros datos

Se utilizara este abonado en el analisis? SI NO

## APPENDIX M: EXPERIENCE OF PARTICIPATING CUSTOMERS

This appendix presents notes on the participating customers describing their experiences with load control.

### ALUNASA

This rolling mill, which produces aluminum sheet and foil, was shut down during the baseline period October-November 1987 owing to economic problems. For many years a heavy rolling mill (1,000 kW) has been operated only during off-peak hours. In October 1988 two 660 kW foil annealing furnaces were placed under manual load control to ensure low levels of operation during peak periods. This measure has reduced their combined peak demand to 200 kW.

In November 1988 an electronic demand monitor was installed, and a goal of 1,000 kW coincident peak demand was set for the facility. The load monitor output will be connected to the annealing furnaces to control their load automatically during peak hours, and to shut them down completely when demand reaches the 1,000 kW limit.

The cost of load management measures taken during the pilot program was 205,000 colones, the installed cost of the load monitor.

### ARROCERA LOS SAUCES

This rice processor was shut down from July 1987 to August 1988, and had registered a demand of less than 40 kW during the idle period. They are now controlling load manually, but little is known about their load control activities because they failed to submit the final questionnaire.

### BORDA AZUL

This food processor has initiated load control, but has not been able to maintain it during peak production days. Borda Azul was not included in the statistical analysis because they did not have meters in 1987 and it was not possible to contact the engineer responsible for load control to obtain final project data.

### CARNES DE CENTRO AMERICA (EL ARREO)

This slaughterhouse produces beef and byproducts for the domestic market. While its operation is not seasonal, there is a considerable daily variation in production because

cattle are provided by a large number of suppliers, large and small. Because supply cannot be controlled closely and production cannot be planned, the plant must work at full capacity several days per month.

Under the direction of the plant manager, the company carried out load control trials over a four-month period in 1988. It achieved a demand reduction of about 800 kW, but found that it could not be maintained during peak production days when production needs took priority over load management.

The plant manager was very interested in the load control rate and/or the interruptible rates. This facility can provide significant benefits of over 800 kW on these rates.

Carnes de Central America is considering purchasing a large ranch that would provide a predictable supply of cattle. This acquisition would allow the programming of production and facilitate load management.

The company has not had a load management study by specialized consultants. Without such a study it is not possible to conclude that there is no opportunity for demand reduction that would be compatible with production requirements.

## CARTAGO BEEF PACKING

This slaughterhouse conducted load control trials and then installed equipment on February 28, 1989. They will control load manually. They did not submit information on their activities at the end of the project.

## CEMPA

Cempa, a cement mill, began load control in 1982, reducing demand from 8,500 to 4,650 kW by stopping mills and quarrying operations during peak hours. An electronic demand register was installed recently, and Cempa plans a further 100 kW reduction in 1989, from 4,650 to 4,550 kW. Since it began load control before the beginning of this project, it was not included in the statistical analysis of the impact of the project.

## CNP MONTECILLOS (COOPEMONTECILLOS, R.L. - MEAT DIVISION (ALAJUELA))

This slaughterhouse cooperative processes cattle and pigs on a contract basis and on its own account.

The company's load management efforts were carried out by the maintenance department, with support from outside consulting engineers. Following a change to a time-of-use tariff, an electronic recording meter was installed in November, 1988.

Manual load control trials began in December 1988, and are in progress. (Details from F. Moya.)

The production department is not giving its complete support to load management. An action and investment plan was to be presented to the general manager in March, 1989.

A load management study is lacking. Such a study is necessary to determine the true potential for demand reduction and to serve as a basis for further efforts.

## CONDUCEN

Conducen manufactures copper and aluminum power cables, operating in three shifts. During 1988 attempts were made to program equipment to minimize demand during peak periods, and some small equipment is operated only off-peak. Load management efforts have not been entirely successful because of surges in production toward the month's end that prevent control of certain equipment.

New equipment is being added during 1989 to increase capacity.

## COOPEAGRI EL GENERAL (BENEFICIO)

The recently appointed general manager of this coffee processing business has great interest in load management. He has engaged the consultants Disenos y Montajes to rationalize energy use, and an analysis is being carried out.

This seasonal business has production peaks in October and November. There is an opportunity to shift some operations to off-peak hours. Capacity has been increased yearly, but demand has not risen proportionately because more efficient equipment has been installed.

## COOPEVICTORIA-BENEFICIO

This coffee processor has been rationalizing its use of electricity for three years with the continuing assistance of a consulting engineer. Load is reduced as permitted by production volume and capacity. Thus, the sections that operate during peak hours vary. Management feels that more can be done, but the support of the general manager must be obtained.

Production is very low in October and November, the system peak months, and rises sharply to a peak in December.

Following a visit by the load control project team in February 1989, Coopevictoria management called their consultant to request a demand alarm system.

## EL GALLITO INDUSTRIAL

This family-owned candy manufacturer has been controlling load manually since July 1988 on a trial basis. Awareness-raising and motivation of personnel were important considerations. The customer's initial attempts at load control prompted a decision to install a sophisticated energy management system. The equipment is being designed and built using internal resources for the most part. Printed circuit boards for the microprocessor-controlled programmable system are being built in Costa Rica, and installation is planned for March 1989.

## EMPACADORA DE CARNES (COOPEMONTECILLOS-BARRANCA)

This slaughterhouse produces mainly for export and has a seasonal pattern of operation. They are not yet controlling load, but are discussing the installation of load control equipment with consulting engineers. They plan to achieve load reduction beginning in May 1989.

## FERTICA

This large fertilizer plant has eliminated equipment and lighting loads during peak hours. The nitric acid plant, which consumes 69 percent of Fertica's energy, has been programmed to start up only during off-peak hours. If the plant must be started during peak periods, a low-load starting procedure is used.

Load management has been helpful in reducing Fertica's financial losses.

## ICAA (PUENTE DE MULAS AND SAN RAFAEL DE ESCAZU)

In 1988 this water utility carried out a detailed study of controllable loads and subsequently initiated load control at two major pumping stations with considerable success. Pump operation is controlled from a central station that telephones instructions to pump operators. There is potential for load control at six additional sites.

The general manager and the engineers in charge of the load management effort have provided strong support.

ICAA intends to extend the program to several other pumping stations and well sites in 1989, and in this connection they have requested that their utility, CNFL, consolidate billings at locations where there are several meters billed individually.

## INDUSTRIA AKRON DE COSTA RICA (FORMERLY FIRESTONE)

This major tire and tube manufacturer stepped up load management efforts during 1988. During peak periods personnel were moved from high-demand equipment to other equipment and work. Control of additional equipment is planned for 1989.

Load management activities have the support of the company's president, and there has been no opposition from production personnel.

Management expressed a strong interest in the interruptible rate; however, they were reluctant to participate owing to the risk entailed (a possible service interruption of up to 300 hours per year). Under the interruptible tariff there is a potential peak load reduction of 1.5 MW.

## INGENIO TABOGA

This large sugar mill has moved swiftly to take advantage of the time-of-use tariff. Since Taboga has sufficient cogeneration capacity to meet production requirements, the facility is able to disconnect most operations from the grid during peak periods. During these periods employee housing is supplied with power from a recently-installed 550 kVA diesel-generator set. As a further load reduction measure, 31 electric ranges in employee housing were replaced with gas ranges.

The mill operates from January through April. At other times the consumption of electricity is limited to maintenance operations, and amounts to 1,447 kW maximum.

## PUNTO ROJO

This soap manufacturer has been on the time-of-use tariff since October 1986, and has installed a demand meter that operates signal lights and bells when demand reaches a set level during peak periods. During 1988 operations were rescheduled in the department with highest demand, and it was placed on a two-shift operation. Also, certain high-demand equipment was fitted with devices that prevent operation during peak hours. Assistance was provided by the consulting engineers Disenos Electricos.

Further measures planned for 1989 are changes in work schedules, changes in lighting, down-sizing of electric motors and adjustment of production programs.

## RAFYTICA

This customer manufactures woven polypropylene bags in a spacious, modern plant that will expand production capacity moderately during 1989. Apart from awareness raising, little was done to manage demand during 1988. Management expects that the capacity

being added will provide flexibility in scheduling equipment in the future; consequently, they will attempt to control load this year.

The general manager expressed a strong interest in load control rates or interruptible rates.

## RICALIT

This manufacturer of composite building materials is one of the best examples of successful load management produced by the pilot project. Ricalit has installed a demand monitor and a time device to control certain equipment by means of alarms. Also, the production capacity of a mill was increased to provide flexibility of operation that allows shutdown during peak periods. Monthly savings in demand charges are estimated by the customer at $2,000 to $3,000.

Management has maintained a high level of interest throughout the pilot project and is very satisfied with the results achieved.

## SCOTT PAPER DE COSTA RICA

This large paper mill initiated demand management efforts in July 1988 with manual control of selected equipment. Owing to human error they were unable to obtain consistently good results; consequently, they obtained assistance from a consulting engineer. They now plan to install a demand monitor with limited control capability. The monitor will control six machines with a total demand of 500 kW.

Scott management continues to show great interest in the load management program.

## TALMANA

This food processor is a sister company of Borda Azul, and has also had its load control activities overridden by production priorities. Talmana was not included in the statistical analysis because they did not have meters in 1987 and it was not possible to reach the responsible engineer to obtain a report on their experience.

## TICATEX

This textile manufacturer has attempted to reduce load by raising awareness, programming production, reducing lighting load and shutting off a 120 kW heater in the finishing department. Also, 24 branch meters have been installed to monitor kWh consumption.

Plant engineering has requested information on maximum demand meters from Costa Rican and Japanese sources, but at the moment no further measures are planned.

## URGELLES Y PENON

This well established furniture maker opened a second plant in Alajuela in 1988 and announced plans to move its San Jose plant into the Alajuela facility. It was the Alajuela plant that participated in the load management project. The general manager, an engineer, has maintained great interest in load management and has led the company's load control initiative.

Beginning in August 1988, when the plant started operations, manual load management was initiated. A 200 HP rip saw was switched off during the peak periods, along with other equipment having excess capacity. (The saw performs the first operation of the process, sawing rough timber into boards.) Also, newly hired workers were organized into shifts outside peak periods. In November 1989 the plant was operating at 40 percent of its capacity.

Current plans call for automatic control of the rip saw and of the largest electric motors in the plant. It is also planned to operate only one of the two 90 HP dust extraction system motors during peak periods.

## APPENDIX N: DATA ANALYSIS PROCEDURES

This appendix describes the procedures used to collect, process, and analyze the demand, energy consumption, and production data used to analyze the impact of the load control demonstration project.

The participating industries have one of two types of recorders that measure demand (kW) and energy consumption (kWh) in 15 minute increments. Data from these recorders were transferred to two computers at ICE for analysis and billing. The data were translated from these two computers to a format compatible with Lotus 123 to analyze the change in demand. Energy consumption data from ICE billing files and production data obtained from the participants were used to adjust demand data to take into account changes in industry activity during 1988.

## DATA COLLECTION AND TRANSLATION

This section explains the procedures used to collect, translate, and process demand, energy consumption, and production data.

### Data Collection Equipment and Software

Two different computer systems and their associated meters are used by ICE to track daily demand at participating companies. ICE uses a Hewlett Packard 1000 minicomputer (HP) to prepare bills and analyze data obtained from meters at customer sites. Meters installed at customer sites record daily load data in 15 minute intervals on a magnetic tape cartridge. These cartridges are periodically brought to ICE where the data are transferred onto standard magnetic tape reels on the HP. Once in the HP, the data are analyzed using Sangamo ST-21 software, a 1980 vintage piece of software from Sangamo, Inc., a U.S. company.

This system is being phased out for many uses, but it will remain ICE's primary system for preparing bills. All companies included in this analysis have magnetic tape demand recorders, although some companies had problems with the meters during the analysis period.

The second system uses an IBM-compatible personal computer (PC) and DataStar pulse recorders, also from Sangamo. The DataStar recorders measure demand for electricity in pulses in 15 minute intervals, as do the magnetic tape readers for the HP. The PC-DataStar combination is a modern system with many advantages over the older HP-magnetic tape reader system. The DataStar recorders are capable of transferring their readings directly to the PC through phone lines, thus eliminating the need for physically collecting magnetic tapes. A data call can be initiated either by the recorder

itself, or by the central system on the PC. The PC can also re-configure the recorders remotely, if needed. As of November 1988, however, the vast majority of companies did not have phone lines dedicated to their recorders and several companies did not have phone lines at all. As a result, for many of the companies, data were collected on site from the Sangamo readers with hand-held recorders -- not through the phone lines. The Sangamo software for the PC performs the same tasks as the HP system; however, it can also send data to a disk file so that the data can be used, with some cleaning up, in other PC software packages.

**Data Translation Procedures**

Data collected from the demand recorders are in a proprietary format on the HP and PC. The analysis options available using the Sangamo software on the Hewlett Packard 1000 and IBM-compatible PC are limited,[1] which prohibited analyzing the data using ICE's computers and software. The data were thus translated and imported into Lotus 123 for analysis. For the purposes of this analysis, the HP was useful for three functions: printing load curves and load data by the quarter hour for individual customers (Exhibits N.1 and N.2), aggregating customers to print composite load curves, and transferring data from the demand recorders' magnetic tape cartridges to standard magnetic tape. The Sangamo software owned by ICE for the HP could aggregate groups of customers, but it could not average or otherwise summarize or adjust daily load curves for individual customers or groups of customers and it could not export data in a format that would facilitate using other programs to analyze the data.

The HP stores data on magnetic tapes in raw form (pulse counts) and it currently has no hardware or software options for transferring data directly to PCs. As a result, translating the data into a format useable in Lotus 123 required three steps:

1. Combine the relevant data onto one magnetic tape using the HP.
2. Translate the data from the magnetic tape to diskettes for use on a PC.[2]
3. Translate the data from raw pulse counts to kilowatts and organize them into the appropriate format of days and quarter-hours in a Lotus 123 spreadsheet.[3]

---

1 Sangamo, however, makes other packages for these computers that provide additional analysis options.

2 ICE's computer center has facilities to perform this translation.

3 The procedures for analyzing the data were quite cumbersome and time-consuming. However, given the limited nature of this analysis, it was decided that it was not cost-effective to develop or purchase software that would simplify the procedures.

Exhibit N.1 Sample Daily Demand Load Curve from Hewlett-Packard 1000 and Sangamo Software

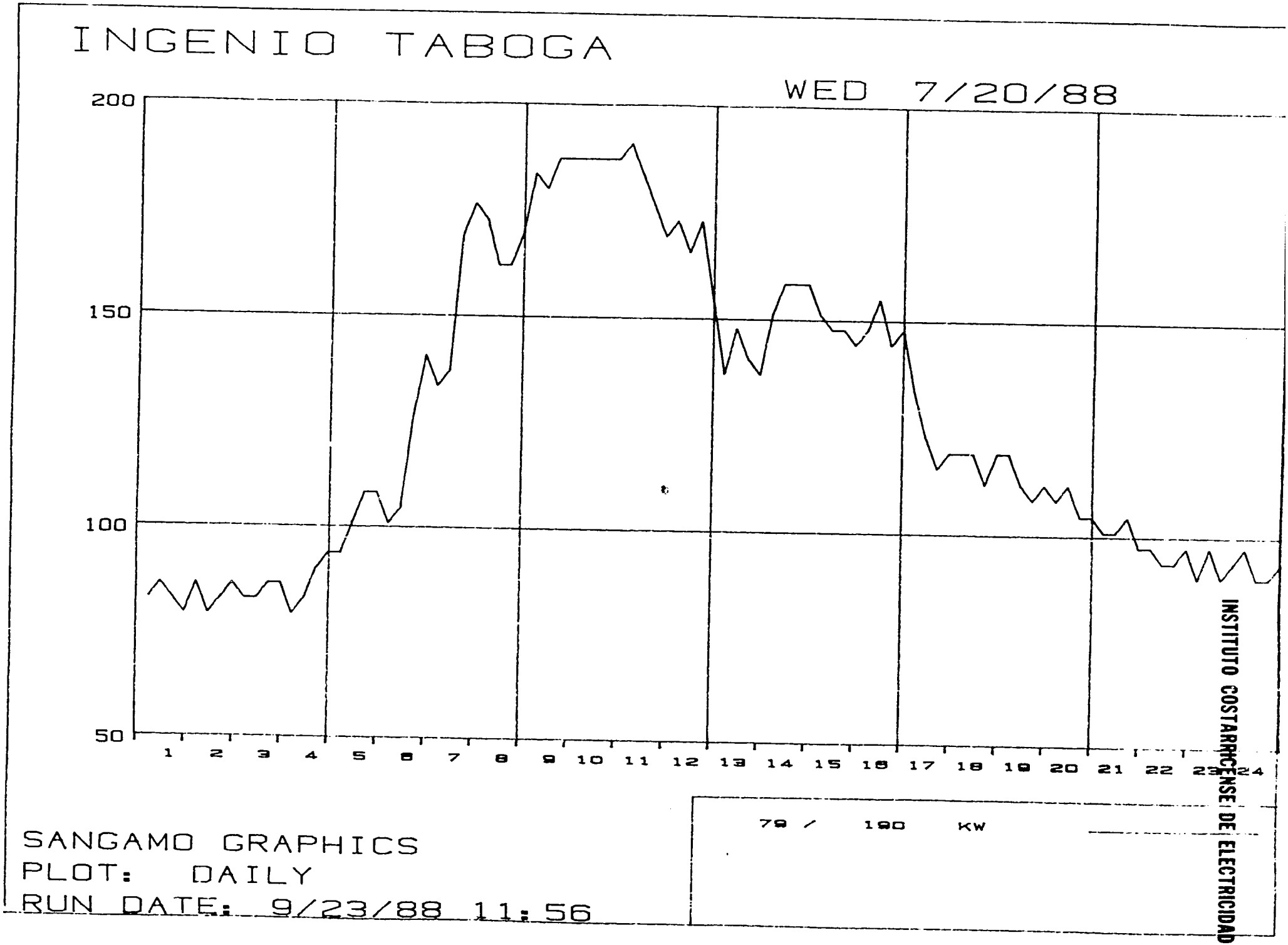



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**Exhibit N.2** **Sample Daily Demand Data from Hewlett-Packard 1000 and Sangamo Software**

200
FIELD TAPE LIMITS 7/13/88 1249 TO 8/13/88 1432 EMPACADORA DE CARNES CR 175-25 RPT-DATE 9/20/88 09:32 PAGE 1
OFIC.CONTROL DE CALIDAD=PICOS CADA 15 MIN. EN KW=PICOS2

DAY - 8/ 2/88 (TUE) HST - 1 DMD FCTR - 1

| TIME TC | KW S | TIME TC | KW S | TIME TC | KW S | TIME TC | KW S | TIME TC | KW S | TIME TC | KW S |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 15 | 53.55 | 30 | 53.55 | 45 | 53.55 | 100 | 53.55 | 115 | 53.55 | 130 | 53.55 |
| 145 | 53.55 | 200 | 58.28 | 215 | 89.78 | 230 | 88.20 | 245 | 88.20 | 300 | 86.63 |
| 315 | 85.05 | 330 | 85.05 | 345 | 83.48 | 400 | 83.48 | 415 | 83.48 | 430 | 81.90 |
| 445 | 81.90 | 500 | 81.90 | 515 | 80.33 | 530 | 75.60 | 545 | 159.08 | 600 | 173.25 |
| 615 | 182.70 | 630 | 190.58 | 645 | 200.03 | 700 | 263.03 | 715 | 318.15 | 730 | 348.08 |
| 745 | 362.25 | 800 | 360.68 | 815 | 384.30 | 830 | 374.85 | 845 | 343.35 | 900 | 344.93 |
| 915 | 363.83 | 930 | 359.10 | 945 | 370.13 | 1000 | 393.75 | 1015 | 403.20 | 1030 | 371.70 |
| 1045 | 381.15 | 1100 | 371.70 | 1115 | 371.70 | 1130 | 360.68 | 1145 | 354.38 | 1200 | 365.40 |
| 1215 | 415.80 | 1230 | 448.88 | 1245 | 404.78 | 1300 | 311.85 | 1315 | 297.68 | 1330 | 285.08 |
| 1345 | 270.90 | 1400 | 259.88 | 1415 | 250.43 | 1430 | 236.25 | 1445 | 233.10 | 1500 | 232.83 |
| 1515 | 237.83 | 1530 | 228.38 | 1545 | 225.23 | 1600 | 226.80 | 1615 | 226.80 | 1630 | 223.65 |
| 1645 | 222.08 | 1700 | 222.08 | 1715 | 220.50 | 1730 | 217.35 | 1745 | 215.78 | 1800 | 215.78 |
| 1815 | 111.83 | 1830 | 97.65 | 1845 | 86.63 | 1900 | 83.48 | 1915 | 85.05 | 1930 | 83.48 |
| 1945 | 80.33 | 2000 | 81.90 | 2015 | 81.90 | 2030 | 81.90 | 2045 | 80.33 | 2100 | 78.75 |
| 2115 | 78.75 | 2130 | 77.18 | 2145 | 80.33 | 2200 | 78.75 | 2215 | 78.75 | 2230 | 78.75 |
| 2245 | 78.75 | 2300 | 77.18 | 2315 | 78.75 | 2330 | 77.18 | 2345 | 77.18 | 2400 | 77.18 |

The situation with the software on the PC was better, but still not optimal. Sangamo offers an option for its PC program that will export data to a file that can be used by spreadsheet programs, but ICE does not own that module. However, the Sangamo software on the PC is capable of creating an ASCII file of kW demand and kWh consumption data (for an example, see Exhibit N.3).[4] The latter option was used to obtain kW data to import into a Lotus 123 spreadsheet for analysis.

### Final Format of Translated Data

Once the data were imported into Lotus 123, they were organized into a format that facilitated the analysis of daily demand during peak hours (see Exhibit N.4). The maximum daily demand during peak hours was calculated for each day, and the average demand and maximum demand for the entire month were calculated for each quarter hour for each customer. These averages and maximums were later combined in a table to prepare information on the customers as a whole. Data from all companies were combined to create a composite daily load curve for the day of maximum system peak demand in 1987 and 1988. And finally, average before and after demand curves were created for each participant to enable the comparison of changes in the shape of demand over the course of the project.

### Production and Energy Consumption Data

Variables such as weather, economic climate, labor relations, and world prices for inputs and outputs affect the total level of activity in industrial enterprises. By doing so they can also affect the peak demand for electricity. An exhaustive assessment of the impact of a load management program would calculate indices for such variables in order to factor out their effect on demand. In this limited study, however, it was not possible to include these variables in the analyses. An analysis was made using indices created from statistics on total energy consumption and industrial production to adjust the peak demand numbers for changes in level of activity. However, limitations with this methodology prevented the project team from drawing conclusions based on that analysis. The results from that analysis and its limitations will be presented here for discussion's sake.

Production data were collected for 14 of the companies in the analysis using mailed forms and letters and by the team members' personal contact with participants. When production data could not be obtained, total energy consumption (kWh) was used as a

4 The software can print to a file, creating an ASCII file. ASCII is a standard disk file format that can be used by a variety of other programs, including Lotus 123.

# Exhibit N.3 Sample Daily Demand Data from PC and Datastar Software

**NAME OF REPORT & ACCT. NO.**

****** PC-REP ******
Account #:104646

**DATE & TIME REPORT WAS MADE**

9/25/85 16:45 Page 1

Recorder Type : DSR
Recorder Interval Length: 30
Recorder Number Of Channels: 4

**RECORDER INFORMATION**

Logamo PCT
ID:16230002
Name:Georgia Pacific

**WEEKLY REPORT OF KW IN 30 MIN. INTERVALS**

| TIME | Monday 5/06/85 KW ST | Tuesday 5/07/85 KW ST | Wednesday 5/08/85 KW ST | Thursday 5/09/85 KW ST | Friday 5/10/85 KW ST | Saturday 5/11/85 KW ST | Sunday 5/12/85 KW ST | TIME |
|---|---|---|---|---|---|---|---|---|
| 00:30 | 6721.92 | 9262.08 | 8786.88 | 9832.32 | 9996.48 | 8640.00 | 7732.80 | 00:30 |
| 01:00 | 6609.60L | 9616.32 | 8847.36 | 10350.72 | 9953.28 | 9184.32 | 7439.04 | 01:00 |
| 01:30 | 6721.92 | 9806.40 | 9115.20 | 9599.04 | 9910.08 | 9383.04H | 7819.20H | 01:30 |
| 02:00 | 6739.20 | 8907.84 | 9201.60 | 9555.84 | 9434.88 | 9192.96 | 7784.64 | 02:00 |
| 02:30 | 6868.80 | 8570.88 | 8475.84 | 9192.96 | 8942.40 | 8311.68 | 7563.68 | 02:30 |
| 03:00 | 6920.64 | 8527.68 | 8501.76 | 9028.80 | 8976.96 | 8173.44 | 7741.44 | 03:00 |
| 03:30 | 6955.20 | 8467.20 | 8484.48 | 8786.88 | 8786.88 | 8069.76 | 7741.44 | 03:30 |
| 04:00 | 6851.52 | 8337.60 | 8441.28 | 8605.44L | 8544.96 | 7767.36 | 7663.68 | 04:00 |
| 04:30 | 7007.04 | 8501.76 | 8354.88L | 8657.28 | 8588.16 | 7862.40 | 7594.56 | 04:30 |
| 05:00 | 7205.76 | 8873.28 | 8562.24 | 8959.68 | 8873.28 | 7879.68 | 7464.96 | 05:00 |
| 05:30 | 7508.16 | 9184.32 | 9264.80 | 9564.48 | 9374.40 | 8519.04 | 7637.76 | 05:30 |
| 06:00 | 8130.24 | 9866.88 | 9581.76 | 9884.16 | 9201.60 | 8570.88 | 7395.84 | 06:00 |
| 06:30 | 9313.92 | 10005.12 | 10074.24 | 10532.16 | 9391.68 | 8605.44 | 7499.52 | 06:30 |
| 07:00 | 9711.36 | 10445.76 | 10126.08 | 10566.72H | 9763.20 | 8251.20 | 7447.68 | 07:00 |
| 07:30 | 8942.40 | 10480.32 | 9987.84 | 10333.44 | 9728.64 | 7966.08 | 7672.32 | 07:30 |
| 08:00 | 8890.56 | 10592.64H | 10169.28 | 10471.68 | 10281.60 | 8225.28 | 7663.68 | 08:00 |
| 08:30 | 9417.60 | 10229.76 | 10376.64 | 10031.04 | 10342.08 | 8121.60 | 7456.32 | 08:30 |
| 09:00 | 10359.36H | 10074.24 | 10869.12H | 10091.52 | 9936.00 | 8216.64 | 7136.64 | 09:00 |
| 09:30 | 9789.12 | 9573.12 | 10177.92 | 9495.36 | 10056.96 | 8009.28 | 7309.44 | 09:30 |
| 10:00 | 9734.56 | 9581.76 | 10039.68 | 9530.56 | 10169.28 | 8164.80 | 7171.20 | 10:00 |
| 10:30 | 9737.28 | 10437.12 | 10748.16 | 10221.12 | 10601.28H | 8173.44 | 7197.12 | 10:30 |
| 0 | 9780.48 | 9849.60 | 10359.36 | 10333.44 | 10342.08 | 7776.00 | 7318.08 | 11:00 |
| 0 | 9357.12 | 10177.92 | 10402.56 | 10195.20 | 9443.52 | 8112.96 | 7197.12 | 11:30 |
| 12:00 | 9106.56 | 10307.52 | 10091.52 | 10074.24 | 9564.48 | 7325.44 | 7128.00 | 12:00 |
| 12:30 | 10160.64 | 10393.92 | 10523.52 | 10108.80 | 9927.36 | 7378.56L | 6946.56 | 12:30 |
| 13:00 | 10290.24 | 10203.84 | 10661.76 | 10152.00 | 10022.40 | 7499.52 | 6920.64 | 13:00 |
| 13:30 | 10082.88 | 10272.96 | 10644.48 | 10229.76 | 9642.24 | 7387.20 | 6894.72 | 13:30 |
| 14:00 | 9599.04 | 9901.44 | 9806.40 | 8812.80 | 9262.08 | 7456.32 | 6903.36 | 14:00 |
| 14:30 | 9270.72 | 9192.96 | 9728.64 | 8683.20 | 8640.00 | 7594.56 | 6661.44 | 14:30 |
| 15:00 | 9175.68 | 8985.60 | 9322.56 | 8743.68 | 8674.56 | 7819.20 | 7058.88 | 15:00 |
| 15:30 | 8959.68 | 8562.24 | 9313.92 | 8907.84 | 8398.08 | 7827.84 | 7594.56 | 15:30 |
| 16:00 | 9097.92 | 8804.16 | 8372.16 | 8726.40 | 8458.56 | 7776.00 | 7629.12 | 16:00 |
| 16:30 | 9469.44 | 8985.60 | 8354.88 | 8959.68 | 8354.88L | 7577.28 | 7032.96 | 16:30 |
| 17:00 | 9201.60 | 8208.00L | 8899.20 | 9046.08 | 8665.92 | 7672.32 | 6668.80 | 17:00 |
| 17:30 | 10031.04 | 9694.08 | 9512.64 | 9866.88 | 9279.36 | 8415.36 | 7585.92 | 17:30 |
| 18:00 | 10186.56 | 9763.20 | 10108.80 | 10013.76 | 9858.24 | 8588.16 | 7421.76 | 18:00 |
| 18:30 | 9944.64 | 9694.08 | 10039.68 | 9996.48 | 9745.92 | 8363.52 | 6402.24 | 18:30 |
| 19:00 | 9089.28 | 9348.48 | 10160.64 | 9763.20 | 9374.40 | 8164.80 | 5935.68L | 19:00 |
| 19:30 | 8994.24 | 9115.20 | 10065.60 | 9694.08 | 9737.28 | 8493.12 | 6004.80 | 19:30 |
| 20:00 | 9529.92 | 9452.16 | 10281.60 | 9659.52 | 9737.28 | 8726.40 | 6402.24 | 20:00 |
| 20:30 | 9918.72 | 9711.36 | 10143.36 | 9806.40 | 9702.72 | 8821.44 | 6531.84 | 20:30 |
| 21:00 | 10074.24 | 9849.60 | 10022.40 | 9789.12 | 9599.04 | 8959.68 | 6566.40 | 21:00 |
| 21:30 | 9288.00 | 8960.32 | 9711.36 | 9313.92 | 8726.40 | 8285.76 | 6566.40 | 21:30 |
| 22:00 | 9538.56 | 9400.32 | 9910.08 | 9599.04 | 9443.52 | 7836.48 | 6652.80 | 22:00 |
| 22:30 | 9391.68 | 8786.88 | 9676.80 | 9469.44 | 9305.28 | 7896.96 | 7568.64 | 22:30 |
| 23:00 | 9434.88 | 9132.48 | 10082.88 | 10048.32 | 9227.52 | 7853.76 | 7464.96 | 23:00 |
| 23:30 | 9694.08 | 9210.24 | 10212.48 | 9840.96 | 8925.12 | 7948.80 | 7560.00 | 23:30 |
| 24:00 | 9141.12 | 8856.00 | 10048.32 | 9720.00 | 8570.88 | 7922.88 | 7663.68 | 24:00 |
| MAX | 10359.36 | 10592.64 | 10869.12 | 10566.72 | 10601.28 | 9383.04 | 7819.20 | |
| | 09:00 | 08:00 | 09:00 | 07:00 | 10:30 | 01:30 | 01:30 | |
| MIN | 6609.60 | 8208.00 | 8354.88 | 8605.44 | 8354.88 | 7378.56 | 5935.68 | |
| | 01:00 | 17:00 | 04:30 | 04:00 | 16:30 | 12:30 | 19:00 | |
| | 8915.94 | 9661.88 | 9679.68 | 9642.78 | 9405.90 | 8145.18 | 7223.22 | |
| | 0.86 | 0.89 | 0.89 | 0.91 | 0.89 | 0.87 | 0.92 | |
| TOT | 427965 | 454170 | 464625 | 462853 | 451483 | 390969 | 346715 | |

**THIS REPORT CAN BE DONE WITH ANY DESIRED PARAMETER.**

**MAX. READING DURING THE DAY AND TIME OF OCCURRENCE**

**MIN. READING DURING THE DAY AND TIME OF OCCURRENCE**

**AVERAGE READING PER DAY**

**LOAD FACTOR**

**TOTAL OF COLUMN**

# Exhibit N.4 Sample Month of Demand Data for Analysis

CARTAGO BEEF PACKING

| NOV 87 TIME/DATE | Sun 1 | Mon 2 | Tue 3 | Wed 4 | Thurs 5 | Fri 6 | Sat 7 | Sun 8 | Mon 9 | Tue 10 | Wed 11 | Thurs 12 | Fri 13 | Sat 14 | Sun 15 | Mon 16 | Tue 17 | Wed 18 | Thurs 19 | Fri 20 | Sat 21 | Sun 22 | Mon 23 | Tue 24 | Wed 25 | Thurs 26 | Fri 27 | Sat 28 | Sun 29 | Mon 30 | AVERAGE | MAXIMUM |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 00:15 | 517 | 445 | 591 | 659 | 603 | 696 | 725 | 581 | 437 | 720 | 640 | 702 | 617 | 599 | 555 | 413 | 656 | 692 | 593 | 510 | 534 | 647 | 419 | 677 | 628 | 736 | 707 | 684 | 581 | 314 | 596 | 736 |
| 00:30 | 594 | 468 | 615 | 629 | 611 | 690 | 700 | 580 | 446 | 672 | 627 | 703 | 645 | 597 | 563 | 413 | 657 | 700 | 573 | 400 | 546 | 637 | 419 | 678 | 619 | 722 | 704 | 690 | 582 | 376 | 595 | 722 |
| 00:45 | 565 | 447 | 646 | 637 | 592 | 685 | 705 | 547 | 449 | 655 | 683 | 715 | 708 | 621 | 521 | 415 | 625 | 692 | 534 | 407 | 535 | 654 | 410 | 683 | 606 | 700 | 684 | 673 | 600 | 477 | 596 | 715 |
| 01:00 | 568 | 436 | 654 | 617 | 619 | 680 | 723 | 482 | 436 | 596 | 673 | 697 | 692 | 629 | 513 | 357 | 475 | 668 | 533 | 402 | 535 | 664 | 415 | 684 | 577 | 660 | 661 | 669 | 609 | 443 | 579 | 723 |
| 01:15 | 546 | 434 | 618 | 610 | 582 | 700 | 724 | 526 | 434 | 553 | 634 | 691 | 681 | 620 | 509 | 346 | 481 | 666 | 577 | 390 | 529 | 661 | 411 | 675 | 608 | 641 | 663 | 646 | 623 | 445 | 574 | 724 |
| 01:30 | 540 | 426 | 563 | 628 | 597 | 680 | 715 | 518 | 436 | 575 | 649 | 646 | 678 | 639 | 518 | 345 | 481 | 673 | 617 | 438 | 538 | 641 | 404 | 684 | 646 | 627 | 610 | 643 | 589 | 448 | 573 | 715 |
| 01:45 | 421 | 424 | 560 | 600 | 586 | 672 | 721 | 515 | 460 | 549 | 664 | 645 | 675 | 648 | 509 | 341 | 476 | 668 | 629 | 365 | 553 | 653 | 407 | 672 | 642 | 633 | 596 | 631 | 561 | 473 | 565 | 721 |
| 02:00 | 414 | 423 | 559 | 634 | 651 | 666 | 747 | 473 | 436 | 558 | 664 | 623 | 674 | 647 | 557 | 342 | 476 | 657 | 643 | 565 | 534 | 642 | 401 | 654 | 637 | 625 | 601 | 644 | 598 | 470 | 574 | 747 |
| 02:15 | 424 | 417 | 560 | 616 | 653 | 643 | 727 | 493 | 443 | 559 | 663 | 609 | 667 | 631 | 572 | 359 | 486 | 647 | 612 | 610 | 555 | 599 | 403 | 653 | 685 | 626 | 597 | 597 | 570 | 468 | 571 | 727 |
| 02:30 | 413 | 421 | 561 | 622 | 643 | 612 | 723 | 499 | 444 | 526 | 666 | 536 | 659 | 621 | 558 | 410 | 579 | 612 | 588 | 617 | 573 | 556 | 398 | 653 | 701 | 607 | 675 | 586 | 557 | 540 | 572 | 723 |
| 02:45 | 480 | 415 | 563 | 594 | 635 | 604 | 665 | 496 | 448 | 521 | 689 | 600 | 651 | 610 | 576 | 503 | 569 | 590 | 581 | 663 | 560 | 552 | 400 | 656 | 692 | 646 | 681 | 391 | 555 | 601 | 580 | 692 |
| 03:00 | 449 | 412 | 644 | 565 | 541 | 600 | 680 | 498 | 449 | 495 | 704 | 680 | 646 | 604 | 568 | 511 | 560 | 547 | 577 | 692 | 552 | 550 | 400 | 654 | 685 | 663 | 751 | 568 | 509 | 596 | 578 | 751 |
| 03:15 | 451 | 415 | 643 | 617 | 522 | 602 | 680 | 476 | 434 | 534 | 703 | 674 | 643 | 621 | 511 | 502 | 547 | 501 | 647 | 625 | 537 | 547 | 394 | 652 | 654 | 620 | 742 | 566 | 491 | 592 | 572 | 742 |
| 03:30 | 488 | 404 | 677 | 656 | 563 | 606 | 706 | 461 | 504 | 558 | 729 | 653 | 655 | 664 | 490 | 473 | 535 | 532 | 617 | 625 | 554 | 532 | 462 | 670 | 627 | 559 | 736 | 561 | 494 | 562 | 579 | 736 |
| 03:45 | 479 | 459 | 647 | 654 | 605 | 682 | 720 | 459 | 500 | 608 | 743 | 650 | 742 | 666 | 499 | 445 | 556 | 534 | 609 | 615 | 564 | 506 | 416 | 697 | 706 | 552 | 736 | 602 | 486 | 526 | 589 | 743 |
| 04:00 | 500 | 484 | 613 | 639 | 622 | 711 | 694 | 448 | 492 | 590 | 730 | 659 | 731 | 647 | 488 | 437 | 537 | 494 | 597 | 582 | 579 | 481 | 356 | 683 | 702 | 559 | 714 | 601 | 476 | 517 | 579 | 731 |
| 04:15 | 486 | 461 | 562 | 588 | 605 | 713 | 691 | 446 | 489 | 641 | 667 | 650 | 734 | 616 | 485 | 442 | 549 | 460 | 611 | 559 | 565 | 492 | 358 | 667 | 632 | 636 | 698 | 584 | 522 | 518 | 571 | 734 |
| 04:30 | 485 | 484 | 506 | 546 | 595 | 707 | 679 | 442 | 470 | 669 | 641 | 643 | 737 | 598 | 520 | 450 | 565 | 465 | 575 | 551 | 560 | 480 | 351 | 643 | 618 | 634 | 692 | 524 | 549 | 518 | 563 | 737 |
| 04:45 | 491 | 482 | 470 | 607 | 562 | 699 | 666 | 443 | 482 | 658 | 645 | 642 | 720 | 590 | 525 | 451 | 548 | 581 | 560 | 547 | 563 | 480 | 351 | 636 | 628 | 589 | 655 | 560 | 552 | 546 | 564 | 720 |
| 05:00 | 486 | 478 | 466 | 624 | 539 | 676 | 650 | 440 | 475 | 662 | 642 | 645 | 679 | 643 | 500 | 480 | 544 | 596 | 582 | 545 | 572 | 472 | 345 | 636 | 703 | 605 | 653 | 622 | 519 | 493 | 566 | 703 |
| 05:15 | 488 | 475 | 469 | 616 | 556 | 641 | 614 | 452 | 469 | 658 | 639 | 648 | 652 | 610 | 500 | 458 | 531 | 595 | 555 | 606 | 574 | 478 | 349 | 651 | 687 | 562 | 645 | 597 | 510 | 309 | 560 | 687 |
| 05:30 | 490 | 437 | 505 | 612 | 558 | 639 | 551 | 508 | 459 | 629 | 654 | 666 | 628 | 638 | 511 | 430 | 589 | 601 | 556 | 646 | 549 | 501 | 377 | 613 | 651 | 566 | 630 | 561 | 608 | 521 | 563 | 666 |
| 05:45 | 482 | 430 | 505 | 588 | 590 | 637 | 593 | 510 | 459 | 667 | 657 | 660 | 580 | 633 | 536 | 434 | 589 | 616 | 595 | 612 | 542 | 532 | 387 | 605 | 661 | 631 | 624 | 585 | 582 | 522 | 568 | 667 |
| 06:00 | 485 | 437 | 636 | 586 | 594 | 629 | 630 | 499 | 437 | 680 | 657 | 691 | 637 | 659 | 568 | 419 | 600 | 624 | 589 | 564 | 574 | 532 | 400 | 552 | 692 | 640 | 615 | 630 | 588 | 486 | 578 | 692 |
| 06:15 | 491 | 462 | 605 | 611 | 619 | 654 | 638 | 504 | 468 | 673 | 686 | 644 | 710 | 684 | 557 | 436 | 636 | 651 | 581 | 572 | 565 | 532 | 416 | 595 | 651 | 667 | 579 | 645 | 568 | 505 | 587 | 710 |
| 06:30 | 476 | 451 | 605 | 629 | 587 | 645 | 675 | 506 | 487 | 651 | 679 | 632 | 700 | 689 | 558 | 405 | 604 | 573 | 589 | 562 | 566 | 343 | 420 | 581 | 604 | 599 | 602 | 653 | 558 | 549 | 573 | 700 |
| 06:45 | 481 | 453 | 593 | 622 | 589 | 589 | 678 | 503 | 474 | 640 | 688 | 667 | 686 | 687 | 559 | 421 | 607 | 594 | 595 | 564 | 578 | 504 | 431 | 576 | 622 | 457 | 659 | 671 | 563 | 597 | 578 | 688 |
| 07:00 | 469 | 474 | 597 | 612 | 505 | 585 | 672 | 500 | 481 | 638 | 677 | 653 | 705 | 665 | 530 | 484 | 602 | 705 | 617 | 573 | 576 | 528 | 437 | 565 | 661 | 658 | 684 | 680 | 513 | 587 | 588 | 705 |
| 07:15 | 491 | 471 | 587 | 638 | 553 | 613 | 681 | 514 | 483 | 640 | 658 | 626 | 719 | 697 | 482 | 448 | 625 | 702 | 618 | 622 | 594 | 527 | 434 | 557 | 648 | 646 | 662 | 699 | 509 | 554 | 590 | 719 |
| 07:30 | 490 | 470 | 602 | 621 | 575 | 631 | 705 | 448 | 489 | 652 | 644 | 616 | 712 | 724 | 481 | 427 | 636 | 676 | 613 | 766 | 606 | 492 | 416 | 546 | 683 | 661 | 686 | 726 | 506 | 555 | 595 | 766 |
| 07:45 | 505 | 511 | 544 | 624 | 633 | 627 | 716 | 440 | 516 | 668 | 631 | 625 | 720 | 730 | 402 | 507 | 650 | 665 | 617 | 765 | 635 | 480 | 435 | 610 | 701 | 596 | 682 | 744 | 514 | 552 | 602 | 765 |
| 08:00 | 497 | 515 | 549 | 688 | 672 | 629 | 755 | 440 | 499 | 698 | 654 | 656 | 722 | 731 | 399 | 500 | 720 | 669 | 613 | 775 | 660 | 462 | 436 | 611 | 720 | 576 | 672 | 738 | 516 | 572 | 611 | 775 |
| 08:15 | 479 | 530 | 569 | 681 | 703 | 623 | 756 | 459 | 554 | 703 | 671 | 703 | 769 | 715 | 392 | 559 | 729 | 744 | 621 | 780 | 690 | 446 | 478 | 650 | 743 | 703 | 675 | 752 | 507 | 606 | 633 | 780 |
| 08:30 | 471 | 560 | 599 | 688 | 747 | 635 | 762 | 463 | 654 | 722 | 706 | 687 | 755 | 742 | 387 | 496 | 769 | 765 | 651 | 860 | 678 | 433 | 555 | 683 | 747 | 723 | 663 | 709 | 490 | 622 | 647 | 860 |
| 08:45 | 482 | 601 | 603 | 682 | 735 | 642 | 752 | 530 | 653 | 715 | 575 | 710 | 741 | 764 | 389 | 545 | 725 | 813 | 666 | 848 | 679 | 438 | 532 | 697 | 769 | 717 | 599 | 699 | 529 | 649 | 649 | 848 |
| 09:00 | 488 | 639 | 624 | 677 | 662 | 669 | 746 | 519 | 648 | 739 | 572 | 707 | 734 | 752 | 381 | 559 | 735 | 775 | 719 | 775 | 683 | 435 | 497 | 700 | 776 | 672 | 589 | 700 | 546 | 614 | 644 | 776 |
| 09:15 | 482 | 586 | 630 | 695 | 554 | 665 | 730 | 525 | 666 | 745 | 597 | 736 | 778 | 723 | 397 | 608 | 722 | 751 | 701 | 805 | 680 | 437 | 475 | 708 | 773 | 678 | 606 | 773 | 542 | 606 | 646 | 805 |
| 09:30 | 492 | 601 | 679 | 718 | 709 | 681 | 757 | 469 | 682 | 741 | 779 | 739 | 809 | 688 | 464 | 657 | 748 | 760 | 685 | 833 | 678 | 442 | 484 | 710 | 786 | 674 | 624 | 802 | 541 | 630 | 669 | 833 |
| 09:45 | 473 | 603 | 729 | 725 | 686 | 727 | 766 | 529 | 681 | 727 | 815 | 720 | 790 | 685 | 458 | 684 | 723 | 746 | 706 | 792 | 691 | 437 | 514 | 722 | 781 | 651 | 647 | 809 | 539 | | 674 | 815 |
| 10:00 | 446 | 590 | 715 | 732 | 695 | 715 | 780 | 519 | 684 | 741 | 825 | 747 | 790 | 674 | 461 | 708 | 770 | 768 | 702 | 807 | 709 | 421 | 515 | 709 | 761 | 732 | 712 | 821 | 540 | | 684 | 825 |
| 10:15 | 406 | 587 | 710 | 703 | 539 | 721 | 797 | 513 | 703 | 781 | 827 | 780 | 774 | 718 | 454 | 720 | 811 | 787 | 689 | 756 | 719 | 386 | 598 | 715 | 774 | 831 | 725 | 792 | 531 | | 634 | 831 |
| 10:30 | 495 | 617 | 705 | 731 | 595 | 742 | 821 | 508 | 721 | 618 | 839 | 796 | 790 | 703 | 380 | 730 | 804 | 765 | 739 | 831 | 732 | 432 | 576 | 720 | 778 | 855 | 777 | 779 | 525 | | 693 | 855 |
| 10:45 | 518 | 611 | 698 | 732 | 723 | 739 | 821 | 508 | 723 | 840 | 812 | 797 | 764 | 699 | 373 | 723 | 822 | 662 | 735 | 771 | 759 | 440 | 632 | 722 | 778 | 793 | 808 | 749 | 535 | | 699 | 840 |
| 11:00 | 552 | 666 | 685 | 714 | 727 | 733 | 828 | 523 | 718 | 838 | 790 | 776 | 789 | 736 | 381 | 751 | 785 | 666 | 758 | 571 | 820 | 433 | 679 | 720 | 785 | 777 | 805 | 753 | 515 | | 699 | 338 |
| 11:15 | 586 | 611 | 671 | 650 | 696 | 721 | 820 | 563 | 713 | 829 | 808 | 694 | 687 | 772 | 383 | 784 | 738 | 645 | 705 | 705 | 764 | 440 | 675 | 710 | 741 | 830 | 788 | 765 | 492 | | 689 | 830 |
| 11:30 | 550 | 629 | 686 | 663 | 651 | 716 | 820 | 590 | 724 | 823 | 780 | 705 | 741 | 773 | 382 | 747 | 757 | 608 | 688 | 702 | 754 | 439 | 712 | 714 | 791 | 828 | 809 | 750 | 509 | | 691 | 828 |
| 11:45 | 517 | 646 | 703 | 737 | 639 | 704 | 748 | 650 | 726 | 812 | 789 | 671 | 758 | 731 | 381 | 713 | 804 | 646 | 706 | 722 | 756 | 448 | 687 | 719 | 769 | 830 | 797 | 688 | 489 | | 689 | 830 |
| 12:00 | 517 | 690 | 697 | 674 | 627 | 694 | 732 | 650 | 698 | 628 | 749 | 684 | 738 | 717 | 383 | 703 | 752 | 655 | 674 | 729 | 821 | 440 | 641 | 694 | 764 | 744 | 724 | 661 | 497 | | 668 | 821 |
| 12:15 | 450 | 705 | 681 | 599 | 596 | 681 | 771 | 658 | 661 | 783 | 729 | 689 | 724 | 715 | 451 | 694 | 571 | 651 | 674 | 709 | 771 | 429 | 629 | 685 | 714 | 718 | 731 | 695 | 511 | | 658 | 783 |
| 12:30 | 430 | 663 | 724 | 731 | 605 | 694 | 832 | 656 | 677 | 723 | 737 | 727 | 722 | 737 | 518 | 690 | 786 | 719 | 695 | 718 | 776 | 423 | 670 | 692 | 753 | 724 | 735 | 753 | 491 | | 683 | 832 |
| 12:45 | 486 | 580 | 802 | 731 | 616 | 689 | 830 | 628 | 728 | 733 | 763 | 707 | 112 | 746 | 515 | 713 | 806 | 700 | 586 | 724 | 768 | 420 | 714 | 713 | 710 | 739 | 588 | 743 | 502 | | 658 | 830 |
| 13:00 | 481 | 629 | 799 | 738 | 591 | 713 | 818 | 578 | 739 | 765 | 757 | 752 | 11 | 753 | 512 | 798 | 817 | 703 | 586 | 756 | 791 | 420 | 691 | 727 | 723 | 754 | 762 | 703 | 496 | | 668 | 818 |
| 13:15 | 528 | 742 | 794 | 746 | 756 | 711 | 787 | 586 | 750 | 775 | 761 | 760 | 642 | 744 | 506 | 795 | 823 | 706 | 592 | 778 | 776 | 423 | 692 | 734 | 729 | 678 | 765 | 710 | 502 | | 700 | 823 |
| 13:30 | 502 | 759 | 800 | 730 | 811 | 725 | 801 | 549 | 734 | 778 | 765 | 806 | 830 | 804 | 398 | 783 | 825 | 691 | 610 | 773 | 830 | 422 | 692 | 734 | 731 | 425 | 766 | 705 | 474 | | 698 | 830 |

# Exhibit N.4 Sample Month of Demand Data for Analysis (cont)

CARTAGO BEEF PACKING

| NOV 87 TIME/DATE | Sun 1 | Mon 2 | Tue 3 | Wed 4 | ThursFri 5 | 6 | Sat 7 | Sun 8 | Mon 9 | Tue 10 | Wed 11 | ThursFri 12 | 13 | Sat 14 | Sun 15 | Mon 16 | Tue 17 | Wed 18 | ThursFri 19 | 20 | Sat 21 | Sun 22 | Mon 23 | Tue 24 | Wed 25 | ThursFri 26 | 27 | Sat 28 | Sun 29 | Mon 30 | AVERAGE | MAXIMUM |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 13:45 | 483 | 733 | 793 | 715 | 835 | 735 | 806 | 604 | 760 | 784 | 811 | 825 | 765 | 808 | 384 | 754 | 827 | 668 | 643 | 771 | 833 | 490 | 705 | 764 | 721 | 608 | 765 | 768 | 560 | | 714 | 835 |
| 14:00 | 499 | 736 | 792 | 691 | 790 | 723 | 811 | 564 | 769 | 870 | 789 | 816 | 681 | 774 | 389 | 743 | 818 | 691 | 584 | 752 | 669 | 472 | 743 | 644 | 712 | 660 | 757 | 780 | 593 | | 701 | 870 |
| 14:15 | 506 | 749 | 776 | 839 | 746 | 735 | 836 | 559 | 785 | 650 | 786 | 803 | 672 | 753 | 382 | 732 | 823 | 692 | 605 | 780 | 757 | 437 | 707 | 650 | 734 | 787 | 736 | 722 | 577 | | 701 | 839 |
| 14:30 | 515 | 747 | 758 | 806 | 762 | 735 | 861 | 551 | 751 | 753 | 821 | 780 | 679 | 784 | 382 | 699 | 828 | 680 | 597 | 774 | 774 | 414 | 721 | 642 | 725 | 813 | 756 | 710 | 543 | | 702 | 861 |
| 14:45 | 504 | 725 | 737 | 790 | 805 | 608 | 526 | 554 | 760 | 836 | 789 | 777 | 672 | 846 | 393 | 709 | 824 | 713 | 601 | 754 | 741 | 403 | 716 | 673 | 752 | 797 | 669 | 707 | 497 | | 685 | 846 |
| 15:00 | 506 | 725 | 745 | 789 | 800 | 612 | 825 | 549 | 751 | 822 | 777 | 771 | 728 | 830 | 458 | 842 | 822 | 654 | 584 | 739 | 781 | 401 | 742 | 672 | 736 | 722 | 734 | 677 | 501 | | 700 | 842 |
| 15:15 | 525 | 726 | 717 | 771 | 796 | 747 | 733 | 537 | 793 | 809 | 807 | 749 | 710 | 731 | 462 | 779 | 770 | 631 | 601 | 735 | 774 | 374 | 721 | 680 | 822 | 758 | 711 | 637 | 516 | | 694 | 822 |
| 15:30 | 505 | 733 | 699 | 774 | 806 | 778 | 843 | 538 | 790 | 820 | 813 | 749 | 635 | 778 | 479 | 721 | 771 | 612 | 581 | 775 | 699 | 433 | 699 | 742 | 817 | 741 | 731 | 686 | 526 | | 699 | 843 |
| 15:45 | 490 | 710 | 695 | 817 | 822 | 778 | 585 | 525 | 689 | 837 | 795 | 756 | 642 | 790 | 461 | 699 | 806 | 651 | 622 | 710 | 688 | 362 | 642 | 742 | 836 | 795 | 723 | 719 | 513 | | 686 | 837 |
| 16:00 | 495 | 697 | 719 | 830 | 698 | 777 | 869 | 509 | 622 | 809 | 813 | 784 | 701 | 839 | 459 | 697 | 814 | 689 | 642 | 753 | 711 | 328 | 680 | 747 | 852 | 751 | 775 | 722 | 509 | | 700 | 869 |
| 16:15 | 489 | 763 | 736 | 838 | 597 | 795 | 829 | 538 | 767 | 807 | 827 | 789 | 724 | 799 | 493 | 633 | 834 | 674 | 640 | 747 | 707 | 379 | 719 | 734 | 817 | 739 | 779 | 727 | 479 | | 703 | 838 |
| 16:30 | 488 | 815 | 733 | 800 | 762 | 800 | 802 | 528 | 768 | 822 | 838 | 785 | 685 | 817 | 503 | 627 | 840 | 701 | 676 | 759 | 789 | 404 | 801 | 768 | 747 | 737 | 786 | 622 | 497 | | 714 | 840 |
| 16:45 | 485 | 820 | 727 | 757 | 758 | 800 | 800 | 525 | 806 | 834 | 855 | 762 | 748 | 727 | 499 | 619 | 843 | 705 | 636 | 755 | 687 | 472 | 763 | 784 | 752 | 747 | 713 | 740 | 518 | | 712 | 855 |
| 17:00 | 566 | 797 | 717 | 731 | 742 | 796 | 791 | 524 | 698 | 820 | 853 | 765 | 769 | 715 | 498 | 680 | 852 | 744 | 734 | 738 | 700 | 520 | 738 | 798 | 749 | 720 | 689 | 752 | 471 | | 713 | 853 |
| 17:15 | 552 | 765 | 719 | 765 | 737 | 794 | 765 | 523 | 496 | 834 | 846 | 757 | 691 | 759 | 498 | 674 | 853 | 736 | 721 | 748 | 707 | 507 | 707 | 767 | 778 | 822 | 728 | 602 | 497 | | 702 | 853 |
| 17:30 | 534 | 760 | 721 | 782 | 712 | 791 | 765 | 466 | 553 | 848 | 810 | 760 | 642 | 778 | 471 | 652 | 854 | 721 | 701 | 747 | 705 | 465 | 734 | 750 | 802 | 720 | 759 | 651 | 495 | | 695 | 854 |
| 17:45 | 507 | 705 | 715 | 749 | 726 | 785 | 743 | 447 | 657 | 817 | 815 | 766 | 696 | 755 | 459 | 702 | 815 | 684 | 704 | 744 | 762 | 513 | 798 | 731 | 814 | 751 | 778 | 709 | 492 | | 701 | 817 |
| 18:00 | 465 | 701 | 754 | 777 | 753 | 791 | 749 | 469 | 859 | 829 | 827 | 789 | 655 | 808 | 462 | 723 | 741 | 647 | 679 | 749 | 706 | 488 | 770 | 748 | 846 | 671 | 843 | 687 | 501 | | 706 | 859 |
| 18:15 | 503 | 723 | 714 | 780 | 719 | 817 | 741 | 469 | 706 | 812 | 812 | 801 | 656 | 801 | 451 | 728 | 848 | 674 | 674 | 731 | 688 | 446 | 753 | 757 | 843 | 750 | 768 | 678 | 481 | | 701 | 848 |
| 18:30 | 503 | 734 | 708 | 726 | 710 | 750 | 715 | 464 | 632 | 816 | 800 | 797 | 663 | 771 | 448 | 725 | 847 | 680 | 701 | 735 | 680 | 443 | 793 | 756 | 831 | 607 | 724 | 663 | 506 | | 687 | 847 |
| 18:45 | 397 | 755 | 738 | 748 | 689 | 811 | 690 | 438 | 659 | 797 | 786 | 801 | 675 | 746 | 452 | 715 | 828 | 719 | 750 | 719 | 668 | 435 | 797 | 759 | 822 | 717 | 749 | 669 | 477 | | 690 | 828 |
| 19:00 | 347 | 740 | 753 | 754 | 765 | 806 | 715 | 471 | 661 | 780 | 772 | 801 | 683 | 741 | 448 | 675 | 810 | 709 | 709 | 702 | 655 | 435 | 785 | 755 | 830 | 612 | 663 | 649 | 491 | | 680 | 830 |
| 19:15 | 339 | 686 | 733 | 751 | 768 | 820 | 724 | 525 | 613 | 767 | 768 | 825 | 683 | 736 | 448 | 641 | 790 | 695 | 675 | 695 | 651 | 425 | 893 | 750 | 835 | 730 | 781 | 651 | 505 | | 686 | 893 |
| 19:30 | 354 | 645 | 700 | 719 | 763 | 813 | 712 | 533 | 608 | 738 | 774 | 818 | 666 | 726 | 448 | 665 | 785 | 696 | 664 | 697 | 641 | 417 | 892 | 675 | 804 | 675 | 756 | 639 | 478 | | 672 | 892 |
| 19:45 | 343 | 639 | 735 | 684 | 751 | 800 | 706 | 471 | 597 | 734 | 783 | 802 | 711 | 715 | 443 | 655 | 782 | 698 | 636 | 721 | 629 | 377 | 868 | 612 | 793 | 685 | 754 | 645 | 492 | | 664 | 868 |
| 20:00 | 386 | 725 | 708 | 729 | 690 | 761 | 708 | 462 | 690 | 726 | 739 | 790 | 773 | 714 | 446 | 601 | 552 | 702 | 678 | 692 | 694 | 377 | 774 | 595 | 769 | 686 | 743 | 659 | 500 | | 658 | 790 |
| 20:15 | 413 | 708 | 710 | 758 | 646 | 738 | 707 | 458 | 721 | 734 | 747 | 764 | 755 | 711 | 443 | 586 | 742 | 707 | 670 | 676 | 658 | 373 | 794 | 613 | 749 | 622 | 742 | 721 | 484 | | 660 | 794 |
| 20:30 | 413 | 691 | 643 | 753 | 673 | 725 | 689 | 457 | 746 | 716 | 753 | 786 | 716 | 704 | 442 | 577 | 704 | 726 | 670 | 649 | 619 | 378 | 817 | 619 | 762 | 683 | 675 | 715 | 485 | | 655 | 817 |
| 20:45 | 423 | 660 | 651 | 696 | 687 | 733 | 636 | 452 | 681 | 675 | 742 | 738 | 702 | 704 | 435 | 580 | 651 | 656 | 668 | 624 | 626 | 393 | 798 | 630 | 717 | 659 | 712 | 707 | 450 | | 637 | 798 |
| 21:00 | 421 | 672 | 566 | 644 | 698 | 796 | 596 | 455 | 692 | 680 | 758 | 732 | 697 | 702 | 433 | 608 | 641 | 673 | 663 | 618 | 694 | 399 | 764 | 611 | 649 | 650 | 739 | 698 | 447 | | 634 | 796 |
| 21:15 | 417 | 652 | 634 | 683 | 524 | 816 | 655 | 489 | 716 | 690 | 764 | 766 | 698 | 697 | 417 | 562 | 698 | 680 | 654 | 615 | 634 | 274 | 763 | 514 | 622 | 656 | 732 | 680 | 478 | | 627 | 816 |
| 21:30 | 424 | 647 | 673 | 658 | 588 | 788 | 644 | 490 | 656 | 708 | 765 | 750 | 706 | 695 | 419 | 563 | 799 | 680 | 650 | 599 | 619 | 301 | 753 | 521 | 607 | 731 | 715 | 702 | 463 | | 632 | 799 |
| 21:45 | 423 | 627 | 642 | 684 | 756 | 732 | 628 | 453 | 728 | 746 | 751 | 734 | 690 | 686 | 417 | 564 | 799 | 674 | 639 | 583 | 594 | 447 | 750 | 534 | 620 | 753 | 681 | 698 | 498 | | 639 | 799 |
| 22:00 | 420 | 608 | 523 | 700 | 756 | 710 | 625 | 444 | 760 | 733 | 751 | 725 | 672 | 673 | 415 | 608 | 794 | 662 | 634 | 579 | 571 | 439 | 754 | 574 | 639 | 742 | 675 | 663 | 479 | | 632 | 794 |
| 22:15 | 420 | 596 | 664 | 681 | 745 | 717 | 626 | 443 | 750 | 732 | 750 | 758 | 658 | 662 | 418 | 651 | 761 | 654 | 638 | 579 | 580 | 436 | 735 | 707 | 708 | 733 | 698 | 681 | 439 | | 642 | 761 |
| 22:30 | 419 | 583 | 670 | 672 | 741 | 763 | 649 | 439 | 750 | 722 | 732 | 746 | 643 | 649 | 414 | 647 | 729 | 649 | 638 | 578 | 657 | 436 | 725 | 647 | 710 | 731 | 690 | 647 | 425 | | 638 | 763 |
| 22:45 | 424 | 591 | 645 | 675 | 715 | 769 | 673 | 448 | 754 | 713 | 734 | 730 | 659 | 598 | 415 | 641 | 702 | 637 | 634 | 575 | 647 | 432 | 728 | 646 | 725 | 729 | 692 | 672 | 421 | | 635 | 769 |
| 23:00 | 453 | 592 | 626 | 676 | 705 | 762 | 647 | 449 | 747 | 704 | 741 | 719 | 711 | 562 | 414 | 637 | 692 | 622 | 633 | 564 | 638 | 433 | 726 | 707 | 723 | 728 | 671 | 651 | 413 | | 633 | 762 |
| 23:15 | 444 | 580 | 602 | 647 | 687 | 730 | 648 | 426 | 750 | 685 | 734 | 692 | 708 | 569 | 415 | 638 | 682 | 616 | 629 | 556 | 650 | 431 | 730 | 666 | 718 | 725 | 675 | 644 | 408 | | 624 | 750 |
| 23:30 | 444 | 597 | 628 | 631 | 683 | 721 | 651 | 423 | 744 | 676 | 726 | 663 | 659 | 552 | 412 | 678 | 667 | 614 | 630 | 547 | 620 | 433 | 723 | 619 | 741 | 722 | 666 | 644 | 402 | | 618 | 744 |
| 23:45 | 446 | 595 | 633 | 662 | 685 | 731 | 625 | 439 | 745 | 680 | 719 | 636 | 662 | 549 | 413 | 676 | 673 | 606 | 661 | 622 | 594 | 417 | 711 | 607 | 745 | 717 | 688 | 595 | 388 | | 618 | 745 |
| 00:00 | 446 | 592 | 677 | 657 | 686 | 729 | 594 | 448 | 726 | 639 | 700 | 663 | 647 | 542 | 411 | 652 | 687 | 593 | 579 | 550 | 608 | 416 | 700 | 619 | 737 | 714 | 670 | 592 | 362 | | 608 | 737 |
| MAXAM | 586 | 705 | 724 | 737 | 727 | 742 | 832 | 658 | 726 | 840 | 839 | 797 | 790 | 773 | 518 | 784 | 822 | 787 | 758 | 831 | 821 | 448 | 712 | 722 | 791 | 855 | 809 | 821 | 540 | | | |
| MAXPM | 566 | 820 | 754 | 800 | 768 | 820 | 802 | 533 | 859 | 848 | 855 | 825 | 773 | 817 | 503 | 728 | 854 | 744 | 750 | 759 | 789 | 520 | 893 | 798 | 846 | 822 | 843 | 752 | 518 | | | |

substitute, assuming that changes in production would be mirrored in changes in total energy consumption and assuming no change in total energy efficiency.[5] Energy consumption data were collected from ICE's billing files.

## CALCULATION METHODOLOGY AND RESULTS

Three separate procedures were used for calculating the results: (1) comparing aggregate load curves on the day of the system peak for 1987 (without load control) with the aggregate load curves for 1988 (with load control); (2) comparing the average of the aggregate maximum peak demand for the two years for October and November; and (3) examining average load curves for each customer to compare average on-peak demand with average off-peak demand. In addition, estimates were prepared for additional companies when complete data were not available, but the project team members knew that load reduction had been achieved. Each procedure is sensitive to a different set of variables and, as a consequence, each produces somewhat different results. Project team members drew from their knowledge of each company and the limitations of the analysis to reach conclusions about actual savings.

### System Peak Day

ICE's maximum system peak demand in 1987 reached 612 MW on the 12th of November and in 1988 it reached 612.9 MW on the 18th of November. One of the primary goals of demand management is to reduce the system peak load so that utilities can avoid or delay costly expenditures on peaking capacity plants. To determine the impact of this project on the day of maximum peak demand, an aggregate demand curve for both system peak days was created by adding together the quarter-hour demand data for each participant. Subtracting the maximum on-peak demand for 1987 from the maximum on-peak demand for 1988 produced a measure of the reduction in demand from 1987 to 1988 (Exhibit N.5).

5 However, in interpreting these results it must be kept in mind that for ICE a secondary goal of this project was to reduce total energy consumption (at no cost to production levels), thus improving energy efficiency.

**Exhibit N.5**

**Total Participant Demand on System Peak Days**
(kW)

| TIME | Thursday 12 Nov 87 | Friday 18 Nov 88 | Change 1988-1987 Kilowatts | Percent |
|---|---|---|---|---|
| On-Peak Average (AM) | 19,990 | 15,672 | (4,318) | 21.6 |
| On-Peak Average (PM) | 19,321 | 16,351 | (2,970) | 15.4 |
| On-Peak Maximum (AM) | 20,244 | 17,057 | (3,187) | 15.7 |
| On-Peak Maximum (PM) | 20,135 | 16,710 | (3,425) | 17.0 |

Comparing the aggregate load curves from 1987 and 1988 shows a striking drop in demand during the peak hours (Exhibit N.6).

The maximum evening peak aggregate demand for 18 of the participants on November 12, 1987 was 20.1 MW; on November 18, 1988 it was 16.7 MW, representing a reduction in demand of 3.4 MW. The average evening peak aggregate demand for those same companies was 19.3 MW in 1987 and 16.4 MW in 1988, or 3 MW less.

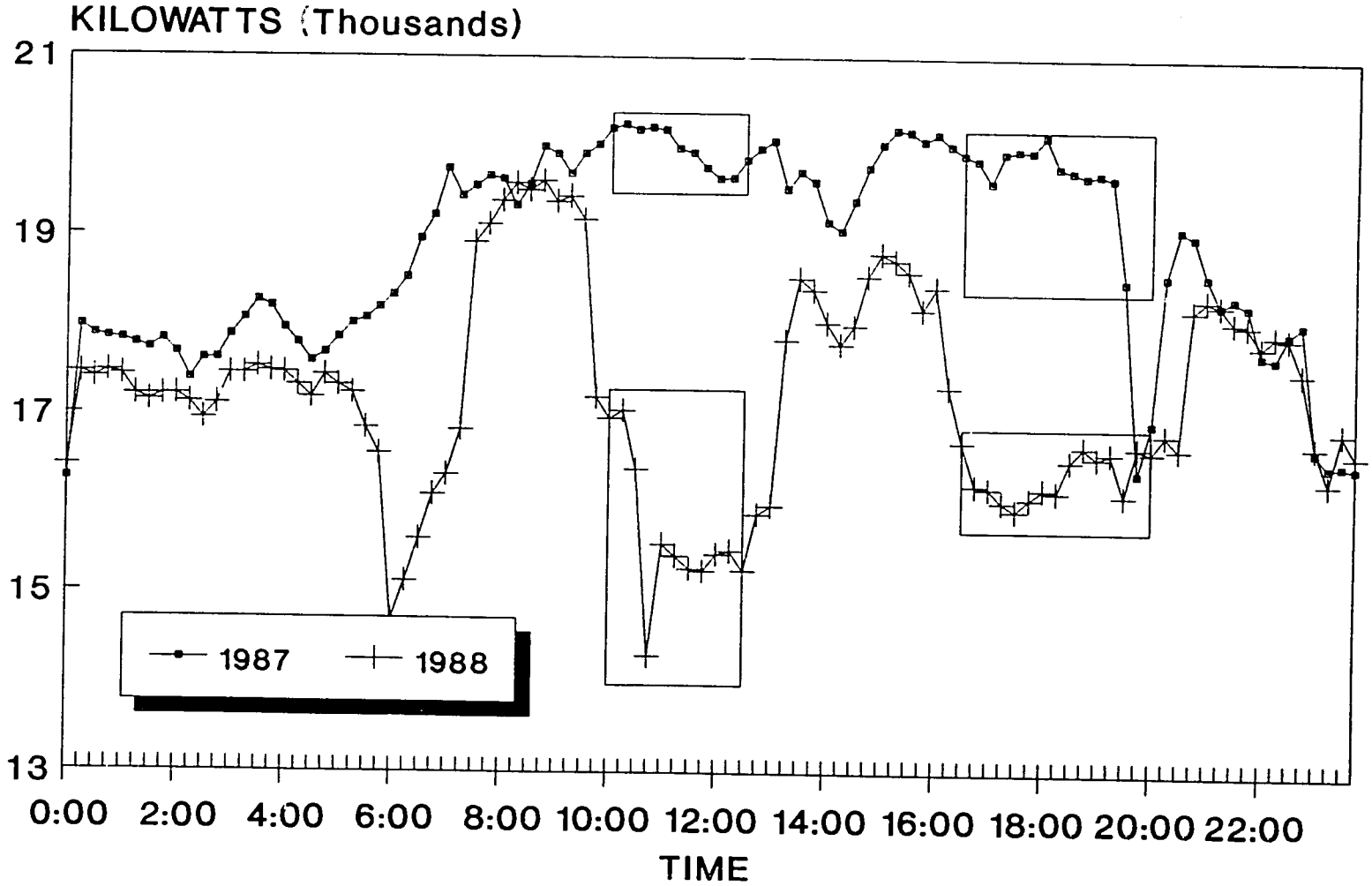
In order to show savings on a company-by-company basis, a calculation of the average peak demand must be used because the maximum peak demand numbers for each of these participants will not present an accurate picture. Each company experiences its maximum peak demand at a different time; thus, their sum would exceed the true aggregate peak demand. The actual savings were concentrated in a few companies and some companies showed an increase in demand (see Exhibit N.7). The ten companies with a reduced average peak demand together reduced their demand by 4.7 MW in the evening peak.[6]

The system peak day analysis presents an interesting view of the impact of the load management program; however, the statistical significance of the analysis is not large. Demand varies significantly from day to day for many of the participants. As a result, by analyzing only one day, these variations are not averaged out and can create unrepresentative results. (For example, Coopevictoria Beneficio had a demand of zero in 1987, apparently being shut down for the day. Including it in the analysis necessarily skews the results.) A more accurate method would be to compare data for any day that total system demand was above 95 percent of the maximum total system peak. Limitations on time and computer assistance available at ICE prohibited performing the analysis to this depth.

6 However, since a new pumping station was brought on-line, demand reduction at the ICAA facilities is not entirely due to load control measures.

Exhibit N.6

# TOTAL PARTICIPANT DEMAND
## ON SYSTEM PEAK DAYS




Boxed region represents peak hours.

142.

**Exhibit N.7**

**Change in Average Demand During Peak Hours on System Peak Days (kW)**

| | AM | PM |
|---|---|---|
| Carnes de C.A. | (4) | (12) |
| Cartago Beef Packing | (238) | (286) |
| CNP Montecillos | 107 | 164 |
| Conducen | (108) | (54) |
| Coopeagri el General (Beneficio) | 362 | 135 |
| Coopeatenas | (23) | (61) |
| Coopevictoria Beneficio | 241 | 372 |
| El Gallito | (64) | 60 |
| Empacadora de Carnes | (366) | (82) |
| Fertica | 559 | 864 |
| ICAA Puente de Mulas | (1,712) | (1,706) |
| ICAA San Rafael de Escazu | (1,700) | (1,693) |
| Ingenio Taboga | (221) | (149) |
| Punto Rojo | (44) | 21 |
| Rafytica | 52 | 34 |
| Ricalit | (578) | (599) |
| Scott Paper | (733) | 103 |
| Ticatex | 153 | (82) |
| TOTAL | (4,318) | (2,970) |

### Aggregate Maximum Peak Demand

This analysis also compares real demand data; but by examining an entire month's worth of data, it eliminates potential inaccuracies encountered by examining only one day. Briefly stated, this analysis calculates maximum daily demand during peak hours for each customer, aggregates those data for all participants, and calculates average work-week changes in demand from October and November 1987 to 1988. One complete set of data for this analysis is presented in Exhibit N.8.

Because ICE's primary concern is to reduce demand during their peak hours, the analysis focused on these times: from 10:00 a.m. to 12:30 p.m. and from 4:30 p.m. to 8:00 p.m. The evening peak is the higher and is given the greater attention.

The analysis proceeded through four steps:

1. For each participant, the maximum demand was obtained for the peak morning and evening hours for each day of the month for October and November, 1987 and 1988.

2. Combined daily morning and evening peak demand numbers were calculated by adding the data for all participants.

3. The aggregate 1988 data were subtracted from the 1987 data, for both October and November, to obtain the total change in demand for each month. Because the days of the week fall on different dates in 1987 and 1988, data from corresponding **days** were used, e.g., Monday, October 3, 1988 was subtracted from Monday October 5, 1987.

4. To provide summary information, several averages were created for each month of data:

   A. Average for each day of the week (e.g., the average of all Mondays)

   B. Average for the entire month

   C. Average for the work week (the Monday through Friday average for the whole month).

The average change in evening peak demand during on-peak hours for the work week (Monday through Friday) for October was 4.1 MW for the 18 companies and for November it was 3.8 MW (see Exhibit N.9). The average total demand during evening peak hours in 1987 for the 18 companies in the October data was 21.7 MW; thus, these participants reduced their peak demand by 19 percent.

EXHIBIT N.8: CHANGE IN MAXIMUM PEAK DEMAND DURING ON-PEAK HOURS (KW)

| TOTAL | | | Tue | Wed | Thurs | Fri | Sat | Sun | Mon | Tue | Wed | Thurs | Fri | Sat | Sun | Mon | Tue | Wed |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| NOVEMBER 1987 | | | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 |
| NOVEMBER 1988 | | | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 |
| 1987 | MAXAM | | 21,244 | 19,282 | 19,543 | 21,835 | 23,530 | 18,910 | 21,480 | 21,722 | 21,713 | 21,156 | 19,577 | 18,503 | 16,128 | 21,788 | 22,547 | 22,076 |
| | MAXPM | | 19,544 | 20,074 | 20,811 | 21,462 | 19,334 | 19,335 | 22,070 | 21,717 | 21,590 | 21,603 | 19,033 | 20,148 | 16,422 | 21,991 | 22,759 | 21,694 |
| 1988 | MAXAM | | 16,893 | 14,773 | 18,214 | 17,472 | 20,623 | 18,805 | 20,915 | 20,474 | 21,112 | 22,234 | 21,386 | 24,643 | 24,053 | 19,786 | 21,944 | 22,196 |
| | MAXPM | | 16,881 | 15,325 | 17,732 | 17,144 | 22,361 | 15,206 | 22,308 | 22,567 | 22,230 | 22,587 | 22,191 | 25,671 | 18,817 | 21,523 | 21,081 | 21,102 |
| DIFFERENCE | | AM | 4,351 | 4,509 | 1,329 | 4,363 | 2,907 | 105 | 566 | 1,248 | 602 | (1,078) | (1,810) | (6,140) | (7,925) | 2,002 | 603 | (119) |
| | | PM | 2,664 | 4,749 | 3,080 | 4,318 | (3,028) | 4,129 | (238) | (850) | (640) | (984) | (3,158) | (5,523) | (2,395) | 468 | 1,678 | 592 |
| PERCENT CHANGE | | AM | 20% | 23% | 7% | 20% | 12% | 1% | 3% | 6% | 3% | -5% | -9% | -33% | -49% | 9% | 3% | -1% |
| | | PM | 14% | 24% | 15% | 20% | -16% | 21% | -1% | -4% | -3% | -5% | -17% | -27% | -15% | 2% | 7% | 3% |
| INDIVIDUAL PARTICIPANTS 1987 AM | | | | | | | | | | | | | | | | | | |
| NOV87HP\7AGRIB11.WK1~ | | AM | 400 | 431 | 386 | 388 | 416 | 203 | 184 | 180 | 358 | 166 | 10 | 256 | 22 | 412 | 369 | 175 |
| NOV87HP\7ATENA11.WK1~ | | AM | 28 | 51 | 50 | 53 | 81 | 109 | 82 | 77 | 29 | 57 | 115 | 134 | 89 | 90 | 44 | 81 |
| NOV87HP\7CARTA11.WK1~ | | AM | 724 | 737 | 727 | 742 | 832 | 658 | 726 | 840 | 839 | 797 | 790 | 773 | 518 | 784 | 822 | 787 |
| NOV87HP\7CEMPA11.WK1~ | | AM | 484 | 444 | 444 | 383 | 3,750 | 3,770 | 444 | 464 | 423 | 444 | 444 | 0 | 262 | 484 | 403 | 444 |
| NOV87HP\7CNPMO11.WK1~ | | AM | 581 | 613 | 560 | 548 | 278 | 55 | 475 | 538 | 550 | 565 | 508 | 280 | 50 | 534 | 572 | 547 |
| NOV87HP\7COND111.WK1~ | | AM | 338 | 308 | 446 | 477 | 209 | 144 | 547 | 497 | 443 | 425 | 288 | 383 | 299 | 187 | 416 | 310 |
| NOV87HP\7CONDU11.WK1~ | | AM | 302 | 289 | 289 | 229 | 259 | 14 | 418 | 330 | 310 | 284 | 209 | 282 | 130 | 333 | 350 | 346 |
| NOV87HP\7ESCAZ11.WK1~ | | AM | 2,437 | 2,444 | 2,430 | 2,434 | 1,951 | 1,944 | 1,951 | 1,944 | 1,955 | 2,196 | 2,200 | 2,196 | 2,196 | 2,200 | 2,207 | 2,200 |
| NOV87HP\7FERTI11.WK1~ | | AM | 2,868 | 1,750 | 1,750 | 3,413 | 3,471 | 3,327 | 3,643 | 3,528 | 3,500 | 3,356 | 1,807 | 2,180 | 4,202 | 4,159 | 4,331 | 4,288 |
| NOV87HP\7MULAS11.WK1~ | | AM | 2,462 | 2,462 | 2,455 | 2,462 | 2,459 | 2,459 | 2,462 | 2,462 | 2,462 | 2,214 | 2,214 | 2,210 | 2,203 | 2,210 | 2,214 | 2,210 |
| NOV87HP\7RAFIA11.WK1~ | | AM | 183 | 217 | 278 | 288 | 266 | 173 | 176 | 179 | 206 | 219 | 208 | 214 | 192 | 210 | 169 | 213 |
| NOV87HP\7RICA11.WK1~ | | AM | 604 | 675 | 538 | 586 | 558 | 291 | 597 | 606 | 617 | 699 | 600 | 532 | 233 | 654 | 648 | 626 |
| NOV87HP\7ROJO11.WK1~ | | AM | 411 | 370 | 398 | 360 | 204 | 6 | 424 | 403 | 364 | 390 | 419 | 212 | 18 | 415 | 374 | 354 |
| NOV87HP\7TABOG11.WK1~ | | AM | 248 | 274 | 252 | 256 | 230 | 0 | 248 | 234 | 245 | 234 | 234 | 234 | 115 | 234 | 248 | 256 |
| NOV87HP\7TICA11.WK1~ | | AM | 2,282 | 2,311 | 2,372 | 2,315 | 2,016 | 68 | 2,167 | 2,282 | 2,365 | 2,192 | 2,300 | 1,868 | 97 | 2,207 | 2,351 | 2,315 |
| NOV87HP\7VICTB11.WK1~ | | AM | 140 | 193 | 303 | 287 | 374 | 378 | 320 | 308 | 0 | 0 | 138 | 141 | 67 | 93 | 145 | 138 |
| 7empac11~ | | AM | 740 | 776 | 836 | 891 | 835 | 469 | 570 | 691 | 907 | 772 | 914 | 773 | 432 | 696 | 915 | 1,030 |
| 7scott11~ | | AM | 4,416 | 3,339 | 3,490 | 4,221 | 3,912 | 4,202 | 4,442 | 4,555 | 4,549 | 4,612 | 4,530 | 4,549 | 4,366 | 4,322 | 4,334 | 4,114 |
| 7carne11~ | | AM | 904 | 874 | 855 | 902 | 931 | 493 | 885 | 874 | 868 | 843 | 939 | 780 | 450 | 869 | 876 | 865 |
| 7galli11~ | | AM | 689 | 724 | 683 | 598 | 497 | 145 | 719 | 729 | 724 | 691 | 711 | 504 | 186 | 694 | 759 | 779 |
| TOTAL 1987 AM | | | 21,244 | 19,282 | 19,543 | 21,835 | 23,530 | 18,910 | 21,480 | 21,722 | 21,713 | 21,156 | 19,577 | 18,503 | 16,128 | 21,788 | 22,547 | 22,076 |
| 1988 AM | | | | | | | | | | | | | | | | | | |
| NOV88HP\8AGRIB11.WK1~ | | AM | 426 | 500 | 394 | 463 | 414 | 244 | 162 | 375 | 575 | 463 | 330 | 509 | 483 | 288 | 581 | 705 |
| NOV88HP\8ATENA11.WK1~ | | AM | 23 | 17 | 19 | 29 | 22 | 21 | 41 | 21 | 32 | 38 | 55 | 51 | 49 | 44 | 48 | 52 |
| NOV88HP\8CARTA11.WK1~ | | AM | 509 | 561 | 707 | 435 | 621 | 536 | 559 | 609 | 596 | 546 | 445 | 543 | 505 | 572 | 577 | 639 |
| NOV88HP\8CEMPA11.WK1~ | | AM | 665 | 464 | 706 | 645 | 4,113 | 5,826 | 3,347 | 3,306 | 3,548 | 4,556 | 4,576 | 4,677 | 8,326 | 3,347 | 4,516 | 4,435 |
| NOV88HP\8CNPMO11.WK1~ | | AM | 664 | 685 | 597 | 660 | 387 | 277 | 642 | 512 | 644 | 609 | 624 | 408 | 267 | 641 | 535 | 636 |
| NOV88HP\8COND111.WK1~ | | AM | 428 | 461 | 500 | 452 | 441 | 99 | 463 | 261 | 463 | 216 | 232 | 257 | 29 | 238 | 353 | 410 |
| NOV88HP\8CONDU11.WK1~ | | AM | 183 | 222 | 340 | 210 | 253 | 91 | 288 | 186 | 233 | 266 | 301 | 295 | 0 | 217 | 187 | 268 |
| NOV88HP\8ESCAZ11.WK1~ | | AM | 497 | 497 | 493 | 497 | 0 | 1,451 | 497 | 497 | 497 | 497 | 0 | 1,451 | 1,454 | 497 | 497 | 497 |
| NOV88HP\8FERTI11.WK1~ | | AM | 4,202 | 2,481 | 4,303 | 4,188 | 4,504 | 2,467 | 4,374 | 4,202 | 4,317 | 4,303 | 4,504 | 4,475 | 4,575 | 4,231 | 3,887 | 4,073 |
| NOV88HP\8MULAS11.WK1~ | | AM | 500 | 500 | 500 | 500 | 0 | 1,476 | 500 | 500 | 500 | 500 | 0 | 1,480 | 1,480 | 500 | 500 | 500 |
| NOV88HP\8RAFIA11.WK1~ | | AM | 190 | 142 | 200 | 194 | 92 | 6 | 49 | 0 | 160 | 98 | 194 | 176 | 173 | 132 | 174 | 230 |
| NOV88HP\8RICA11.WK1~ | | AM | 30 | 21 | 24 | 30 | 30 | 29 | 24 | 34 | 25 | 26 | 43 | 32 | 34 | 32 | 33 | 20 |
| NOV88HP\8ROJO11.WK1~ | | AM | 297 | 291 | 220 | 204 | 193 | 8 | 289 | 318 | 329 | 284 | 277 | 214 | 9 | 320 | 341 | 359 |
| NOV88HP\8TABOG11.WK1~ | | AM | 11 | 43 | 0 | 18 | 209 | 119 | 7 | 0 | 83 | 14 | 11 | 209 | 94 | 18 | 11 | 18 |
| NOV88HP\8TICA11.WK1~ | | AM | 2,287 | 2,206 | 2,344 | 2,249 | 2,244 | 58 | 2,269 | 2,264 | 2,284 | 2,246 | 2,327 | 2,350 | 397 | 2,330 | 2,261 | 2,295 |
| NOV88HP\8VICTB11.WK1~ | | AM | 60 | 76 | 142 | 95 | 119 | 81 | 166 | 180 | 221 | 260 | 193 | 199 | 75 | 197 | 119 | 156 |
| 8empac11~ | | AM | 783 | 680 | 561 | 616 | 778 | 356 | 736 | 676 | 605 | 636 | 680 | 673 | 156 | 698 | 673 | 921 |
| 8scot11a | | AM | 3,635 | 3,427 | 4,460 | 4,423 | 4,681 | 4,794 | 4,933 | 4,958 | 4,385 | 5,046 | 4,946 | 5,090 | 4,864 | 3,799 | 5,015 | 4,391 |



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EXHIBIT N.8: CHANGE IN MAXIMUM PEAK DEMAND DURING ON-PEAK HOURS (KW)

| TOTAL | NOVEMBER 1987 | Tue 3 | Wed 4 | Thurs 5 | Fri 6 | Sat 7 | Sun 8 | Mon 9 | Tue 10 | Wed 11 | Thurs 12 | Fri 13 | Sat 14 | Sun 15 | Mon 16 | Tue 17 | Wed 18 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | NOVEMBER 1988 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 |
| 8carne11~ | AM | 795 | 846 | 1,051 | 909 | 871 | 214 | 917 | 923 | 964 | 975 | 997 | 902 | 430 | 1,035 | 986 | 936 |
| 8galli11~ | AM | 708 | 652 | 652 | 652 | 652 | 652 | 652 | 652 | 652 | 652 | 652 | 652 | 652 | 652 | 652 | 652 |
| TOTAL 1988 AM | | 16,893 | 14,773 | 18,214 | 17,472 | 20,623 | 18,805 | 20,915 | 20,474 | 21,112 | 22,234 | 21,386 | 24,643 | 24,053 | 19,786 | 21,944 | 22,196 |
| 1987 PM | | | | | | | | | | | | | | | | | |
| NOV87HP\7AGRIB11.WK1~ | PM | 264 | 559 | 502 | 383 | 312 | 379 | 398 | 427 | 460 | 462 | 21 | 261 | 310 | 305 | 458 | 224 |
| NOV87HP\7ATENA11.WK1 | PM | 70 | 92 | 67 | 102 | 96 | 58 | 136 | 41 | 80 | 117 | 133 | 81 | 67 | 111 | 79 | 85 |
| NOV87HP\7CARTA11.WK1~ | PM | 754 | 800 | 768 | 820 | 802 | 533 | 859 | 848 | 855 | 825 | 773 | 81, | 503 | 728 | 854 | 744 |
| NOV87HP\7CEMPA11.WK1~ | PM | 504 | 423 | 383 | 484 | 302 | 3,730 | 544 | 484 | 383 | 544 | 484 | 202 | 302 | 464 | 524 | 524 |
| NOV87HP\7CNPMO11.WK1~ | PM | 425 | 443 | 413 | 395 | 255 | 231 | 449 | 478 | 423 | 388 | 436 | 262 | 265 | 430 | 409 | 400 |
| NOV87HP\7COND111.WK1~ | PM | 364 | 376 | 509 | 508 | 178 | 40 | 535 | 511 | 387 | 425 | 508 | 428 | 31 | 392 | 486 | 419 |
| NOV87HP\7CONDU11.WK1~ | PM | 344 | 302 | 325 | 353 | 258 | 0 | 395 | 333 | 343 | 325 | 295 | 301 | 20 | 304 | 366 | 323 |
| NOV87HP\7ESCAZ11.WK1~ | PM | 2,434 | 2,437 | 2,434 | 1,955 | 1,948 | 1,944 | 1,948 | 1,948 | 2,200 | 2,196 | 2,196 | 2,200 | 2,210 | 2,200 | 2,210 | 2,200 |
| NOV87HP\7FERTI11.WK1~ | PM | 1,649 | 1,764 | 3,528 | 3,786 | 3,901 | 3,801 | 3,872 | 3,901 | 3,901 | 3,801 | 1,922 | 4,331 | 4,331 | 4,331 | 4,346 | 4,331 |
| NOV87HP\7MULAS11.WK1~ | PM | 2,466 | 2,466 | 2,466 | 2,462 | 2,462 | 2,473 | 2,466 | 2,459 | 2,462 | 2,214 | 2,214 | 2,214 | 2,210 | 2,221 | 2,214 | 2,218 |
| NOV87HP\7RAFIA11.WK1~ | PM | 212 | 238 | 299 | 312 | 248 | 149 | 194 | 219 | 226 | 248 | 250 | 195 | 139 | 225 | 187 | 213 |
| NOV87HP\7RICA11.WK1~ | PM | 600 | 638 | 593 | 580 | 425 | 213 | 658 | 653 | 688 | 662 | 701 | 457 | 228 | 620 | 631 | 664 |
| NOV87HP\7ROJO11.WK1~ | PM | 302 | 341 | 372 | 230 | 15 | 22 | 380 | 350 | 343 | 354 | 202 | 27 | 23 | 382 | 362 | 320 |
| NOV87HP\7TABOG11.WK1~ | PM | 212 | 216 | 220 | 212 | 104 | 108 | 173 | 209 | 209 | 216 | 205 | 122 | 115 | 191 | 209 | 205 |
| NOV87HP\7TICA11.WK1~ | PM | 2,376 | 2,419 | 2,239 | 2,138 | 1,912 | 94 | 2,250 | 2,358 | 2,214 | 2,275 | 2,135 | 1,901 | 101 | 2,376 | 2,441 | 2,239 |
| NOV87HP\7VICTB11.WK1~ | PM | 139 | 365 | 507 | 564 | 577 | 465 | 554 | 243 | 0 | 0 | 238 | 220 | 67 | 175 | 243 | 271 |
| 7empac11~ | PM | 788 | 776 | 707 | 765 | 685 | 353 | 657 | 628 | 671 | 575 | 583 | 647 | 373 | 564 | 810 | 813 |
| 7scott11~ | PM | 4,391 | 4,234 | 3,289 | 4,309 | 4,127 | 4,127 | 4,460 | 4,385 | 4,517 | 4,712 | 4,561 | 4,624 | 4,530 | 4,700 | 4,612 | 4,202 |
| 7carne11~ | PM | 654 | 580 | 580 | 597 | 485 | 482 | 569 | 636 | 625 | 709 | 553 | 498 | 454 | 673 | 769 | 674 |
| 7galli11~ | PM | 597 | 606 | 610 | 507 | 241 | 135 | 575 | 607 | 603 | 556 | 624 | 357 | 143 | 600 | 549 | 624 |
| TOTAL 1987 PM | | 19,544 | 20,074 | 20,811 | 21,462 | 19,334 | 19,335 | 22,070 | 21,717 | 21,590 | 21,603 | 19,033 | 20,148 | 16,422 | 21,991 | 22,759 | 21,694 |
| 1988 PM | | | | | | | | | | | | | | | | | |
| NOV88HP\8AGRIB11.WK1~ | PM | 630 | 698 | 679 | 605 | 639 | 139 | 524 | 739 | 442 | 683 | 566 | 651 | 231 | 389 | 706 | 663 |
| NOV88HP\8ATENA11.WK1~ | PM | 19 | 22 | 33 | 53 | 23 | 4 | 57 | 28 | 30 | 54 | 41 | 48 | 40 | 38 | 44 | 68 |
| NOV88HP\8CARTA11.WK1~ | PM | 465 | 539 | 417 | 409 | 500 | 434 | 575 | 539 | 619 | 472 | 444 | 449 | 464 | 511 | 568 | 563 |
| NOV88HP\8CEMPA11.WK1~ | PM | 585 | 524 | 585 | 1,210 | 4,193 | 2,964 | 4,496 | 4,596 | 4,617 | 4,576 | 4,596 | 8,145 | 4,697 | 4,617 | 4,476 | 3,427 |
| NOV88HP\8CNPMO11.WK1~ | PM | 452 | 600 | 494 | 547 | 325 | 85 | 539 | 459 | 547 | 460 | 558 | 314 | 76 | 541 | 419 | 531 |
| NOV88HP\8COND111.WK1~ | PM | 459 | 511 | 520 | 509 | 448 | 49 | 527 | 497 | 518 | 472 | 481 | 279 | 41 | 331 | 227 | 400 |
| NOV88HP\8CONDU11.WK1~ | PM | 223 | 249 | 348 | 219 | 256 | 0 | 308 | 266 | 300 | 343 | 357 | 285 | 0 | 327 | 242 | 276 |
| NOV88HP\8ESCAZ11.WK1~ | PM | 500 | 500 | 500 | 497 | 1,462 | 1,321 | 565 | 500 | 500 | 497 | 500 | 972 | 976 | 500 | 497 | 500 |
| NOV88HP\8FERTI11.WK1~ | PM | 4,245 | 2,524 | 4,260 | 4,174 | 4,159 | 2,496 | 4,561 | 4,403 | 4,331 | 4,360 | 4,288 | 4,633 | 4,575 | 4,331 | 3,858 | 4,159 |
| NOV88HP\8MULAS11.WK1~ | PM | 508 | 504 | 504 | 508 | 1,483 | 1,415 | 504 | 504 | 504 | 504 | 504 | 983 | 986 | 504 | 504 | 504 |
| NOV88HP\8RAFIA11.WK1~ | PM | 185 | 110 | 210 | 118 | 52 | 10 | 42 | 62 | 200 | 189 | 199 | 186 | 162 | 191 | 180 | 215 |
| NOV88HP\8RICA11.WK1~ | PM | 21 | 15 | 88 | 76 | 68 | 113 | 97 | 67 | 20 | 81 | 97 | 77 | 71 | 81 | 49 | 13 |
| NOV88HP\8ROJO11.WK1~ | PM | 246 | 259 | 202 | 97 | 135 | 15 | 291 | 287 | 288 | 310 | 181 | 175 | 15 | 323 | 315 | 292 |
| NOV88HP\8TABOG11.WK1~ | PM | 7 | 14 | 11 | 7 | 169 | 104 | 29 | 4 | 4 | 4 | 22 | 101 | 97 | 22 | 25 | 14 |
| NOV88HP\8TICA11.WK1~ | PM | 2,313 | 2,246 | 2,356 | 2,347 | 2,117 | 46 | 2,269 | 2,390 | 2,419 | 2,344 | 2,281 | 1,944 | 52 | 2,301 | 2,298 | 2,336 |
| NOV88HP\8VICTB11.WK1~ | PM | 64 | 48 | 70 | 61 | 97 | 53 | 88 | 143 | 105 | 135 | 116 | 87 | 79 | 119 | 217 | 312 |
| 8empac11~ | PM | 740 | 753 | 671 | 611 | 465 | 373 | 540 | 718 | 572 | 573 | 526 | 0 | 534 | 673 | 605 | 616 |
| 8scot11a | PM | 3,875 | 3,881 | 4,750 | 3,736 | 4,631 | 4,649 | 4,883 | 5,097 | 4,870 | 5,090 | 5,103 | 5,040 | 4,832 | 4,423 | 4,536 | 4,832 |
| 8carne11~ | PM | 695 | 677 | 384 | 710 | 490 | 285 | 762 | 617 | 695 | 791 | 680 | 654 | 238 | 650 | 665 | 729 |
| 8galli11~ | PM | 650 | 650 | 650 | 650 | 650 | 650 | 650 | 650 | 650 | 650 | 650 | 650 | 650 | 650 | 650 | 650 |
| TOTAL 1988 PM | | 16,881 | 15,325 | 17,732 | 17,144 | 22,361 | 15,206 | 22,308 | 22,567 | 22,230 | 22,587 | 22,191 | 25,671 | 18,817 | 21,523 | 21,081 | 21,102 |



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EXHIBIT N.8: CHANGE IN MAXIMUM PEAK DEMAND DURING ON-PEAK HOURS (KW)

| TOTAL | | Thurs | Fri | Sat | Sun | Mon | Tue | Wed | Thurs | Fri | Sat | Sun | Mon |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| NOVEMBER 1987 | | 19 | 20 | 21 | 22 | 23 | 24 | 25 | 26 | 27 | 28 | 29 | 30 |
| NOVEMBER 1988 | | 17 | 18 | 19 | 20 | 21 | 22 | 23 | 24 | 25 | 26 | 27 | 28 |
| 1987 | MAXAM | 21,746 | 22,234 | 21,950 | 15,859 | 20,304 | 20,655 | 22,023 | 21,715 | 20,346 | 22,290 | 13,950 | 18,317 |
| | MAXPM | 22,532 | 21,181 | 19,893 | 15,573 | 21,421 | 21,932 | 21,553 | 21,760 | 19,884 | 16,337 | 13,549 | 21,665 |
| 1988 | MAXAM | 21,481 | 20,756 | 26,524 | 23,220 | 21,312 | 22,175 | 21,378 | 22,642 | 21,675 | 25,040 | 18,682 | 19,173 |
| | MAXPM | 21,710 | 21,737 | 25,158 | 19,350 | 20,824 | 21,979 | 22,011 | 22,205 | 21,516 | 25,783 | 16,644 | 20,060 |
| DIFFERENCE | AM | 265 | 1,478 | (4,575) | (7,361) | (1,009) | (1,520) | 645 | (928) | (1,329) | (2,750) | (4,732) | (855) |
| | PM | 822 | (556) | (5,266) | (3,777) | 596 | (47) | (458) | (445) | (1,632) | (9,446) | (3,095) | 1,605 |
| PERCENT CHANGE | AM | 1% | 7% | -21% | -46% | -5% | -7% | 3% | -4% | -7% | -12% | -34% | -5% |
| | PM | 4% | -3% | -26% | -24% | 3% | 0% | -2% | -2% | -8% | -58% | -23% | 7% |
| INDIVIDUAL PARTICIPANTS 1987 AM | | | | | | | | | | | | | |
| NOV87HP\7AGRIB11.WK1~ | AM | 445 | 10 | 472 | 374 | 336 | 406 | 360 | 242 | 8 | 381 | 200 | 311 |
| NOV87HP\7ATENA11.WK1~ | AM | 133 | 139 | 145 | 140 | 80 | 140 | 175 | 164 | 119 | 168 | 170 | 219 |
| NOV87HP\7CARTA11.WK1~ | AM | 758 | 831 | 821 | 448 | 712 | 722 | 791 | 855 | 809 | 821 | 540 | 741 |
| NOV87HP\7CEMPA11.WK1~ | AM | 444 | 423 | 625 | 343 | 383 | 444 | 444 | 464 | 444 | 4,052 | 302 | 423 |
| NOV87HP\7CNPMO11.WK1~ | AM | 607 | 625 | 409 | 245 | 524 | 519 | 590 | 618 | 574 | 506 | 374 | 615 |
| NOV87HP\7COND111.WK1~ | AM | 401 | 416 | 437 | 92 | 212 | 356 | 445 | 241 | 270 | 263 | 115 | 329 |
| NOV87HP\7CONDU11.WK1~ | AM | 337 | 282 | 366 | 232 | 289 | 354 | 354 | 369 | 367 | 310 | 89 | 261 |
| NOV87HP\7ESCAZ11.WK1~ | AM | 2,200 | 2,200 | 2,200 | 2,203 | 2,200 | 2,203 | 2,196 | 2,196 | 2,196 | 2,196 | 1,937 | 1,944 |
| NOV87HP\7FERTI11.WK1~ | AM | 4,346 | 3,614 | 3,614 | 3,471 | 3,485 | 3,614 | 3,514 | 3,629 | 3,571 | 1,678 | 1,606 | 2,022 |
| NOV87HP\7MULAS11.WK1~ | AM | 2,210 | 2,214 | 2,207 | 2,207 | 2,207 | 2,214 | 2,210 | 2,207 | 2,207 | 2,207 | 1,962 | 1,962 |
| NOV87HP\7RAFIA11.WK1~ | AM | 190 | 185 | 200 | 143 | 181 | 195 | 210 | 159 | 177 | 164 | 73 | 187 |
| NOV87HP\7RICA11.WK1~ | AM | 621 | 639 | 559 | 480 | 640 | 619 | 683 | 619 | 648 | 575 | 465 | 604 |
| NOV87HP\7ROJO11.WK1~ | AM | 388 | 426 | 212 | 19 | 423 | 408 | 366 | 417 | 391 | 199 | 8 | 404 |
| NOV87HP\7TABOG11.WK1~ | AM | 248 | 256 | 230 | 104 | 227 | 263 | 277 | 252 | 241 | 248 | 112 | 238 |
| NOV87HP\7TICA11.WK1~ | AM | 2,362 | 2,419 | 2,174 | 112 | 2,315 | 2,232 | 2,354 | 2,210 | 2,218 | 2,110 | 0 | 2,088 |
| NOV87HP\7VICTB11.WK1~ | AM | 180 | 181 | 154 | 148 | 0 | 0 | 66 | 68 | 32 | 44 | 70 | 66 |
| 7empac11~ | AM | 945 | 1,213 | 1,134 | 584 | 934 | 0 | 1,047 | 1,058 | 1,123 | 1,101 | 761 | 1,125 |
| 7scott11~ | AM | 3,345 | 4,599 | 4,624 | 4,026 | 4,278 | 4,322 | 4,309 | 4,290 | 3,301 | 3,704 | 4,240 | 3,717 |
| 7carne11~ | AM | 882 | 896 | 890 | 490 | 879 | 902 | 926 | 936 | 958 | 936 | 480 | 884 |
| 7galli11~ | AM | 704 | 666 | 477 | | | 741 | 704 | 721 | 692 | 627 | 446 | 179 |
| TOTAL 1987 AM | | 21,746 | 22,234 | 21,950 | 15,859 | 20,304 | 20,655 | 22,023 | 21,715 | 20,346 | 22,290 | 13,950 | 18,317 |
| 1988 AM | | | | | | | | | | | | | |
| NOV88HP\8AGRIB11.WK1~ | AM | 720 | 558 | 571 | 223 | 252 | 304 | 582 | 375 | 504 | 310 | 296 | 235 |
| NOV88HP\8ATENA11.WK1~ | AM | 68 | 62 | 81 | 52 | 69 | 72 | 57 | 71 | 80 | 84 | 41 | 75 |
| NOV88HP\8CARTA11.WK1~ | AM | 501 | 397 | 561 | 542 | 685 | 547 | 623 | 673 | 468 | 570 | 580 | 610 |
| NOV88HP\8CEMPA11.WK1~ | AM | 4,496 | 4,516 | 6,673 | 7,923 | 4,254 | 3,548 | 4,375 | 4,395 | 4,375 | 8,447 | 4,859 | 4,476 |
| NOV88HP\8CNPMO11.WK1~ | AM | 619 | 658 | 457 | 298 | 621 | 662 | 645 | 619 | 685 | 386 | 274 | 584 |
| NOV88HP\8COND111.WK1~ | AM | 239 | 277 | 297 | 128 | 430 | 437 | 484 | 479 | 202 | 445 | 74 | 457 |
| NOV88HP\8CONDU11.WK1~ | AM | 321 | 268 | 297 | 99 | 239 | 328 | 207 | 245 | 272 | 194 | 0 | 213 |
| NOV88HP\8ESCAZ11.WK1~ | AM | 497 | 497 | 1,451 | 1,451 | 497 | 497 | 497 | 493 | 497 | 1,454 | 972 | 497 |
| NOV88HP\8FERTI11.WK1~ | AM | 3,915 | 3,901 | 4,618 | 4,489 | 2,955 | 4,446 | 4,188 | 4,202 | 3,729 | 1,463 | 3,471 | 3,528 |
| NOV88HP\8MULAS11.WK1~ | AM | 500 | 497 | 1,476 | 1,480 | 500 | 500 | 500 | 500 | 500 | 1,476 | 983 | 500 |
| NOV88HP\8RAFIA11.WK1~ | AM | 249 | 226 | 186 | 127 | 172 | 192 | 179 | 182 | 181 | 166 | 100 | 160 |
| NOV88HP\8RICA11.WK1~ | AM | 19 | 38 | 42 | 35 | 35 | 21 | 15 | 16 | 25 | 23 | 25 | 29 |
| NOV88HP\8ROJO11.WK1~ | AM | 343 | 340 | 411 | 35 | 392 | 385 | 360 | 347 | 351 | 325 | 45 | 355 |
| NOV88HP\8TABOG11.WK1~ | AM | 22 | 14 | 209 | 94 | 22 | 22 | 11 | 7 | 14 | 209 | 79 | 18 |
| NOV88HP\8TICA11.WK1~ | AM | 2,376 | 2,431 | 2,068 | 130 | 2,310 | 2,347 | 2,339 | 2,284 | 2,327 | 2,105 | 311 | 2,307 |
| NOV88HP\8VICTB11.WK1~ | AM | 147 | 271 | 364 | 98 | 430 | 301 | 450 | 385 | 387 | 451 | 240 | 194 |
| 8empac11~ | AM | 728 | | 852 | 335 | 803 | 696 | 723 | 758 | 827 | 709 | 394 | 791 |
| 8scot11a | AM | 4,618 | 4,397 | 4,826 | 4,574 | 4,876 | 5,090 | 3,471 | 4,845 | 4,757 | 4,964 | 4,725 | 2,312 |

EXHIBIT N.8: CHANGE IN MAXIMUM PEAK DEMAND DURING ON-PEAK HOURS (KW)

| TOTAL | NOVEMBER 1987 | Thurs 19 | Fri 20 | Sat 21 | Sun 22 | Mon 23 | Tue 24 | Wed 25 | Thurs 26 | Fri 27 | Sat 28 | Sun 29 | Mon 30 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | NOVEMBER 1988 | 17 | 18 | 19 | 20 | 21 | 22 | 23 | 24 | 25 | 26 | 27 | 28 |
| 8carne11~ | AM | 452 | 906 | 910 | 392 | 1,006 | 1,008 | 914 | 1,010 | 981 | 977 | 435 | 1,052 |
| 8galli11~ | AM | 652 | 503 | 176 | 716 | 765 | 769 | 758 | 756 | 512 | 283 | 780 | 781 |
| TOTAL 1988 AM | | 21,481 | 20,756 | 26,524 | 23,220 | 21,312 | 22,175 | 21,378 | 22,642 | 21,675 | 25,040 | 18,682 | 19,173 |
| 1987 PM | | | | | | | | | | | | | |
| NOV87HP\7AGRIB11.WK1~ | PM | 363 | 21 | 344 | 260 | 220 | 434 | 296 | 325 | 21 | 306 | 316 | 308 |
| NOV87HP\7ATENA11.WK1~ | PM | 122 | 121 | 106 | 97 | 100 | 167 | 130 | 180 | 166 | 176 | 107 | 121 |
| NOV87HP\7CARTA11.WK1~ | PM | 750 | 759 | 789 | 520 | 893 | 798 | 846 | 822 | 843 | 752 | 518 | 827 |
| NOV87HP\7CEMPA11.WK1~ | PM | 504 | 464 | 484 | 282 | 544 | 504 | 423 | 464 | 403 | 323 | 323 | 517 |
| NOV87HP\7CNPMO11.WK1~ | PM | 465 | 435 | 320 | 269 | 434 | 439 | 415 | 456 | 505 | 309 | 227 | 473 |
| NOV87HP\7COND111.WK1~ | PM | 470 | 513 | 441 | 112 | 509 | 416 | 466 | 522 | 443 | 292 | 40 | 517 |
| NOV87HP\7CONDU11.WK1~ | PM | 287 | 301 | 307 | 158 | 380 | 369 | 386 | 344 | 307 | 301 | 0 | 265 |
| NOV87HP\7ESCAZ11.WK1~ | PM | 2,200 | 2,203 | 2,200 | 2,203 | 2,200 | 2,203 | 2,192 | 2,203 | 2,214 | 1,944 | 1,944 | 1,948 |
| NOV87HP\7FERTI11.WK1~ | PM | 4,417 | 3,657 | 3,600 | 3,586 | 3,80[illegible] | 3,930 | 3,915 | 3,930 | 3,629 | 1,735 | 1,664 | 4,002 |
| NOV87HP\7MULAS11.WK1~ | PM | 2,210 | 2,210 | 2,214 | 2,214 | 2,214 | 2,218 | 2,214 | 2,225 | 2,214 | 2,210 | 1,962 | 2,300 |
| NOV87HP\7RAFIA11.WK1~ | PM | 196 | 204 | 175 | 175 | 226 | 216 | 220 | 172 | 195 | 134 | 139 | 200 |
| NOV87HP\7RICA11.WK1~ | PM | 649 | 630 | 461 | 195 | 650 | 654 | 636 | 646 | 659 | 474 | 253 | 643 |
| NOV87HP\7ROJO11.WK1~ | PM | 369 | 197 | 25 | 24 | 387 | 296 | 327 | 339 | 195 | 22 | 24 | 379 |
| NOV87HP\7TABOG11.WK1~ | PM | 212 | 223 | 104 | 97 | 212 | 205 | 202 | 209 | 198 | 119 | 104 | 223 |
| NOV87HP\7TICA11.WK1~ | PM | 2,358 | 2,282 | 1,904 | 115 | 2,333 | 2,448 | 2,372 | 2,239 | 2,261 | 1,886 | 108 | 2,074 |
| NOV87HP\7VICTB11.WK1~ | PM | 277 | 223 | 266 | 117 | 0 | 0 | 114 | 106 | 32 | 84 | 117 | 130 |
| 7empac11~ | PM | 832 | 884 | 928 | 669 | 806 | 1,052 | 917 | 899 | 907 | 1,010 | 657 | 1,062 |
| 7scott11~ | PM | 4,624 | 4,593 | 4,334 | 3,849 | 4,120 | 4,133 | 4,202 | 4,460 | 3,402 | 3,289 | 4,372 | 4,427 |
| 7carne11~ | PM | 573 | 682 | 632 | 465 | 800 | 841 | 709 | 611 | 753 | 754 | 482 | 680 |
| 7galli11~ | PM | 654 | 579 | 259 | 164 | 590 | 609 | 569 | 608 | 538 | 217 | 192 | 570 |
| TOTAL 1987 PM | | 22,532 | 21,181 | 19,893 | 15,573 | 21,421 | 21,932 | 21,553 | 21,760 | 19,824 | 16,337 | 13,549 | 21,665 |
| 1988 PM | | | | | | | | | | | | | |
| NOV88HP\8AGRIB11.WK1~ | PM | 660 | 491 | 555 | 213 | 269 | 501 | 504 | 456 | 503 | 555 | 202 | 324 |
| NOV88HP\8ATENA11.WK1~ | PM | 54 | 45 | 48 | 44 | 68 | 56 | 71 | 64 | 81 | 51 | 42 | 50 |
| NOV88HP\8CARTA11.WK1~ | PM | 467 | 430 | 549 | 524 | 743 | 526 | 629 | 628 | 417 | 609 | 521 | 577 |
| NOV88HP\8CEMPA11.WK1~ | PM | 4,476 | 4,496 | 7,802 | 4,798 | 4,476 | 4,395 | 4,455 | 4,657 | 4,556 | 8,165 | 3,750 | 4,617 |
| NOV88HP\8CNPMO11.WK1~ | PM | 520 | 563 | 337 | 83 | 554 | 400 | 591 | 464 | 592 | 316 | 79 | 575 |
| NOV88HP\8COND111.WK1~ | PM | 398 | 306 | 205 | 104 | 486 | 482 | 468 | 229 | 481 | 461 | 41 | 486 |
| NOV88HP\8CONDU11.WK1~ | PM | 285 | 291 | 334 | 14 | 302 | 258 | 310 | 262 | 282 | 256 | 0 | 252 |
| NOV88HP\8ESCAZ11.WK1~ | PM | 500 | 497 | 976 | 1,454 | 500 | 497 | 500 | 497 | 497 | 979 | 972 | 500 |
| NOV88HP\8FERTI11.WK1~ | PM | 4,030 | 3,987 | 4,059 | 4,088 | 2,438 | 4,045 | 3,815 | 4,116 | 3,442 | 3,514 | 3,356 | 3,471 |
| NOV88HP\8MULAS11.WK1~ | PM | 504 | 504 | 986 | 1,483 | 504 | 504 | 504 | 504 | 504 | 997 | 986 | 504 |
| NOV88HP\8RAFIA11.WK1~ | PM | 210 | 188 | 187 | 131 | 194 | 183 | 185 | 179 | 160 | 174 | 105 | 179 |
| NOV88HP\8RICA11.WK1~ | PM | 79 | 86 | 125 | 64 | 73 | 49 | 11 | 64 | 73 | 121 | 86 | 83 |
| NOV88HP\8ROJO11.WK1~ | PM | 350 | 292 | 168 | 16 | 336 | 364 | 316 | 331 | 298 | 124 | 15 | 319 |
| NOV88HP\8TABOG11.WK1~ | PM | 25 | 11 | 104 | 112 | 18 | 7 | 7 | 14 | 11 | 94 | 94 | 11 |
| NOV88HP\8TICA11.WK1~ | PM | 2,367 | 2,232 | 2,033 | 52 | 2,267 | 2,269 | 2,316 | 2,304 | 2,249 | 2,088 | 49 | 2,258 |
| NOV88HP\8VICTB11.WK1~ | PM | 245 | 427 | 151 | 85 | 392 | 378 | 433 | 454 | 424 | 628 | 108 | 420 |
| 8empac11~ | PM | 677 | 830 | 499 | 335 | 778 | 668 | 762 | 652 | 687 | 671 | 367 | 673 |
| 8scot11a | PM | 4,700 | 4,769 | 4,801 | 4,637 | 4,864 | 4,845 | 4,857 | 4,946 | 5,015 | 4,757 | 4,757 | 3,364 |
| 8carne11~ | PM | 512 | 643 | 589 | 461 | 914 | 902 | 625 | 734 | 594 | 575 | 465 | 748 |
| 8galli11~ | PM | 650 | 650 | 650 | 650 | 650 | 650 | 650 | 650 | 650 | 650 | 650 | 650 |
| TOTAL 1988 PM | | 21,710 | 21,737 | 25,158 | 19,350 | 20,824 | 21,979 | 22,011 | 22,205 | 21,516 | 25,783 | 16,644 | 20,060 |



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EXHIBIT N.8: CHANGE IN MAXIMUM PEAK DEMAND DURING ON-PEAK HOURS (KW)

| TOTAL | NOVEMBER 1987<br>NOVEMBER 1988 | | AVERAGES<br>Sat | Sun | Mon | Tue | Wed | Thurs | Fri | WEEKLY AVERAGE | MONDAY-FRIDAY AVERAGE |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1987 | MAXAM | 21,568 | 16,212 | 20,472 | 21,542 | 21,274 | 21,040 | 20,998 | 20,444 | 21,065 |
| | | MAXPM | 18,928 | 16,220 | 21,787 | 21,488 | 21,228 | 21,677 | 20,390 | 20,193 | 21,314 |
| | 1988 | MAXAM | 24,208 | 21,190 | 20,296 | 20,371 | 19,865 | 21,143 | 20,322 | 21,126 | 20,399 |
| | | MAXPM | 24,744 | 17,504 | 21,179 | 20,627 | 20,167 | 21,059 | 20,647 | 20,876 | 20,736 |
| DIFFERENCE | | AM | (2,640) | (4,978) | 176 | 1,170 | 1,409 | (103) | 676 | (683) | 666 |
| | | PM | (5,816) | (1,284) | 608 | 861 | 1,061 | 618 | (257) | (683) | 578 |
| PERCENT CHANGE | | AM | -12% | -31% | 1% | 5% | 7% | 0% | 3% | -3% | 3% |
| | | PM | -31% | -8% | 3% | 4% | 5% | 3% | -1% | -3% | 3% |

INDIVIDUAL PARTICIPANTS

| 1987 AM | | MAX WEEKLY | MAX M-F | M-F AVERAGE |
|---|---|---|---|---|
| NOV87HP\7AGRIB11.WK1~ | AM | 472 | 445 | 279 |
| NOV87HP\7ATENA11.WK1~ | AM | 219 | 219 | 96 |
| NOV87HP\7CARTA11.WK1~ | AM | 855 | 855 | 777 |
| NOV87HP\7CEMPA11.WK1~ | AM | 4,052 | 484 | 438 |
| NOV87HP\7CNPMO11.WK1~ | AM | 625 | 625 | 563 |
| NOV87HP\7COND111.WK1~ | AM | 547 | 547 | 368 |
| NOV87HP\7CONDU11.WK1~ | AM | 418 | 418 | 315 |
| NOV87HP\7ESCAZ11.WK1~ | AM | 2,444 | 2,444 | 2,197 |
| NOV87HP\7FERTI11.WK1~ | AM | 4,346 | 4,346 | 3,310 |
| NOV87HP\7MULAS11.WK1~ | AM | 2,462 | 2,462 | 2,286 |
| NOV87HP\7RAFIA11.WK1~ | AM | 288 | 288 | 202 |
| NOV87HP\7RICA11.WK1~ | AM | 699 | 699 | 626 |
| NOV87HP\7ROJO11.WK1~ | AM | 426 | 426 | 395 |
| NOV87HP\7TABOG11.WK1~ | AM | 299 | 299 | 248 |
| NOV87HP\7TICA11.WK1~ | AM | 2,419 | 2,419 | 2,283 |
| NOV87HP\7VICTB11.WK1~ | AM | 378 | 320 | 133 |
| 7empac11~ | AM | 1,257 | 1,257 | 859 |
| 7scott11~ | AM | 4,624 | 4,612 | 4,154 |
| 7carne11~ | AM | 958 | 958 | 891 |
| 7galli11~ | AM | 779 | 779 | 679 |
| TOTAL 1987 AM | | 28,566 | 24,901 | |

| 1988 AM | | MAX | M-F MAX | M-F AVG |
|---|---|---|---|---|
| NOV88HP\8AGRIB11.WK1~ | AM | 720 | 720 | 440 |
| NOV88HP\8ATENA11.WK1~ | AM | 84 | 81 | 49 |
| NOV88HP\8CARTA11.WK1~ | AM | 707 | 707 | 563 |
| NOV88HP\8CEMPA11.WK1~ | AM | 8,447 | 4,576 | 3,427 |
| NOV88HP\8CNPMO11.WK1~ | AM | 685 | 685 | 627 |
| NOV88HP\8COND111.WK1~ | AM | 500 | 500 | 374 |
| NOV88HP\8CONDU11.WK1~ | AM | 340 | 340 | 250 |
| NOV88HP\8ESCAZ11.WK1~ | AM | 1,454 | 497 | 472 |
| NOV88HP\8FERTI11.WK1~ | AM | 4,618 | 4,504 | 3,997 |
| NOV88HP\8MULAS11.WK1~ | AM | 1,480 | 500 | 475 |
| NOV88HP\8RAFIA11.WK1~ | AM | 249 | 249 | 165 |
| NOV88HP\8RICA11.WK1~ | AM | 43 | 43 | 27 |
| NOV88HP\8ROJO11.WK1~ | AM | 411 | 392 | 320 |
| NOV88HP\8TABOG11.WK1~ | AM | 209 | 83 | 18 |
| NOV88HP\8TICA11.WK1~ | AM | 2,431 | 2,431 | 2,304 |
| NOV88HP\8VICTB11.WK1~ | AM | 451 | 450 | 221 |
| 8empac11~ | AM | 921 | 921 | 715 |
| 8scot11a | AM | 5,090 | 5,090 | 4,389 |

EXHIBIT N.8: CHANGE IN MAXIMUM PEAK DEMAND DURING ON-PEAK HOURS (KW)

| TOTAL NOVEMBER 1987 NOVEMBER 1988 | | AVERAGES Sat | Sun | Mon | Tue | Wed | Thurs | Fri | WEEKLY AVERAGE | MONDAY-FRIDAY AVERAGE | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 8carne11~ | AM | | | | | | | | 1,052 | 1,052 | 933 |
| 8galli11~ | AM | | | | | | | | 781 | 781 | 669 |
| TOTAL 1988 AM | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 30,674 | 24,602 | |
| 1987 PM | | | | | | | | | MAX | M-F MAX | M-F AVG |
| NOV87HP\7AGRIB11.WK1~ | PM | | | | | | | | 559 | 559 | 322 |
| NOV87HP\7ATENA11.WK1~ | PM | | | | | | | | 180 | 180 | 111 |
| NOV87HP\7CARTA11.WK1~ | PM | | | | | | | | 893 | 893 | 808 |
| NOV87HP\7CEMPA11.WK1~ | PM | | | | | | | | 3,730 | 544 | 478 |
| NOV87HP\7CNPMO11.WK1~ | PM | | | | | | | | 505 | 505 | 456 |
| NOV87HP\7COND111.WK1~ | PM | | | | | | | | 535 | 535 | 464 |
| NOV87HP\7CONDU11.WK1~ | PM | | | | | | | | 395 | 395 | 332 |
| NOV87HP\7ESCAZ11.WK1~ | PM | | | | | | | | 2,437 | 2,437 | 2,186 |
| NOV87HP\7FERTI11.WK1~ | PM | | | | | | | | 4,417 | 4,417 | 3,621 |
| NOV87HP\7MULAS11.WK1~ | PM | | | | | | | | 2,473 | 2,466 | 2,307 |
| NOV87HP\7RAFIA11.WK1~ | PM | | | | | | | | 312 | 312 | 223 |
| NOV87HP\7RICA11.WK1~ | PM | | | | | | | | 701 | 701 | 643 |
| NOV87HP\7ROJO11.WK1~ | PM | | | | | | | | 387 | 387 | 321 |
| NOV87HP\7TABOG11.WK1~ | PM | | | | | | | | 259 | 259 | 208 |
| NOV87HP\7TICA11.WK1~ | PM | | | | | | | | 2,448 | 2,448 | 2,291 |
| NOV87HP\7VICTB11.WK1~ | PM | | | | | | | | 577 | 564 | 209 |
| 7empac11~ | PM | | | | | | | | 1,062 | 1,062 | 785 |
| 7scott11~ | PM | | | | | | | | 4,712 | 4,712 | 4,317 |
| 7carne11~ | PM | | | | | | | | 841 | 841 | 663 |
| 7galli11~ | PM | | | | | | | | 654 | 654 | 589 |
| TOTAL 1987 PM | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 28,076 | 24,871 | |
| 1988 PM | | | | | | | | | MAX | M-F MAX | M-F AVG |
| NOV88HP\8AGRIB11.WK1~ | PM | | | | | | | | 739 | 739 | 552 |
| NOV88HP\8ATENA11.WK1~ | PM | | | | | | | | 81 | 81 | 49 |
| NOV88HP\8CARTA11.WK1~ | PM | | | | | | | | 743 | 743 | 527 |
| NOV88HP\8CEMPA11.WK1~ | PM | | | | | | | | 8,165 | 4,657 | 3,722 |
| NOV88HP\8CNPMO11.WK1~ | PM | | | | | | | | 600 | 600 | 520 |
| NOV88HP\8COND111.WK1~ | PM | | | | | | | | 527 | 527 | 439 |
| NOV88HP\8CONDU11.WK1~ | PM | | | | | | | | 357 | 357 | 285 |
| NOV88HP\8ESCAZ11.WK1~ | PM | | | | | | | | 1,462 | 565 | 502 |
| NOV88HP\8FERTI11.WK1~ | PM | | | | | | | | 4,633 | 4,561 | 3,942 |
| NOV88HP\8MULAS11.WK1~ | PM | | | | | | | | 1,483 | 508 | 504 |
| NOV88HP\8RAFIA11.WK1~ | PM | | | | | | | | 215 | 215 | 169 |
| NOV88HP\8RICA11.WK1~ | PM | | | | | | | | 125 | 97 | 61 |
| NOV88HP\8ROJO11.WK1~ | PM | | | | | | | | 364 | 364 | 285 |
| NOV88HP\8TABOG11.WK1~ | PM | | | | | | | | 169 | 29 | 13 |
| NOV88HP\8TICA11.WK1~ | PM | | | | | | | | 2,419 | 2,419 | 2,308 |
| NOV88HP\8VICTB11.WK1~ | PM | | | | | | | | 628 | 549 | 232 |
| 8empac11~ | PM | | | | | | | | 830 | 830 | 666 |
| 8scot11a | PM | | | | | | | | 5,103 | 5,103 | 4,622 |
| 8carne11~ | PM | | | | | | | | 914 | 914 | 686 |
| 8galli11~ | PM | | | | | | | | 650 | 650 | 650 |
| TOTAL 1988 PM | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 30,207 | 24,507 | |

EXHIBIT N.8: CHANGE IN MAXIMUM AVERAGE WORK-DAY PEAK DEMAND DURING ON-PEAK HOURS (KW)

| | 1987 AM REAL | 1988 AM REAL | 1988 AM ADJUSTED | 1988-1987 REAL | 1988-1987 ADJUSTED | 1987 PM REAL | 1988 PM REAL | 1988 PM ADJUSTED | 1988-1987 REAL | 1988-1987 ADJUSTED |
|---|---|---|---|---|---|---|---|---|---|---|
| NOV87HP\7AGRIB11.WK1~ | 279 | 440 | 273 | 161 | (6) | 322 | 552 | 328 | 229 | 6 |
| NOV87HP\7ATENA11.WK1~ | 96 | 49 | 36 | (48) | (60) | 111 | 49 | 34 | (62) | (77) |
| NOV87HP\7CARTA11.WK1~ | 777 | 563 | 702 | (214) | (75) | 808 | 527 | 652 | (281) | (157) |
| NOV87HP\7CEMPA11.WK1~ | 438 | 3,427 | 1,441 | 2,989 | 1,003 | 478 | 3,722 | 1,436 | 3,243 | 957 |
| NOV87HP\7CNPMO11.WK1~ | 563 | 627 | 474 | 64 | (89) | 436 | 520 | 373 | 85 | (63) |
| NOV87HP\7COND111.WK1~ | 368 | 374 | 408 | 6 | 41 | 464 | 439 | 460 | (24) | (4) |
| NOV87HP\7CONDU11.WK1~ | 315 | 250 | 208 | (65) | (107) | 332 | 285 | 229 | (47) | (103) |
| NOV87HP\7ESCAZ11.WK1~ | 2,197 | 472 | 1,389 | (1,725) | (807) | 2,186 | 502 | 1,392 | (1,684) | (794) |
| NOV87HP\7FERTI11.WK1~ | 3,310 | 3,997 | 3,295 | 687 | (14) | 3,621 | 3,942 | 3,287 | 321 | (333) |
| NOV87HP\7MULAS11.WK1~ | 2,286 | 475 | 1,445 | (1,811) | (842) | 2,307 | 504 | 1,449 | (1,802) | (858) |
| NOV87HP\7RAFIA11.WK1~ | 202 | 165 | 212 | (36) | 11 | 223 | 169 | 215 | (54) | (7) |
| NOV87HP\7RICA11.WK1~ | 626 | 27 | 28 | (599) | (598) | 643 | 61 | 68 | (581) | (574) |
| NOV87HP\7ROJO11.WK1~ | 395 | 320 | 257 | (75) | (138) | 321 | 285 | 214 | (37) | (107) |
| NOV87HP\7TABOG11.WK1~ | 248 | 18 | 72 | (230) | (177) | 208 | 13 | 52 | (195) | (157) |
| NOV87HP\7TICA11.WK1~ | 2,283 | 2,304 | 1,863 | 21 | (419) | 2,291 | 2,308 | 1,823 | 17 | (468) |
| NOV87HP\7VICTB11.WK1~ | 133 | 221 | 242 | 89 | 109 | 209 | 232 | 237 | 23 | 28 |
| 7empac11~ | 859 | 715 | 916 | (144) | 57 | 785 | 666 | 850 | (119) | 66 |
| 7scott11~ | 4,154 | 4,389 | 4,120 | 235 | (35) | 4,317 | 4,622 | 4,258 | 305 | (59) |
| 7carne11~ | 891 | 933 | 856 | 42 | (35) | 663 | 686 | 629 | 23 | (35) |
| 7galli11~ | 679 | 669 | 554 | (10) | (125) | 589 | 650 | 562 | 61 | (27) |
| TOTAL | 21,099 | 20,435 | 18,792 | (664) | (2,307) | 21,314 | 20,736 | 18,548 | (578) | (2,766) |
| TOTAL - CEMPA | 20,661 | 17,008 | 17,351 | (3,653) | (3,309) | 20,835 | 17,014 | 17,112 | (3,821) | (3,724) |
| COUNT | 20 | | | | | | | | | |



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EXHIBIT N.8: CHANGE IN MAXIMUM AVERAGE WORK-DAY PEAK DEMAND DURING ON-PEAK HOURS (KW)

| | PERCENT OF TOTAL KW | | | | PERCENT OF TOTAL SAVINGS | | | |
|---|---|---|---|---|---|---|---|---|
| | | | | | REAL | | ADJUSTED | |
| | 87 AM | 87 PM | 88 AM | 88 PM | AM | PM | AM | PM |
| NOV87HP\7AGRIB11.WK1~ | 1.32% | 1.51% | 2.15% | 2.66% | -24.19% | -39.63% | 0.24% | -0.21% |
| NOV87HP\7ATENA11.WK1~ | 0.46% | 0.52% | 0.24% | 0.24% | 7.19% | 10.75% | 2.60% | 2.79% |
| NOV87HP\7CARTA11.WK1~ | 3.68% | 3.79% | 2.75% | 2.54% | 32.18% | 48.64% | 3.24% | 5.66% |
| NOV87HP\7CEMPA11.WK1~ | 2.08% | 2.24% | 16.77% | 17.95% | -450.19% | -560.83% | -43.47% | -34.61% |
| NOV87HP\7CNPMO11.WK1~ | 2.67% | 2.04% | 3.07% | 2.51% | -9.64% | -14.64% | 3.86% | 2.28% |
| NOV87HP\7COND111.WK1~ | 1.74% | 2.18% | 1.83% | 2.12% | -0.98% | 4.22% | -1.77% | 0.14% |
| NOV87HP\7CONDU11.WK1~ | 1.49% | 1.56% | 1.22% | 1.37% | 9.84% | 8.17% | 4.64% | 3.74% |
| NOV87HP\7ESCAZ11.WK1~ | 10.41% | 10.26% | 2.31% | 2.42% | 259.83% | 291.14% | 35.00% | 28.69% |
| NOV87HP\7FERTI11.WK1~ | 15.69% | 16.99% | 19.56% | 19.01% | -103.48% | -55.56% | 0.61% | 12.06% |
| NOV87HP\7MULAS11.WK1~ | 10.84% | 10.82% | 2.33% | 2.43% | 272.79% | 311.68% | 36.49% | 31.02% |
| NOV87HP\7RAFIA11.WK1~ | 0.96% | 1.04% | 0.81% | 0.81% | 5.48% | 9.29% | -0.47% | 0.27% |
| NOV87HP\7RICA11.WK1~ | 2.97% | 3.02% | 0.13% | 0.30% | 90.23% | 100.56% | 25.94% | 20.77% |
| NOV87HP\7ROJO11.WK1~ | 1.87% | 1.51% | 1.57% | 1.37% | 11.31% | 6.33% | 5.98% | 3.88% |
| NOV87HP\7TABOG11.WK1~ | 1.18% | 0.98% | 0.09% | 0.06% | 34.65% | 33.67% | 7.66% | 5.66% |
| NOV87HP\7TICA11.WK1~ | 10.82% | 10.75% | 11.28% | 11.13% | -3.19% | -2.90% | 18.18% | 16.92% |
| NOV87HP\7VICTB11.WK1~ | 0.63% | 0.98% | 1.08% | 1.12% | -13.33% | -4.03% | -4.73% | -1.02% |
| 7empac11~ | 4.07% | 3.68% | 3.50% | 3.21% | 21.69% | 20.50% | -2.45% | -2.38% |
| 7scott11~ | 19.69% | 20.25% | 21.48% | 22.29% | -35.40% | -52.75% | 1.50% | 2.13% |
| 7carne11~ | 4.22% | 3.11% | 4.57% | 3.31% | -6.36% | -3.99% | 1.52% | 1.25% |
| 7galli11~ | 3.22% | 2.76% | 3.27% | 3.14% | 1.57% | -10.62% | 5.44% | 0.97% |
| TOTAL | 100.00% | 100.00% | 100.00% | 100.00% | 100.00% | 100.00% | 100.00% | 100.00% |



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Exhibit N.9

Change in Maximum AVERAGE WORK-WEEK EVENING PEAK DEMAND DURING ON-PEAK HOURS (KW)
(Using the average for the Work-Week)
(kW)

| | OCTOBER | | | | NOVEMBER | | | |
|---|---|---|---|---|---|---|---|---|
| | 1987 | 1988 | Change | Percent | 1987 | 1988 | Change | Percent |
| Carnes de C.A. | 599 | 744 | (145) | 24% | 663 | 686 | (23) | 3% |
| Cartago Beef Packing | 602 | 456 | 146 | -24% | 808 | 527 | 281 | -35% |
| CNP Montecillos | 410 | 497 | (86) | 21% | 436 | 520 | (85) | 19% |
| Conducen | 694 | 679 | 15 | -2% | 796 | 724 | 72 | -9% |
| Coopeagri Beneficio | | | | | 322 | 552 | (229) | 71% |
| Coopeatenas | | | | | 111 | 49 | 62 | -56% |
| Coopevictoria Beneficio | 74 | 33 | 41 | -56% | 209 | 232 | (23) | 11% |
| El Gallito | 575 | 632 | (57) | 10% | 589 | 650 | (61) | 10% |
| Empacadora de Carnes | 748 | 551 | 198 | -26% | 785 | 666 | 119 | -15% |
| Fabrica Nacional de Licores | 490 | 446 | 44 | -9% | 0 | 0 | 0 | |
| Fertica | 3,468 | 2,631 | 837 | -24% | 3,621 | 3,942 | (321) | 9% |
| Hacienda Atirro (Beneficio) | 128 | 990 | (861) | 672% | 0 | 0 | 0 | |
| ICAA Puente de Mulas | 2,427 | 508 | 1,920 | -79% | 2,307 | 504 | 1,802 | -78% |
| ICAA San Rafael de Escazu | 2,378 | 523 | 1,855 | -78% | 2,186 | 502 | 1,684 | -77% |
| Industrias Akron de C.R. (Firestone) | 1,733 | 1,721 | 12 | -1% | 0 | 0 | 0 | |
| Ingenio Taboga | 202 | 45 | 156 | -77% | 208 | 13 | 195 | -94% |
| Punto Rojo | 299 | 295 | 3 | -1% | 321 | 285 | 37 | -11% |
| Rafytica | 240 | 221 | 19 | -8% | 223 | 169 | 54 | -24% |
| Ricalit | | | | | 643 | 61 | 581 | -90% |
| Scott Paper | 4,228 | 4,296 | (67) | 2% | 4,317 | 4,622 | (305) | 7% |
| Ticatex | 2,363 | 2,308 | 55 | -2% | 2,291 | 2,308 | (17) | 1% |
| TOTAL | 21,659 | 17,575 | 4,084 | -19% | 20,835 | 17,014 | 3,821 | -18% |

There are two caveats for this analysis:

First, the demand data produced by this analysis may overstate the true aggregate demand. By calculating maximum demand by company and then combining these calculations, the analysis calculates the upper bound for the real combined demand. Because each company experiences its maximum peak demand at a different time, the sum of their maximum demands will exceed the true aggregate peak demand (the maximum demand of the sum of their daily load curves). The large quantity of data involved and the inconsistencies in the format of the data received by the project team made it impractical and too time-consuming to create a day-by-day composite load curve for the entire group of participants.

Second, this analysis may overstate the savings attributable to load management efforts because some companies reduced their entire operations (and thus demand) during 1988 for reasons other than load control. For several companies, the entire average demand curve for 1988 was significantly below the corresponding curve for 1987; the most conservative assumption from such a situation is that there was an overall reduction in activity in the plant unrelated to load management efforts. Variables such as weather, economic climate, labor relations, and world prices for inputs and outputs affect the total level of activity in industrial enterprises. In this limited study, it was not possible to include these variables in the analyses. Attempts were made to use indices based on total energy consumption and industrial production to adjust the demand numbers for changes in level of activity; however, limitations with this methodology prevented the project team from drawing conclusions based on that analysis. This adjusted analysis is described in the following paragraphs.

### Adjusted Aggregate Maximum Peak Demand

Under ideal demand management conditions, an industry can change its level of production with minimal impact on the level of on-peak demand for power. This can be accomplished by adding shifts or by increasing off-peak machinery use. With this in mind, the real change in demand from 1987 to 1988 should not be significantly affected by moderate production changes. However, some companies in the analysis had such large changes in production that their on-peak demand was significantly changed. For several companies, the entire average demand curve for 1988 was significantly below the corresponding curve for 1987. The most conservative assumption from such a situation is that there was an overall reduction in activity in the plant unrelated to load management efforts.

In order to adjust the demand data to take into account changes in level of activity, the maximum demand data for 1988 from the previous analysis (aggregate maximum peak demand) were adjusted down or up by the same percentage as the total production (or energy consumption) changed between 1987 and 1988. Production data were collected for 14 of the companies in the analysis using mailed forms and letters and by team

members' personal contact with participants. When production data could not be obtained, total energy consumption (kWh) was used as a substitute, assuming that changes in production would be mirrored in changes in total energy consumption and assuming no change in total energy efficiency. Energy consumption data were collected from ICE's billing files.

Starting with the 1988 demand data analyzed in the previous analysis, the percentage change in total production (or energy consumption) between the relevant months of 1987 and 1988 was calculated and the 1988 demand data were reduced (or increased) by this percentage. Summary results using this analysis are presented in Exhibit N.10. Company-by-company results, the production data, and the production multipliers are not included to protect the privacy of the participants.

As mentioned above, limitations with this methodology prevented the project team from drawing conclusions based on this analysis. Its results and limitations are presented here solely for discussion's sake.

The primary problem with this analysis is that electricity demand does not necessarily increase in direct proportion to increases in production or total energy consumption (kWh). For example, if a company increases production by adding shifts rather than adding workers to existing shifts, their demand level may not increase at all. Or if a company normally operates at full capacity for short periods of time and increases production by operating, again at full capacity, for longer periods of time, their demand level will not increase. Further doubt is added to the analysis by the fact that the production and energy consumption indices showed a very poor correlation to each other.

### Average Daily Demand Curves

Successful load management efforts are reflected in changes in the shape of the daily load curve by reductions in demand during on-peak hours. Measuring the difference between demand on-peak and off-peak can give a measure of the demand savings as a result of load control efforts.

When a company has reduced its on-peak demand to below its off-peak demand, a lower-bound estimate for its savings can be calculated by comparing the average on-peak demand with the average off-peak demand. Using the average daily demand curves for the participants, an analysis of the off- to on-peak demand was undertaken. The method chosen for this analysis was to compare the average on-peak demand with the average off-peak demand from hours just before and after the peak hours. Specifically, for the monthly average demand curves for each of the participants, the average of the on-peak demand was compared with the average demand of the two hours before and the two hours after the peak hours.

Exhibit N.10

CHANGE IN MAXIMUM PEAK DEMAND DURING ON-PEAK HOURS (KW)

TOTAL OCTOBER 1987
OCTOBER 1988

ADJUSTED AVERAGES

| | | Sat | Sun | Mon | Tue | Wed | Thurs | Fri | WEEKLY AVERAGE | MONDAY-FRIDAY AVERAGE |
|---|---|---|---|---|---|---|---|---|---|---|
| 1987 | MAXAM | 28,530 | 21,006 | 25,983 | 26,151 | 25,206 | 26,081 | 26,835 | 25,685 | 26,051 |
| | MAXPM | 27,867 | 20,588 | 26,347 | 25,132 | 25,030 | 26,076 | 26,361 | 25,343 | 25,789 |
| 1988 | MAXAM | 29,539 | 24,890 | 22,069 | 24,239 | 23,293 | 23,980 | 23,962 | 24,567 | 23,509 |
| | MAXPM | 28,168 | 25,872 | 22,241 | 23,594 | 21,636 | 22,066 | 23,802 | 23,911 | 22,668 |
| DIFFERENCE | AM | (1,009) | (3,884) | 3,913 | 1,912 | 1,913 | 2,102 | 2,872 | 1,117 | 2,542 |
| | PM | (301) | (5,284) | 4,106 | 1,539 | 3,395 | 4,009 | 2,559 | 1,432 | 3,122 |
| PERCENT CHANGE | AM | -4% | -18% | 15% | 7% | 8% | 8% | 11% | 4% | 10% |
| | PM | -1% | -26% | 16% | 6% | 14% | 15% | 10% | 6% | 12% |

TOTAL NOVEMBER 1987
NOVEMBER 1988

| | | Sat | Sun | Mon | Tue | Wed | Thurs | Fri | WEEKLY AVERAGE | MONDAY-FRIDAY AVERAGE |
|---|---|---|---|---|---|---|---|---|---|---|
| 1987 | MAXAM | 19,461 | 15,042 | 20,039 | 21,093 | 20,835 | 20,591 | 20,574 | 19,662 | 20,627 |
| | MAXPM | 18,600 | 15,060 | 21,269 | 20,984 | 20,789 | 21,203 | 19,931 | 19,637 | 20,835 |
| 1988 | MAXAM | 19,918 | 16,021 | 16,962 | 17,474 | 16,954 | 17,657 | 16,651 | 17,448 | 17,140 |
| | MAXPM | 18,582 | 14,851 | 16,835 | 16,931 | 16,912 | 17,144 | 16,768 | 16,898 | 16,918 |
| DIFFERENCE | AM | (456) | (979) | 3,076 | 3,619 | 3,881 | 2,934 | 3,923 | 2,214 | 3,487 |
| | PM | 18 | 209 | 4,434 | 4,053 | 3,877 | 4,059 | 3,163 | 2,739 | 3,917 |
| PERCENT CHANGE | AM | -2% | -7% | 15% | 17% | 19% | 14% | 19% | 11% | 17% |
| | PM | 0% | 1% | 21% | 19% | 19% | 19% | 16% | 14% | 19% |

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For some companies, peak demand is also reduced between the morning and evening peak hours (see Exhibit N.11 on Coopeagri Beneficio). In this case, a more accurate calculation compares the morning peak with the hours before the peak and the afternoon peak with the hours after the peak. For the analysis, the maximum value produced by either of these two methods was used (see Exhibit N.12).

This analysis avoids the problem of changes from year to year by measuring the changes from hour to hour. It presents a very accurate calculation for some companies and an accurate calculation of the minimum amount of load management being achieved. However, it will understate the actual achievements. In cases where load management efforts change a demand curve that shows a significant daily peak demand is reached during peak hours to one with a flat curve during the peak hours, this analysis will underestimate the true load reduction. (The average demand curves for Coopeatenas provide a good example, Exhibit N.13.)

## NOTES ON SPECIFIC PARTICIPANTS

In estimating the actual savings achieved by the participants, many factors had to be taken note of. Some of these are explained in the following paragraphs. Other relevant company characteristics are described in Appendix M.

**ICAA Puente de Mulas and San Rafael de Escazu:** ICAA, the water utility, brought a new pumping station on-line during 1988. This significantly reduced the requirements for the two ICAA stations included in the analysis. As a result, gross changes in demand from 1987 to 1988 overstate the savings achieved from load management. A more accurate analysis is to measure the change from off-peak to on-peak demand for an average load curve (see Exhibits N.14 and N.15).

**Cempa** is a participant in the program but an examination of its load curves reveals that it began controlling demand before the beginning of the program. As a result, its savings are not calculated into the savings attributed to the demonstration project. Nonetheless, Cempa presents an excellent example of the successes of load management and its savings, on the order of 1,400 kW, still contribute to reducing the system's peak demand (see Exhibit N.16).

**Ricalit** is considered to be one of the project's best examples of successful load management. It has installed a demand monitor and a timing device to set off alarms when demand exceeds specified limits on certain equipment. Ricalit estimates that it is saving between $2,000 and $3,000 in demand charges. Problems in its demand data have created demand curves that do not accurately reflect the savings achieved.

Exhibit N.11

# COOPEAGRI BENEFICIO
## AVERAGE DEMAND -- NOVEMBER

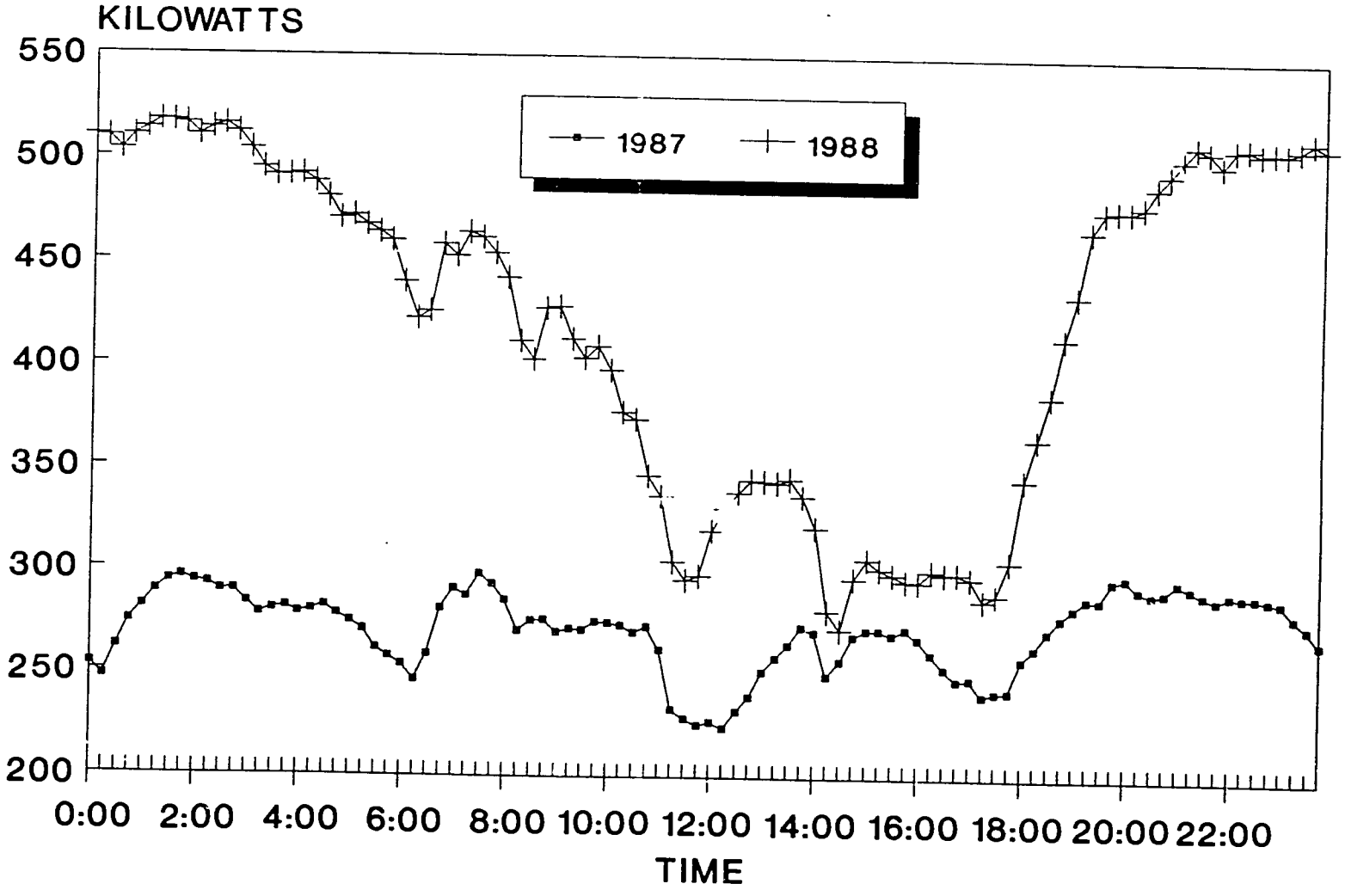

Exhibit N.12

AVERAGE CHANGE OFF-PEAK TO ON-PEAK

| | AM | PM | AM * BEFORE | PM * AFTER | AM MAX | PM MAX |
|---|---|---|---|---|---|---|
| Alunasa | 253 | 193 | 313 | 157 | 313 | 193 |
| Arrocera los Sauces | 24 | 21 | 31 | 54 | 31 | 54 |
| Carnes de C.A. | (22) | 84 | 6 | 7 | 6 | 84 |
| Cartago Beef Packing | 40 | 40 | 37 | 10 | 40 | 40 |
| CNP Montecillos | (25) | 18 | (29) | (45) | (25) | 18 |
| Conducen | (14) | (35) | (12) | (26) | (12) | (26) |
| Coopeagri el General (Beneficio) | 33 | 22 | 83 | 125 | 83 | 125 |
| Coopeatenas | (2) | (4) | (3) | (6) | (2) | (4) |
| Coopevictoria Beneficio | (0) | (1) | 15 | 9 | 15 | 9 |
| El Gallito | (12) | (17) | (12) | (104) | (12) | (17) |
| Empacadora de Carnes | 6 | 25 | 7 | (19) | 7 | 25 |
| Fabrica Nacional de Licores | 2 | 3 | (5) | 13 | 2 | 13 |
| Fertica | 152 | 181 | 287 | 182 | 287 | 182 |
| Firestone | 110 | 82 | 119 | 96 | 119 | 96 |
| Hacienda Atirro Beneficio | 37 | 73 | 101 | (161) | 101 | 73 |
| ICAA Puente de Mulas | 583 | 537 | 638 | 443 | 638 | 537 |
| ICAA San Rafael de Escazu | 578 | 522 | 646 | 427 | 646 | 522 |
| Ingenio Taboga | 113 | 92 | 126 | 58 | 126 | 92 |
| Punto Rojo | 9 | (12) | 8 | (75) | 9 | (12) |
| Rafytica | (3) | (8) | 3 | (13) | 3 | (8) |
| Ricalit | 11 | 4 | 1 | 2 | 11 | 4 |
| Scott Paper | 81 | 4 | 148 | 98 | 148 | 98 |
| Ticatex | (2) | (15) | 19 | (91) | 19 | (15) |
| Urgelles y Penon | 64 | (23) | 50 | (130) | 64 | (23) |
| TOTAL | 2,017 | 1,786 | 2,576 | 1,013 | 2,616 | 2,060 |

* Compares the morning peak with hours before the peak and the afternoon peak with the hours after the peak.

Exhibit N.13

# COOPEATENAS
## AVERAGE DEMAND -- NOVEMBER

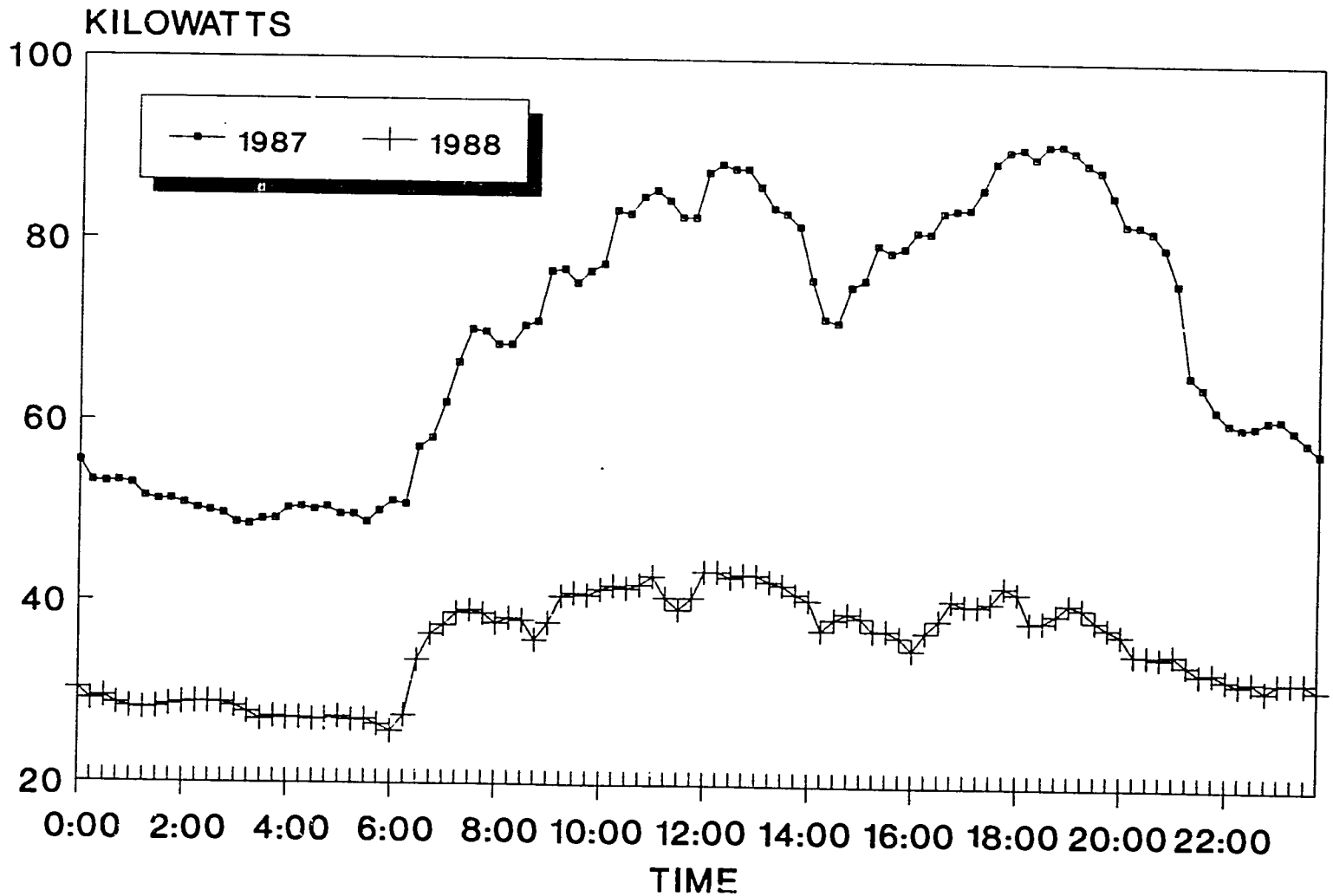


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Exhibit N.14

# ICAA PUENTE DE MULAS
## AVERAGE DEMAND -- NOVEMBER

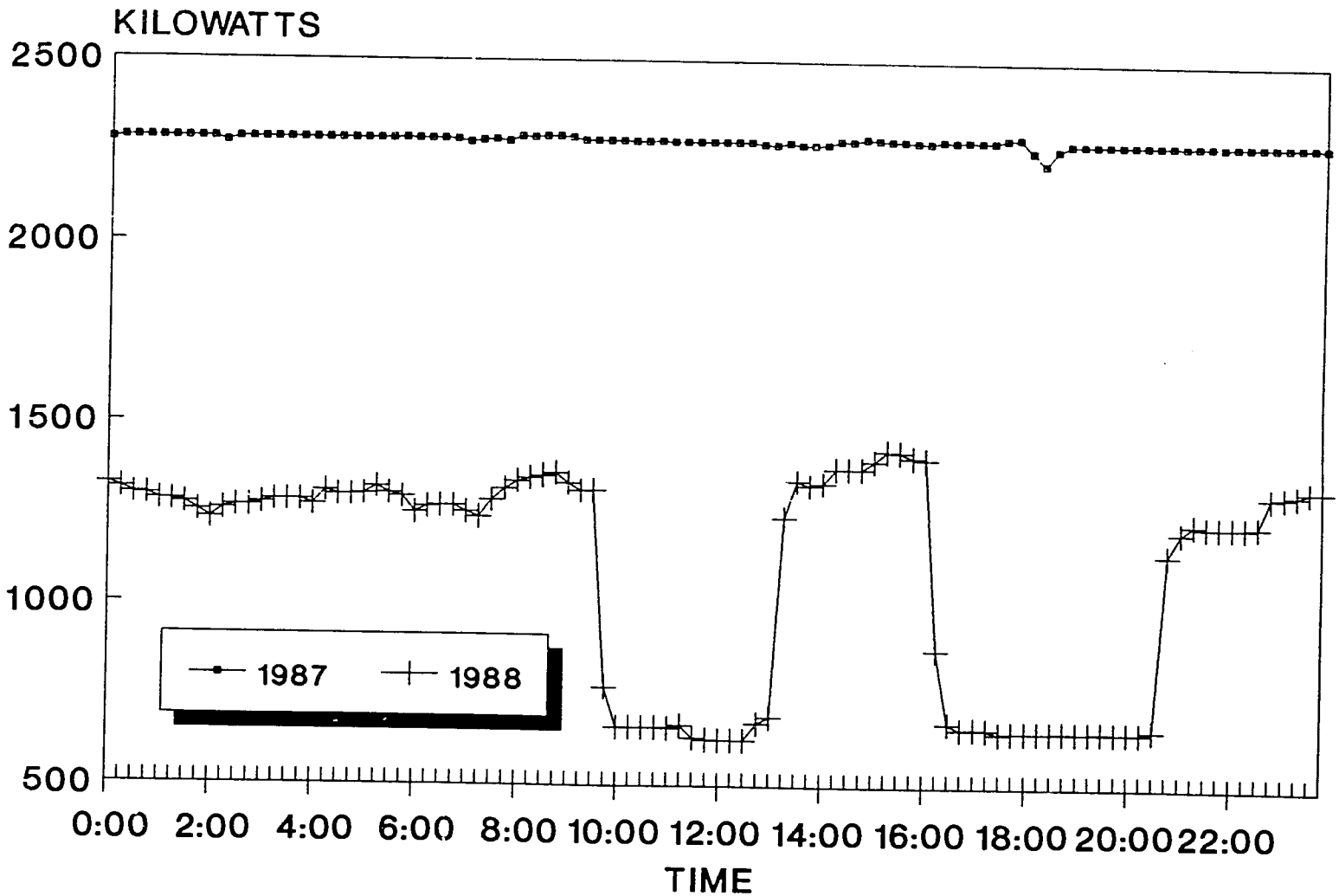


Exhibit N.15

# ICAA SAN RAFAEL DE ESCAZU
## AVERAGE DEMAND -- NOVEMBER

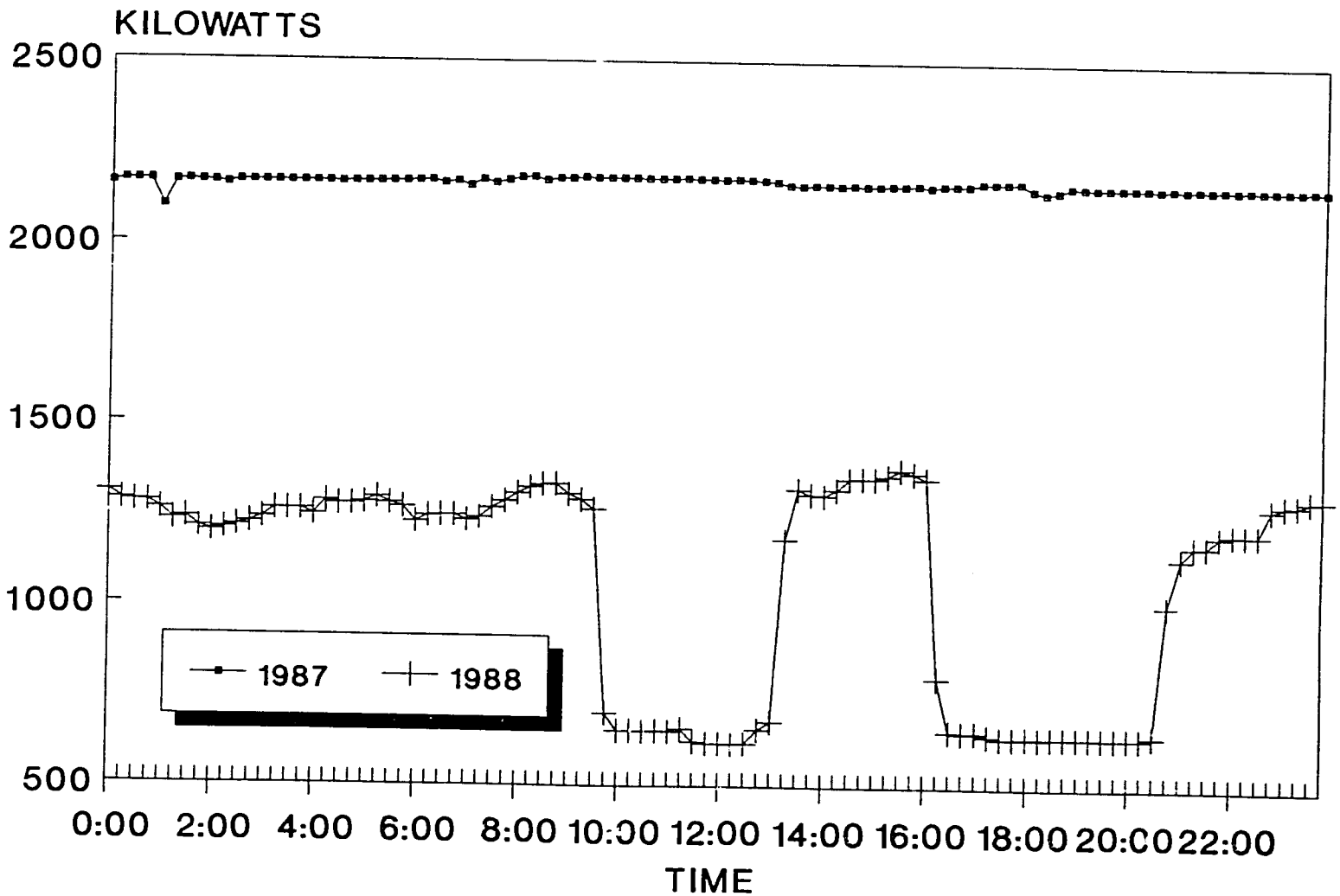
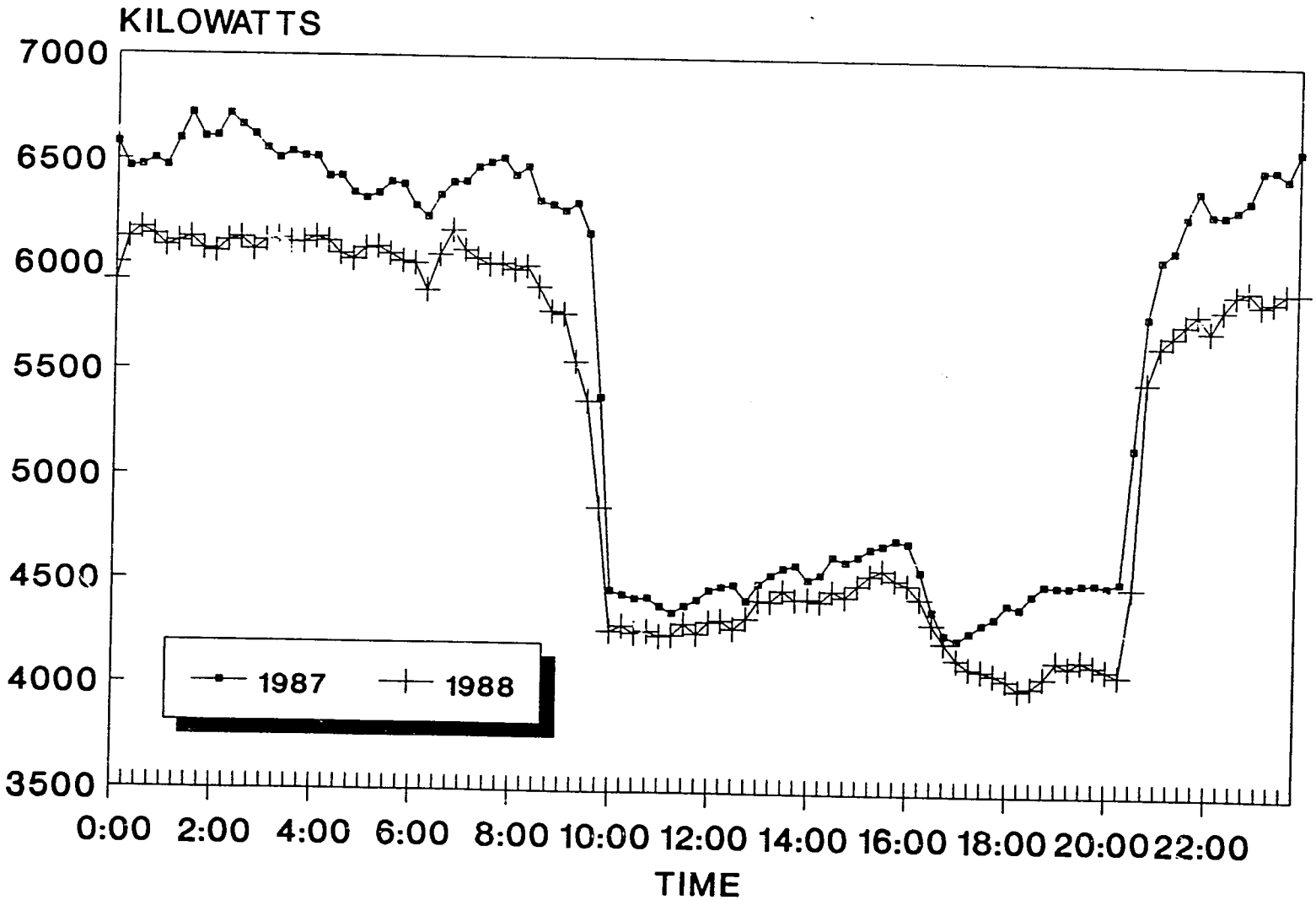


Exhibit N.16

# CEMPA
## AVERAGE DEMAND -- OCTOBER

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## APPENDIX O: TERMS OF REFERENCE FOR AN EXPANDED LOAD MANAGEMENT PROGRAM IN COSTA RICA

Two previous studies* have demonstrated that an expanded load management program in Costa Rica is technically and institutionally feasible as well as economically and financially justified. The purpose of this proposal is to use the momentum created by the project's recent activities to develop an Expanded Load Management Program to achieve a significantly greater reduction of the electric power system's coincidental evening peak demand.

### OBJECTIVE

The objective of this phase is to enroll up to 150 commercial and industrial customers in a load management program and achieve a total peak evening demand reduction of not less than 20 MW and/or a reduction of not less than 3 percent to the total system peak.

### RATIONALE

In the previous phase, a set of twenty industrial and commercial customers were able to reduce their electric peak demand from 21 MW to less than 18 MW, that is, a 3 MW or 14 percent savings. Because the population of large commercial and industrial customers (CCIs) -- defined as customers with monthly consumption levels of at least 20,000 kWh or a maximum demand exceeding 100 kW, or both -- consists of approximately 425 accounts with a 1987 aggregate demand of about 175 MW and a coincidental load of 120 - 130 MW, it appears reasonable to expect a coincidental peak demand reduction of 15 - 25 MW.

### DESCRIPTION OF ACTIVITIES

This phase of the project will consist of six tasks:

**Task 1** - Make logistical and organizational arrangements

**Task 2** - Select customers and obtain their participation

**Task 3** - Assist ICE in making the Load Management and Efficiency Department operational

**Task 4** - Identify customer needs and provide ongoing technical assistance to customers

**Task 5** - Collect and analyze data

**Task 6** - Prepare final report

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* Costa Rica: Load Management Project. Phase I: Planning. ECSP report, April 1988 and this report.

Each task is briefly described below.

**Task 1 - Make Logistical and Organizational Arrangements (Pre-Project Activities)**

The starting point for this phase will be to implement the recommendations of the pilot project, particularly:

**For ICE to:**

- initiate the tariff revision and institutionalize the Load Management and Efficiency Department (LMED)
- nominate a project manager, assign staff to the project, and obtain office space and related working and communication equipment
- complete the promotion package to be sent to potential program participants

**For MINEREM to:**

- define and establish coordination mechanisms between this project and other components of the National Power Efficiency Initiative
- establish a dialogue with prospective funding sources, e.g., IDB, CEPAL and the World Bank, in order to secure financing for the implementation of the recommended programs.

Although the technical assistance team may help ICE and MINEREM in those tasks, it is expected that both organizations will be abie to carry out most of the work needed.

**Task 2 - Select Customers and Obtain Their Participation**

The first step of this task will be for the technical assistance team, together with ICE, to review the list of large C&I accounts and develop an up-to-date data base of their key characteristics including: coordinates, load profile, annual and daily peak demand, tariff subscribed to, type of activity and production data. Next, the team and ICE will develop a list of selection criteria for participation in this phase. The criteria used for participation in the pilot project were primarily based on load characteristics and willingness to participate, as expressed by senior management. For this phase, ICE, the consultants, and some selected pilot project participants will review the list and choose the final criteria. The criteria will then be applied to the data base in order to screen not less than 300 candidates. Those 300 customers will then be contacted by mail, asking for their participation and their financial commitment to install recommended control systems at their facilities. A copy of the promotion pamphlet mentioned in the Task 1 discussion will be included with each mailing. Follow-up telephone calls will be made and random site visits will be conducted by ICE and its consultants to firm up the participant enrollment. It is expected that about 150 customers will join the program.



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**Task 3 - Assist ICE in Making the LMED Operational**

This task, which will be undertaken in parallel to Task 2, will consist of assisting LMED to develop its internal organization and establish its working system. In particular, some computer equipment and related software should be ordered and installed to allow the department to manage the project effectively and track the progress made on a real time basis. For example, data extracted from magnetic tapes and from electronic meters will have to be integrated to generate, as often as needed, each customer's load profile. These load profiles will then be normalized by production or activity level indices. Training will be provided to LMED staff, both in-country (on-the-job and classroom) and in the U.S., probably at Florida Power and Light's Qualtec Division (training at this facility will maintain project continuity because the key personnel received training at Qualtec in 1988).

**Task 4 - Identify Customer Needs and Provide Ongoing Technical Assistance to Customers**

As in the pilot project, ICE staff, assisted by U.S. and local consultants (e.g., Disenos Electricos, Sol 2000, ICAITI) will visit, on request, each participant facility. During the site visits they will offer, for a limited fee, an "electric load audit" which will lay out the load control options available at the facility and the approximate cost/benefit of each option. A short technical report will be prepared for each facility and will be kept in ICE's LMED files as a reference document. In some cases, specialized training may be offered by the local consultants for the benefit of plant staff.

**Task 5 - Collect and Analyze Data**

This task will use the same approach for data collection and analysis as that used in the pilot project. Three methodologies will be applied: (1) total demand on system peak days, (2) aggregate maximum peak demand, and (3) average change on-peak to off-peak (see Final Report Chapter 2 and Appendix N for details).

**Task 6 - Prepare Final Report**

A detailed final report presenting the various activities carried out, the results achieved, the problems encountered, and the cost/benefit of the program will be prepared. This final report will also present recommendations for future activities, particularly in the residential sector, which is one of the anticipated targets for the final phase of this project.

**Schedule and Budget**

It is anticipated that it will take 18 months to carry out this phase of the program. The cost for this phase is estimated to be $2.8 million, of which $0.9 million is for technical assistance (total minus equipment).

## APPENDIX P: LOAD CONTROL DISSEMINATION PLAN FOR ICE

The ultimate goal of this load control demonstration project is to enroll the majority of establishments in Costa Rica's industrial and commercial sectors in a load control program and expand load control efforts to include the residential sector. By replicating the success of the pilot program throughout the country, ICE can hope to reduce its system peak significantly and thereby improve the efficiency of its entire system. To ensure that the efforts of the pilot project are continued, a dissemination plan was developed. The draft plan presents a variety of activities that ICE and other Costa Rican organizations can pursue to distribute information on the benefits of load management, encourage customers to participate in a continuing load control program, enroll more customers in load management tariffs, and generally raise the awareness and understanding of the need for and benefits of load management.

This appendix presents a draft load control dissemination plan. The plan was based on discussions with ICE staff. Additional effort will be required to complete the plan, including a detailed determination of target facilities, gathering of cost data, identification of available resources and setting of a budget. The final dissemination plan will be prepared and carried out by ICE.

The dissemination activities will target an audience of approximately 425 commercial and industrial customers, who are concentrated in the Central Plateau of Costa Rica. These customers have an estimated coincidental peak load of 122.5 MW, or 20 percent of the 1988 system peak load. The program will target both management and technical (mainly plant engineering and maintenance) staff whose interest and support are essential in planning and implementing load control.

The extent of the dissemination effort will be determined largely by funds available for it and the services that can be obtained free of charge. For example, information might be enclosed with mailings of electricity bills at little or no extra cost, or some publications (newsletters, journals) might publish articles at no charge. The public relations department of ICE has recently carried out an energy conservation campaign and should play an important role in designing, producing and disseminating load control information.

The first step is to plan the dissemination campaign using a table similar to that shown in Exhibit P.1. The table will show the total cost of promotional materials, publicity services and distribution. The plan may then have to be modified to fit the financial and human resources available for the campaign.

A preliminary dissemination plan was prepared by ECSP staff working with the ICE counterpart staff. It consists of the following elements:

**Exhibit P.1**

**Load Management Dissemination Program for Commercial and Industrial Customers**

| Description | Medium | Target Audience | Audience Size | Copies to be Printed 1989 | Cost | Channels of Distribution | Distribution Cost | Completion Date | Remarks |
|---|---|---|---|---|---|---|---|---|---|
| ICE Demonstration Project Paper | Technical Paper | Industrial Customers Technical Staff | | | | Mailings of: ICE (With Bills) Camera de Industrias Other Industry Associations Plant Visits | | | Focus on case studies |
| Case Study of Banco Nacional de C.R. Project (SOL 2000) | Technical Paper | Commercial Customers Technical Staff | | | | Mailings of: ICE (With Bills) Camera de Industrias Other Industry Associations Plant Visits | | | Requires Collaboration of SOL 2000 S.A. |
| Promotional Brochure | Brochure | Industrial and Commercial Customers Management and Technical Staff | 850 | | | Mailings of: ICE (With Bills) Camera de Industrias Other Industry Associations Plant Visits | | | |
| Final Meeting-Demonstration Project | Meeting | Industrial and Commercial Customers Technical Staff | 80-150 | | | | | | Include Case Studies and Panel Discussions |
| Load Management Talks | Meeting | Industrial and Commercial Customers Management and Technical Staff Engineering Students | Various 20-50 | | | | | | |
| Tours of Facilities | Tour | Industrial and Commercial Customers Technical Staff | | | | | | | Can be combined with meetings |
| Newspaper Articles | Daily Newspaper and Sunday Supplement | General Public | | | | Newspaper Distribution | | | Some services involve cost |
| Articles in Periodicals | Technical, Industry, Trade Journals | Engineers Technicians Managers | | | | Periodical Distribution | | | |
| | | | | Total | | Total | | | |

**1. Prepare a technical project paper with case studies.**

The paper will be based on the final ECSP report on the project, the experience of the project staff, and information from the project files. It will describe the project in detail and focus on case studies of the best examples of applied load management. It will be oriented toward the technical personnel who will plan and implement load control; consequently, it will provide much information on relevant technologies and techniques. It will be of interest mainly to industrial customers, which were the most active participants in the project.

**2. Prepare a technical paper on the electrical energy rationalization project at the Banco Nacional de Costa Rica.**

This project was carried out by consulting engineers from Sol 2000 S.A. independently of the demonstration project; however, it is said to be an excellent example of load management and electrical energy savings.

The preparation of this case study will be subject to the agreement of Sol 2000 and the bank, and will be of interest primarily to commercial customers. It will be oriented toward the technical maintenance personnel of banks, hotels, hospitals, restaurants and office buildings, and will provide practical information on load control technologies and techniques.

**3. Prepare a promotional brochure.**

The purpose of this brochure is to create an interest in load control on the part of management and technical personnel in the commercial and industrial customer classes, and to persuade them to take action (to contact ICE for guidance).

It will explain the concept to non-technical people, and will, at the same time, be technically informative to appeal to engineers and technicians. It will explain the special tariffs available to commercial and industrial customers.

It must be well-prepared, professionally produced and attractive. It will also serve in future load control programs as a sales aid. The first draft of this brochure is presented in Appendix I.

**4. Develop mailing lists of commercial and industrial customers.**

The mailing list of the Camara de Industrias might be used as a starting point, and expanded using ICE customer files together with information from other industry associations, such as sugar, coffee, and rice producers. Consulting engineers will

probably agree to provide mailing lists from their files because the dissemination program will generate business for them.

**5. Mail the technical papers and promotional brochure to all commercial and industrial customers with a demand of 50 kW or more.**

Existing distribution channels can be used to reduce cost. Consideration might be given to sending the material enclosed with electricity bills. Alternatively, it might be included in regular mailings of the Camara de Industrias or specific industry associations.

**6. Hold a meeting of participants and interested customers.**

This meeting will mark the end of the load control demonstration and will spread news of the results. It will provide feedback to participants and will also furnish an opportunity to inform other interested customers. It might include case studies and a panel discussion with panel members representing ICE and other utilities, project participants, DSE, the Camara de Industrias, consulting engineers and equipment suppliers.

**7. Visit interested customers to provide assistance.**

The dissemination activities will generate interest in load control among many customers. ICE engineers should visit their facilities to provide information and guide their load control efforts.

**8. Arrange visits to facilities with good load management.**

The most convincing argument for load management is a successful application. With a view toward replication, ICE will organize visits for interested customers to facilities that have applied load management successfully.

**9. Provide guest speakers on load management.**

Some industry and professional associations will provide a place and an audience for communicating load control information. The following are possible hosts of such meetings:

- Camara de Industrias
- Associations of sugar, coffee and rice producers

- Hotel association
- Hospital administrators' association
- Colegio de Ingenieros y Arquitectos

Where appropriate, the talk could be followed by a panel discussion.

With a view toward reaching future engineers, talks might be given to engineering students at various universities.

**10. Publish articles in newspapers and periodicals.**

Large audiences can be reached through newspapers, and selective audiences through technical and trade journals. This type of publicity is largely free, with the exception of some types of newspaper services.

Examples are:

- Feature articles in newspapers, including Sunday supplements
- Technical articles in the journal of the Colegio de Ingenieros y Arquitectos
- Articles in other technical, industry, and trade publications.

The plan described above is designed to disseminate news of the demonstration at moderate cost. The cost can be reduced, if necessary, by eliminating the paid newspaper articles, which are aimed at the general public.

## GLOSSARY

**ASCII (American Standard Code for Information Interchange):** The term also includes diesel engines and combustion turbines.: An 8-bit coded character set to be used for the general interchange of information among information processing systems, communication systems, and associated equipment.

**Avoided Costs:** The electric utility's marginal cost of fuel or capacity not incurred due to conservation or load management investment or actions.

**Capacity:** The load for which a generator, turbine, transformer, transmission circuit, apparatus, station, or system is rated. Capacity is also used synonymously with capability.

**Capacity Costs:** Costs associated with capital investments in electricity production and delivery.

**Capacity Factor:** The ratio of the average load on a generating resource to its capacity rating during a specified period of time, expressed as a percentage.

**Cost-Effective:** A term meaning a conservation or load management investment or program is economic -- one where the benefits outweigh costs (cost of investment or program).

**Demand:** The term used to describe the rate of use of electric energy expressed in kilowatts. Demand is a synonym of load. Billing demand describes the maximum rate of use of electric energy averaged over a specific interval of time and usually expressed in kilowatts.

**Download:** The transfer of digital data or programs from a host computer to another data processing system such as central computer to micro-computer.

**End Use:** A category of electricity use described by the work performed (i.e., lighting or air conditioning).

**Energy Audit:** A detailed analysis of energy and material streams to evaluate the efficiency of energy use and to identify recommendations and estimate investments to improve energy efficiency.

**Energy Demand Management:** A system of integrated activities to monitor, evaluate, and control energy consumption.

**Energy Management System:** A microprocessor-based control system at the enterprise level that centralizes and coordinates several energy information and control functions in a given facility, process, operation, or piece of equipment.

**Firm Capacity:** Capacity of electric power available at all times except for forced outages and scheduled maintenance.

**Hardware:** The mechanical, magnetic, electrical, and electronic devices of which a computer is built, as well as the similar components of peripheral devices.

**Kilowatt (kW):** 1,000 Watts

**Kilowatt-hour (kWh):** A unit of electric power consumption indicating the total energy developed by a power of one watt acting for one hour.

**Load:** The amount of electric power demand on the system. Load is a synonym of demand.

**Load Factor:** The ratio of average load to peak load during a specified period of time, expressed as a percentage.

**Load Shedding:** Deliberate scheduled or unscheduled disconnecting of load from the grid by a utility because of supply shortage.

**Marginal Cost:** The change in total cost caused by a change in output. Marginal cost can also be understood as the additional cost to produce an additional unit of output, or the savings from producing one unit less of output (i.e., avoided cost).

**Modem:** An acronym for MOdulator/DEModulator, a hardware device used for changing digital information to and from an analog form to allow transmission over voice grade circuits.

**Net Present Value (NPV):** A dollar figure that describes the "worth" of an investment. It is determined by discounting the annual cash flows (both "+", or inflows, and "-", or outflows) at a specified discount rate, then summing all values to arrive at a "net" value.

**Outage:** Interruption of electricity supply by the utility or because of faults in the utility's system.

**Peak Load:** The maximum electric load in a stated period of time.

**Power Factor:** The ratio of the actual (or average, or active) power to the apparent power (root-mean-square voltage times root-mean-square current) of an alternating current circuit. Abbreviated PF. Also know as phase factor and is equal to cosine $\phi$ where $\phi$ is the phase angle between the voltage and current waveforms.

**Program:** A sequence of instructions causing the computer to perform a specified function.

**Rate:** Any price, rate charge, or classification made, demanded, observed, or received with respect to the sale or purchase of electrical energy or capacity, or any rule,

regulation, or practice respecting any such rate, charge, or clarification, and any contract pertaining to the sale or purchase of electrical energy or capacity.

**Reserve Margin:** Extra power generation capacity available to (1) meet anticipated demands for power or (2) serve load in the event of a loss of generation resulting from an unscheduled outage. The reserve margin is the ratio of excess capacity to anticipated peak load, expressed as a percentage.

**Retrofitting:** In general: making changes to equipment/processes that are currently operating. In energy conservation: Installing an energy-saving device or process after a plant has begun operating.

**Software:** A term used to describe all computer programs whether in machine, assembly, or high-level language.

**Thermal Power Generation:** A process which uses oil, gas, or coal to generate thermal energy, usually in the form of steam, which in turn is used to drive electric turbine generators.



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