A Microeconomic Study of the Interdependence of Players and Participating Agents in a Potential Game Situation within the Electricity Supply Industry

by

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ABSTRACT

This thesis describes the inherent interdependencies between electricity supply business companies and their competitive customer base. Specifically, the issue of "triad" forecasting is analysed as a means of demonstrating these interdependencies.

Triads, by definition, are particular half hourly periods in which the national demand for electricity is at a peak. At these times, suppliers of electricity and certain customers pay expensive charges to the National Grid Company of England and Wales as a means of reflecting the cost of providing a transmission system which is capable of providing capacity to meet these peaks in demand.

Following the privatisation of the electricity industry, the incentive existed for the electricity supply companies to broaden their product range and gain competitive advantage over their rivals. A "triad forecasting service" was developed which intended to identify when these peak demand periods were likely to occur, in order that customers could be warned and reduce their demand to avoid these charges.

In it's first year of operation, the service described in this thesis was successful in this aim. However, in the second year of operation this success led to a proliferation in the number of electricity companies offering the service and the number of customers wishing to benefit from the services on offer. Consequently, the effectiveness of the triad forecasting strategy described was reduced. The very act of customers reducing their demand for electricity reduced the level of demand that was initially forecast and hence the predictability of the triads.

A strategic gaming situation appears to have emerged whereby the action of customers acting upon the advice of triad forecasting strategies has influenced the objective of the strategies. Indeed, the actions of competing triad forecasting strategies needs to be further taken into account in order to develop a revised solution.

The implications of this interaction are described in detail and explained within the context of contemporary game theory. Further analysis illustrates the ability of various sets of customers to manage their demand for electricity and consequently provides a rudimentary indication of the price elasticity of their demand for electricity.

The conclusions of this research have implications for both future triad forecasting strategies and potentially for the contract policies of electricity supply businesses.

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1 INTRODUCTION

Overview

101 The privatisation of the UK electricity supply industry signified the emergence of a partially competitive market with guarantees of further competition over a period of time. Out of the Central Electricity Generating Board's (CEGB) assets derived twelve privately owned Regional Electricity Companies (RECs), two private electricity generating companies and the state owned nuclear generating arm of the supply industry. These companies, in a competitive market situation were to act independently and given the nature and integration of the industry, were to act interdependently.

102 Decision making at all levels in a competitive market requires the assimilation of the potential action or reactions of the competitive rivals. Rivals may respond to policy decisions enacted by a particular company and unless such an action has been anticipated and incorporated into the strategy, this could be to the detriment of the initial policy action. Alternatively, the anticipated reaction of competitive rivals to a policy decision could be anticipated and indeed is a necessary component of the success of any enacted strategy. Indeed, any interdependent actions or series of parallel independent decisions potentially influence the desired and anticipated outcome to either the detriment or requirement of the initial action.

103 This situation becomes further complicated when policy decisions designed to benefit the customer base require the active participation of customers. Any successful policy which enables financial rewards for both customers and firms will ensure further customers and firms will seek to share these rewards. In a perfectly competitive market, the generation of abnormal profits will attract new firms into the market in the long run given the assumptions of perfect knowledge and ease of entry and exit to

the market. This principal is analogous to both firms and customers who wish to secure the financial benefits accruing from the actions of the leading firm and customer base.

104 The aim of this research is to define a microeconomic situation within the electricity supply industry (ESI) where the interaction of competing firms and the active participation of customers for the purpose of financial reward have influenced the objective of the initial action and consequently the perceived outcome.

105 The situation observed involves a strategy enacted by competing firms which offers energy cost savings to their competitive customers bases. The situation has been defined as a strategic game although not by the classical game theory definition. The "players" of the game and instigators of the strategy are the competitive firms (the RECs and private generating companies). The "participating agents" in the game are the customers who act upon the advice of the strategists.

106 The initial policy decision did not fully account for the interaction of both firms and customers. With few players and participating agents, the subsequent actions of both parties have a minimal adverse influence upon the anticipated outcome. In an increasingly active market, with many players instigating parallel strategies and given these strategies requires the actions of an increasingly interested and participating customer base, the overall outcome is a severe distortion to a carefully calculated situation. In the beginning, the outcome of the strategy could be modelled with a degree of certainty. However, the success of the strategy has led to the proliferation in both the number of players and participating agents.

107 This thesis defines the microeconomic situation that has applied to the electricity supply industry in the initial years of privatisation. The interdependence of both firms and customers has been observed and a "strategic gaming situation" appears to have emerged.

Background to the industry

108 The electricity supply industry of the United Kingdom has experienced fundamental structural reviews and organisational changes over the last 100 years of its existence. The industry's origins were placed firmly within the private sector however its move to the private sector was completed by the nationalisation of the industry in 1947. More recently, with the radical change in political and economic ideology shaping industrial policy in the 1980s, the majority of the industry has returned into the hands of the private sector.

109 The Electricity Act of 1947 brought the distribution and supply activities of 560 separate companies in England and Wales under state control and integrated them into 12 regional Area Boards. The generating facilities of numerous separate companies were also transferred to a single state controlled body. The Electricity Act of 1957 established two bodies, the Central Electricity Generating Board (CEGB) with responsibility for electricity generation, and the Electricity Council whose role was to act as a source of coordination for national pay bargaining and other areas of common interest. The CEGB had a statutory duty to provide bulk supplies of electricity to the 12 Area Boards. As a result of this obligation the CEGB planned for a margin of generating capacity in excess of anticipated demand. With its control of the transmission system and its operation of power stations the CEGB had a monopoly in generation as the Area Boards had a regional monopoly in electricity distribution.

110 The government White Paper of 1988 set out proposals for privatising the ESI of England, Wales and Scotland with the aim of introducing competition into generation and supply. The Electricity Act of 1989 detailed the proposed new structure for the industry. Under the final privatisation the CEGB's assets were transferred into four companies. Three of these companies are involved primarily in generation. The ownership of the CEGB's fossil fuelled power stations being divided

between two companies Nation Power and PowerGen, with the ownership of its nuclear power stations being transferred to Nuclear Electric, a company which remans in state hands. The National Grid with its interconnections to France and Scotland, together with the pumped storage power stations in Wales were transferred from the CEGB to the National Grid Company (NGC), the fourth company. This company is under shared ownership of the Regional Electricity Companies (RECs) created out of the 12 Area Boards serving the same regions as under nationalisation. The coordinating role of the Electricity Council was effectively abolished with the creation of the Electricity Association to provide common services for the newly privatised companies.

111 In the current structure National Power, PowerGen and the other generating companies (with the RECs now active in electricity generation) compete in the generation of electricity. There is also competition in supply activities. The RECs compete with each other to supply electricity to (currently) larger users of electricity and other operators can compete with the RECs provide they are eligible for a license to supply. Further competition was introduced into the supply market in April 1994 with full competition across all consumers of electricity scheduled for 1998.

112 A Director General of Electricity Supply was appointed to regulate the industry to provide protection for the consumer from any abuse of monopoly power granted to the various new electricity companies. Regulation is enforced upon the wholesale and retail price of electricity and has been subject to a number of reviews and revisions over the years. As competition in generation and supply increases with the gradual erosion of the granted monopoly franchises, the aim is to reduce the burden of regulation over time. The regulation imposed upon the industry signified a departure from the "rate of return" regulation that dominated thinking and policy in the United States and the UK until the 1980s. RPI-X regulation was adopted as it has been argued that this type of regulation

encourages efficiency and ensures that risks are not automatically passed onto the consumer but are shared with the shareholders.

113 In its nationalised state, "provision" not "profitability" was the driving force for the monopolistic electricity industry. The privatisation of the industry enabled the initial introduction of a partially competitive market structure, The aim was to introduce the benefits of competition into a monopolistic industrial structure and remove the dead weight loss caused by the presence of monopoly. The emphasis within political and economic ideology switched to the dynamic benefits of market forces and faith in the innovative role of entrepreneurship. Indeed the structure of the ESI after privatisation suggests there was a real attempt to introduce competition into the industry and not repeat the mistakes of the British Telecom and British Gas privatisations. A public monopoly was not simply transferred into a private monopoly. A number of companies were created and full competition was to be introduced into the market at progressive stages over a controlled period of time.

The trading mechanisms

114 The new industry structure created was accompanied by the creation of totally new trading arrangements. A single market for the bulk trading of electricity, the "Pool" was established. The new trading arrangements attempted to reflect two important characteristics associated with the generation and supply of electricity in a fully integrated system. The first characteristic is that it is not possible to trace from a particular generator the electricity provided to a particular supplier. Secondly, electricity cannot be stored in great quantities. Demand for electricity has to match quantities supplied on a constant basis for maximum allocative efficiency. For these reasons, electricity generated within the integrated system is "pooled" to meet demand. Electricity is sold by generators and purchased by suppliers through the pool at determinate prices. The NGC plays a role in this process by scheduling and despatching generator sets to meet

predicted demand on a merit order basis using prices and availabilities offered by generators. Those generators offering the lowest prices are scheduled first in this process.

115 The pool itself does not buy or sell electricity, it merely facilitates trading between participating buyers and sellers. To take account of the variability in the supply of and demand for electricity, half hourly prices for electricity bought and sold by pool members are determined. The system is complex and is constantly being revised and enhanced with major reviews of the initial pool framework already having been carried out. However, the pool represents a fundamentally new market for the trading of electricity having significant implications for both the supply and generation businesses.

Introducing competition into the market

116 This thesis aims to examine a particular aspect of the interdependence which results from the competitive interrelationships arising from the structure of the new electricity supply industry. The competitive arena with which this research is concerned relates to the competition progressively being introduced in supply business activities. Competition within the generation market exists but this is an area which will only be touched upon in the conclusions of this research. Indeed, the implications for the area to be investigated reach into the competitive generation arena.

117 In the supply business, although the RECs are the major operators other companies may legitimately compete with the RECs. Currently this is subject to transitional restrictions to supply to the larger users of electricity (whose maximum demand exceeds 100 kilowatts). Full competition is to be introduced in 1998 across all consumers of electricity following the partial relaxation of restrictions in 1994. Each RECs' competitors in the supply market comprise other RECs, the generating

companies and other suppliers all of whom are entitled to give such supplies using the National Grid and the local distribution systems. For the purpose of the Electricity Act, customers are classified according to their demand for electricity at a particular premise. Domestic, industrial or commercial classifications are irrelevant in this context. The reason for this classification according to demand not customer type is to enable the definition of the restrictions applicable to competitive suppliers.

118 Each REC is allowed the sole right to supply all customers in its authorised area within the applicable franchise limit up to March 1998. Customers above the franchise limit can contract to purchase electricity direct from National Power, PowerGen, all other RECs and other operators as well as their local REC. Consequently, until full competition is introduced into the supply market there exists two distinct sectors - the "franchise" market and the "non franchise" market. Initially, the non franchise market was defined as those customers whose maximum demand exceed 1 megawatt (MW) of electricity and this consisted of around 5,000 customers in the UK. Competition within this market was evident with about one third of customers (accounting for almost half of the non franchise electricity supply) receiving electricity from suppliers other than their local regional electricity company in 1993. From April 1994 around 50,000 customers became eligible to chose the source of their supplier. This now accounts for about half the total electricity supplied in the UK.

Supply contracts

119 In the competitive supply market, competition exists not only price terms but on the quality of service offered by supplying company. Customers who are eligible are often keen to negotiate a competitive price for their electricity purchased and are also interested in the after sales service and overall "package" provided by their supplier. Particularly interested customers, where energy costs are a major part of overall costs,

require information relating to developments in the electricity market and the general pricing arena.

120 There have been considerable developments in electricity pricing in the privatised electricity markets from the simple "block" tariffs offered to customers before the opening of the market. Prices offered to customers may vary from half hour to half hour under "pool" related contracts. They may vary according to different time periods during the day, between days of the week and times of the year.

121 The potential exists for certain customers to manage their electricity consumption in order to reduce the overall cost of their electricity purchased. Price signals are provided to customers who purchase their requirements from the pool and are not restricted to fixed price tariffs in the form of published day ahead provisional prices. On the basis of these provisional prices, customers may schedule their operations to avoid expensive periods. In 1993 in England and Wales around 1,500 customers took their supply on terms directly related to pool prices rather than on fixed price contracts. The RECs have actively facilitated pool related contracts as well as offering contract arrangements for smoothing out the variations in pool prices.

122 The types of contracts offered effectively enable electricity customers to control their energy costs. Customers may have the option of reducing their demand for electricity when prices are high. This in turn suggests that customer demand responsiveness to price could theoretically be estimated (a feature dealt with in section 6 of this thesis). The complexity of contracts offered to customers enable increasingly sophisticated mechanisms for managing electricity consumption and the control of energy costs. Under particular contract arrangements customers who can feasibly manage their electricity consumption are offered additional savings by certain suppliers. Indeed the range of contracts offered are often designed to suit the particular needs of individual

customers in accordance with the varying profiles of their electricity consumption. The competition within the supply market that now exists ensures that suppliers have to be responsive to the needs and differing circumstances of individual customers. Sophisticated consumers of electricity can demand particular contract arrangements which enable them to manage load and ultimately ensure greater control over their energy costs. If one supplier is not willing to accommodate these arrangements, other suppliers may offer more suitable contracts in the competitive supply market.

Value added services

123 Competition in the supply market does not exist on price terms alone. The importance of "value added" services to suppliers in a tightly regulated electricity supply market cannot be underestimated. Prices can only be discounted to a point and only for particular types of customer. If a customer is faced with a series of contract offers that are similar in price terms alone it is the overall "package" that may be important in determining the choice of supply company.

124 The RECs have recognised this factor and numerous companies have offered "data services" packages to their customers with the intention of informing and advising customers on the complexities and any developments within the electricity supply market.

125 This thesis is concerned with an added value service offered by numerous RECs since the liberalisation of the supply market. The service has aimed to facilitate electricity cost reductions for customers through the management of electricity consumption at certain times of the day and year. Specifically, this service aims to exploit the method by which the National Grid Company recoups its peak demand transmission charges - this is explained in detail in section 3.

Triads

126 Since NGC is responsible for providing and maintaining the transmission system through which the electricity passes from generator to supplier, it needs to ensure that the system has the capacity to cope with peak periods of demand for electricity. The provision of such a system necessarily incurs costs to NGC and consequently NGC charges users of the system a cost which reflects the cost of providing system capacity. These charges, which are automatically incurred by suppliers, are passed through to particular customers in accordance with their contract arrangements.

127 Suppliers of electricity and certain non-franchise customers pay charges to reflect the cost of this provision on the basis of their average demand for electricity at three retrospectively determined half hours when national demand is at a peak. These three peak half hours occur (by definition) between the months of November and February every financial year running from April to March. The half hour periods are consistent with the settlements system that facilitates trading within the pooled market for electricity whereby demand for electricity is a measurable factor by half hour period.

128 The three peak half hour periods are defined as the "Triads" and are identified on the basis of national demand for electricity by NGC. The triads are defined by NGC as;

"*the half hour of system peak and the two other half hours of highest demand which are separated from the system peak and each other by at least ten days.*"[1]

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[1] National Grid Company Plc "Transmission License Condition 10 Statement of Charges for Use of System and Connection to the System" (1993)

These periods are determined retrospectively at the end of a financial year when final electricity demand data has been established.

129 RECs and certain non franchise customers are charged on the basis of their average demand for electricity at the time when the triads occur. This charge varies according to geographical location but can be in the order of £10 per kW of electricity. Compared to a price of around 8 pence per kW for a domestic consumer this is a considerable sum.

130 The reduction or even avoidance of this charge offers potentially huge savings to large energy users. Triads by definition represent peak periods of demand for electricity. It should be possible therefore to analyse the circumstances which coincide with these peaks and attempt to identify when these peak demand periods will occur in advance of their occurrence. Since privatisation, some of the RECs attempted to "forecast" the triad periods in advance of their occurrence. Having established mechanisms for forecasting triads, RECs have offered services to interested non franchise customers in order to help them avoid this component of the transmission charge. Forecasting services continue to be offered to customers to assist them with effective load management and lower electricity costs. The forecasting service with which this thesis is concerned involved providing warnings to customers identifying when a triad was likely to occur. Customers responded to these warnings by reducing their electricity demand in an attempt to avoid this component of the energy charge.

131 Since 1991 numerous "triad forecasting" services have been offered by supply companies. All RECs have differed in their approach to the problem and indeed varying degrees of effort has been made by customers to reduce their demand for electricity in response to triad warnings. The effort is probably related to a number of factors, notably;

- to a firms ability to reduce its demand on call;

- to the cost to individual businesses of reducing demand against the benefit accrued from avoiding the charge; and
- according to the priorities attached to cost avoidance.

Issues to be investigated

132 A number of issues will be covered within this thesis;

- Triad demands;
- forecasting peak demand periods;
- measuring responsiveness to warnings; and
- analysing the types of customers who can and do respond to overt price signals.

The nature of the problem however enables further analysis thus enabling one to investigate the potential for strategic gaming. This gaming potential derives from the interdependence of supply companies who offer triad forecasting services as an added value service to their large customers.

133 The subject to be investigated within this thesis can be defined simply. The RECs and electricity supply companies are offering a service to large customers. The objective of the services is to provide cost saving opportunities to their customers. Subsequent objectives may involve providing a more effective and accurate service than the supply company's competitive rivals in order to gain an element of competitive advantage. The primary requirement of a successful service is to identify in advance of their occurrence peak demand periods which will satisfy the definition of triads in order that participating customers will not incur the large charges associated with NGC's cost recuperation policy. On identification of the potential triads, suppliers should provide sufficient warning to customers to enable them to respond to reduce demand at the times suggested. The objective of customers is simple and common - to reduce energy costs by managing the consumption of electricity. This management

may involve simple reductions in consumption by halting the operational process or it may require the rescheduling of operational plant to avoid the triad periods.

134 A consequence of forecasting peak demand periods and expecting customers to reduce their load upon warnings is that the whole concept could prove self defeating. Peak demand periods are often associated with cold weather conditions (this will be explained in detail in sections 3 and 4). However, the demand for electricity by non franchise customers at the times of these peaks contribute to the overall high level of demand. If a peak is forecast, warnings are provided to customers who may wish to reduce their demand in order to reduce costs. If sufficient demand is reduced by a large group of customers across the country the predicted peak demand period may not actually occur. The peak may shift to a different time of the day or indeed to a different day which was not initially identified as a potential triad. The interdependent action of competing firms and the participation of their customers could influence the anticipated outcome of the strategy to the detriment of the initial action. The initial action is the attempt to forecast a peak demand period - in the light of the circumstances, the peak may not occur and the forecast is wrong.

135 With only one supply company offering this type of service and with only few customers responding to warnings, ceteris paribus, the subsequent actions have a minimal adverse influence on the desired objective with forecast peak periods emerging as actual peak periods. In an increasingly competitive market situation there are many RECs and suppliers striving to achieve the same goal. Given that this goal involves the subsequent actions of an increasingly interested and participating customer base, the overall effect is to severely distort the outcome of a carefully calculated situation.

136 Indeed shortly after privatisation only a few suppliers and a relatively small number of customers participated in such services around the country. The success of these evolutionary services for both suppliers and customers alike led to a proliferation in both the number of suppliers offering the service and the number of customers able and wishing to reduce their triad costs. The very act of monitoring a target variable effects the movements and predictability of the variable.

137 The nature of the objective enables a role for the Economist within the electricity supply industry. The possibilities for using statistical methods for providing an effective service are obvious and the potential for modelling the gaming is evident. A number of issues will be explored in conjunction with the aim of providing an accurate and effective triad warning service. The consequences of such services for customer demand patterns, gaming strategies, pricing policy and NGC cost recuperation policy will be also be investigated.

138 The academic literature search to support this thesis is based around the fields of classical game theory and statistical decision theory. Within the investigation of game theory, Nash equilibria will be examined alongside zero sum game situations. Indeed, the findings are such that the classic approaches provide little relevance to this particular issue. The problem is one of optimisation and the gaming potential derives from the interaction of competing firms and participating customers influencing pre determined calculations and predictions. Principal-Agent models with the adoption of maxi-min strategies provide little assistance to this problem and the solutions do not resemble true zero sum games. Through the use of statistical decision theory literature, the aim is to provide a statistical framework assisting the making of optimal decisions in the face of uncertainty and interaction. Substantial statistical data is utilised when forecasting triads and the components of this data could be mathematically and probabilistically modelled and combined with a suitable optimality principal to determine the best decision.

139 An analysis of the UK electricity system is essential to place in context the very specific microeconomic issue of triads. The role of the NGC will be examined alongside its operating structure and cost recuperation policy. The development of triads as a method for recouping system requirement costs from the previous bulk supply tariff system employed under the nationalised electricity supply industry will be examined. An analysis of the pool system is required to place in context the variations in demand and supply experienced over time, the types of contract offered to customers and the basis for half hourly demand measurement from which the concept of triads arises.

140 Demand forecasting plays a role within the pool market for electricity. Demand forecasting is also an issue with which the supply companies are concerned for the purpose of forecasting electricity purchase costs and pool prices. The methodology for forecasting electricity demand over different time horizons has been the subject of debate and academic analysis for some time within the electricity supply industry. The mechanics of demand forecasting is not an issue that will be explored in full depth however the method by which NGC forecast demand will be examined. These forecasts of demand are an important component of any triad forecasting service.

141 Following the analysis of the relevant components of the UK electricity system, the concept of triads as an entity will be explored. Triad periods can easily be identified over the years in accordance with the rules employed by NGC. From the identification stage, key properties of triad demand periods can be identified. Such peaks naturally occur during the winter months and are particularly associated with cold weather conditions. The weather sensitivity of electricity demand is an issue which is dealt with in section 3. Substantial weather data is available for analysis at both the sub-regional and national level. The concept of "effective temperatures" is of importance. A succession of cold days or extreme temperature

conditions has a cumulative influence upon electricity demand and effects the incidence of demand peaks.

142 A full analysis of the empirical information relating to peaks in demand and any weather relationships is essential prior to any attempt at designing a system capable of forecasting such peaks. This will be followed by an assessment of the type of contracts that have been offered to large users of electricity. The type of contracts are often related to the mechanisms of the pool or are designed specifically to meet the needs of customers for whom load management is a desirable and practical option. Indeed the forecasting services, combined with the variety of contract frames on offer to customers form part of a larger electricity package available to customers.

143 Once the need for a Triad forecasting service has been established, the methodology adopted by the author can be examined. This methodology has derived from the analysis of the key properties of triads, an understanding of econometric and time series demand forecasting techniques and the weather relationships determined. The forecasting solution has not remained static - it has been influenced by corporate policy and is likely to develop with the changing market place and through the awareness of the potential and actual gaming taking place. A number of criteria can be established as the basis for a triad forecasting procedure. Indeed, the forecasting procedure that was developed has now been in operation for three years and the success of this system can be evaluated on the basis of two of the three years of empirical data.

144 Following this evaluation, the potential for a formal gaming strategy to be incorporated into such forecasting systems will be evaluated. The influence of the interdependencies between supply companies and responding customers has potentially become a measurable factor which may need to be included within the parameters of a triad forecasting system. At this stage the potential "game" situation can be defined in terms

of players and participating agents (suppliers and customers). A statistical framework for modelling any action-reaction identity could be incorporated into new strategies in the future.

145 Extensive customer demand and demand/price responsiveness analysis has been undertaken within the context of this thesis. Section 6 presents an original analysis of substantial data from non franchise electricity customers from a wide spectrum of industry classifications. A thorough and extensive process of analysis has been applied to two years half hourly demand data for 30 major customers. This data has been profiled, statistically and graphically represented in order to examine the response of customers to the triad warning service. Demand-price elasticities can be established for various types and category of customer. Particular customers have been found to have reduced load as a direct response to warnings and physically halt or slow down production processes. Other types of customer reschedule plant and shift load in response to these signals. A full analysis of customer responses has been carried out according to different category of industry in order to evaluate cost savings, calculate demand elasticities and to assess the consequences of these responses for the forecasting system itself. The results of this analysis provides an insight into the respective cost benefit decisions taken by customers in their own assessment of the importance of electricity costs as a proportion of total controllable costs. This has certain implications for the supplier whose aim is to design contracts tailored to meet the needs of these customers. Groups of customers could be targeted for load management or triad related contracts. For other customers whose response is negligible, more different contract frames may prove more appropriate.

146 The conclusions of this research may serve to question the effectiveness of NGC's policy for redeeming the costs of providing and maintaining the transmission system required to cope with peaks in demand. Industry papers have been circulated by NGC with the aim of

evaluating the effectiveness of the triad system. In order to avoid the manipulation of the system in the way this thesis describes, alternatives to triads have been proposed.

147 On a broader scale the implications of load management potential has consequences for the development of the pool. The pool until recently was totally supply side driven. In recent months, demand side bidding has been introduced albeit on a limited scale. This has enabled customers and suppliers to bid into the pool any demand reductions possible with the aim of reducing pool prices at peak periods. Triad responsiveness suggests some customers can and will load manage if the incentive is provided. The implications for the development of full scale demand side bidding are apparent.

148 The conclusions of this research should serve to emphasise the sophistication of the market place in which electricity is traded. Competition within the market has enabled innovation in business opportunities and may serve to increase allocative and economic efficiency. However, should the service with which this thesis is concerned be regarded as a tangible benefit of privatisation or is it simply an exploitation of a short term charging anomaly on the part of the supply companies?

149 It can be argued that increased competition in the electricity supply market has led to greater efficiency of operation than under the old nationalised industry. Economists have four measures of the efficiency benefits of competition:

- where price is closer to marginal cost (allocative efficiency);
- where there are lower overall costs across the board (productive efficiency);
- where there is a re-alignment in both the number and size of firms (scale efficiencies); and

- where there is a wider range of products, customer choice and innovation (dynamic/innovation efficiency)

150 The triad warning service that was commercially available as a service offered by Norweb and which is the primary subject of this thesis, is a prime example of the latter measure of efficiency gain - ie an example of an innovative efficiency gain through an additional service offered to customers. This efficiency gain has been enabled as a result of the removals of barriers to entry from the electricity supply industry and from the perspective of an economist, is a true efficiency gain.

151 From the business perspective and in a tightly regulated market, the receipt of additional income for innovative services enhances the unregulated income of supply companies. In the competitive market this allows increased competitive advantage and contributes directly to bottom line profit of any electricity supply businesses.

2 LITERATURE SEARCH

Overview

201 The academic literature with which this thesis is concerned covers a number of strands, the subjects of which are broad and independent of one another. This literature search will concentrate on the relevance and application of both statistical decision theory and classical game theory for the most part. The situation defined in this thesis whilst being described as a strategic gaming situation, is difficult to model in terms of formal game theory techniques. Nevertheless, the formulae required for statistically supported decision making could provide a useful benchmark with which to model inherent interdependencies. Thus the format of this section will be sub-divided according to the following areas;

- statistical decision theory;
- game theory ideas and concepts;
- electricity demand modelling and forecasting; and
- the application of game theory to the electricity supply industry.

202 The aim of this literature search has been to focus attention on research areas which may provide a formal framework for the academic analysis of what initially was a business requirement. The initial solutions were developed from a business perspective with an emphasis upon mathematical and statistical forecasting techniques. It is from observing the situation in practise and having gathered empirical data and evidence that the broader academic modelling techniques become relevant.

Statistical decision theory

203 Decision theory is the science of making optimal decisions in the face of uncertainty. If some of these uncertainties can be explained or related to statistical data which is available, then decisions can be made in the face of any uncertainty but by taking into account available information. Decision theory aims to break down a problem into a number of components which can then be formally modelled and combined with an appropriate optimality principle to aid the best decision

204 Berger[2] suggests the most useful breakdown of a decision problem is thus;

- into actions;
- a utility function;
- prior information; and
- data.

205 Keeny and Raiffa[3] devised a "paradigm of decision analysis" as a framework for undertaking formal statistical decision analysis. This paradigm comprises five basic steps;

- **Preanalysis** for a decision maker who is undecided about a course of action once a problem has been identified and about the alternative courses of action;
- **Structural analysis** where the decision maker structures the qualitative anatomy of his problem. This may involve an appraisal of the possible choices, assessing what data and information can be gathered to help in the decision process,

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[2] J Berger "Statistical Decision Theory and Bayesian Analysis" (Springer-Verlag 1985)

[3] R.L. Keeney and H Raiffa "Decisions with Multiple Objectives: Preferences and Value Tradeoffs" (Wiley 1976)

what experiments may be performed and what is likely to happen if the decision maker does nothing. Consequently "decision nodes" and "chance nodes" represent potential paths which are and are not under the decision makers control;

- **Uncertainty analysis** where the decision maker assigns probabilities to the branches of the decision tree emanating from the chance nodes based upon empirical data and assumptions made;
- **Utility or value analysis** where the decision maker assigns utility values to consequences associated with paths through the decision tree. This process requires the maximization of expected utility which becomes the appropriate criterion for the decision maker's optimal action; and
- **Optimization analysis** where following the above steps, the decision maker calculates his optimal strategy ie the strategy which maximizes his expected utility. This strategy indicates the required action at the start of the tree and at every decision node arrived at. Of the techniques to arrive at this strategy, the dynamic programming algorithm of "averaging out and folding back" can be assumed to be most appropriate.

206 The two approaches can be seen to be broadly analogous. Berger explains that in breaking down a decision problem, the primary concept is that of one party undertaking an action 'a'. 'A' represents the set of all possible actions. The unknown quantity θ is involved in any decision undertaken. One must then attempt to quantify the gain or loss resulting in taking any possible actions. This gain or loss depends upon both the actions undertaken (α) and the unknown quantity θ. Berger thus represents the outcome in terms of a utility function of both variable. Thus;

$U(\theta,\alpha)$

Where U represents the gain or loss upon action α and θ obtains. This can also be represented as a loss function (as opposed to a gain) thus;

$$L(\theta,\alpha)$$

and since loss is negative gain;

$$L(\theta,\alpha) = -U(\theta,\alpha)$$

meaning whatever maximizes utility will minimize loss.

207 Keeney and Raiffa stress the necessity of introducing utility functions into the decision making process. By systematically probing the decision makers "value structure" and deriving a utility function, decision makers need not make decide the course of action based upon ad hoc and heuristic simplifications in the face of complex data and probabilistic distributions. The utility function ensures that all available information is available for processing rather than introducing pragmatic simplifications. Berger suggests that the utility function can be defined in any scale terms - not just monetary gain or loss. This is an important concept when attempting to measure the gain or loss associated with predicting the occurrence of a triad. For a customer, the occurrence of a triad and the prior notification of it would be measured in purely monetary terms. These terms would be associated with the cost of loss of production and the benefit of avoiding the triad charge. For the supplier of electricity, the associated loss or gain is less readily quantifiable with a "good will" factor or reputation at stake associated with the accuracy of information provided to customers. This consideration cannot easily be expressed in monetary terms but is an important feature in the formation of a primary utility function.

208 The other important component of the decision problem is the information available about the uncertainty element θ This information will be

be greater or lesser for different problems and could derive from a number of sources. Berger simplifies this situation and considers a standard statistical scenario where θ is explained by;

- data X (from a statistical experiment relating to θ); and
- prior information about θ, denoted by $\Pi(\theta)$.

One or both of these components could be absent for any given problem.

209 X can be modelled as arising from some probability density $\rho 0(X)$, meaning the probability of a particular data value when θ obtains. The prior information about θ can also be described by a probability density $\Pi(\theta)$. This density represents the probability given to each possible value of θ in the light of which values of θ are believed to be most likely.

Bayesian Decision Theory

210 The Bayes Principle can be regarded as the most important principle for reaching a decision. When θ is known, the optimal action is achieved by maximizing $U(\theta,\alpha)$ over α. When θ is unknown, the natural generalisation is to average $U(\theta,\alpha)$ over θ and then maximize over α. Berger suggests that to average over θ, the overall probability density of θ has to be determined $\Pi^*(\theta)$, and considering the Bayesian expected utility;

$$U^*(\alpha) = E\,\Pi^*[\,U,\,(\theta,\alpha)] = \int U\,(\theta,\alpha)\,\Pi^*\,(\theta)\,\delta\theta$$

where the final expression assumes θ is a continuous variable taking values in an interval of numbers.

211 The optimal Bayes action (α^*) will be yielded by maximizing $U^*(\alpha)$ over α. If θ is explained by both prior information ($\Pi(\theta)$) and data X, these two sources of information have to be combined within the overall

probability density Π^* for θ. Bayes' Theorem gives the overall density (the posterior density) enabling this procedure;

$$\Pi^* (\theta) = \rho\theta (X)\, \pi (\theta) / \mu (X)$$

where

$$\mu (X) = \int \rho\theta (X)\, \pi (\theta)\, \delta\, \theta$$

where $\rho\theta(X)$ is the probability density for the experiment with the observed values of data X inserted.

Frequentist Decision Theory

212 This approach to decision theory enables the decision maker to take a 'long run' perspective as to the outcome of the actions undertaken. Neyman, Pearson and Wald developed the frequentist approach based upon the principle of developing a decision strategy through repeating a decision problem a large number of times.

213 Any decision strategy ($\delta(X)$) reflects the repetition of the decision problem which may yield different data X thus requiring one to specify the numerous actions which will be undertaken for any possible X. Consequently the utility function has to be revised to account for the array of possible actions which may form part of the decision strategy;

$$U [\theta, \delta (X)]$$

in terms of the loss function (ie. the inverse of the utility function);

$$L (\theta,\delta) = - U (\theta,\delta)$$

214 Berger explains the first step in the frequentists approach is to calculate the risk function which describes the expected loss over X of δ;

$$R(\theta,\delta) = E\theta\{L[\theta,\delta(X)]\} = \int L[\theta,\delta(X)]\,\rho\theta(X)\,\delta X$$

Thus for a fixed θ, the risk function indicates how well δ(X) would perform if utilizes repeatedly for data arising from the probability density ρθ(X). The next step is to select criterion for defining optimal risk functions of which the Minimax Principle is one of the most common, based on the consideration of the maximum possible risk;

$$R^*(\delta) = \max\theta\, R(\theta,\delta)$$

215 This represents what Berger describes as the 'cautious' approach to decision making since R*(δ) indicates the worst possible performance of δ(X)over the course of a decision strategy. Thus the optimal decision would seek to minimize R*(δ) ie. the minimax decision rule which is analogous to the minimax criterion of classical game theory. Frequentist decision theory could alternately involve the Invariance Principle which enables the best decision rule to be arrived at through the class of rules which are invariant under certain mathematical transformations of the decision problem.

A comparison of the two approaches

216 Berger concludes that the Beyesian approach to decision making is the best for solving a real decision problem. It's advantages over the frequentist approach are;

- it's relative simplicity in terms of modelling; and
- it's incorporation of all available information (X and Π(θ)) where prior information is available.

217 Under the frequentist approach it is necessary to consider the best actions for each possible X which complicates the procedure. The Bayesian approach considers only the actions necessary for the actual data X observed. Thus Berger concludes that "maximizing $U^*(\alpha)$ over all actions is generally much easier than minimizing something like $R^*(\delta)$ over all decision rules". Thus the Bayesian approach has two distinct advantages over the frequentist approach;

- optimal performance for each X alone guarantees good performance in repeated use (ie. through the formation of a decision strategy) thus negating the need to consider in isolation the frequentist approach; and
- even when prior information is not available or cannot be formally modelled, the Bayesian approach is still of relevance through the application of 'non informative' prior densities.

218 The frequentist approach may be theoretically appealing, but it is a Bayesian solution that is of relevance to this research given the need to simplify the solution in the light if substantial data and limited prior information. It is only through refining the decision problem inherent through the accumulation of experience and application that the Bayesian solution can be remodelled to account for $\Pi(\theta)$.

Game theory ideas and concepts

219 Like the body of literature which encompasses statistical decision theory, game theory is concerned with the overall logic of decision making. Specifically, Colman[4] suggests;

[4] A Colman "Game Theory and Experimental Games: The Study of Strategic Interaction" (Pergamon Press 1982)

"game theory is concerned with the logic of decision making in social situations in which the outcomes depend upon the decisions of two or more autonomous agents. An essential feature of such situations is that each decision maker has only partial control over the outcomes."

220 Given the requirement for more than one autonomous agent, and given that each agent has only partial control over the outcome of a course of action, a degree of interdependence in the decision making process is inherent. A formal game theory model can only be constructed if the options available to each decision maker and their possible consequences are well defined, and each decision maker has consistent preferences among the potential outcomes. This has certain implications for the formal modelling of the situation defined within this research given the many uncertainties which are present in a forecasting problem. Thus game theory attempts to abstract the logical properties from a situation in an attempt to find a solution to the particular "game". Colman describes the solution as a specification of the decisions that have to be made and the outcome which will be reached if the decision makers act in a rational manner. It is envisaged that a formal game theory solution is not attainable within the scope of this research but by using informal methods to analyse the game situation, the study should provide a useful insight into interdependent decisions.

221 Within the confines of formal game theory, the autonomous decision makers are called "players". The decisions made are sometimes referred to as "moves" the outcome of which are not definite given the incidence of chance. In game theory "Nature" represents the unexplained and irrational element of the game situation which is beyond the control of the players. A game has to involve at least two players to ensure a degree of interdependence. Each player must also have at least two options from which to choose and the game requires the outcomes of these options to be a known quantity. The players are assumed to be rational and can rank the order of preferences so that "payoffs" indicating the relative

preferences can be assigned to the outcomes. From this a "payoff function" is defined for each player indicating the individual preferences can be compared to one another. The "strategy" is the set of actions which specifies the moves one player is likely to make. A players "pure strategy" is a players complete plan of action which specifies in advance what moves a player will make in all possible situations. The players state of knowledge in any game is defined in terms of "complete information" where players know their own possible moves or pure strategies and payoff functions as well as those of other players. If the preference scales of the other players are not known then this defines a game where "perfect information" defines the state of knowledge.

222 Certain classes of games have been defined within the game theory literature. Games of skill and chance are generally one person games and games of strategy involve two or more players. Games of skill involves "individual decision making under certainty". Games of chance involve "individual decision making under risk or certainty". Games of strategy are concerned with "situations in which the outcomes depend upon the choices of two or more decision makers, each of whom has partial control over the outcomes". Decisions are made under uncertainty not risk since it is not possible to assign probabilities to the moves of other players in the game. This research is particularly concerned with games of strategy.

223 Game theory further divides games of strategy according to the structural properties of the games. The relation of players payoff functions where players interests may be common are described as "coordination games". Competitive games where the interests of players are in opposition are known as "zero-sum games" and are characterised by winners and losers in a game situation. For losers, the payoffs sum to zero. "Mixed motive games" describe games where the interests of players are neither totally opposite or strictly coincident.

224 A number of strategies emerge from the simplest one person games. The "maximin" strategy developed by Wald[5] from the theory of von Neuman and Morgenstern[6] advises the player to first determine the worst payoff that can result from each possible decision within the payoff matrix.Then the player must pursue the strategy that offers the best of the worst possible outcome. Hence, the player maximizes the minimum possible payoff. The approach offers a method of maximizing security and minimizing risk rather than attempting to maximize possible utility.

225 In a strictly competitive game situation with two players may involve a zero sum situation where the payoffs to players in any outcome add up to zero ie. the gain of one player is necessarily the loss of another. This means there are no benefits to be gained from mutual collaboration as the interests of players are necessarily in opposition. Within such games, "dominant strategies" define one of a player's pure strategies if it yields an outcome at least as good as the outcome of any of the pure strategies his opponent may choose.

226 Colman describes games in which the players' preferences among outcomes are neither identical (as in pure coordination games) nor totally opposed (as in zero sum situations) as mixed motive games. Thus the sum of the payoffs differs by each outcome and are widely non as "variable sum" or "non zero sum games". Such games can prove mathematically inconclusive and do not necessarily yield logical conclusions. These games can produce the "Prisoner Dilemma" which presents a paradox between individual and collective rationality.

227 Multi person games add an additional degree of complexity to the modelling of formal game situations. Games involving three or more

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[5] A Wald "Statistical decision functions which minimise maximum risk" (Annals of Mathematics, 46 1945)

[6] J von Neumann and O Morgenstern "Theory of Games and Economic Behaviour" (Princeton University Press 1953)

players ensure that the possibility of coalitions between certain players may have to be accounted for. If the decision makers' interests coincide, then multi person interdependent decisions are pure coordination games. Thus any coalition to be worth while would have to involve all players of the game and would not benefit individual factions. In mixed motive games however interests will differ amongst some of players but may be alike for others, increasing the chance of coalition within the game situation. In a non cooperative game, each player decides their strategy independently without coalition. Coalitions may occur in a cooperative game situation.

228 When situations arise in which a number of decision makers have to choose in isolation from a number of alternative possible strategies, the solution to these non cooperative games are based upon equilibrium points. Equilibrium points represent an outcome that the player will not regret when the strategies of the other players are revealed. Such "Nash equilibria" describe the equilibrium strategy from which no player will wish to deviate given that the other players do not deviate. It is a combination of best responses given the other players' strategy choice. A Pareto efficient equilibrium is the combination of strategies from which no deviation can make one player better off without making another worse off. In a Dominant Strategy equilibrium situation the situation consists of each players' strictly best response to any strategy choice of the other players.

229 This section has attempted to draw together some of the essential concepts from the literature which form the essence of formal game theory analysis. The concepts have not been illustrated through the standard text examples given the constraints of this research. However, some of the concepts will be applied to the issue of triad forecasting in an informal sense, given the uncertainties associated with forecasting ensure that outcomes remain unknown. Nevertheless, this work provides a further dimension into the game theory arena by introducing the role of what will be described as "Participating Agents" who are integral part of the game

situation ie. they are secondary players. The actions of these Participating Agents also, to some extent, influence the strategies enacted by the Players in addition to knowledge relating to the other Players' strategies. Thus a further dimension of complexity is added to the multi person game situation defined.

Electricity demand modelling and forecasting

230 The subject of electricity demand forecasting has stimulated considerable debate and research both within the industry and within academic institutions. The debate centres on the relative merits of the various methodologies used for forecasting electricity demand, which ones perform "best" over different time horizons and which methods are realistically capable of being modelled and put into practise. The area of demand forecasting is particularly important to the industry given the need for reliable estimates of demand to aid numerous operations, notably;

- the planning of production requirements and the scheduling of plant requiring both long term and short term forecasts of demand;
- planning capacity requirements for the transmission of varying quantities of electricity;
- forecasts of demand are required for the operation of the pool trading arrangements and hence are an integral component of the price setting mechanisms;
- RECs thus require forecasts of demand to assist them with the modelling of possible pool prices under various scenarios to assist them with the commercial decisions with respect to contract arrangements with the generators;
- RECs also need to forecast their likely electricity requirements from the generators and other sources to assist them with their costing and price setting functions.

231 A brief resume of some of the energy demand forecasting literature is required within this section given that the problem defined within this thesis is initially a demand forecasting problem. It is once the forecasting solution has been established and put into practise that the strategic gaming element enters into the equation. The context of the methods described and the approaches investigated draws primarily upon the authors practical experience of electricity demand forecasting as well as the methods applied for forecasting demand within the pool trading arrangements as performed by NGC.

232 Lang[7]suggests that traditional business forecasting models cannot be applied directly to energy forecasting because demand for a energy is not ruled by price alone. Generally, energy demand is related to a number of different factors including environmental factors, the weather (primarily temperature) and other factors such as location and type of demand rather than price. The complexity of solutions to most energy forecasting problems is great given the data inputs to solutions and the difficulty in modelling and predicting the independent variables. Lang, however argues that the complexity of solutions to these problems do not necessarily provide the best results. He argues that relatively simply regression models can provide good forecasts and illustrates his case through a simple one stage regression model of gas demand.

233 Generally both econometric (regression) analysis and time series analysis are used in forecasting electricity demand. Lang argues that time series models are recursive models and are more applicable for forecasting cyclical variations which are more often time dependent. Thus, the time series approach is of particular use when the forecast horizon is of a short term nature (such as within day forecasting and day ahead forecasting). For longer term forecasting requirements, other external factors may influence the trend in electricity demand (such as the growth of the nations

[7] P Lang "Energy Forecasting Made Simple", (OR Insight, Operational Research Society Autumn 1988)

economy and hence its requirements for power). In such cases, econometric solutions (which provide a causal or explanatory method for describing the relationship between dependent and independent variables) may prove more appropriate.

234 Official models of energy demand exist, for example the Department of Trade and Industry[8] estimate various sectoral long term energy requirements and output elasticities with particular reference to the domestic sector across all energy types. Econometric models of energy demand and supply were originally introduced by the Department of Energy for energy planning purposes. This role diminished as the sector became progressively privatised during the 1980s but interest in the Department's role was rekindled as the need to forecast levels of pollutants became apparent. Whereas the official model does not measure demand for electricity exclusively (with an overall sectoral approach being preferred), it demonstrates the advantages of using a set of econometric equations in forecasting long term energy demand.

235 Within the trading mechanisms of the privatised electricity market, demand forecasts are an integral component of scheduling plant and setting prices. The Grid Operator of NGC is required to prepare a forecast of consumer demand (known as Nominal Demand) for the next Availability Declaration Period within the rules of the Settlement Agreement. Baker[9] describes the methodology currently employed in the preparation of Nominal Demand forecasts and the performance of the methods used in forecasting demand by this definition. By definition, "the Nominal Demand forecast is a forecast of demand which will be taken by consumers in England and Wales (other than large customers and NGC pumped storage) taking no account of price response and ignoring demand

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[8] D Hodgson and K Miller "Modelling UK Energy Demand" (Department of Trade and Industry 1992)

[9] A B Baker "The Methodology and Process of Forecasting Nominal Demand" (NGC Oct 1992)

met by non centrally despatched generation". The items of demand excluded from this equation (including the demand of external pool members) is forecast by a Demand Adjustment Model. The specifics of this approach is detailed in the following paragraphs.

236 The technique employed in producing these daily forecasts is Multiple Regression analysis which is applied to the historic data available to estimate regression models of demand at key turning points (cardinal points) of the daily demand profiles. These cardinal points are generally located at the turning points of the demand profiles (examples of which are illustrated in section 4). Turning points occur according to the "working day", with demand for electricity increasing at different points during the day. Peaks and hence turning points tend to occur at the "tea time" period for example (between approximately 5:00 pm and 6:00 pm) when increased domestic demand (for cooking etc) occurs at the same time as industry demand. Demand magnitudes at the cardinal points within the specified period (the Availability Declaration Period) are forecast using the specified regression models making use of weather forecasts and other predicted components. An interpolation procedure is used to convert these discrete forecasts at the cardinal points into a continuous half hourly time series of forecasts throughout the forecast period.

237 The models developed are based upon a number of available data items;

(a) **demand data** (from NGC demand data sources both based upon metered demand and station transformer demand);

(b) **weather data** supplied from the Meteorological Office. Six weather stations have been identified by NGC to represent the impact of weather on NGC demand. Hourly observations of various weather elements at these stations are provided to assist in the forecasting process. The component weather elements include temperature, wind speed and direction,

precipitation type and amounts and details of cloud cover. Weather variables are derived from this data for the modelling of demand-weather relationships. The derived weather variables are Effective Temperature, Effective Illumination and Cooling Power of the wind.

(i) Effective temperature (TE) is an exponentially smoothed function of the temperature time series which takes account of the lag response of demand to temperature which relates to the insulation capacity of buildings;

(ii) Effective illumination (EI) is derived from measures of maximum illumination and illumination deficit (the component of natural illumination which does not reach the earth's surface due to cloud cover);

(iii) Cooling power (CP) of the wind is a function of wind speed and temperature and models changes in heating demand associated with air changes in buildings.

238 Further complications have to be taken into account when modelling electricity demand by this method. Weather sensitivity of demand differs by season as do daily demand profiles and the location of cardinal points. The Spring and Autumn clock changes also disrupt the continuity of demand through the year. Baker describes the NGC model as being split into two parts, the GMT and BST components.In order to model the differences in daily profiles, a years data is used to construct models to represent weekdays, Saturdays and Sundays as separate categories during the daytime periods with night time period models covering a complete week. "Special Days" have to be separately modelled to account for the varying demand profiles associated with Public and Bank holidays and their adjacent days (which are not typical in shape or character). Other days which are subject to extraordinary circumstances such as major industrial disputes, severe weather conditions and Royal

Weddings have to be modelled separately so as not to impede model estimation efficiency.

239 The overall specification of for each regression model constructed is of the form;

Total Demand = Weather Sensitive Demand
+ Non Weather Sensitive Demand
+ Day of Week dependent Demand
+ Error term

Price is not taken into account when forecasting nominal demand as this is prohibited according to the Pool Rules.

- Weather sensitive demand is described as having an additive sub structure being composed of terms relating to the three derived weather variables and is typically of the form;

$\alpha_1 TE + \alpha_2 TE2 + \alpha_3 TE3 + \beta EI + \gamma CP$

- Non Weather Sensitive Demand represents the seasonal and trend structures of the demand which are not influenced by short term weather variations. A polynomial sub structure is used to represent this term and is based upon a day number count (n) that increments with the calendar ;

$A + Bn + Cn2 + Dn3 + En4 + ...$

- Day of the Week Dependent Demand describes the systematic variation in demand which is related to particular days of the week. To perform this function, dummy variables are employed D1 representing Monday to D5 representing Friday. An additive function of these dummy variables is

used to model the day of the week dependent component of demand in the form;

$$\delta 2\, D2 + \delta 3\, D3 + \delta 4\, D4 + \delta 5\, D5$$

- Error Term represents the noise and measures that part of the variation in demand which is not described by the other terms of the model.

240 This specification of the demand forecasting model adopted by NGC appears complex but is nevertheless robust. It takes into account all available data which can be modelled and which needs to be accounted for when formulating a prediction of electricity demand. The illustrations of the variability in demand across time, season, day of the week and different weather conditions (particularly different temperature conditions) in section 4 demonstrate the complexity of the problem.

241 NGC model these specified terms and data inputs using the demand forecasting programme FORCE. This programme evaluates each specified cardinal point demand model using the forecast weather (supplied by the Meteorological Office) and predicted basic demand through each forecast period. An algorithm is then used to evaluate interpolates of the cardinal point demand forecasts to produce a half hour time series of forecast demand. The output of these forecasts is then electronically transferred to NGC Settlements in order that the system administrator can calculate demand according to the required definition (known as the "Q0" definition). These demand forecasts are then incorporated into the pool price setting mechanism and are also available to pool members who electronically receive information relating to the following days pool for electricity ie prices, forecast demands etc.

242 The Grid Operator is responsible for maintaining a record of it s demand forecasting accuracy. An analysis of forecast errors is carried out

for each Standard Review Month of the electricity industry calender. Baker suggests that the long run standard deviation of Nominal Demand forecasts since vesting has achieved 2.2% (ie the tendency is to over or under forecast demand over the course of the day by an average of 2.2%).

243 This sub-section has attempted to summarise the methodological approaches that are in practise adopted for electricity demand forecasting purposes. The literature differentiates between the various time series and econometric approaches that are available to the modeller and describes the appropriateness of each technique for both long term and short term situations. I have placed particular emphasis on the NGC method of forecasting demand for input into the pool trading system as this combines the multiple regression approach with a pragmatic system of profiling daily demands for time series interpolations of data series. It has been important to detail the mechanisms behind these demand forecasts as the results of this system form an integral part of the triad forecasting methodology outlined in the subsequent sections. I have not attempted to describe the methods behind other tried and tested demand forecasting systems which are in operation within the industry. The Box-Jenkins approach to time series modelling has been applied to the electricity demand forecasting arena throughout numerous of the RECs. The methodology behind such systems has been described by McLeod[10] with individual systems placing different emphasis upon the modelled explanatory variables. This represents a more complex time series approach to the demand forecasting problem. However, as Lang argues, complex solutions do not necessarily produce the best forecasts of demand over longer time horizons.

[10] G McLeod "Box Jenkins in Practise" (GJP Time Series Library 1983)

The application of game theory to the electricity supply industry

244 Numerous economists have applied the principles of game theory to particular situations specifically within the electricity supply industry. In the US and in other countries there are several electricity exchange and brokerage mechanisms, the most famous being the Florida Power Broker. Nearly all operate a "split savings" rule and measure efficiency gains in terms of the sum of bids net of the sum of offers. Indeed, recent economic research which applies the fundamental principles of game theory to the electricity industry has tended to concentrate on the mechanics and efficiency gains associated with the trading mechanisms. This has often been associated with the analysis of various spot markets with the conduction of auctions on the basis of bids and offers. Hahn and Boening[11] compared the split-savings rule (SS) with the single price auction (SP) in an experimental setting specifically in the context of electricity spot markets. Their results suggested that efficiency was higher under the SP rule with the incidence of strategic behaviour resulting in a reduction in efficiency under both regimes.

245 Newbery and Greene[12] conducted a simulation to investigate whether markets locate Nash equilibria and assess the efficiency gains associated with spot markets. Their results suggest that the Nash equilibrium in supply functions suggested an outcome far from the competitive equilibrium with two sellers in a market but with five sellers, the outcome is close to the competitive equilibrium. The possible conclusions deriving from this are that spot markets do not break down the collusive behaviour or failure to locate Nash equilibria even with small numbers. They also suggest that with four to five participants, the allocation is not unacceptably far from competitive equilibrium.

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[11] R Hahn and M van Boening "An experimental examination of spot markets for electricity" (Economic Journal Dec 1990)

[12] D Newbery and R Greene "Competition in the British Electricity market" (CEPR paper 57, 1991)

246 Such research demonstrates the applicability of the principles of game theory to the electricity market but the content of these studies is far removed from the basis of this research. Powell[13] applies game theory analysis to the strategic behaviour of the electricity generation oligopoly within the UK. Again this deals specifically with the UK spot market trading arrangements (the pool) and also the contracts market between the generators and the RECs. The paper argues that the electricity industry operates within a market where contracts are struck regularly and where the spot market is imperfect given the dominance of National Power and PowerGen who are responsible for approximately 50% and 30% of generation capacity respectively.

247 Powell argues that the contracts negotiated prior to vesting between all participants within the industry have played an important part in determining the behaviour of the generators and the discrepancy between contract prices and expected spot prices from the pool. Through the application of Cournot theory to the actions of the two private generators, Powell devises a model of recontracting between the generators and the RECs based upon the application of further Cournot solutions to the situation. Specifically, the generators are regarded as price setters in the contracts market and quantity setters in the spot market. The RECs set quantity in the market for contracts for differences (hedges against the pool). Different solutions to the game are investigated;

- when the generators are non cooperative;
- when the generators cooperate in both the spot market and the futures market (as represented by the contracts market); and
- when the generators are cooperative in the futures market and non cooperative in the spot market.

[13] A Powell "Trading Forward in an Imperfect Market: The Case of Electricity in Britain" (Economic Journal, March 1993)

The results showed that only if the generators are truly non cooperative would a competitive result emerge (marginal cost pricing and the contract price equal to the expected spot prices). In this situation, risk averse RECs "hedge" against all electricity demanded ie purchase contracts for electricity which reduce exposure to the pool and the risk associated with such purchases. With collusion between the generators, contracts prices are above expected spot prices and spot prices are above marginal costs meaning hedging is only partial.

248 Exelby and Lucas[14] use game theory analysis to analyse how the bidding strategy of generators is effected by the administered payments for capacity availability in an attempt to establish whether there exists genuine competition between the generators. By devising a formal gaming framework and constructing payoff matrixes exhibiting Nash equilibria, the issue of collusion for mutual benefit is explored. It is concluded that the capacity payment mechanism creates incentives to reduce plant declarations and achieve the revenue associated with capacity payments. The game theory analysis shows that the generators will adopt monopolistic positions through their bidding strategies without collusion.

Summary

249 This literature search has provided the theoretical framework as a context in which to model the axioms of this research. It has concentrated upon the key principles arising from the literature of both statistical decision theory and formal game theory. The relevance of these principles is apparent in the proceeding sections. The issue of demand forecasting has been dealt with from a practical perspective, introducing the concepts available for formal energy demand modelling but concentrating upon the theory applied by NGC in their formulation of demand forecasts for pool

[14] M J Exelby and N J D Lucas "Competition in the UK Market for Electricity Generating Capacity: A Game Theory Analysis" (Energy Policy, Butterworth-Heinman April 1993)

settlement purposes. This both introduces the role and character of independent explanatory variables and defines the modelling framework adopted within the industry and described by Baker. It has been necessary to pursue these independent lines of theory given the nature of the issue with which this research deals. The requirement to forecast triads was initially a forecasting problem and it is from the practical application of the solution that the principles of game theory and statistically supported decision making apply.

250 Finally, some of the literature which applies game theory techniques to the electricity supply industry has been summarised to show how this theory is increasingly being applied to real business situations. The literature tends to concentrate on the potential oligopolistic behaviour of the generators and the trading mechanisms of the pool, however it provides a useful example of how to apply these principles in the context of the wider electricity business.

3 THE UK SYSTEM TO BE EXAMINED

Overview

301 The concept of triads is a very small and specific component of the overall framework of the privatised electricity industry. Consequently, it is necessary to place into context this concept. The broad arena with which triads are an issue concerns the contractual relations between the National Grid Company and users of the grid system. Consequently, this section will outline the nature of these arrangements, the rational and reasoning behind the concept, and the implications for customer contracts and electricity tariff charges. It will be necessary to understand the activities of the National Grid Company and the transmission system in operation alongside the distribution and supply businesses of the RECs. This overall assessment will however be restricted and not a comprehensive survey of the operation of the electricity industry given the specific nature of the issue to be explored. This thesis is primarily concerned with the application of microeconomic theory to a specific electricity supply business issue, hence the restriction to the discussion of the business framework.

The National Grid Company

302 NGC owns and operates the transmission system in England and Wales, known as the national grid, and the interconnections linking the national grid with the transmission systems in Scotland and France. NGC also contracts for the provision of ancillary services, owns and operates the pumped storage power stations in Wales and administers, through a subsidiary, the settlement system. However the core business of NGC is the operation of the transmission system. The responsibility for operating and managing this system was assumed from the former Central Electricity Generating Board (CEGB) in 1989. On 31 March 1990, the property, rights and liabilities of the CEGB relating to the national grid were transferred to NGC by virtue of the Electricity Act. Apart from the NG

Holding Special Share which is owned by the Secretary of State, the entire issued share capital of NG Holding is currently owned by the RECs and has been allocated broadly in proportion to the net assets of each REC at 31 March 1989.

303 NGC as the controller and owner of the national grid has an effective monopoly over the transmission of electricity at 400kV and 275kV in England and Wales. In accordance with the Electricity Act, NGC is required to "develop and maintain an efficient, coordinated and economical system of electricity transmission and to facilitate competition in the supply and generation of electricity". NGC does not trade in electricity itself, and indeed the Electricity Act prohibits it from doing so.

304 There are distinctions made between the separate businesses of NGC in accordance with it s transmission licence. These businesses, which are without any element of cross subsidy and are accounted for individually are;

- the Transmission Business;
- the Settlement Business;
- the Interconnections Business;
- the Ancillary Services Business; and
- the Generation Business.

NGC also engages in other businesses which are not regulated by its transmission license including consultancy and contracting for maintenance work on transmission. The business which is of relevance to this research is the core business of NGC, the Transmission Business.

The transmission system

305 NGC has approximately 13,500 circuit kilometres of overhead lines which are supported by some 21,350 pylons. Almost all of the lines operate at 400kV or 275kV. There are also some 280 substations which connect

different parts of the transmission system and form the grid entry points and grid exit points at which power stations, RECs and NGC directly connected customers are connected to the transmission system.

306 NGC is responsible for the day to day operation of the grid and for the scheduling and despatching generation according to the merit order of prices on offer from the generators. Using NGC's own demand forecasts and the information received from electricity operators, the control centre prepares a generation schedule each day for the matching of available generation with demand for the following day. It is this information which is made available to the Settlement Business for use in calculating payments due as a result of pool trading.

307 In accordance with NGC's transmission licence, the company has to plan, develop, operate and maintain the overall transmission system.

Contractual relations with users of the grid

308 NGC's transmission license requires it to produce an annual statement setting out the basis of its charges for use of and connections to the transmission system. There are numerous components of the overall charge for connection and use of the system;

- Use of system charges;
- Connection charges; and
- Metering charges.

309 Use of system charges are divided into system service charges and infrastructure charges. The system service charge is payable by predominantly suppliers of electricity and is meant to reflect the costs to NGC of providing, operating and maintaining a skeletal transmission network. It is levied per kW of demand at times of system peak demand which is the average of the three highest actual metered demands, at grid

exit points, separated from each other by at least ten days in the period between November and February inclusive.

310 The infrastructure charge is intended to reflect the costs to NGC of installing, operating and maintaining transmission system assets to the standards required by the transmission licence for the purposes of accommodating bulk transfers of electricity and providing system security. This is a charge which is levied on generators as well as suppliers according to their location and level of activity and includes the following elements;

- a charge per kW of demand at times of system peak demand on the transmission system;
- a charge per kW of capacity (as registered with NGC) of generating plant connected to the transmission system; and
- a charge per kWh of the actual energy input of generating plant.

311 NGC divided its authorised area into 11 zones. Infrastructure charges have been set in accordance with grid entry points and grid exit points in each zone and are meant to reflect the cost of proving the transmission system in each particular zone. Through this mechanism, the cost to NGC in terms of the need for reinforcing the transmission system in each zone is conveyed to the users of this system. As a result of the net transfer of electricity from the north of England to the south of England, given the concentration of generating capacity, generators who are connected to the transmission system in the north of England pay higher infrastructure charges than those in the south of England. Conversely, transmission system users with demand in the north of England typically pay lower infrastructure charges than those in the south.

312 Connection charges are intended to reflect the cost of NGC providing grid entry points and grid entry points and connections to them plus a rate of return on the capital associated with such costs. Entry

charges are levied on the generators and exit charges are payable typically by the RECs and NGC directly connected customers.

313 Flows of electricity to and from the transmission system are measured by meters at power stations and bulk supply points. A charge is levied to users of the system to reflect the cost of providing and running this equipment which is required for settlement purposes.

314 Use of system charges are invoiced monthly in equal instalments based on an estimated amount calculated for each user at the beginning of the financial year. This amount is estimated on the basis of the published zone charges per kW of demand and a forecast of the user's demand at the times of system peak demand. At the end of the financial year, the actual amounts of revenue due from each user are recalculated on the basis of actual system peak demand in the financial year ie. the average of the three highest half hours in the period November to February separated by at least ten days (the triad). Reconciliation statements reflect any over or undercharging on the basis of the estimates.

Transmission use of system charges review

315 It was recognised early on in the process of privatisation that the charging mechanisms set in place by NGC would require review given the complexities of the transmission pricing based policy enacted. In June 1992, NGC published the results of a fundamental review of its charges to users of the system[15]. NGC concluded that the basis by which it divides between connection and use of system charging should be continued. However, NGC proposed a new methodology for use of system charging based upon Investment Cost Related Pricing (ICRP).

[15] Transmission Use of System Charges Review: Proposed Investment Cost Related Pricing for Use of System. NGC June 1992

316 The ICRP approach adopted by NGC represents a compromise between various methods considered in the review, ranging from a "deep connection" policy which would have yielded fixed rates over long periods, to short run marginal costing with the potential for half hourly charging at numerous separate nodes of the system. The principal changes under the new approach are;

- an increase from 11 to 14 zones with zonal boundaries to be reviewed every five years;
- the introduction of the concept that demand is negative generation and generation is equivalent to negative demand;
- the widening of cost differentials between zones from the transitional arrangements to more cost reflective values. Thus demand charges varied from zero in Zone 1 in the north in 1993/94 to £22.1 per kW in zone 14 in the south west of England. The concept of payments to generators to encourage the siting of plant in the south was also introduced;
- charges were to continue to be based on triad kw for demand;
- charges are to be revised annually on the basis of the expected pattern of demand and generation for the year; and
- because of the significant cost differentials across the system, especially with the widening of differentials between the north and the south of the country, the new charges were to be phased in over three years.

317 Thus, where the concept of the triad is concerned, the ICRP approach retains the principal of the cost of investment undertaken by NGC in transport capability at time of peak demand and to the requirement to maintain a secure transmission system at time of peak demand. Since the configuration of demand and generation at the time of

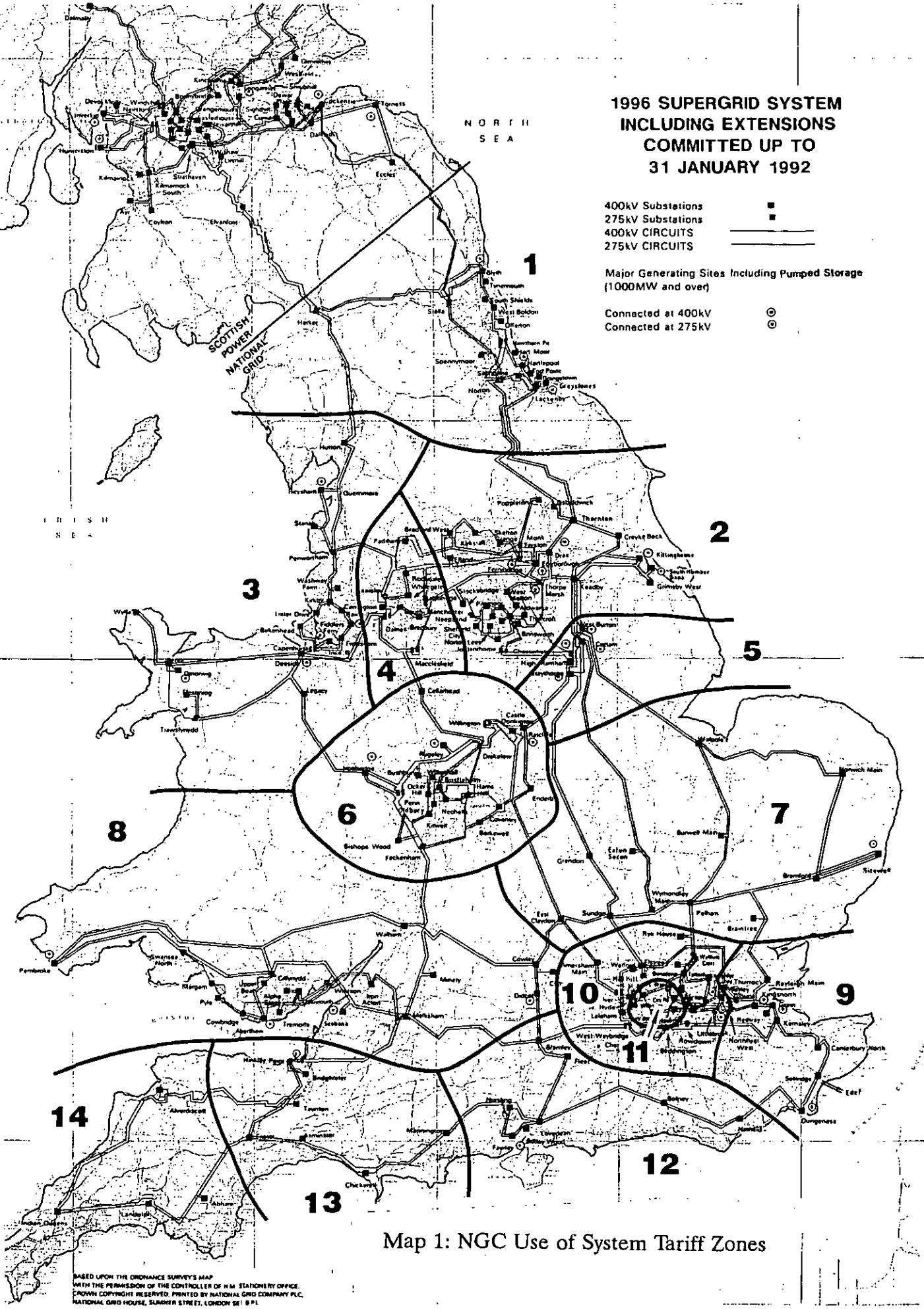
peak determines the amount of transmission capacity required, it is appropriate for demand and generation to be charged or paid according to their contributions at the time of peak. Following the review, demand charged according to the triad demands remains as the principal for recovering this element of cost to NGC since the triad is defined in such a way as to capture the appropriate measure of peak demand over the winter period.

318 The new charging methodology introduced in April 1993 abandoned the principal of splitting the use of system charge between the system service and infrastructure charges. The new charging methodology identified only one category known as the "infrastructure charge" and for those representing demand from the system represents a charge per kW of demand at times of system peak demand as defined by the triad definition. The infrastructure charges set for the 14 separate charging zones as shown in Map 1. The schedule of charges for use of system in 1993/94 are detailed in Table 1.

Table 1: Schedule of Charges for Use of System in 1993/94 Infrastructure Charge

	Zone	Demand (£/kW)
1	North	7.612767
2	Yorkshire	9.043849
3	N Wales & W Lancs	9.542485
4	E Lancs	10.003966
5	Notts	9.195032
6	W Midlands	10.348089
7	Anglia	12.101864
8	West & Wales	12.077377
9	Estuary	10.289090
10	Outer London	13.780465
11	Inner London	15.563223
12	South Coast	13.199920
13	Wessex	13.656434
14	Peninsula	13.656434

Source: NGC Statement of Charges for Use of System and Connection to the System for the year 1993/94 (April 1993)



Map 1: NGC Use of System Tariff Zones

Implications for the business of the RECs

319 Since privatisation, the businesses of the RECs has proliferated substantially from the "core" businesses of the supply and distribution of electricity. Most RECs are engaged in appliance retailing activities, some in electricity generation (notably utilising Combined Cycle Gas Turbine - CCGT - technology), electricity contracting and consultancy and more wider energy businesses such as gas retailing with the opening of the domestic gas market to further competition. Nevertheless, given the constraints of this thesis, it is the supply business of the RECs and to a lesser extent the distribution businesses that are of relevance to this research.

320 The distribution businesses of the RECs consist of the planning, construction, operation and maintenance of the distribution system in the RECs authorised area. The supply business consists of the bulk purchase of electricity and its sale to customers of that business. The distribution business is the core business of each REC with the majority of profits originating from this business. However, this position will have to change as increasingly tight regulation ensures that future profit generation will be sourced from the emerging activities of the RECs. The principal activities of the distribution business of each REC are the provision of connections to and use of its distribution system. Connections are provided for those wishing to take a supply from the distribution system and for generators who wish to export electricity onto the system.

321 The distribution charges levied by each REC to some extent mirror the charges levied by NGC to users of the Grid, and consist of;

- use of system charges;
- connection charges; and
- charges for other excluded services.

322 Use of system charges reflect the costs of providing, operating and maintaining each RECs distribution system. They are paid by any user of the REC's system (both demand and supply) and are charged with reference to the units distributed and the characteristics of supply (ie. whether high or low voltage connection is required). Use of system charges may include a standing charge to cover fixed costs, charges per kW or kVA to cover system capacity, charges per kW or kWh for active power or charges per kVAr or kVArh for reactive power designed to reflect utilisation of the system at different voltage levels, and metering charges. Use of system charges represent around 90 per cent of each REC's distribution revenue.

323 The supply business of each REC is operated as a separate business to the distribution business, the principal activity of which is to buy and sell electricity as suppliers. The majority of electricity is bought in bulk under the pool trading arrangements and is sold to a range of customers both within the traditional geographical boundaries of operation and across the boundaries of the competing REC supply businesses. Not every customer to whom a REC distributes electricity is a customer of the supply business given the competition within this market.

324 In devising tariffs and contracts for customers, each supply business aims to pass over the costs of buying electricity onto customers plus an amount representing operating profit. Electricity purchase costs depend upon pool prices, the RECs portfolio of contracts to reduce exposure to the variability of pool costs ("contracts for differences"), and the level and pattern of supply business demand.

325 The revenues of each supply business depend on the number of units supplied and the contractual terms of supply. In the non competitive franchise market, the majority of customers purchase their electricity on fixed tariff terms which reflect the expected costs of supplying those customers. In the competitive market, prices are generally lower than in

the franchise market but are influenced by competition from other suppliers and potentially lower costs of supplying these customers.

Norweb plc

326 This thesis is concerned primarily with the author's practical experience with Norweb plc, the north west based regional electricity company. Norweb's area covers approximately 12,500 square kilometres extending from the Scottish borders to the Peak District and hence does not equate with the geographic region of the North West. The area includes the majority of Lancashire and Greater Manchester and parts of Cheshire, Merseyside, North Yorkshire and Derbyshire. The area has a resident population of 4.7 million and the company distributes electricity to an estimated 2.2 million customers.

327 It is estimated that approximately half of Norweb's domestic customers are resident in the densely populated conurbation of Greater Manchester where the region's heavy industry is also particularly concentrated. Customers in Greater Manchester account for approximately half of Norweb's total electricity sales.

328 The mix of units of electricity distributed between domestic, commercial and industrial customers has been affected by recent economic events. The recession of the early 1980s meant the loss of a significant proportion of the region's industrial base and subsequently a significant loss of sales of electricity to the industrial market with a reduction in industrial units sold of 10 per cent in 1981 alone. However the growth in unit sales to commercial customers (with Manchester developing into an important commercial and financial centre for the region) over the course of the 1980s has resulted in a broader balance of unit sales across all categories of sales.

329 In 1993/94 Norweb distributed 21,797 GWh of electricity with a total turnover of £1,215.6 million. Table 2 details the growth in turnover and units distributed since 1990.91. In 1993/94 some 34.6% of units distributed were within the domestic market, 25.1% in the commercial market, 34.0% in the industrial market and 6.4% to "other" customers. In the same year, the company received total profits of £149.4 million. Throughout the period following privatisation, the supply business has remained in profit and increased it's profit from £11.8 million in 1990/91 to £16.1 million in 1993/94. The majority of the company's profits have continued to derive from the distribution business however the implications of the recent distribution business regulatory review may reduce the overall contribution in the years to come.

Table 2: Units distributed and total turnover for Norweb plc 1990/91 to 1993/94

Year	Units Distributed (GWh)	Turnover (£ million)
1990/91	21,218	1154.4
1991/92	21,483	1163.2
1992/93	21,400	1210.7
1993/94	21,797	1215.6

Source: Norweb plc

Terms of supply

330 Before privatisation, the CEGB supplied electricity in bulk to the twelve Areas Boards in England and Wales with the terms of supply set out in the Bulk Supply Tariff (BST). The BST essentially aimed to allocate costs amongst these Boards on a basis deemed to be "clear and reasonable". The foundation of the BST was provided by marginal cost analysis and attempted to provide a measure of the increment of cost per

unit of change for each parameter in the establishment of system costs. The principal of marginal costing underlying the terms relating to the bulk supply of electricity consequently had significant implications for the tariff structure underpinning the supply of electricity to the customer.

331 The BST was above all a national tariff dealing with non uniform demands across geographical location as well as across time. Consequently, the charge for capacity is divided into two components. The main measure of capacity charge was taken as the average demand over a sizable number of the most highly loaded half hours in the year (between 250 and 300 representing the top 1.5 to 2% of demand levels). This comprised the basic capacity period. Despite the fact that this measure was limited to high demands, there existed considerable variation across the values and hence a second capacity charge (the "peak") was levied on the average of the three highest half hourly demands separated by at least ten days.

332 Unit rates dealt with the need to capture the diversity of seasonal and hourly load level by taking a grouping of days, broadly differentiating between summer and winter and between working days and weekends.

333 The simple tariff arrangements which determined the wholesale transfer of electricity from the CEGB to the individual Area Boards were translated into similar tariff arrangements for large and small customers alike. Larger and more sophisticated customers however, were ruled by more slightly more complex contractual arrangements to enable these customers to benefit from the management of consumption and to reflect the lower cost of incremental fuel.

334 Most tariffs fell into two broad categories (and essentially this remains the case today for tariffs in the franchise market);

- Quarterly tariffs comprising a standing charge and one or more unit (kWh) rates; and

- Monthly tariffs comprising a standing charge, one or more unit rates, and availability charge and maximum demand charges. Seasonal time of day tariffs are also generally available in this form.

335 Non franchise customers may also enter into direct contracts with suppliers instead of purchasing their electricity at tariff rates. In formulating individual contracts or contract frames for certain types of customer, RECs follow similar methods and pricing principles as those used in setting tariffs. Supply contracts are individually negotiated with the larger customers and as such tend to be tailored to the needs and reflect the characteristics of the customer's requirements.

336 The terms and prices of such contracts tend to reflect the current trading arrangements within the electricity supply business ie. the pool. Terms may be offered to non franchise customers which relate directly to the terms of the pool with variable unit costs per half hour (as explained below) or they may include a fixed price element which is of a similar nature to a standard tariff. Consequently the electricity pricing arena is a much more complicated process today than prior to privatisation when the establishment of the BST set the benchmark for final supply tariffs and contract agreements. In order to understand the consequences of NGC's charging mechanisms (and subsequently the component of charges which is the triad) and the other components of final supply price (which tend to be determined by the pool and the contracts for differences entered into by supply companies to minimise the risk associated with the pool), it is necessary to outline the contract arrangements available to customers. Certain contract arrangements isolate the triad component of the final price and it is such contracts which are of particular relevance to this research.

The pool, pool price contracts and fixed price agreements

337 The pool exists as a mechanism to allow trading between generators and suppliers and consequently it facilitates trade and does not itself buy or sell electricity. The pool trading arrangements establishes prices for sales and purchases of electricity, taking into account the variable supply and demand for the product. It is not possible to detail fully the trading mechanisms of the pool given the scope of this research. However, it is important to note that prices are set by individual half hour, The Pool Selling Price (PSP) ie. the unit cost of electricity purchased from the pool consists of the following components;

- Pool Purchase Price (PPP), which includes a capacity element and the System Marginal Price (SMP), is affected by national demand for electricity, the availability of electricity and the offer prices of the generators. Consequently the variation in PPP over a day and over the year can be substantial give the variations in, for example, weather, fuel prices and availability; and
- Uplift which is meant to reflect the costs associated with maintaining a "stable integrated system". This may include payments for unplanned events and hence this component of the PSP can also vary substantially.

338 Of relevance to this research is a portion of the day ahead bidding process which contributes to the determination of the final PSP. The process involves equating forecast demand with generator offered availability and the prices of this availability. A demand forecast is made, on a day-ahead basis, for each half hour using the following procedure;

- By 10:00 on each day the Grid Operator produces a forecast of Nominal Demand in MW for each half hour based upon

historic data adjusted for weather factors and other specific factors which may affect demand;

- the Grid Operator then converts this forecast of Nominal Demand into a forecast of Total Demand in MW for each half hour (known as Settlement Periods) in the forthcoming Availability Declaration Period;
- Total Demand does not take into account demand from Large Consumers (ie those with a maximum demand in excess of 250 MW in a half hour), External Pool Members and NGC Pumped Storage. Such users are expected to provide to the Grid Operator a schedule of demand for the same period.
- The Total Demand and the estimated demand for these consumers are then totalled to give the Forecast Demand.

These forecasts of demand, which are modelled by the Grid Operator and the Settlements process to produce the following days pool prices are available to pool members the day prior to trading. The consequences of this are explained in Section 4.

339 RECs purchase their electricity through the pool and enter into contracts with the generators to reduce their exposure to the variability of the pool and the resulting variable Pool Selling Prices. This is necessary given that the RECs offer fixed price tariffs to their franchise customers as well as fixed price contracts to some of their competitively gained customers. Customer themselves may wish to enter into contracts either with their local REC, competing RECs or the generators directly to purchase their electricity on pool related terms. This enable them to take advantage of lower unit rates at certain times of the day than offered under fixed price agreements but it does expose them to the same risk and variability associated with the variations in final Pool Selling Prices.

340 For a customer who has entered into a Pool Price Contract with a supplier of electricity, a number of elements of the total charge are detailed. Many of the elements of cost that make up the total price of electricity are common to all suppliers of electricity. Often contracts stipulate a "transparent" charge for these elements so that the costs to the supplier are simply passed onto the customer with nothing added on. Nevertheless, the final bill received by the customer is much more complicated than that of a tariff related contract. The charges to such customers include the following items;

- The **Energy charge** which is charged by half hour in accordance with the number of units consumed at the Pool Selling Price. Pool prices are provisional until firm prices are issued by NGC approximately 23 days later;
- **Transmission losses** which represent the loss of energy between generation and supply given the nature of electricity. This amount (the difference between total metered generation and total metered demand) is added to the energy consumptions to allow for such losses from the Grid. This amount is currently estimated given the nature of losses from the system;
- **National Grid Charges for Transmission** which includes the System Service Charge and the Infrastructure Charge. This infrastructure charge, as explained above, varies according to zone and is based on the mean of the customer's demand at the time of the three system peaks ie. this represents the triad charge to these consumers. Since the precise level of demand is not known until the year end, the maximum demand for such customers is estimated and a coincidence factor is applied to estimate the demand at the time of the triad. A final year adjustment is made when the demand is determined;

- **Distribution System Losses** are charged for to allow for the energy lost within the local distribution network. These losses apply to all the above items;
- **Distribution Use of System Charges** in the form of a standing charge, an availability charge (the highest of the supply capacity in a month or any of the previous eleven months subject to a minimum supply capacity determined on an individual customer basis), units charges split between night and day rates, and reactive power charges for each kVArh consumed in excess of 50% of the number of the total units consumed each month;
- A **Metering System Charge** which includes metering and NGC administration charges;
- An **Administration Charge** levied by the supplier, a nominal value to provide a contribution to overheads and often based on the total units consumed by the customer;
- The **Fossil Fuel Levy** for which all the above charges are subject to the levy and which is determined by the regulator;
- and **VAT** which is leviable on all the components of charge at the appropriate rate according to the customer.

For customers entering into pool price contracts with any other supplier other than the local (host) REC, a **non site specific charge** is incurred which is administered through NGC Settlements Limited.

341 Clearly, customers entering into pool price contracts are liable to the full charge associated with their demand at the time of the triad. Customers may also enter into fixed price arrangements with suppliers, with a fixed unit rate to cover all or certain periods of the day and time of year depending upon the nature of the contract. This replaces the energy charge above and some of the other charges detailed separately under the pool price contract such as the charge to cover transmission losses. At Norweb, some contracts were designed specifically to take account of the

incidence of the triad charge - triad contracts. It is easily recognisable that pool price contracts are particularly beneficial to customers who are able to shed load at times when pool prices are particularly high or who are able to exercise some flexibility in determining when their peak demands are. Following this principle, if customers can exercise a degree of flexibility at the times of high pool prices they may be able to exercise similar flexibility at the times of the anticipated system peaks which attract the triad charge. Triad contracts were developed as a direct response to this and encouraged the management of load to reduce customers overall electricity costs.

342 Customers of Norweb on Triad Demand or pool related contracts are charged NGC transmission charges relating to the triads. The charges are calculated according to a specified price per kW of average customer demand over the triads. In 1992/93, these charges were apportioned geographically with Zone 1 attracting a charge of £7.613, Zone 3 at £9.542 and Zone 4 at £10.004 as portrayed in Map 1.

343 A customer with the demands of 1,800 kW, 1,600 kW and 1,400 kW at the time of the three triad periods located in Zone 4 would pay NGC transmission charges of £16,006.4 based on an average demand of 1,600 kW. By reducing their demand during the three triad periods, a customer could make substantial savings, of up to 100 per cent if load could be cut altogether. Consequently, the triad demand contract was designed and entered into by customers who could actively manage their demand to reduce or eliminate this component of their total electricity bill.

344 Thus triads represent another potentially controllable portion of a customers electricity costs. The appeal of pool price contracts and triad demand contracts to more sophisticated customers capable of managing their consumption is obvious. This also presents further opportunities to the supplier of electricity. Given the suppliers knowledge of the trading mechanisms and market for electricity, it is well placed to offer assistance

to it's customers in managing their controllable electricity costs. Simply, the supplier could provide advance warnings to customers of particularly high pool prices when the day ahead prices are received. Where triads are concerned, the supplier could provide similar warnings to customers when a system peak period which could qualify as a triad is anticipated. This is a more complex proposition since the supplier would have to act on their own calculation and opinion of when the triad is likely to occur. However, if the supplier was capable of devising a procedure capable of identifying likely triads, it could offer this service to the customer and receive additional income from this service. In the highly regulated supply business, any additional income received though the provision of such a service would be unregulated and as such contribute directly to bottom line profit. Thus, such a service has potential advantages for both the customer and the supplier. The customer is provided with assistance in reducing or eliminating a portion of its electricity costs. The supplier receives income from the provision of this service and would also benefit from the "good will" factor of providing this service. This again would provide the supplier with a competitive advantage over other suppliers given the importance of value added services in the overall supply package available to customers.

345 Triads are therefore a component of certain customers' electricity costs. The remainder of this thesis describes the attempt by the author to provide a service to customers aimed at identifying triads prior to their occurrence. It is through this, that the issues of demand forecasting and ultimately the complex interaction of both suppliers and customers, provide for a complicated problem requiring an increasingly complex solution.

4 THE KEY PROPERTIES OF TRIAD DEMANDS

Overview

401 The NGC definition of triads ensures they are easily identifiable once final demand information has been collated;

"*Demand is measured as the average demand attributable to a user measured with respect to National Grid Company grid supply point (including demand caused by distribution losses) over a specified number of peak half hours between November and February (inclusive) in a financial year.....demand will be measured as the average demand attributable to that user over three half-hours: the half hour of system peak and the two other half hours of highest demand which are separated from the system peak and each other by at least 10 days*".

As explained in Section 3, suppliers and particular contract customers pay charges to NGC on the basis of demand at the time of these system peaks. This charge is levied according to kW of demand for electricity.

402 By definition, the triad demands which are identifiable in any one year represent peaks in demand for electricity from the transmission system. Consequently it is possible to analyse the causes of these peaks in order that any such peak could be forecast in advance of it's occurrence. This is a desirable action if one wishes to avoid the charges associated with the peaks in demand.

The business requirement

403 In 1991, a requirement was defined by Norweb to provide a triad forecasting/identification system to enable the customers who qualified for triad associated charges to manage their own demand and reduce or avoid altogether the triad charges. This necessitated research to investigate

factors which are of consequence to the occurrence of triads. These potentially included;

- actual and predicted demand;
- "spikes" in pool prices; and
- weather related factors.

404 The overall aim was to identify the conditions associated with triads and produce a set of rules that could be used to predict the probability of a triad occurring prior to its actual occurrence. If the triads could be predicted the aim was to sell the service to Norweb's large competitively gained customers who are effected by triad charges. These customers would then act upon Norweb's advice and reduce their own demand to reduce or avoid the triad-associated charges.

405 It was envisaged initially that "triad warnings" could be issued to customers subscribing to the service. It was hoped to provide at least 24 hours notice to customers if a triad was likely to occur to provide time to the customer to reschedule or plan to wind down plant operations. It was also envisaged that the warnings would provide a specific time of the probable triad alongside some indication of the probability of the triad occurring eg. a percentage probability or an indication of a high or lower probability.

406 In response to this specific business requirement, a programme of research was planned in an attempt to identify the "key properties" of triad demands if indeed identifiable and predictable properties were to exist. This section deals with the initial programme of research which necessitated the analysis of data available up until 1991. The aim of this research was to establish the sources of available data which may aid the triad prediction process as well as establishing any demand/temperature/price relationships that may exist in order to formulate an algorithm and means of forecasting system peaks.

Programme of research

407 The starting point for the analysis was to identify the causes of peaks in the overall demand for electricity since triads, by definition, are likely to represent peaks in demand. A number of strands of available data was available for such an analysis;

(a) **Historical national demand and triad data.** On the basis of empirical demand and triad data it was envisaged that it would be possible to analyse the chronology of triad demands ie. which months triads most often occurred in, at what time of day and at what level of demand these peaks occurred. National demand data by half hourly time period was available from 1 April 1979 to 31 March 1991 for this analysis and has been collated on a daily basis since these dates. Demand data relating to the Norweb region specifically was also available from 1 April 1982 and again has been updated on a daily basis since 1991.

(b) **Historical weather data** was acquired from the Electricity Association. This data related to a number of weather stations across the UK and covered the period 1 April 1985 to 31 March 1991. The data consisted of an "effective UK actual temperature" measured in degrees Celsius for each day as well as an effective "normal" temperature for each day of the year. This data was calculated using a weighted average of temperature readings from 15 weather stations around the UK. These definitions will be described in further detail within this section. Temperature data was also available from Manchester Airport (Ringway) which is the primary weather station serving the Norweb area. This data is available from 1 April 1979 and details daily maximum and minimum temperatures.

(c) Half hourly **pool price information** was available from the day of vesting and has been available on a daily basis since. This data was analysed to assess any demand/price relationships using simple statistical techniques and in order to assess any identifiable demand responsiveness to price. Other pool price related data which was deemed to be of relevance to this study included the advance day ahead pool prices that are published via the Settlements system. These prices are provisional Pool Selling prices (ie. do not include uplift) and are based upon predicted levels of demand. However, these prices are received by pool contract related customers the day prior to trading and it can thus be assumed that any demand responsiveness to price would be based on this a priori information received.

(d) The **predictions of system demand** calculated by NGC are required to calculate the provisional pool prices determined on the day prior to trading. These predictions of demand are available to the RECs and to pool members in general, again on a day ahead basis. This information is available to Supply companies and pool members the day prior to trading. The provided data is essentially a forecast of demand for the forthcoming day and is available by half hour. It was envisaged that this data could be used as a forecast of demand which could aid the identification of any peaks in demand anticipated. The intention was therefore to use these forecasts in conjunction with Norweb's own forecasts of demand to assist with the triad identification procedure. This data was also available from the date of vesting and is again available on a daily basis for the updating of information sources. The aim was to analyse this data to assess the accuracy of the demand forecasts, whether there is any systematic under or over forecast tendency and

whether this source of forecast of demand was a reliable means for the prior identification of triads;

(e) The final source of data available for analysis for the winter of 1991/92 were the dates and times of **load management** called by the two major private generating companies, National Power and PowerGen, in 1990/91. The generators, in calling load management periods did not necessarily intend to provide their own customers with a triad warning service. Nevertheless, load management was meant to coincide with peak periods of demand and was an attempt to reduce the extent of these peaks and avoid the cost of peak period generating plant. Such plant is costly to schedule, given the high start up costs and it was beneficial to both generator and customer alike to avoid unnecessary peaks in demand. Unlike the triad avoidance system described below, load management was a compulsory condition of the arrangements between customer and generator. It was envisaged that this data could be analysed in conjunction with the national demand data available in order to assess the impact of load management upon peak periods if indeed any such impact was identifiable.

408 This section therefore details the initial programme of research and investigates each of the above strands of available data as a means of formulating a triad identification system.

The analysis of national electricity demand data

409 Data detailing national electricity demand is available by half hour time period from 1 April 1979 by a definition consistent with NGC Settlements definition of "national metered demand". This data was analysed to determine the dates and time periods of those system peak

demands which would be defined as triads under the NGC definition. Simple data sorts were performed on each years data (for the period November 1 to February 28/29) and the ten day separation rule applied to the descending demand ordered data. Table 3 details each years individual triad demands for the period 1979/90 to 1990/91 alongside the associated time period, date, day of the week, and order of demand. Appendix 1 contains the top 50 winter demands for each year from 1979/80 to 1990/91 and identifies the individual triad demands in order of descending demand.

Table 3: Triad demand history based upon national demand data (MW)

Year	Order of demand	Time period	Date	Day of the week	Demand (MW)
1979/80	1	17:00	14/01/80	Mon	44,225
	6	17:00	03/01/80	Thu	42,736
	17	17:30	19/12/79	Wed	42,253
1980/81	1	17:30	13/01/81	Tue	42,600
	3	17:00	01/12/80	Mon	42,377
	23	17:30	05/11/80	Wed	40,582
1981/82	1	17:30	12/01/82	Tue	42,597
	2	17:00	10/12/81	Thu	42,226
	67	17:00	21/12/81	Mon	40,589
1982/83	1	17:00	14/12/82	Tue	42,067
	8	17:00	02/12/82	Thu	40,708
	13	17:30	19/01/83	Wed	40,356
1983/84	1	17:00	07/12/83	Wed	42,243
	4	17:30	24/01/84	Tue	41,963
	7	17:30	22/11/83	Tue	41,725
1984/85	1	17:30	17/01/85	Thu	46,219
	20	18:00	12/02/85	Tue	43,306
	56	17:00	18/12/84	Tue	42,080
1985/86	1	17:00	07/01/86	Tue	45,185
	3	17:00	20/11/85	Wed	44,052
	4	17:30	03/02/86	Mon	44,015
1986/87	1	17:30	12/01/87	Mon	47,925
	105	17:00	17/12/86	Wed	43,444
	113	17:30	27/01/87	Tue	43,187
1987/88	1	17:00	15/12/87	Tue	46,935
	23	17:30	01/12/87	Tue	44,965
	29	17:30	12/01/88	Tue	44,486
1988/89	1	17:30	22/11/88	Tue	46,880
	5	17:30	06/12/88	Tue	46,020
	14	17:30	25/01/89	Wed	45,219
1989/90	1	17:00	11/12/89	Mon	46,714
	3	17:00	28/11/89	Tue	46,650
	34	17:30	29/01/90	Mon	44,948
1990/91	1	17:30	07/02/91	Thu	47,035
	7	17:30	15/01/91	Tue	46,570
	8	17:00	18/12/90	Tue	46,556

Source: National demand data

410 From the analysis summarised in Table 3, a number of conclusions can be drawn which derive from the simple data sorts and provide some rudimentary indications of the properties of triads.

411 Between 1979/80 and 1990/91 the triads have occurred in the half hour ending 17:00 and ending 17:30. In 1984/85 a triad occurred in the half hour ending 18:00 and this took place in February. Indeed in the two years since 1990/91 the triads too took place in the half hours ending 17:00 and 17:30. The peak demands therefore are associated with the "tea time" periods over the winter months. The explanation for this is relatively simple. These peaks correspond with peaks in demand in the domestic market as people returning from work turn on lights, cookers and other household appliances. Since these domestic "surges" in electricity demand occur early in the evening, industry and commerce is still in operation and the demand of factories and offices contribute to the overall peak in demand;

412 It is evident from the demand data that the triad demands do not simply comprise the top three half hourly demands in any one year. This is a direct result of the rule by which triads are determined ie. the separation of ten days between the system peak and the two other half hours of highest demand. Often the two peak half hours may occur on the same day and within the same hourly period, given the conditions contributing to the peak on that day. This was the case in 1979/80 with the two peak demands occurring within the same hour (the half hours ending 17:00 and 17:30) on the same day 14/1/1980. The third peak in demand occurred on the following day but was not a triad given the above rule. The second triad occurred on 3/1/1980 ten days prior to the peak of this particular winter. Only in 1984/85 do three of the top five demands qualify as triads, encompassing the months of November, January and February. In the following year 1986/87, the majority of the top fifty demands occurred in a four day period between 12 January and 15 January 1987. This corresponded with very cold temperatures over this sustained period

and ensured that only the peak demand within this period qualified as a triad. Consequently, the second and third triads occurred substantially down the demand order at 105 and 113 respectively;

413 If one attempts to identify in which months the triads are most likely to occur, of the 36 triads which were observed between 1979/80 and 1990/91 only five occurred in November. Fourteen triads occurred in December, with 11 in the period ending 17:00 and 3 in the half hour ending 17:30. Fourteen triads occurred in January over the same period, 11 in the half hour to 17:30 and 3 in the half hour ending 17:00. Only 3 triads occurred in February, 2 in the half hour ending 17:30 and 1 in the period ending 18:00. Thus an initial conclusion may be that it appears more likely, on the basis of empirical evidence that triads are likely to occur in the months of December and January over and above the months of November and February. This conclusion can be drawn prior to any analysis of temperature information.

414 If triads occur in the months of November and February, they appear more likely to occur towards the end of November and the beginning of February. The earliest date of a triad is 5 November 1980 , while the latest is 12 February 1985. This is potentially a result of the hours of daylight at the extremes of these two months effecting the peaks in the daily demand profile, as explained below.

415 It is also apparent that triads and peak demands are essentially working day phenomena ie. on no occasion do the triads occur on weekends, bank holiday periods or during the Christmas shutdown period. Out of the 36 triads identified since 1979/80, 17 have occurred on a Tuesday, 7 on a Monday, 7 on a Wednesday and 5 on a Thursday. Indeed, triads were never identified on a Friday as well as weekends during the period examined. Thus it can be concluded that one can concentrate analysis on the four working days of the week in which a triad is most

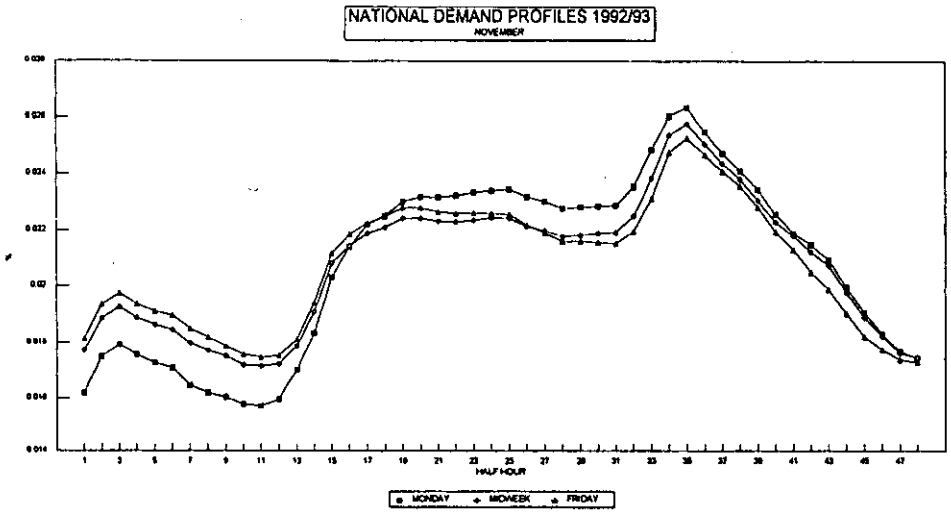
likely to occur. The incidence of triads occurring on a Tuesday cannot be readily explained on the basis of this demand data alone.

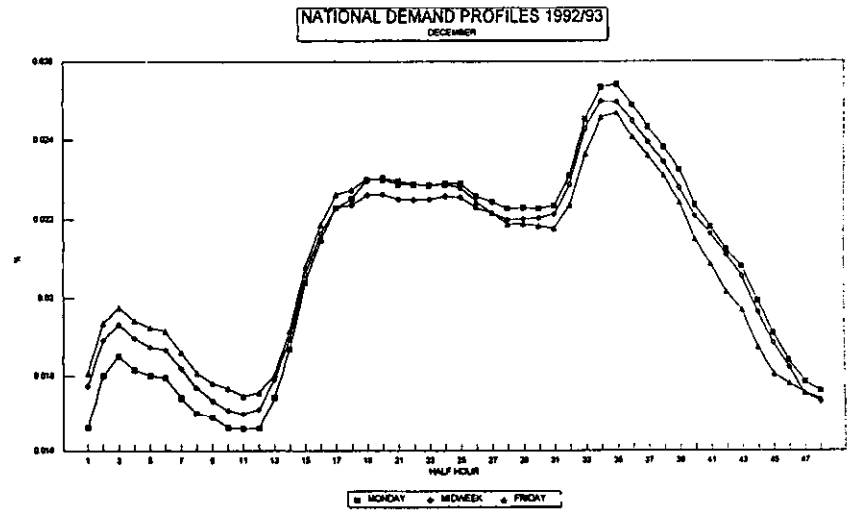
416 To explain the chronology of triads and the likelihood of the incidence of triads occurring in the mid period months (December and January), one can refer to what Baker[16] refers to as "non weather sensitive demand". That is, the component of demand that is not influenced by short term weather variations but is a function of the time of day, day of the week, month and season. Figure 1 illustrates the difference in demand profile for the various days of the week described over the winter months, with a typical November or December profile differing from a February daily demand profile. In Figure 1, daily national demands have been averaged for typical weekdays for each winter month over the financial year 1992/93 (ie excluding public/bank holidays and the following days). Profiles have been produced for Mondays, Midweek (combining Tuesdays, Wednesdays and Thursdays given the overall similarities in these profiles) and Fridays. Figure 2 illustrates similar profiles for Saturdays and Sundays by winter month for 1992/93 with Figure 3 displaying the profiles of the Christmas and New Year holiday period ("Xmas shutdown" referring to the average of the intervening non holiday days affected).

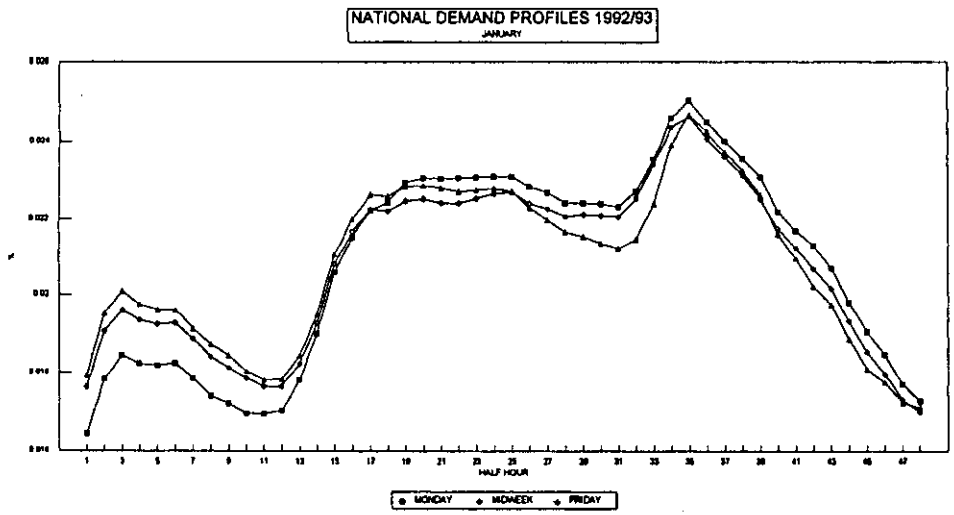
417 The profiles for the weekdays display predominant peaks particularly in December and January. In December the peak tends to corresponds with time period 35 (the half hour ending 17:00) and in January the peak occurs at time period 36 (the half hour ending 17:30). The February peak is still apparent at around the same time period, however the overall February load profiles are less "peaky" particularly around the tea time period but more generally across the day time demands. The reason behind this lies in the extended daytime period across February. The domestic lighting load that combines with other domestic demand and industrial and commercial usage creating the

[16] A B Baker op cit

Figure 1 **NATIONAL ELECTRICITY DEMAND PROFILES : WEEKDAY AVERAGES 1992/93**







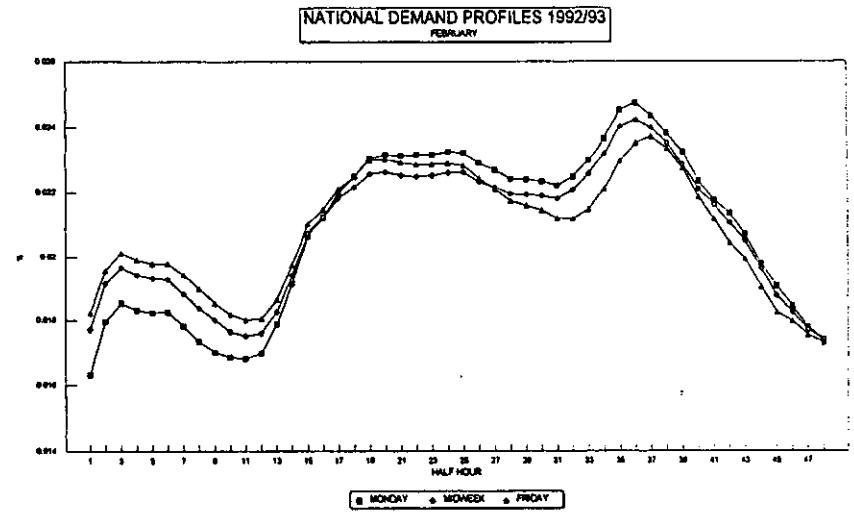
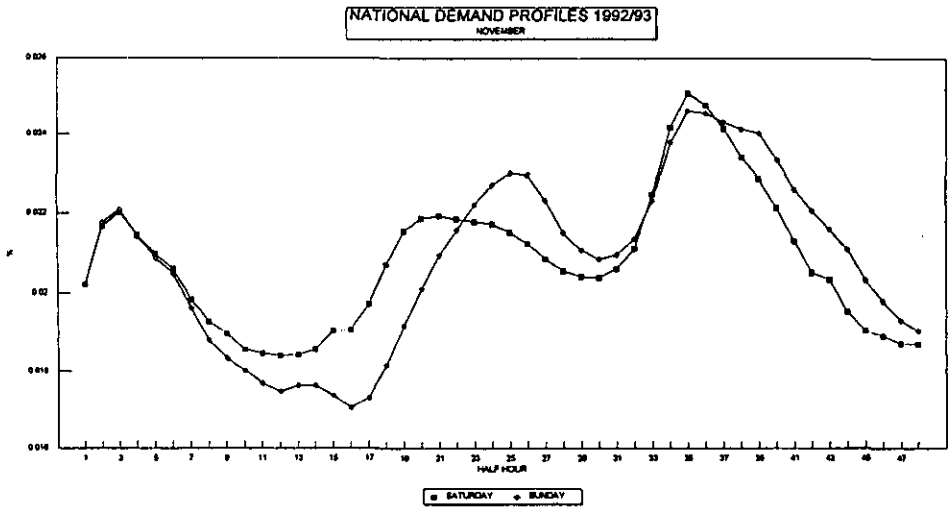
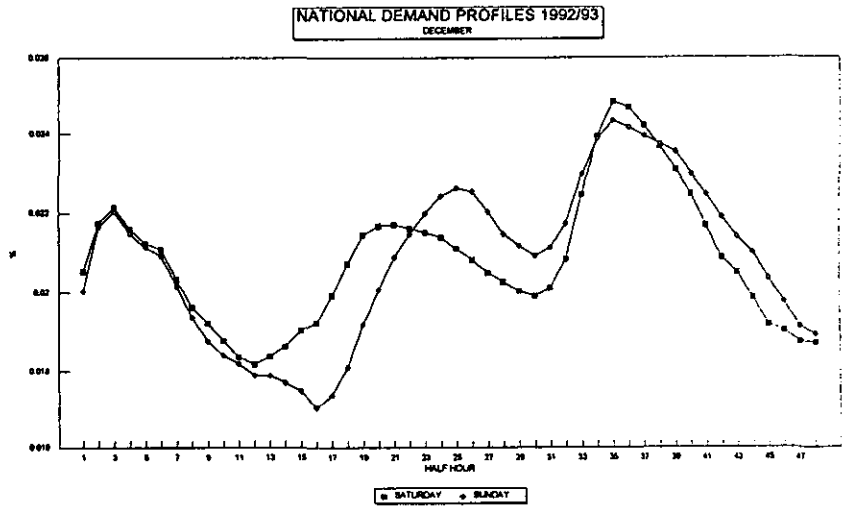
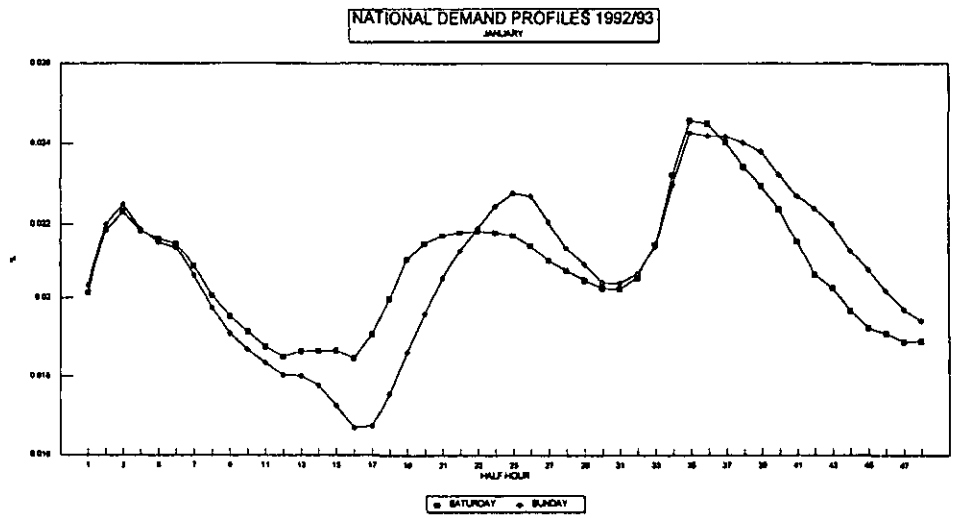


Figure 2

NATIONAL ELECTRICITY DEMAND PROFILES : WEEKEND AVERAGES 1992/93







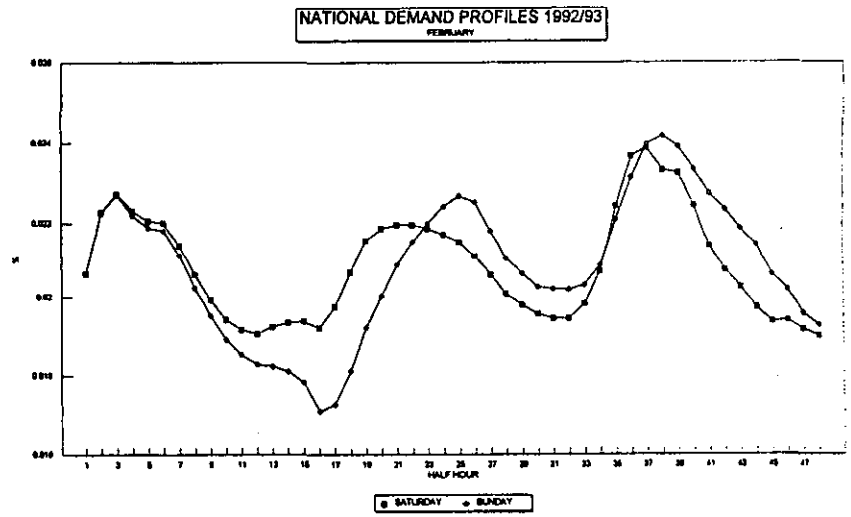
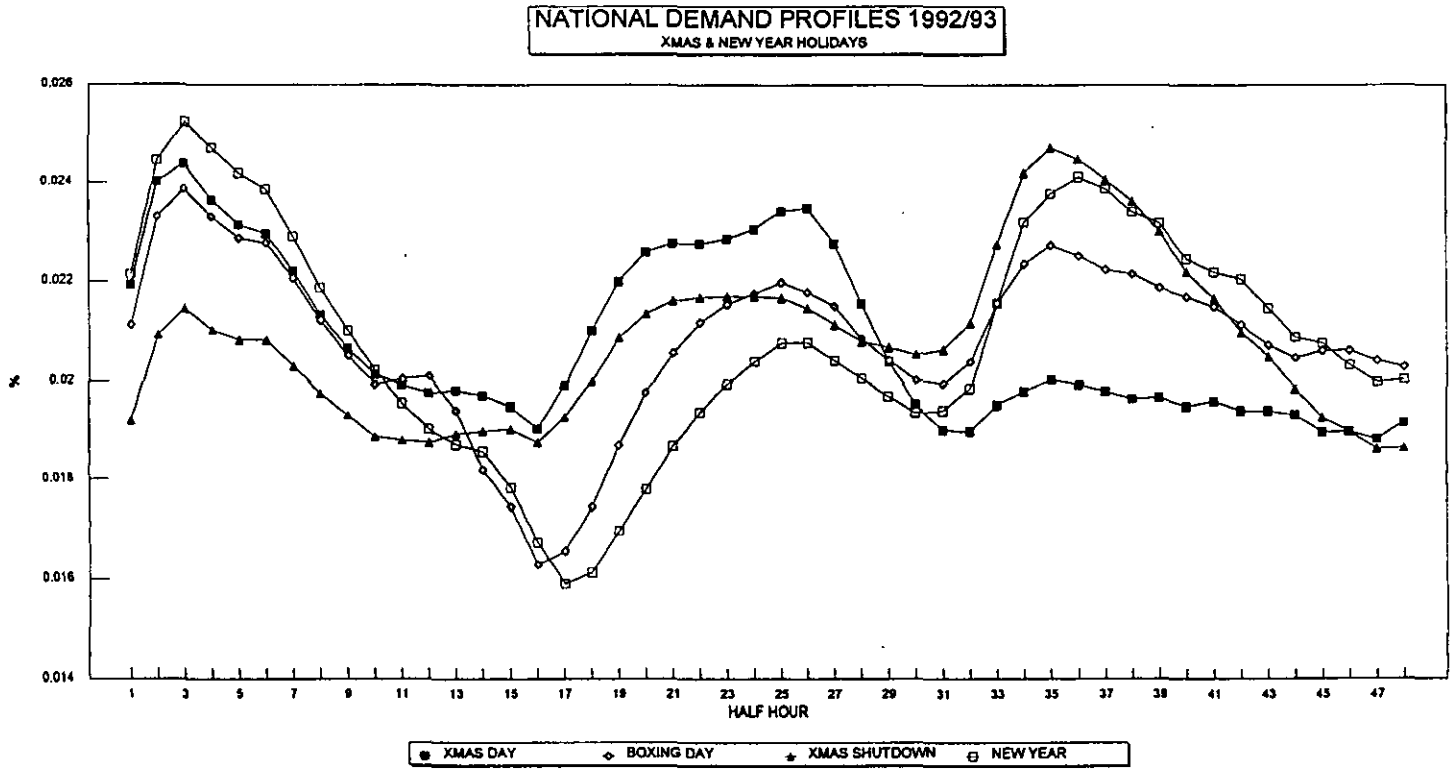


Figure 3

NATIONAL ELECTRICITY DEMAND PROFILES : HOLIDAY PERIOD AVERAGES 1992/93



pronounced peaks during the mid winter does not occur coincidentally in the later winter period. This has the effect of creating a plateau around the teatime peak in February and tends to suppress the peak in any one half hour. Consequently, this suppression of peak demands may reduce the likelihood of a triad occurring in February. February triads may result from particularly cold temperature conditions or simply a by product of the "ten day rule" which ultimately determines the timing of the triads.

418 Figure 4 portrays the growth in maximum demand over the period 1979/80 to 1990/91. Whereas growth is evident from the graph it is not consistent, with significant increases between 1983/84 and 1984/85 for example. Since 1987/88 growth appears to have plateaued, nevertheless the maximum demand of 46,556 MW in 1990/91 is 6.4% higher than the 44,225 of 1979/80. The peak demand prior to 1990/91 occurred in 1986/87 with a recorded demand of 47,925 MW. Table 4 presents the year on year growth of national maximum demand for electricity.

Figure 4

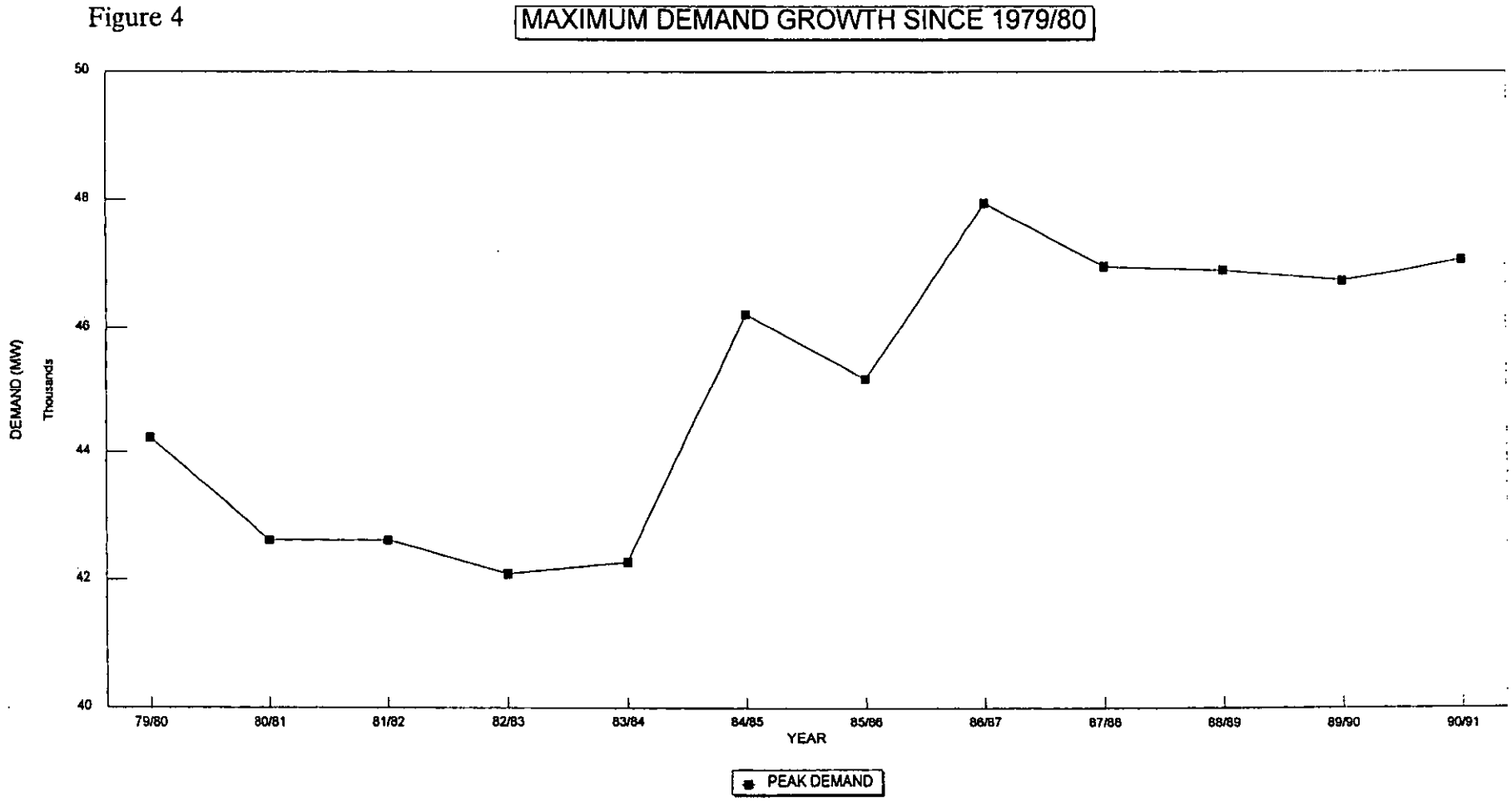

MAXIMUM DEMAND GROWTH SINCE 1979/80
DEMAND (MW)
Thousands
50
48
46
44
42
40
79/80
80/81
81/82
82/83
83/84
84/85
85/86
86/87
87/88
88/89
89/90
90/91
YEAR
PEAK DEMAND

Table 4: National Maximum Demand Growth 1979/80 to 1992/93

Year	Time	Date	Demand (MW)	Year on Year Growth (%)
1979/80	17:00	14/01/80	44,225	
1980/81	17:30	13/01/81	42,600	-3.67
1981/82	17:30	12/01/82	42,597	-0.01
1982/83	17:00	14/12/82	42,067	-1.24
1983/84	17:00	07/12/83	42,243	0.42
1984/85	17:30	17/01/85	46,219	9.41
1985/86	17:00	07/01/86	45,185	-2.24
1986/87	17:30	12/01/87	47,925	6.06
1987/88	17:00	15/12/87	46,935	-2.07
1988/89	17:30	22/11/88	46,880	-0.12
1989/90	17:00	11/12/89	46,714	-0.35
1990/91	17:30	07/02/91	47,035	0.69
1991/92	17:30	11/12/91	47,289	0.54
1992/93	17:30	17/11/92	44,638	-5.61

Source: National demand data

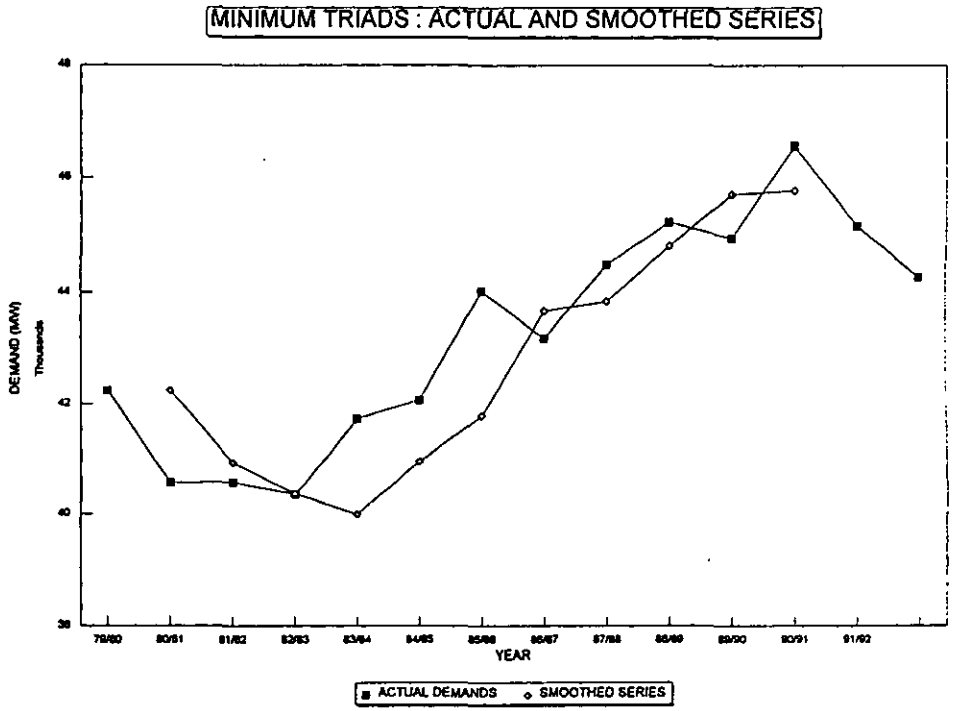
419 The growth in maximum demand displays much fluctuation. If one plots the "minimum" triad observed over the period ie. the triad with the least highest demand, the trend growth is more noticeable and consistent over the period to 1990/91. Figure 5 plots the growth of the "minimum" triad and displays the results of the exponentially smoothed series using double parameter exponential smoothing to stabilise the trend and iron out the irregularities. In 1990/91 the level of demand of the minimum triad was 10.2% above that in 1979/80 with a compound rate of growth of some 1% per annum.

420 Demand data relating to the Norweb region in particular was also available for analysis in relation to the national demand peaks. This data comprised MW distribution demands for the whole of the transmission system within the Norweb area. Similar data sorts were conducted on each years demand data to identify the peaks in the regional demand data. Attempts were made to apply the "ten day rule" to this data to simulate

Figure 5

"MINIMUM TRIADS"

YEAR	NUMBER	TIME	DAY	MONTH	YEAR	DEMAND	Y ON Y GROWTH	DOUBLE PARAMETER EXPONENTIALLY SMOOTHED SMOOTH DATA (S a) 0.6	SMOOTH TREND (b) 0.3	FORECAST F m=1 1
79/80	17	1730	19	12	79	42,253		42253	0	
80/81	23	1730	5	11	80	40,582	-3.95%	41250	-301	42253
81/82	67	1700	21	12	81	40,589	0.02%	40733	-366	40950
82/83	13	1730	19	1	83	40,356	-0.57%	40361	-368	40368
83/84	7	1730	22	11	83	41,725	3.39%	41032	-56	39993
84/85	56	1700	18	12	84	42,080	0.85%	41638	143	40976
85/86	4	1730	3	2	86	44,015	4.60%	43121	545	41781
86/87	113	1730	27	1	87	43,187	-1.88%	43379	459	43666
87/88	29	1730	12	1	88	44,486	3.01%	44226	575	43837
88/89	14	1730	25	1	89	45,219	1.65%	45052	650	44802
89/90	34	1730	29	1	90	44,948	-0.60%	45250	515	45703
90/91	8	1700	18	12	90	46,556	3.58%	46239	657	45764
91/92	16	1730	21	11	91	45,150	-3.02%			46896
92/93	4	1700	9	12	92	44,261	-1.97%			



the timing of Norweb specific triads in isolation from the official triad times. Of the 27 triads that were measured between 1982 and 1990/91 on only 4 occasions did the Norweb peak demand occur within the same hour as the national triad. Norweb demand peaks therefore bear little relevance to the timing of the national triads and it was concluded that by using Norweb specific data alone, this data would be insufficient as an aid to forecasting triads.

421 In summary, from the analysis of national demand data it is apparent that triads are most likely to occur within the hour from 16:30 pm to 17:30 pm. This is particularly the case in November and December. In January the peaks are most likely to occur in the half hour ending 17:30 and in February there is the possibility of the peak occurring in the half hour ending 18:00, with less chance of any peak occurring in the half hour ending 17:00. Triads are also more likely to occur within the working week and exclude the weekend periods (including Fridays).

Analysis of historical weather data

422 The weather data available for analysis was not as comprehensive as that available to NGC when producing forecasts of nominal demand. The weather data utilised within the analysis comprised temperature data which was provided on a historical basis from the Electricity Association[17]. This data covered the whole period from 1 April 1986 to 31 March 1991. The data comprised an effective UK actual temperature in degrees celsius for each day along with a long run average effective temperature in degrees celsius for each day of the year enabling, for comparative purposes, a "normalised" temperature series. The effective temperatures are calculated on the basis of weighted average nightly minimum temperatures between the hours of 10:00 pm and 09:00 am and daily maximum temperatures (between the hours of 09:00 am and 10:00

[17] Courtesy of R Thompson, Business Services

pm). Temperatures have been collated from 15 weather stations across the UK to make up the series and weights applied to formulate the UK average. Table 5 details the weights applied by the Electricity Association to each weather station temperature recording. These weights attempt to reflect the weather sensitive component of electricity sales of the corresponding electricity supply companies as a proportion of total electricity sales nationally.

Table 5: Temperature weights

Heathrow	0.1778
Gatwick	0.0762
Lyneham	0.0277
Exeter	0.0538
Wattisham	0.1201
Nottingham	0.0738
Birmingham	0.0785
Cardiff	0.0296
Manchester	0.1609
Finningley	0.0653
Leeming	0.0135
Newcastle	0.0314
Aberdeen	0.0682
Stornaway	0.0033
Belfast	0.0199

Source: The Electricity Association

423 The daily weighted average temperatures are calculated as the average of the night minimum and daily maximums. Each days "effective" temperature is calculated by applying the formula:

$$TEd = 0.4\ TAd + 0.6\ TEd\text{-}1$$

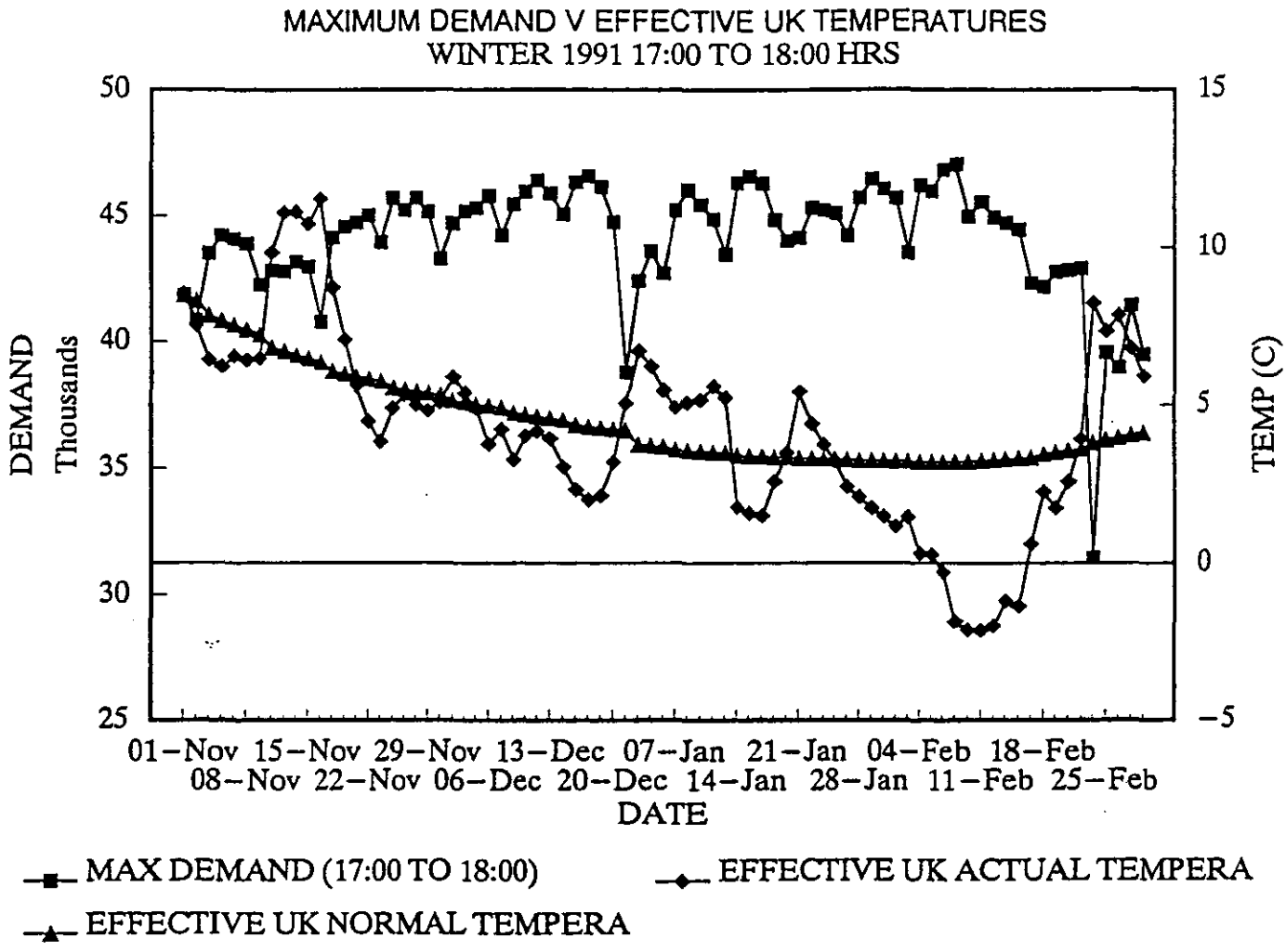
where TE is the effective temperature for day d or d-1 and TAd is the actual temperature on day d. The effective temperature thus takes into account the lagged response of weather sensitive demand for electricity to changes in temperature. The daily effective normal temperatures are calculated similarly, using long term means for each weather station. The

period covered by the long term means is broadly a thirty year period to 1986.

424 Following the analysis of national demand data and having collected the associated nationally weighted temperature data, an attempt was made to assess whether a relationship existed between the weighted national average temperatures and maximum demands. Temperature data was extracted for the period from November to February for each year from 1985/86 to 1990/91. Having taken into account the conclusions derived from the analysis of national demand data, weekend periods, bank holidays and the Christmas shutdown period (effectively the week between Christmas and the new year) were excluded from the analysis. Maximum demand data for the period from 16:30 (the half hour ending 17:00, time period 34) and 18:00 (time period 36) was extracted from the data since peaks were found to most likely occur during this period. This reduced series of maximum demand information was then correlated with the corresponding series of weighted national temperatures for each year in isolation.

425 Figure 6 portrays the relationship between the maximum demands within the specified periods against the effective UK actual temperature and the effective UK normal temperature for the winter of 1990/91. It is obvious from the figure that the relationship between these demands and temperature is of an inverse nature for the most part ie. low temperatures are generally associated with peaks in demand. However, the overall results from the correlations suggested poor results with each year yielding r2 values of less than 0.4. Since established knowledge suggests that long term temperature/demand relationships are generally significant, it is possible that the reduced series of demands used in this analysis was insufficient or misleading. Indeed, the time periods used may not take into account the effect of weather sensitive demand deriving from domestic night heating requirements and the use of storage heating in particular.

Figure 6


MAXIMUM DEMAND V EFFECTIVE UK TEMPERATURES
WINTER 1991 17:00 TO 18:00 HRS
DEMAND
Thousands
50
45
40
35
30
25
15
10
5
0
−5
TEMP (C)
01−Nov 15−Nov 29−Nov 13−Dec 07−Jan 21−Jan 04−Feb 18−Feb
08−Nov 22−Nov 06−Dec 20−Dec 14−Jan 28−Jan 11−Feb 25−Feb
DATE
MAX DEMAND (17:00 TO 18:00)
EFFECTIVE UK ACTUAL TEMPERA
EFFECTIVE UK NORMAL TEMPERA

426 In order to try and account for this element of weather sensitive demand within the short time period specified, a simulation was undertaken for the 1990/91 demand data. National load profiles[18] which identify the proportion of total demand comprised of demand from domestic heating were utilised. The proportion of domestic heating demand from the total demand was then extracted from the total demand series and this series was then correlated against the temperature data. The resulting r2 were better than the first correlation, but the results still proved insignificant (r2 of 0.35) and the method proved undesirable.

427 Another simulation was undertaken with a further reduced demand series. The demand data referring exclusively to the time periods 34, 35 and 36 (the overall period between 16:30 and 18:00) was sorted for each year. Upon this sort, the triads for each year now occur within the top 20 demands for each year ie. the demand order of the triads changes significantly. Consequently, the top 20 demands for each year on this basis were correlated with the corresponding days effective UK temperature. Significant results were obtained from this analysis.

428 Taking national weighted average temperatures as the independent variable (X) and the equivalent days demand from the highest 20 demands between 16:30 and 18:00 as the dependent variable (Y) for each of the winters between 1986/87 and 1990/91, the following results were achieved;

1990/91	$Y = 46510.95 + -139.2(X)$
	$(r)2 = 0.48$
1989/90	$Y = 47617.29 + -412.66(X)$
	$(r)2 = 0.75$
1988/89	$Y = 47139.49 + -404.49(X)$
	$(r)2 = 0.56$
1987/88	$Y = 47164.42 + -543.71(X)$

[18] Source: The Electricity Association

	(r)2 = 0.64
1986/87	Y = 44981.55 + -510.53(X)
	(r)2 = 0.85

429 These results were applied to the demand and temperature data for each year in an attempt to produce and estimate of demand at "normal" temperatures in accordance with the effective UK normal temperature series. Given the above formulae the corresponding "normal" temperature for a particular day was regressed against the top 20 demands in each year to produce an estimate of demand at these normal temperatures. This concept will be developed in section 5.

430 Further to the analysis of the top 20 tea time demands across the winter months, an analysis was undertaken relating to the effective UK temperatures associated with the triads from each year and any deviation from the effective UK normal temperature. Table 6 portrays the results of this analysis.

Table 6: Triads and their associated temperatures

Year	Date	Demand	Effective UK Actual Temp(C)	Effective UK Normal Temp(C)	Temp. Deviation
1990/91	18/12/90	46,556	1.99	4.31	-2.32
	15/01/91	46,570	1.58	3.40	-1.82
	07/02/91	47,035	-1.84	3.21	-5.05
1989/90	29/01/90	44,948	5.08	3.25	1.83
	28/11/89	46,650	2.55	5.41	-2.86
	11/12/89	46,714	3.75	4.68	-0.93
1988/89	25/01/89	44,041	5.06	3.28	1.78
	06/12/88	44,252	5.58	4.96	0.62
	22/11/88	45,168	2.09	5.82	-3.73
1987/88	12/01/88	42,911	5.52	3.46	2.06
	01/12/87	43,567	3.90	5.24	-1.34
	15/12/87	45,174	1.93	4.47	-2.54
1986/87	27/01/87	43,187	3.42	3.26	0.16
	17/12/86	43,464	4.78	4.36	0.42
	12/01/87	47,925	-4.04	3.46	-7.50
1985/86	03/02/86	44,015	2.14	3.21	-1.07
	20/11/85	44,052	2.65	5.98	-3.33
	07/01/86	45,185	0.72	3.59	-2.87

Source: National demand data and the Electricity Association

431 A number of conclusions can be drawn from this analysis. Over the period since 1985/86, triads have occurred at effective UK actual temperatures ranging from -4.04 degrees celsius to +5.58 degrees celsius. Appendix 3 which lists the tea time demands sorted in ascending order by effective UK actual temperature for each year, shows that the maximum demand triad occurs every year during the coldest period of that year ie. around a number of days (even though it may not necessarily correspond with the coldest effective temperature). For example in 1990/91 early to mid February produced the coldest period of the winter with the coldest

effective UK actual temperature occurring on February 11 1991 and the maximum demand occurring on February 7 1991.

432 Given the nature of the rule determining the timing of the triads, not all the triads in one winter will occur during a particular cold spell (unless the period is particularly long). Indeed, triads have not always occurred in very cold periods having occurred at effective UK actual temperatures of up to 2.06 degrees celsius above the norm.

433 The conclusions drawn from this analysis suggest that temperature data in isolation would be an insufficient means of assisting the triad forecasting procedure. Indeed, this analysis has been based upon actual effective temperature data collected and correlated with maximum demand information. If one had to forecast maximum demand and more specifically the occurrence of a triad, then forecast temperature data would be required. The accuracy of short term and long term temperature forecasts to the level of detail required is simply not available.

434 However, the correlations between effective temperatures and working day tea time maximum demands provides a means of "temperature correcting" the triad demands using the regression results above. The aim being to produce an estimate of triad demand at normal temperatures. It was envisaged that by normalising triad demands on a historical basis, it would be possible to project this forward to provide an estimate of triad demands in the forecast years. This could aid the triad prediction process. The details of this approach are covered in section 5.

Analysis of pool price information

435 The half hourly pool price information that had been available from vesting until 1991 was analysed against the demand data available to assess any demand/price relationships. By regressing the corresponding Pool

Selling Prices with the tea time maximum demands in the same way as temperature was modelled it was hoped to establish a relationship that would assist in the prediction of triads.

436 However, the results from this analysis were so poor that it was difficult to establish any such relationship between demand and pool price. This is probably a result of the method used in setting pool prices which at the time was essentially supply driven rather than demand driven ie the generators and their bid prices were of primary significance in the setting of pool prices, customer demand (albeit a feature), was secondary. Consequently, the investigation concentrated upon demand and temperature relationships rather than the price information available.

Analysing the predictions of system demand

437 Section 2 described the methodology by which the predictions of system demand are made by NGC Grid System Management National Control. These demand forecasts are determined prior to trading and are formulated for each Availability Declaration Period (commencing 21:00 hours on one day and ending at 12:00 hours two days later). The predictions of system demand are an integral part of the pool price setting mechanisms and as such are available to pool members along with the advance published pool selling prices the day prior to trading.

438 It was envisaged that the forecasts of demand provided by NGC were a potentially accurate method of forecasting peak demands and ultimately triads if one had already formed an opinion on what level of demand the peak is likely to occur at. Consequently these forecasts of demand were analysed against final measurements of national metered demand in order to assess the accuracy and use of these estimates.

439 Day ahead predictions of demand made by NGC were extracted for the period November 1990 to February 1991. This data series was reduced

in order to assess the accuracy of the forecasts of demand in the tea time periods only (time periods 34,35 and 36 covering the period 16:30 to 18:00). The analysis suggested a tendency towards over-forecasting demand on a day ahead basis. The average absolute error of the forecast series was some 2.78%, with the highest over forecast in the order of 6.3%. There was on occasions a tendency to under-forecast demand within these time periods, however these errors were particularly low and occurred in late February when demand was well below the level required to qualify as a triad.

440 Consequently, it was concluded that the forecasts of demand available from NGC Grid Control were perhaps the best available data source with which to aid the prediction of triads and peak demands. The relative accuracy of these predictions meant decisions could be made upon the basis of the demand forecast. However, it is essential to form a view as to the level of demand at which a triad is likely to occur in the operational period.

Analysis of load management information

441 The two major generating companies National Power and PowerGen provide load management warnings to their large customers in an attempt to avoid the costs associated with starting up "peaking" plant. These warnings coincided with potential peak demand periods and customers were obliged to reduce their demand in the designated periods. The dates and times of these warning periods were available for the winter of 1990/91. The analysis of this information provided little indication of any overall demand responsiveness to these warnings. The days coincided with the peak demand days and the errors in NGC forecast were not significantly different to the average error calculated.

442 Consequently it was concluded that the incidence of load management was not large enough to distort overall demand peaks and predictions in the winter of 1990/91.

Summary

443 This section therefore details the initial programme of research that was undertaken in 1991 in order to investigate the properties of peak demand periods, and specifically triad demands. The intention has been to detail the data sources and identify any significant relationships that could be effectively used in the derivation of a triad demand forecasting system. The most important sources of data are the historical record of half hourly national metered demands, the record of temperature and the calculation of the effective UK actual temperature in comparison to the long run average series, and finally the predictions of system demand available on a day ahead basis and produced using the method detailed in Section 2 by NGC.

444 The subsequent section describes the forecasting system that was devised on the basis of this analysis and the practical experience having put the system into operation during the winters of 1991/92 and 1992/93.

5 FORECASTING TRIADS : METHOD AND EXPERIENCE

Overview

501 The business requirement for forecasting triads was described in the previous section. For the REC, a triad forecasting service is an additional added value service which can be offered to it s eligible customers. It is a means of obtaining additional unregulated revenue and a means of gaining competitive advantage over it s rivals if customers can be accurately advised as to the potential occurrence of triads with minimum possible inconvenience. For the customer, there are potential savings on electricity costs which may be worth obtaining assuming the costs of loss of production does not outweigh these potential savings. Thus if a REC can offer a successful triad forecasting service to it's customers then the benefits accrue to both REC and customer.

502 Following the programme of research to identify the properties of triads, it was concluded that triad demand periods are characterised by particular features. For example, they have occurred in the past at tea time periods during the working days of mid winter and tend to be associated with particular cold periods. On the basis of this analysis and the forecasts of demand available, a triad forecasting system was developed, tested and implemented on a commercial basis by myself for Norweb from the winter of 1991/92. This section describes the logic behind the system, the results of simulations and the success of the operation of the system in the proceeding winters.

Methodology and forecasting logic

503 Triads are by definition peaks in electricity demand. If one is to "forecast" or predict the occurrence of a triad one must first, formulate a prediction of daily peak demand and secondly formulate an opinion of the level of demand in any one year which is likely to constitute that years

triad demand. Section 4 describes the information that is available for the decision maker to formulate this opinion. Applying decision theory, one must decide on the level of demand at which a triad is likely to occur utilising all the information about the situation. In this case, the uncertainty element is explained by a number of data sources but no prior information relating to triad prediction. Decisions have to be made in the face of great uncertainty.

504 The initial aim of the triad prediction system was to produce a set of rules that indicate the probability of a triad occurring a day advance of its occurrence. Once a triad was predicted for the next day, subscribing customers would be warned through the issuing of "triad warnings" of this likelihood. It was hoped to provide at least 24 hours notice to customers to provide sufficient response time. These warnings should specify the date, time and likelihood of the possibility of a triad (ie. high or low or percentage probability of the triad occurring). Given the uncertainties of demand forecasts and the variations in weather, it is not possible to expect to predict the triads with three warnings only. This would require both extremely accurate demand forecast (which as previously demonstrated are subject to a degree of error) which in turn require extremely accurate forecasts of weather conditions (which are known to be subject to error). It would also require an accurate forecast of the level of all three triad demands which again is beyond the realms of realistic forecasting potential. Indeed, the very system adopted by NGC (ie stating that each of the three triads must be separated by at least 10 days) in calculating triads is meant to avoid manipulation of the system and to ensure that the job of predicting the triads is difficult.

505 It is however preferable to issue as few warnings as possible so as not to unnecessarily disrupt the customer's production process. The previous analysis almost defines the confines of the "triad season" ie. mid November to early February restricted to Monday to Thursday tea time periods and excluding the Christmas shut down period. Consequently, one

506 could issue a warning for each day of this season about the tea time period. This would require issuing approximately 60 warnings over the winter period. However, this would prove both wasteful to customers and REC alike and would undoubtedly reduce the effectiveness of the service. Customers may not respond to particular warnings and miss the triad period. A limit of 25 such warnings was set by Norweb management in an attempt to resolve this problem and provide an acceptable framework in which to operate.

507 The concept of the "minimum triad" was introduced in section 4. This term can be used to describe the triad in any one year with the lowest level of demand. Figure 5 shows the trend growth of the minimum triad is noticeable and consistent over the period to 1990/91. The exponentially smoothed series stabilises the trend and irons out any irregularities in the series. In 1990/91 the level of demand of the minimum triad was 10.2% above that in 1979/80 with a compound rate of growth of some 1% per annum.

508 When sorting the demand series relating to the tea time period only (the three half hours between 16:30 and 18:00), it was found that all three triads generally occurred within the top twenty demands of this series. Therefore if one wishes to capture all three triads by issuing no more than 25 warnings, one needs to formulate an opinion about the level of demand at which the "minimum triad" is likely to occur and issue a warning if ever the forecast of demand equals or exceeds this amount.

Forecasting the minimum triad

509 The approach which was adopted to forecast triads is essentially based upon the growth trend that has occurred in the "minimum triad" over the period 1979/80 to 1990/91. Figure 5 plots this growth trend and details the exponentially smoothed series upon which a forecast of the next year's minimum triad can be made. A warning could then be provided to

customers if the predictions of system demand exceeded the level of the minimum triad forecast as any demand above this level has a significant chance of qualifying as a triad.

510 A forecast of the "minimum triad" was made using a number of techniques (involving both time series and econometric methods). However, given the stability of the minimum triad series illustrated in figure 5, a simple double parameter exponential forecast of the minimum triad following variations of the value of both alpha and beta and a degree of "judgment" on observing the results of the forecast was deemed sufficient.

511 A simple data simulation was undertaken on the basis of the winter 1990/91 in order to test the viability of this approach. The simulation involved the following stepped approach to triad predictions;

- A forecast of the minimum triad was made on the basis of the minimum triad series over the period 1979/80 to 1989/90. This series was exponentially smoothed with a value of alpha of 0.6 and beta of 0.3. On this basis a forecast of the minimum triad for 1990/91 was estimated at 45,764 MW (see figure 5). This compares to an actual outturn of 46,556 MW and thus represents an under forecast of 792 MW.
- The NGC day ahead predictions of demand (which can be regarded as the best available predictions of demand on the basis of the robustness of the models used and the analysis described in the previous sections) were then collected in order to compare the data with the forecast of minimum triad.
- Looking specifically at the half hours between 16:30 and 18:00 (since the triads were most likely to occur during this period), warnings were simulated for any period when the

prediction of demand exceeded the forecast of the minimum triad.

- The forecast demands were then compared with the outturn demands available from the settlements system some 28 days later to assess the effectiveness of the methodology following this simulation.
- On this basis, 39 triad warnings would have been issued and all three triads correctly identified.

512 However, the number of warnings is unacceptedly high in this case. The data simulation did not take into account all of the previous analysis undertaken, specifically the fact that the day ahead demand predictions tended to over forecast by a factor of 2.78%. Thus a further simulation was undertaken having revised down the predictions of system demand by a factor of 2.78% uniformly. Figure 7 details this simulation. On the basis of these adjusted predictions of demand, there were 32 half hours over the full winter period where predicted demands exceeded the forecast minimum triad. Some of these half hours covered the same tea time period and consequently only 18 triad warnings would have been issued, correctly identifying all three triads. If the minimum triad had been correctly forecast at 46,557 MW then only 8 warnings would have been necessary.

513 It was concluded that this approach to triad forecasting offered real potential. However, at these early stages no attempt had been made at attaching a probability associated with a triad prediction. Nor had any attempt been made at modelling the temperature data in conjunction with the demand data. The approach appears simple but suggests that triads can be identified, not specifically, but around a demand range. The key to reducing the number of triad warnings required was deemed as producing a better forecast of the minimum triad.

514 The temperature information described in section 4 was therefore modelled with the intention of developing a temperature related approach

Figure 7

TRIAD FORECASTING MODEL SIMULATION 1990/91 DATA

MIN TRIADS: NORMAL 46201, WARM 45801, COLD 45602

Q0 Demand from Dayahead Files From Nov to Dec

TEMPS :

	17:00	17:30	18:00	17:00 FCAST ERROR ADJUST	17:30	18:00 2.78%	17:00 ACTUALS	17:30	18:00	17:00 Adjusted Prediction > Forecast	17:30	18:00	Warm Days	MAX DEM FCAST	WARNING CATEGORY	ACTUAL	RUN AV	NORMAL	RUN AV	ACT DEV	AV DEV
01-Nov-90	41941	43310	42434	40775	42106	41254	39775	41851	41188	0	0	0	0	42106	0 0 0	8.52	8.52	8.49	8.49	0.03	0.03
02-Nov-90	39736	41520	41037	38631	40366	39896	39251	40852	40153	0	0	0	0	40368	0 0 0	7.51	8.02	8.32	8.41	-0.81	-0.39
03-Nov-90	32915	35680	35649	32000	34688	34658	32168	34791	35054	0	0	0	0	34888	0 0 0	6.77	7.60	8.16	8.32	-1.39	-0.72
04-Nov-90	31435	33411	34000	30561	32482	33055	30843	33349	33489	0	0	0	0	33055	0 0 0	6.46	7.32	8.00	8.24	-1.52	-0.92
05-Nov-90	43278	44530	43387	42073	43292	42181	42023	43504	42212	0	0	0	0	43292	0 0 0	6.43	7.14	7.84	8.16	-1.41	-1.02
06-Nov-90	43605	44810	43469	42393	43370	42261	42840	44233	42974	0	0	0	0	43370	0 0 0	6.22	6.99	7.68	8.08	-1.46	-1.09
07-Nov-90	43911	44790	43248	42690	43545	42046	42587	44075	42906	0	0	0	0	43545	0 0 0	6.55	6.93	7.53	8.00	-0.98	-1.08
08-Nov-90	43801	44640	43448	42583	43399	42240	43017	43892	42885	0	0	0	0	43399	0 0 0	6.43	6.86	7.38	7.93	-0.95	-1.06
09-Nov-90	42235	43290	42293	41061	42087	41117	41866	42256	41254	0	0	0	0	42087	0 0 0	6.48	6.82	7.23	7.85	-0.75	-1.03
10-Nov-90	33358	35420	35345	32431	34435	34362	32756	34883	34921	0	0	0	0	34435	0 0 0	8.15	6.95	7.09	7.77	1.06	-0.82
11-Nov-90	32609	33620	33499	31702	32685	32568	31069	33073	32968	0	0	0	0	32685	0 0 0	8.89	7.13	6.95	7.70	1.94	-0.57
12-Nov-90	42546	43450	42180	41363	42242	41007	42101	42834	41477	0	0	0	0	42242	0 0 0	9.83	7.36	6.82	7.62	3.01	-0.27
13-Nov-90	43285	43870	42500	42082	42650	41319	41889	42785	41655	0	0	0	0	42650	0 0 0	11.10	7.64	6.70	7.55	4.40	0.09
14-Nov-90	43247	43820	42352	42045	42407	41175	42388	43148	41727	0	0	0	0	42407	0 0 0	11.12	7.89	6.58	7.48	4.54	0.41
15-Nov-90	42571	43270	42052	41388	42067	40883	42636	42969	41679	0	0	0	0	42067	0 0 0	10.73	8.08	6.47	7.42	4.26	0.66
16-Nov-90	41064	41730	40504	39922	40570	39378	40301	40799	39633	0	0	0	0	40570	0 0 0	11.54	8.30	6.36	7.35	5.18	0.95
17-Nov-90	34044	35400	35114	33098	34416	34138	32770	34583	34443	0	0	0	0	34416	0 0 0	11.44	8.48	6.26	7.29	5.18	1.20
18-Nov-90	33385	33930	33780	32457	32967	32841	31920	33263	33210	0	0	0	0	32967	0 0 0	10.31	8.58	6.16	7.22	4.15	1.36
19-Nov-90	45208	45470	44067	43951	44206	42842	43760	44116	42767	0	0	0	0	44206	0 0 0	8.72	8.59	6.06	7.16	2.66	1.43
20-Nov-90	45902	46080	44409	44626	44799	43174	44008	44544	43242	0	0	0	0	44799	0 0 0	7.07	8.51	5.98	7.10	1.09	1.41
21-Nov-90	46168	46390	45018	44885	45100	43766	44475	44723	43475	0	0	0	0	45100	0 0 0	5.60	8.36	5.89	7.05	-0.29	1.33
22-Nov-90	45515	45960	44465	44250	44682	43229	44675	44997	43986	0	0	0	0	44682	0 0 0	4.48	8.20	5.82	6.99	-1.34	1.21
23-Nov-90	44078	44430	43320	42851	43195	42118	43720	43941	42576	0	0	0	0	43195	0 0 0	3.83	8.01	5.74	6.94	-1.91	1.07
24-Nov-90	37188	38400	38124	36152	37332	37064	35965	37208	36906	0	0	0	0	37332	0 0 0	4.04	7.84	5.67	6.88	-1.63	0.96
25-Nov-90	36235	36520	36327	35228	35505	35317	34161	35027	34892	0	0	0	0	35505	0 0 0	4.26	7.70	5.60	6.83	-1.34	0.87
26-Nov-90	47478	47500	45841	46158	46180	44567	45674	45699	44211	0	0	0	0	46180	0 0 0	4.88	7.59	5.54	6.78	-0.66	0.81
27-Nov-90	47656	47730	46135	46331	46403	44852	44995	45220	44077	1	1	0	1	46403	1 1 0	5.31	7.51	5.47	6.73	-0.16	0.77
28-Nov-90	47153	47300	45676	45842	45985	44406	45468	45688	44125	0	0	0	0	45985	0 0 0	4.98	7.42	5.41	6.69	-0.43	0.73
29-Nov-90	46609	46760	45266	45313	45460	44006	44950	45143	43754	0	0	0	0	45460	0 0 0	4.81	7.33	5.36	6.64	-0.55	0.69
30-Nov-90	44432	44810	43522	43197	43564	42312	43108	43279	42155	0	0	0	0	43564	0 0 0	5.07	7.25	5.30	6.60	-0.23	0.66
01-Dec-90	37114	38570	38118	36082	37498	37058	35788	36932	36628	0	0	0	0	37498	0 0 0	5.24	7.19	5.24	6.55	0.00	0.64
02-Dec-90	35484	36200	36057	34498	35194	35055	34311	35144	34856	0	0	0	0	35194	0 0 0	5.36	7.13	5.18	6.51	0.18	0.62
03-Dec-90	46650	46670	45093	45353	45373	43839	44461	44688	43221	0	0	0	0	45373	0 0 0	5.88	7.09	5.13	6.47	0.75	0.62
04-Dec-90	46874	46970	45418	45571	45664	44155	44940	45167	43710	0	0	0	0	45664	0 0 0	5.37	7.04	5.07	6.43	0.30	0.62
05-Dec-90	46912	47110	44498	45608	45800	43261	44944	45302	44195	0	0	0	0	45800	0 0 0	4.90	6.98	5.01	6.39	-0.11	0.59
06-Dec-90	46224	46490	45194	44939	45198	43938	45779	45712	44407	0	0	0	0	45198	0 0 0	3.76	6.89	4.96	6.35	-1.20	0.54
07-Dec-90	45438	45580	44307	44175	44313	43075	44217	44157	42831	0	0	0	0	44313	0 0 0	4.22	6.82	4.90	6.31	-0.68	0.51
08-Dec-90	38626	39426	39490	37552	38330	38392	35678	36447	36443	0	0	0	0	38392	0 0 0	3.01	6.72	4.85	6.27	-1.84	0.45
09-Dec-90	37465	37900	37768	36423	36846	38716	35606	36103	36113	0	0	0	0	36846	0 0 0	2.63	6.61	4.79	6.23	-2.16	0.38
10-Dec-90	46290	46250	46786	46948	46909	45485	45456	45218	43962	1	1	0	1	46948	1 1 0	3.26	6.53	4.74	6.19	-1.48	0.34
11-Dec-90	48250	48248	46723	46909	46907	45424	45955	45792	44592	1	1	0	1	46909	2 0 1	4.01	6.47	4.68	6.16	-0.67	0.31
12-Dec-90	47620	47409	45822	46296	46091	44548	46386	46387	45177	1	0	0	1	46296	2 0 1	4.17	6.41	4.63	6.12	-0.46	0.29
13-Dec-90	46270	46034	44761	44984	44754	43517	45737	45885	44783	0	0	0	0	44984	0 0 0	3.92	6.36	4.57	6.08	-0.65	0.27
14-Dec-90	44079	44410	43462	42854	43175	42254	44832	45049	44031	0	0	0	0	43175	0 0 0	3.03	6.28	4.52	6.05	-1.49	0.23
15-Dec-90	37763	39220	38998	36713	38130	37914	37754	38885	38755	0	0	0	0	38130	0 0 0	1.96	6.18	4.47	6.01	-2.51	0.17
16-Dec-90	36347	37150	36946	35337	36117	35919	35818	36523	36303	0	0	0	0	36117	0 0 0	2.56	6.11	4.41	5.96	-1.65	0.13
17-Dec-90	47341	47380	45940	46025	46063	44663	46249	46331	45105	0	0	0	0	46063	0 0 0	2.31	6.02	4.36	5.94	-2.05	0.08
18-Dec-90	47930	47928	46768	46598	46596	45466	46556	46514	45500	TRIA 1	1	0	1	46598	1 1 0	1.99	5.94	4.31	5.91	-2.32	0.03
19-Dec-90	47480	47428	46087	46160	46110	44806	45912	46145	45154	0	0	0	0	46160	0 0 0	2.13	5.86	4.26	5.88	-2.13	-0.01
20-Dec-90	45279	45390	44449	44020	44128	43213	44736	44666	43498	0	0	0	0	44128	0 0 0	3.18	5.81	4.22	5.84	-1.04	-0.03
21-Dec-90	40006	41000	40544	38894	39860	39417	38209	38786	38337	0	0	0	0	39860	0 0 0	5.05	5.79	4.18	5.81	0.87	-0.02
22-Dec-90	35497	36760	36846	34510	35736	35627	33530	35021	35042	0	0	0	0	35736	0 0 0	7.01	5.82	4.13	5.78	2.88	0.04
23-Dec-90	31983	32661	32559	31094	31753	31654	31817	32342	32291	0	0	0	0	31753	0 0 0	7.69	5.85	4.09	5.75	3.60	0.11
24-Dec-90	34050	35180	35131	33103	34202	34154	32844	33505	33585	0	0	0	0	34202	0 0 0	7.41	5.88	4.05	5.72	3.36	0.17
25-Dec-90	25718	25921	26540	25003	25200	25802	24442	25510	25154	0	0	0	0	25802	0 0 0	6.53	5.89	4.01	5.68	2.52	0.21
26-Dec-90	27666	28580	28386	26897	27785	27597	26609	27274	27273	0	0	0	0	27785	0 0 0	6.84	5.91	3.98	5.65	2.86	0.26
27-Dec-90	35800	36320	35797	34805	35310	34802	34597	35370	34803	0	0	0	0	35310	0 0 0	5.74	5.91	3.94	5.62	1.80	0.28
28-Dec-90	37196	37540	36854	36162	36498	35829	35379	36014	35309	0	0	0	0	36498	0 0 0	5.70	5.90	3.91	5.59	1.79	0.31
29-Dec-90	34621	35840	35501	33659	34844	34514	32977	33989	33718	0	0	0	0	34844	0 0 0	5.76	5.90	3.87	5.56	1.89	0.34
30-Dec-90	31290	32470	32598	30420	31567	31692	30084	31335	31336	0	0	0	0	31692	0 0 0	5.20	5.89	3.84	5.54	1.36	0.35
31-Dec-90	36204	37340	36622	35198	36302	35604	35281	36203	35788	0	0	0	0	36302	0 0 0	5.10	5.88	3.81	5.51	1.29	0.37

01-Jan-91	32155	32530	32222	31261	31626	31326	31009	32192	31683		0	0	0	0	31626	0	0	0	4.96	5.86	3.77	5.46	1.19	0.38
02-Jan-91	43895	44060	42703	42675	42835	41516	41926	42403	41251		0	0	0	0	42835	0	0	0	6.70	5.88	3.74	5.45	2.96	0.42
03-Jan-91	44960	45180	43832	43710	43924	42613	43300	43575	42396		0	0	0	0	43924	0	0	0	6.22	5.88	3.71	5.42	2.51	0.46
04-Jan-91	43376	44000	42958	42170	42777	41764	41791	42700	41765		0	0	0	0	42777	0	0	0	5.45	5.87	3.68	5.40	1.77	0.48
05-Jan-91	36441	37640	37656	35428	36788	36609	35690	37561	37263		0	0	0	0	36788	0	0	0	5.23	5.86	3.65	5.37	1.58	0.49
06-Jan-91	34849	35890	35835	33860	34892	34839	33950	34981	34657		0	0	0	0	34892	0	0	0	5.30	5.86	3.62	5.35	1.68	0.51
07-Jan-91	46283	46550	44928	44996	45256	43679	44885	45209	43788		0	0	0	0	45256	0	0	0	4.90	5.84	3.59	5.32	1.31	0.52
08-Jan-91	46316	46940	45351	45028	45635	44090	46027	45712	44202		0	0	0	0	45635	0	0	0	5.08	5.83	3.56	5.29	1.52	0.54
09-Jan-91	46267	46670	44968	44981	45373	43718	45190	45420	44076		0	0	0	0	45373	0	0	0	5.15	5.82	3.53	5.27	1.62	0.55
10-Jan-91	45156	45910	44483	43903	44634	43248	43914	44850	43621		0	0	0	0	44634	0	0	0	5.59	5.82	3.51	5.24	2.08	0.57
11-Jan-91	43868	44560	43320	42648	43321	42118	42539	43464	42703		0	0	0	0	43321	0	0	0	5.23	5.81	3.49	5.22	1.74	0.59
12-Jan-91	36370	38740	38622	35359	37683	37548	35790	37645	37457		0	0	0	0	37683	0	0	0	4.12	5.79	3.46	5.20	0.66	0.59
13-Jan-91	34604	36288	36361	33642	35277	35370	34161	36234	36010		0	0	0	0	35370	0	0	0	2.71	5.74	3.44	5.17	-0.73	0.57
14-Jan-91	46091	47060	45668	44810	45752	44398	45059	46294	45289		0	0	0	0	45752	0	0	0	1.77	5.69	3.42	5.15	-1.65	0.54
15-Jan-91	47009	47890	46538	45702	46559	45244	45410	46570	45405	TRIA	0	1	0	1	46559	1	1	0	1.58	5.64	3.40	5.13	-1.82	0.51
16-Jan-91	46308	47900	46680	45021	46568	45382	45098	46274	45028		0	1	0	1	46568	1	1	0	1.51	5.58	3.38	5.10	-1.87	0.48
17-Jan-91	46154	47180	46073	44871	45868	44792	43437	44831	43836		0	0	0	0	45868	0	0	0	2.58	5.55	3.36	5.08	-0.78	0.47
18-Jan-91	43921	44790	43955	42700	43545	42733	43623	44013	42905		0	0	0	0	43545	0	0	0	3.49	5.52	3.35	5.06	0.14	0.46
19-Jan-91	36266	38040	37855	35258	36982	36803	34171	37034	37212		0	0	0	0	36982	0	0	0	3.69	5.50	3.34	5.04	0.35	0.46
20-Jan-91	33905	35810	35518	32962	34814	34531	32581	34491	34491		0	0	0	0	34814	0	0	0	4.96	5.49	3.33	5.02	1.63	0.47
21-Jan-91	43719	45130	43949	42504	43875	42727	42090	44124	43497		0	0	0	0	43875	0	0	0	5.41	5.49	3.32	5.00	2.09	0.49
22-Jan-91	44014	45350	44084	42790	44089	42858	43657	45312	44444		0	0	0	0	44089	0	0	0	4.39	5.48	3.31	4.98	1.08	0.50
23-Jan-91	44240	45680	44274	43010	44410	43043	43895	45225	44301		0	0	0	0	44410	0	0	0	3.73	5.46	3.30	4.96	0.43	0.50
24-Jan-91	44094	46130	45007	42868	44848	43756	43966	45108	44303		0	0	0	0	44848	0	0	0	3.22	5.43	3.29	4.94	-0.07	0.49
25-Jan-91	43985	44760	43694	42762	43516	42479	42879	44215	43550		0	0	0	0	43516	0	0	0	2.41	5.39	3.28	4.92	-0.87	0.48
26-Jan-91	36502	39160	38951	35487	38071	37868	35836	38129	38264		0	0	0	0	38071	0	0	0	1.93	5.35	3.27	4.90	-1.34	0.46
27-Jan-91	34201	36511	36830	33250	35496	35806	34351	35748	35589		0	0	0	0	35806	0	0	0	1.70	5.31	3.26	4.88	-1.56	0.43
28-Jan-91	44768	46470	45653	43522	45178	44384	44842	45703	44619		0	0	0	0	45178	0	0	0	2.08	5.28	3.25	4.86	-1.17	0.42
29-Jan-91	45565	46920	45967	44296	45616	44669	45854	46449	45473		0	0	0	0	45616	0	0	0	1.73	5.24	3.25	4.84	-1.52	0.39
30-Jan-91	45474	46670	45843	44210	45373	44569	45049	46051	45388		0	0	0	0	45373	0	0	0	1.46	5.20	3.24	4.82	-1.78	0.37
31-Jan-91	45570	46720	45902	44303	45421	44626	44615	45680	45102		0	0	0	0	45421	0	0	0	1.17	5.15	3.23	4.81	-2.06	0.34
01-Feb-91	42638	44830	45120	41453	43564	43866	41491	43410	43533		0	0	0	0	43866	0	0	0	1.46	5.11	3.22	4.79	-1.76	0.32
02-Feb-91	36748	39414	39720	35726	38318	38616	34308	37279	38242		0	0	0	0	38616	0	0	0	1.26	5.07	3.22	4.77	-1.96	0.30
03-Feb-91	33814	35793	36091	32874	34798	35088	32782	35340	36002		0	0	0	0	35088	0	0	0	0.68	5.02	3.21	4.76	-2.53	0.27
04-Feb-91	45427	46510	45454	44164	45217	44190	44651	46220	45962		0	0	0	0	45217	0	0	0	0.31	4.98	3.21	4.74	-2.90	0.23
05-Feb-91	46268	47170	46325	44980	45859	45037	44196	45834	45968		0	0	0	0	45859	0	0	0	0.26	4.93	3.21	4.73	-2.93	0.20
06-Feb-91	47396	48640	48094	46078	47288	46757	45471	46593	46824		0	1	1	1	47288	1	1	0	-0.27	4.87	3.21	4.71	-3.48	0.16
07-Feb-91	45088	47323	47910	43835	46007	46578	46095	47035	46818	TRIA	0	0	1	1	46578	2	0	1	-1.84	4.81	3.21	4.69	-5.05	0.11
08-Feb-91	0	0	0	0	0	0	42228	44258	44981		0	0	0	0	0	0	0	0	-2.11	4.74	3.21	4.68	-5.32	0.06
09-Feb-91	37850	41000	41950	36798	39860	40784	36324	39404	40774		0	0	0	0	40784	0	0	0	-3.10	4.66	3.22	4.67	-6.32	-0.01
10-Feb-91	35805	38804	39445	34810	37725	38348	34147	36147	37735		0	0	0	0	38348	0	0	0	-3.04	4.58	3.23	4.65	-6.27	-0.07
11-Feb-91	45567	47113	47900	44300	45803	46568	42987	44496	45546		0	0	1	1	46568	1	1	0	-2.13	4.52	3.25	4.64	-5.38	-0.12
12-Feb-91	46127	47692	47780	44845	46368	46452	43693	44730	44923		0	1	1	1	46452	2	0	1	-1.98	4.46	3.26	4.62	-5.24	-0.17
13-Feb-91	44891	46422	46760	43843	45131	45460	42312	43494	44725		0	0	0	0	45460	0	0	0	-1.19	4.40	3.29	4.61	-4.48	-0.21
14-Feb-91	43168	44584	46011	41968	43345	44732	41803	43198	44457		0	0	0	0	44732	0	0	0	-1.35	4.35	3.31	4.60	-4.66	-0.25
15-Feb-91	42493	44063	44430	41312	42838	43195	40281	41723	42331		0	0	0	0	43195	0	0	0	0.61	4.31	3.34	4.59	-2.73	-0.27
16-Feb-91	33733	35794	37330	32795	34799	36292	31658	34214	36515		0	0	0	0	36292	0	0	0	1.55	4.29	3.38	4.58	-1.83	-0.29
17-Feb-91	29931	31540	34151	29099	30663	33202	30329	32010	33864		0	0	0	0	33202	0	0	0	1.83	4.27	3.42	4.57	-1.59	-0.30
18-Feb-91	41439	42982	44290	40287	41787	43059	40237	41022	42190		0	0	0	0	43059	0	0	0	2.26	4.25	3.46	4.56	-1.20	-0.31
19-Feb-91	43073	43977	44590	41878	42754	43350	40384	41434	42773		0	0	0	0	43350	0	0	0	1.75	4.22	3.51	4.55	-1.76	-0.32
20-Feb-91	41325	42101	43282	40178	40931	42079	41466	42229	42850		0	0	0	0	42079	0	0	0	2.59	4.21	3.56	4.54	-0.97	-0.33
21-Feb-91	40263	40781	41867	39144	39647	40703	42121	42916	42912		0	0	0	0	40703	0	0	0	3.92	4.21	3.62	4.53	0.30	-0.32
22-Feb-91	38874	39794	41248	37793	38888	40101	40344	41030	41561		0	0	0	0	40101	0	0	0	4.41	4.21	3.68	4.52	0.73	-0.31
23-Feb-91	31706	33183	34798	30825	32261	33631	31210	32959	34934		0	0	0	0	33631	0	0	0	6.83	4.23	3.75	4.52	3.08	-0.28
24-Feb-91	29515	30479	31967	28694	29632	31098	28863	29994	31466		0	0	0	0	31098	0	0	0	8.24	4.27	3.82	4.51	4.42	-0.24
25-Feb-91	39931	40459	41020	38521	39334	39880	38181	38983	39586		0	0	0	0	39880	0	0	0	7.34	4.29	3.90	4.50	3.44	-0.21
26-Feb-91	40737	41022	41383	39605	39882	40233	38414	38800	38994		0	0	0	0	40233	0	0	0	7.86	4.32	3.98	4.50	3.88	-0.18
27-Feb-91	41150	41635	41826	40006	40478	40663	40863	41383	41452		0	0	0	0	40663	0	0	0	6.80	4.34	4.06	4.50	2.74	-0.15
28-Feb-91	40704	40905	41170	39572	39768	40025	38340	38778	39504		0	0	0	0	40025	0	0	0	5.92	4.36	4.14	4.49	1.76	-0.14
											5	8	4	11		7	4							

TOTAL 17

NEED WARNINGS ON 11 DAYS

CATEGORY C1 7
C2 4

to improving the forecast of the minimum triad. The idea was to account for the temperature relationship with peak demands and produce a "temperature corrected" series of minimum triads to further stabilise the trend and produce a forecast of the minimum triad under "normal" temperature conditions. From this the forecast of the minimum triad could be varied according to different temperature scenarios (warm and cold for example) and adapted according to the particular features of any one winter. By temperature correcting the trend observed in the growth in demand of the minimum triad, the demand resulting from the effect of temperature can be separated from other influences on demand growth.

515 The regression coefficients arrived at in section 4 refer to the relationship between national weighted average temperatures as the independent variable (X) and the equivalent days demand from the highest 20 demands between 16:30 and 18:00 as the dependent variable (Y) for each of the winters between 1986/87 and 1990/91. If these same demands are regressed against the "normal" UK effective temperature then from the regression coefficients, a simple estimate of demand at "normal" temperatures can be calculated. Warm and cold scenarios were developed by repeating the same process and adjusting the "normal" temperature series by adding and subtracting 1 degree celsius to/from the days normal temperature. Table 7 details the results of this exercise and provides an indication of the demand level associated with the triads under the simulated normal, warm and cold temperature scenarios against the outturn demands under the actual temperature conditions. It was appreciated that by correcting the top 20 demands in any one year by this method, the times and dates of the triads may indeed change under these artificial conditions; producing new peaks at different dates. However, this analysis is primarily concerned with correcting the demands associated with the actual triads.

Table 7: Temperature corrected triad demands

Year	Date	Actual Demand	Normal Scenario	Warm Scenario	Cold Scenario
1990/91	07/02	47,035	46,064	45,925	46,203
	15/01	46,570	46,038	45,898	46,177
	18/12	46,556	45,911	45,772	46,050
1989/90	11/12	46,714	45,686	45,273	46,099
	28/11	46,650	45,385	44,972	45,797
	29/01	44,948	46,276	45,864	46,689
1988/89	22/11	46,880	44,785	44,381	45,190
	06/12	46,020	45,133	44,729	45,538
	25/01	45,219	45,813	45,468	46,217
1987/88	15/12	46,935	44,734	44,190	45,278
	01/12	44,965	44,315	43,772	44,859
	12/01	44,486	45,283	44,739	45,827
1986/87	12/01	47,925	43,315	42,705	43,726
	17/12	43,444	42,756	42,245	43,226
	27/01	43,187	43,317	42,807	43,828

Source: National demand data and output of analysis based on the regression coefficients detailed in section 4.

516 These new series of triad demands were exponentially smoothed according to peak demand, "median" triad, and "minimum" triad series. Forecasts were then made to predict each of the triads at normal, cold and warm temperature scenarios for the winter of 1990/91 using the period to 1989/90 to ensure the forecast was not made within the sample period. The technique used was again double parameter exponential smoothing of the revised demand series similar to that illustrated in figure 5. A similar data simulation exercise was undertaken in order to assess the accuracy of the triad forecasting procedure when adopting a forecast of the minimum triad at "normal" temperatures. Having Adopted the temperature corrected forecast of the minimum triad for 1990/91 and comparing the day ahead predictions of peak demand with this forecast, there were 17 half hours at the tea time periods in which the adjusted forecast demand exceeded the

forecast minimum triad. Consequently 11 triad warnings would have been issued covering a period of 13 hours and successfully identifying all 3 triads.

Resume

517 This describes the results of the triad forecasting simulation when taking a view of the minimum triad at "normal" temperatures. The idea was explored of utilising average UK effective temperature for 5 (as opposed to 15) weather stations and adjusting the weather sensitive sales weights accordingly. If a running average of the winters effective UK temperature was maintained, this could be compared with the long run UK normal effective temperature series. The demand level of the minimum triad could then be varied according to whether the winter of a particular year was normal, warm or cold. Thus in colder winters, the likelihood is that peaks in demand would be higher and consequently the demand level of the minimum triad would be higher. Thus unnecessary warnings would be issued if the minimum triad was forecast under normal temperature conditions only.

The triad forecasting system

518 Thus, the system devised ensured that when the forecast level of system demand received on a day ahead basis is significantly associated with a level of demand about which a triad could occur (taking into consideration the particular winters temperature), a warning would be issued to customers. In order to provide an indication of the probability of the likelihood of a triad occurring, two categories of warning were devised;

- CATEGORY 1; when the predicted level of demand is significant and likely to result in a triad; and
- CATEGORY 2; which were to be issued on applicable consecutive days after previous category 1 or category 2 warnings if the predicted level of demand for the day is

significant and a triad is likely, but is less significant than the previous day's demand ie. if the adjusted demand forecast exceeds the forecast of the minimum triad but is less than the forecast for the previous day which also exceeded the demand threshold.

519 To simplify the issue, the likelihood of a triad occurring was not quantified. The advice was given to customers to always act upon category 1 warnings if they wished to avoid triad charges. If possible they should always act upon category 2 warnings given that errors in the predictions of system demand meant triads could still occur on designated category 2 days, even though the demand forecast was lower than the previous day. Since final settlement demand data was not available until 28 days after the day of trading, another source of indicative demand data was sought to provide an indication of the previous days level of demand. This source of data (the industry definition being "indicative AGCAD demand" data) was available from NGC on the day after trading and provided an estimate of the previous days demand by half hour. This definition of demand differs slightly from the national metered demand definition used for determining the dates and times of the triads. A comparison of this data with final settlement data reveals a tendency to overstate demand (given the metering point at which this data is calculated), however for the purpose of operating the triad forecasting system, this data proved sufficient as an indication of the previous day's peak demands. It provided a means of initially assessing the accuracy of demand forecasts and enabled one to discount particular days as qualifying as a triad by counting 10 days between peaks. Nevertheless, the data had to be viewed with caution since the triads are determined on the basis of final settlement data.

520 On the basis of the analysis of historical demand data, it was intended that triad warnings would cover the hour between 16:30 and 17:30 in November and December and between 17:00 and 18:00 in January and

February. However the actual timing and duration of the warnings would obviously depend upon the adjusted demand forecasts.

521 Applying this procedure to the simulated winter of 1990/91, there were 17 half hours between 17:00 and 18:00 in which the predicted level of demand was likely to result in the occurrence of a triad. The forecast of the minimum triad was taken as the demand under "normal" temperature conditions (1990/91 was deemed as a normal winter with a running average UK effective temperature between November and February of 5.15 degrees celsius compared to an normal running average of 4.9 degrees celsius). As a result 11 triad warnings would have been issued, 7 category 1 warnings and 4 category 2 warnings. All 3 triads were successfully identified by the 11 warnings but as a result if a demand forecasting error one of the triads occurred on a category 2 warning day.

522 Thus an overall system for predicting the occurrence of triads had been devised and tested. The service was sold to the interested non franchise customer base of Norweb for the winter of 1991/92 at a nominal charge given the system had yet to be put into practise under real conditions. Warnings were to be issued by fax to customers the day before a triad is deemed likely to occur and could be expected by customers up to and over 24 hours in advance of the time period identified (Appendix 4 contains copies of the actual faxes transmitted on both category 1 and category 2 warning days). It was hoped that fewer than 20 triad warnings would be issued over the full period, and of these between 15 and 30 per cent were anticipated to be category 2 warnings. Having anticipated that the active participation of customers was likely to affect the forecasts of demand but that this effect had not been modelled, a "health warning" was issued to customers;

> *"it should be noted that the "normal" circumstances under which the triad forecast are made will be subject to the "abnormal" influence of*

customers acting upon triad warnings. As such the effectiveness and accuracy of the issued warnings may be affected."

523 This health warning, and legal disclaimer, recognised the fact that as a result of the way in which triads are determined, a sufficient reduction in demand in response to a triad warning may negate the likelihood of a triad actually occurring. However, without actually knowing how much load was likely to be reduced, on a nationwide not just a local scale, this effect could not be predicted. The effect of this became apparent during the winter of 1992/93 when the "gaming" situation emerged. The practical experience of this triad prediction system is explained below.

Triad forecasting in practice

524 This subsection describes the operation of the defined triad forecasting procedure during the winters of 1991/92 and 1992/93. The year 1992/93 will be explored in some detail to emphasise the effect of the action of customers to triad warnings upon forecasts of demand.

525 In a "real world" situation, the results of any analysis and recommendations based upon such analytical conclusions are sometimes simplified to account for managerial and policy decisions. The recommendations relating to the triad forecasting system to be launched in the winter of 1991/92 were subsequently subject to such decisions and the detail of the system was simplified to take account of company policy and to ensure that the customer understood fully the operations of the system.

526 The concept of the "minimum triad" was adhered to, with warnings being issued when the day ahead forecast of demand (after adjusting for any error) exceeded the estimate of the minimum triad. However, the demand level of the forecast minimum triad was "agreed" rather than truly forecast. Forecasts of the minimum level of triad demand were made using

the methodology described in the previous section with the results being rounded to the nearest (and lowest) 1,000 MW. Also, in practise it was agreed that there was to be no variation in the level of this demand based upon temperature conditions and the calculation that the winter was either "normal", "cold" or "warm". Hence in both of the demonstration years (1991/92 and 1992/93) warnings were generally called when the adjusted forecast of demand received from NGC on a day ahead basis exceeded 46,000 MW.

527 Warnings were only issued around the tea time peaks, even if forecasts exceeded the minimum level at other times of the day. If forecasts were high at other times of the day they were always higher between 16:30 and 18:00 as a rule.

528 Thus in the first year of operation, 1991/92, 12 triad warnings were issued covering a total of 10.5 hours with 10 Category 1 warnings and 2 Category 2 warnings. Two out of the three triads were correctly identified as a result of this system. Warnings were issued for the following dates:

- Monday 9 December 16:30 to 17:30;
- Tuesday 10 December 16:30 to 17:30;
- Wednesday 11 December 16:30 to 17:30;
- Thursday 12 December 16:30 to 17:30;
- Monday 13 January 16:30 to 17:30;
- Tuesday 14 January 16:30 to 17:30;
- Tuesday 21 January 17:00 to 17:30;
- Wednesday 22 January 17:00 to 18:00;
- Thursday 23 January 17:00 to 18:00;
- Monday 27 January 16:30 to 17:30;
- Tuesday 28 January 17:00 to 17:30; and
- Wednesday 29 January 17:00 to 17:30.

529 The triads occurred on the following dates and at the corresponding levels of demand:

- 21 November 1991 at time period 35 (45,150 MW);
- 11 December 1991 at time period 35 (47,289 MW); and
- 23 January 1992 at time period 35 (45,766 MW).

530 A warning was not called for the triad which occurred on 21 November as the forecast of demand was only 44,920 MW for the same time period. After being revised down by an average error element of 2.78%, the forecast was well below the minimum triad threshold. This triad would never have been predicted in advance on the basis of this under forecast element. To have done so would have required a much lower minimum triad threshold and consequently many more warnings. This would have rendered impracticable the triad forecasting service and would have considerably reduced the effectiveness of the overall service. It serves to emphasise the difficulty in predicting such circumstances and the need to keep to a minimum the number of warnings issued in order to provide minimum inconvenience to customers.

531 On the 11 December 1991 at time period 35 the forecast of demand was 47,750 (46,423 MW after revision). Thus the actual forecast error was only some 1%. Indeed on the basis of forecast demands received from NGC (on the day ahead Q0 definition) forecast errors against actual demands for the tea time periods were consistently around the 2% over forecast mark (the under forecast on 21 November being very much an exception).

532 Despite not predicting one of the triads, the forecasting service was regarded as a success for the first year of operation. From industry sources, Norweb were regarded as having issued fewer triad warnings than other RECs and correctly identified 2 out of 3 triads which was generally regarded as acceptable by customers. Section 7 details the reaction of some

30 customers across a range of sizes and classifications of industry to the triad warnings issued during the winter of 1991/92.

The experience of 1992/93

533 Following the success of the 1991/92 triad forecasting service, the number of customers subscribing to the service increased from around 60 to 150, the price of the service was substantially increased to customers (from around £50 per year to £50 per month including additional information services) and an increasing number of RECs decided to participate in offering similar triad forecasting services (although the true number of services being offered is unknown). Indeed, industry sources suggested that the number of customers subscribing to other triad forecasting services substantially increased on a scale similar to that experienced by Norweb.

534 The combined effect of these factors had a major impact upon the accuracy of demand forecasts as the following analysis demonstrates.

535 During the winter of 1992/93 19 triad warnings were issued covering a total of 15.5 hours. Again however, only two out of three triads were identified. This represents a substantial increase on the number of warnings issued in the previous year but the success of the service was not improved.

536 Table 8 shows the days and time periods for which triad warnings were issued including the forecasts of demand and two measures of "actual" demand (the AGCAD definition providing an indication of the demand level received on the day after trading and the "final run" received through the Electricity Contracts Management System (ECMS) 28 days after trading). Daily maximum and minimum temperature readings from Ringway weather station in Manchester are also noted.

537 The triads occurred on the following days and time periods:

Table 8: 1992/93 Triad Warning Analysis

FORECAST AND ACTUAL DEMAND DATA : WINTER 1992/93 WARNING DAYS

FORECAST Q0 DEMANDS FROM NGC

Half hour ending:

		16:30	17:00	17:30	18:00	18:30
1	17/11/92	42,859	45,205	45,580	43,927	42,528
2	18/11/92	42,642	45,569	45,810	44,287	43,018
3	07/12/92	44,745	46,100	46,089	44,583	43,467
4	08/12/92	44,622	46,200	46,055	44,845	43,605
5	16/12/92	44,185	45,804	45,800	43,916	42,654
6	17/12/92	44,156	45,568	45,580	44,428	43,366
7	04/01/93	42,681	45,114	45,590	44,356	43,101
8	05/01/93	44,198	46,297	46,510	44,940	43,641
9	06/01/93	43,866	45,179	45,250	43,572	42,449
10	11/12/93	42,066	44,741	45,550	44,056	42,727
11	12/01/93	43,783	46,143	46,690	45,109	43,623
12	13/01/93	43,563	45,759	46,200	44,760	43,466
13	14/01/93	41,996	44,532	45,660	44,542	43,486
14	19/01/93	41,228	43,601	45,580	44,342	43,077
15	20/01/93	42,340	44,560	45,240	43,864	42,553
16	25/01/93	41,245	43,048	45,630	44,682	43,062
17	26/01/93	41,882	43,757	45,810	44,938	43,522
18	27/01/93	41,174	42,944	45,270	44,345	43,276
19	02/02/93	41,463	43,306	45,020	44,360	43,090

Warning periods shaded

AGCAD DEMANDS

Half hour ending:

16:30	17:00	17:30	18:00	18:30
41,351	44,208	44,655	43,309	42,134
41,799	43,709	43,802	42,496	41,659
42,157	42,764	43,380	42,604	41,822
42,571	43,775	43,821	43,234	42,401
42,091	42,933	42,994	42,362	41,597
43,202	43,913	43,604	42,898	42,290
43,358	44,659	44,867	43,651	42,790
43,034	44,241	43,954	42,773	41,912
42,633	44,014	44,102	42,897	41,851
41,379	43,169	43,718	43,013	42,095
42,191	43,916	44,595	43,796	43,047
42,932	43,976	44,121	43,433	42,310
40,230	42,886	43,698	42,943	42,137
41,239	43,047	43,688	42,953	42,166
39,924	42,087	43,268	42,666	41,573
40,241	41,850	43,556	42,796	42,428
42,675	44,147	44,415	43,180	42,744
41,098	42,991	43,864	42,776	41,837
38,272	39,845	42,387	42,553	41,963

ACTUAL NATIONAL DEMANDS FROM ECMS : FINAL RUN (3)

Half hour ending:

16:30	17:00	17:30	18:00	18:30
41,427	44,210	44,638	43,256	42,114
41,557	43,414	43,426	42,111	41,350
41,687	42,946	42,981	42,205	41,506
42,345	43,472	43,481	42,907	42,139
41,824	42,614	42,613	42,051	41,306
42,878	43,548	43,231	42,506	41,926
42,918	44,214	44,334	43,125	42,312
42,667	43,606	43,320	42,063	41,232
42,325	43,589	43,574	42,422	41,353
41,138	42,860	43,344	42,638	41,754
42,005	43,567	44,206	43,375	42,620
42,627	43,560	43,663	42,630	41,933
39,993	42,647	43,333	42,577	41,785
40,912	42,876	43,287	42,523	41,733
39,773	41,775	42,982	42,333	41,235
40,008	41,851	43,229	42,408	42,080
42,568	43,842	44,087	42,709	42,290
40,977	42,772	43,491	42,387	41,523
38,090	39,666	42,083	42,225	41,638

Triads shaded (omitting Triad occuring 9/12/92)

RINGWAY TEMPERATURES

HIGH	LOW	AVERAGE
6	2	4
11	1	6
8	4	6
7	2	4.5
6	6	6
5	-1	2
5	0	2.5
10	2	6
7	5	6
6	1	3.5
6	0	3
7	1	4
7	1	4
7	3	5
13	9	11
5	2	3.5
9	-2	3.5
7	4	5.5
11	2	6.5

- 17 November 1992 at time period 35 (44,638 MW);
- 9 December 1992 at time period 35 (44,261 MW); and
- 4 January 1993 at time period 35 (44,344 MW).

538 All three triads occurred at much lower demands than the forecast or agreed minimum triad demand level. Indeed, warnings were issued at much lower levels of demand than the agreed threshold of 46,000 MW through intuition rather than mathematical analysis. Hence a warning was issued for 17 November when the peak (unadjusted) forecast was 45,580 MW since this represented a high demand for November and a warning was issued to account for this and the possibility that a triad could occur in that month.

539 Table 9 presents an analysis of demand forecast errors for the winter of 1992/93 in an attempt to explain the resulting situation. In November the average forecast error across the period half hour ending 16:30 to half hour ending 18:30 was 2%. This was 3.4% in December, 3.1% in January and 2.7% in February.

540 Table 10 presents an analysis of the day ahead demand forecasting errors corresponding to the half hours of the triad warning days and for the periods for which triad warnings were issued. In the half hour to 17:30 (for which a warning was issued in all 19 days), the forecast error was an average of 5.3% and was as high as 7.4% on 5/1/93. This represents a substantial over forecast (7.4% represents over 3,000 MW).

541 However, experience suggests that these errors were not purely a result of bad forecasting. The forecasts were made under "normal" conditions based upon empirical relationships between dates, times of day and weather conditions. These relationships can be regarded as robust on the basis of previous empirical data and analysis. It is more likely that the effect of numerous electricity supply companies offering incentives for companies to reduce their demand for electricity at peak times and that a

Table 9

FORECAST ERRORS : WINTER 1992/93

FORECAST Q0 DEMANDS FROM NGC/FINAL DEMANDS

Half hour ending;

	16:30	17:00	17:30	18:00	18:30
01/11/92	7.0%	5.8%	3.6%	3.7%	4.1%
02/11/92	3.8%	2.5%	0.9%	0.4%	0.7%
03/11/92	2.4%	1.6%	1.0%	0.7%	0.0%
04/11/92	4.9%	3.6%	1.8%	0.8%	1.5%
05/11/92	8.4%	5.6%	4.6%	3.5%	4.3%
06/11/92	3.5%	4.0%	3.5%	2.7%	2.8%
07/11/92	-2.0%	0.4%	1.6%	1.7%	2.6%
08/11/92	2.9%	1.8%	0.9%	2.1%	2.2%
09/11/92	-3.8%	-0.8%	0.6%	1.4%	1.6%
10/11/92	9.7%	4.7%	1.5%	0.7%	0.2%
11/11/92	2.5%	2.2%	1.4%	0.6%	0.5%
12/11/92	4.0%	2.7%	2.5%	2.0%	1.8%
13/11/92	4.5%	2.1%	1.4%	0.8%	0.8%
14/11/92	-3.9%	-0.9%	0.1%	0.5%	1.2%
15/11/92	0.5%	1.6%	2.1%	2.3%	2.0%
16/11/92	2.9%	2.2%	1.5%	1.3%	1.1%
17/11/92	3.5%	2.3%	2.1%	1.6%	1.0%
18/11/92	2.6%	5.0%	5.5%	5.2%	4.0%
19/11/92	5.5%	4.7%	3.9%	3.4%	3.1%
20/11/92	5.4%	4.6%	4.4%	4.5%	4.3%
21/11/92	-2.7%	-0.5%	0.8%	1.9%	2.1%
22/11/92	-1.0%	0.5%	2.2%	2.2%	2.1%
23/11/92	-0.3%	0.6%	0.6%	0.4%	0.2%
24/11/92	-2.5%	-0.7%	-0.2%	0.3%	0.3%
25/11/92	1.6%	1.5%	1.3%	1.6%	1.2%
26/11/92	3.0%	2.3%	1.9%	1.5%	1.2%
27/11/92	-0.4%	2.0%	3.2%	3.3%	3.0%
28/11/92	3.4%	0.7%	0.3%	1.0%	1.1%
29/11/92	-0.4%	-0.1%	0.0%	0.3%	0.8%
30/11/92	2.5%	3.4%	3.2%	2.8%	2.4%
01/12/92	3.3%	4.9%	4.8%	2.3%	1.3%
02/12/92	1.2%	1.6%	1.5%	1.5%	2.0%
03/12/92	2.4%	4.7%	5.1%	3.5%	2.9%
04/12/92	4.4%	3.0%	2.9%	2.7%	2.7%
05/12/92	3.9%	3.7%	3.3%	2.9%	3.1%
06/12/92	-0.4%	0.9%	0.7%	1.4%	1.5%
07/12/92	6.8%	7.3%	7.2%	5.6%	4.7%
08/12/92	5.4%	6.3%	5.9%	4.5%	3.5%
09/12/92	2.0%	3.0%	3.1%	1.7%	0.9%
10/12/92	0.4%	2.1%	2.6%	1.3%	1.3%
11/12/92	0.1%	1.3%	1.9%	2.3%	2.3%
12/12/92	4.3%	4.0%	3.4%	3.5%	3.6%
13/12/92	4.1%	3.3%	2.8%	3.2%	4.0%
14/12/92	1.6%	2.1%	2.0%	1.4%	2.6%
15/12/92	-0.5%	0.8%	1.1%	0.9%	1.0%
16/12/92	5.6%	7.0%	7.5%	4.4%	3.3%
17/12/92	3.0%	4.6%	5.4%	4.5%	3.4%
18/12/92	-0.9%	0.3%	-0.1%	-0.2%	0.2%
19/12/92	1.4%	1.7%	2.3%	2.9%	2.9%
20/12/92	5.2%	3.7%	4.2%	3.6%	3.1%
21/12/92	1.3%	1.8%	2.3%	2.8%	3.0%
22/12/92	4.6%	3.8%	3.4%	2.6%	2.4%
23/12/92	3.5%	2.7%	3.1%	2.6%	2.7%
24/12/92	-0.2%	0.2%	0.1%	0.1%	0.2%
25/12/92	5.4%	8.1%	8.7%	8.7%	9.4%
26/12/92	5.2%	6.6%	7.3%	7.7%	7.3%
27/12/92	12.8%	10.2%	7.8%	8.1%	8.0%
28/12/92	13.1%	9.6%	8.8%	8.3%	8.4%
29/12/92	4.8%	3.6%	4.6%	4.2%	4.2%
30/12/92	-1.1%	-0.9%	-0.0%	0.3%	0.8%
31/12/92	1.6%	1.5%	1.2%	2.4%	3.3%

Nov av:	2.2%	2.2%	1.9%	1.8%	1.8% **Total:**	2.0%
Dec av:	3.4%	3.7%	3.7%	3.3%	3.2% **Total:**	3.4%

Table 9 (continued)

FORECAST Q0 DEMANDS FROM NGC/FINAL DEMANDS

Half hour ending;

	16:30	17:00	17:30	18:00	18:30
01/01/93	5.7%	4.5%	5.5%	3.0%	1.8%
02/01/93	-0.3%	-0.7%	0.4%	1.1%	2.2%
03/01/93	4.8%	3.3%	2.5%	3.1%	2.7%
04/01/93	-0.6%	2.0%	2.8%	2.9%	1.9%
05/01/93	3.6%	6.2%	7.4%	6.8%	5.8%
06/01/93	3.2%	3.6%	3.8%	2.7%	2.7%
07/01/93	1.7%	2.2%	2.8%	1.7%	1.3%
08/01/93	2.5%	2.5%	2.8%	2.3%	2.7%
09/01/93	2.7%	2.6%	3.7%	4.2%	3.5%
10/01/93	2.1%	3.0%	2.5%	2.9%	2.6%
11/01/93	2.3%	4.4%	5.1%	3.3%	2.3%
12/01/93	4.2%	5.9%	5.6%	4.0%	2.4%
13/01/93	2.2%	5.0%	5.8%	4.5%	3.7%
14/01/93	5.0%	4.4%	5.4%	4.6%	4.1%
15/01/93	5.3%	4.1%	4.1%	4.0%	3.7%
16/01/93	2.9%	3.3%	2.8%	2.9%	2.0%
17/01/93	8.5%	5.0%	2.8%	3.0%	2.1%
18/01/93	2.8%	1.4%	2.3%	1.9%	2.0%
19/01/93	0.8%	2.2%	5.3%	4.3%	3.2%
20/01/93	6.5%	6.7%	5.3%	3.6%	3.2%
21/01/93	0.5%	1.8%	3.1%	3.2%	2.5%
22/01/93	5.3%	5.6%	3.2%	2.4%	2.6%
23/01/93	-0.8%	1.4%	2.0%	2.0%	2.7%
24/01/93	0.2%	0.5%	0.5%	1.6%	0.9%
25/01/93	3.1%	3.4%	5.6%	5.4%	2.3%
26/01/93	-1.6%	-0.2%	3.9%	5.2%	2.9%
27/01/93	0.5%	0.4%	4.1%	4.6%	4.2%
28/01/93	2.6%	2.0%	2.5%	3.0%	2.6%
29/01/93	0.3%	-0.1%	1.0%	1.0%	1.5%
30/01/93	1.6%	1.7%	1.7%	3.2%	2.6%
31/01/93	5.9%	3.9%	4.0%	4.7%	3.9%
01/02/93	2.5%	1.7%	3.7%	4.1%	3.0%
02/02/93	8.9%	9.2%	7.0%	5.1%	3.5%
03/02/93	2.9%	3.0%	4.4%	4.3%	3.7%
04/02/93	-1.9%	-1.6%	-0.1%	1.7%	1.5%
05/02/93	-1.5%	-1.6%	-0.3%	-0.5%	-0.3%
06/02/93	1.0%	1.4%	3.0%	5.3%	4.8%
07/02/93	5.2%	7.3%	9.7%	8.8%	9.1%
08/02/93	-0.4%	1.2%	2.9%	2.9%	3.0%
09/02/93	-3.3%	-3.2%	0.7%	1.2%	1.8%
10/02/93	-1.0%	-0.8%	0.2%	0.7%	1.2%
11/02/93	-1.8%	-1.6%	-0.8%	1.9%	2.5%
12/02/93	4.1%	4.1%	3.7%	3.2%	3.1%
13/02/93	3.3%	3.1%	2.1%	3.5%	3.5%
14/02/93	1.8%	0.4%	-0.7%	2.3%	2.5%
15/02/93	2.3%	1.6%	1.9%	2.7%	3.1%
16/02/93	3.5%	3.0%	3.0%	3.4%	3.1%
17/02/93	1.0%	0.8%	0.2%	1.4%	3.5%
18/02/93	1.8%	1.3%	1.5%	2.1%	3.2%
19/02/93	5.3%	5.0%	4.3%	4.4%	4.0%
20/02/93	7.1%	7.1%	5.0%	3.7%	3.2%
21/02/93	5.3%	4.5%	4.3%	2.5%	0.8%
22/02/93	-0.5%	-1.4%	-0.5%	0.9%	3.2%
23/02/93	3.6%	3.0%	2.6%	3.5%	3.3%
24/02/93	3.4%	2.7%	2.0%	2.0%	4.5%
25/02/93	3.0%	2.7%	2.5%	3.2%	3.9%
26/02/93	4.3%	4.4%	4.5%	4.3%	4.7%
27/02/93	4.9%	4.2%	2.6%	2.6%	2.9%
28/02/93	0.2%	3.1%	3.7%	3.1%	2.2%

Jan av:	2.7%	3.0%	3.6%	3.3%	2.7%	**Total:**	3.1%
Feb av:	2.3%	2.3%	2.6%	3.0%	3.2%	**Total:**	2.7%

Table 10

FORECAST ERRORS : WINTER WARNING DAYS 1992/93

FORECAST Q0 DEMANDS FROM NGC/FINAL DEMANDS

Half hour ending;

		16:30	17:00	17:30	18:00	18:30
1	17/11/92	3.5%	2.3%	2.1%	1.6%	1.0%
2	18/11/92	2.6%	5.0%	5.5%	5.2%	4.0%
3	07/12/92	6.8%	7.3%	7.2%	5.6%	4.7%
4	08/12/92	5.4%	6.3%	5.9%	4.5%	3.5%
5	16/12/92	5.6%	7.0%	7.5%	4.4%	3.3%
6	17/12/92	3.0%	4.6%	5.4%	4.5%	3.4%
7	04/01/93	-0.6%	2.0%	2.8%	2.9%	1.9%
8	05/01/93	3.6%	6.2%	7.4%	6.8%	5.8%
9	06/01/93	3.2%	3.6%	3.8%	2.7%	2.7%
10	11/12/93	2.3%	4.4%	5.1%	3.3%	2.3%
11	12/01/93	4.2%	5.9%	5.6%	4.0%	2.4%
12	13/01/93	2.2%	5.0%	5.8%	4.5%	3.7%
13	14/01/93	5.0%	4.4%	5.4%	4.6%	4.1%
14	19/01/93	0.8%	2.2%	5.3%	4.3%	3.2%
15	20/01/93	6.5%	6.7%	5.3%	3.6%	3.2%
16	25/01/93	3.1%	3.4%	5.6%	5.4%	2.3%
17	26/01/93	-1.6%	-0.2%	3.9%	5.2%	2.9%
18	27/01/93	0.5%	0.4%	4.1%	4.6%	4.2%
19	02/02/93	8.9%	9.2%	7.0%	5.1%	3.5%
	Average	3.4%	4.5%	5.3%	4.4%	3.3%
	Warning	N/A	5.0%	5.3%	5.2%	N/A

Warning periods shaded

wide customer base participating acted to substantially reduce the demand for electricity that would have been anticipated had these incentives to reduce demand not existed.

542 The triad which was not identified (9 December 1992) corresponded with a forecast of demand of 45,491 MW when the two previous days (for which warnings were issued) were subject to forecasts exceeding 46,000 MW. Hence it was anticipated that if a triad was to occur during this particular week, it was more likely to occur on one of the previous days. This again emphasises the difficulty in attempting to make such prediction but also shows the interdependence between the actions of the REC and it's customer set - the very act of not providing a triad warning meant 150 customers did not reduce demand and the outcome was a higher level of demand (which ironically qualified as a triad) than would otherwise have been the case. This indeed suggests an emerging "gaming" situation.

The game situation defined

543 This situation can be placed into the context of a strategic game - although not in the classical context. The interaction of competing firms (who are the RECs offering the triad forecasting service) combined with the active participation of customers (who are acting upon triad warnings by reducing demand for the purpose of financial reward) has influenced the objective of the initial action (which was to forecast a peak demand period which was likely to be classified as a triad) and consequently the perceived outcome (the triad peaks were much lower in 1992/93 and did not take place when they were deemed most likely to).

544 In the context of a strategic game, the "players" of the game and the instigators of the strategy are the competitive firms (the RECs and private generating companies). Their strategies involve offering a triad warning service to customers with the aim of both identifying triads in advance of

their occurrence and of providing a more accurate and targeted service (ie fewer warnings issued to customers) than their competitive rivals.

545 However, within this game situation there is an added dimension - the "participating agents" who are the non franchise customers acting upon the advice of the strategists and who reduce demand in order to reduce costs. It is both the players and the participating agents who share the potential material winnings from the game. RECs obtain unregulated income from the sale of the service to customers and if they offer a uniquely better service than other RECs gain an element of competitive advantage. Non franchise customers, if they act upon correct advice, can make substantial financial savings by reducing a portion of their energy costs.

546 In 1990/91, it was appreciated that the interaction of both "players" and "participating agents" could influence demand forecasts (hence the "health warning" provided to customers stated on the actual triad warnings, examples of which are illustrated in Appendix 4). However, without empirical evidence and with little idea about the scale of demand reduction, the predictions made and warnings issued did not fully account for any interaction. With few players and participating agents, the subsequent actions of both parties were assumed to have a minimal adverse influence upon any forecast of demand and prediction of a triad. Indeed, the small forecasting errors made during the winter of 1990/91 suggested this was indeed the case.

547 In 1992/93, the market became increasingly active and new "players" entered into the market offering rival triad forecasting services. With more players, more participating agents too entered the market and hoped to reap the financial rewards of avoiding triad charges. The overall outcome of this was to severely distort a carefully calculated situation. In the first year of operation, the outcome of the triad forecasting "strategy" could be modelled with a degree of certainty. However, the success of the strategy

led to the proliferation in both the number of players offering rival but parallel strategies and an increasingly interested and participating customer base.

548 In 1992/93 the whole concept of forecasting triads became a much more difficult issue. Peak demands were much lower than were anticipated (and this is after taking into account the effects of weather which as section 3 describes is already rigorously accounted for in the forecasts of demand which are made). Also, forecasting "errors" were much larger - in excess of 7% against a long run average of around 2 to 3% at the peak period. This does indeed suggest that the forecasting errors were not purely a result of poor demand forecasts due to poor weather predictions for example (an element of this is always likely) but were related to the effect of customers reducing demand in response to triad warnings. The systems designed to forecast demand were meant to operate under "normal" circumstances ie having taken into account empirical weather, time and demand relationships. However, the reduction of demand in response to triad warnings introduced an "abnormal" element into the equation that had not been accounted for within the demand forecast algorithms.

549 The actions of an increasingly interested and participating customer base effected both the accuracy of demand forecasts issued and consequently the accuracy of the triad forecasting service offered - with more warnings being issued in 1992/93 and only 2 out of 3 triads correctly identified by Norweb.

550 Indeed, an important element to this game situation is the strategic action of the RECs and electricity generating companies offering triad warning services. This in part explains both the pattern and number of warnings issued and indeed may explain the occurrence of the triad on 9 December 1992, for which Norweb did not issue a triad warning.

551 Within the industry, the RECs have some knowledge of the actions of competing RECs. In this case, it was possible to find out when certain other RECs had issued triad warnings. Once the effect of both RECs issuing triad warnings and the action of customers reducing their demand in response to these warnings became apparent during November 1992, an attempt was made to incorporate any knowledge about the actions of other RECs into the triad forecasting strategy. If the forecast of demand was such that the likelihood of a triad occurring was only marginal - and given the knowledge that other RECs had issued warnings in anticipation of a potential triad - this was taken into account and a warning was not necessarily issued. It was assumed that the very act of other RECs issuing a warning and with customers acting upon these warnings that the outturn demand was likely to be significantly less than the (marginal) forecast of demand and hence was unlikely to qualify as a triad.

552 This process was incorporated into the strategy but was not modelled in a formal sense. However, the significance of this interaction is such that it is possible that the very act of Norweb not issuing a warning for 9 December 1992 ensured that Norweb's customer base did not reduce their demand and that the peak that occurred in the half hour ending 17:30 of that day qualified as a triad. Indeed, warnings were issued by Norweb for both the 7th and 8th of December (between 16:30 and 17:30 pm) when the unadjusted peak forecasts of demand were 46,100 MW and 46,200 MW for the half hour to 17:00 for both days respectively. On these days the final outturn peak demand was some 42,946 MW and 43,821 MW for each respective day (an over forecast of some 3,154MW (7%) and 2,379 (5%) for each respective day). The unadjusted peak forecast for 9 December 1992 was 45,580 MW and the outturn demand at 44,261 MW represented an over forecast of only 1,319 MW (3%).

553 Had Norweb issued a warning for the 9th of December it is likely that the outturn demand would have been significantly lower and that the peak that occurred on that day may not have actually qualified as a triad.

This in itself emphasised the significance of the interaction of competing RECs on the outcome of individual strategies aimed at forecasting triads. It is likely that such interaction requires formal modelling, taking into account the theoretical frameworks and techniques presented in section 2 in order to ensure an optimum outcome to a triad prediction strategy.

554 Indeed, this section presents the practical experience of the author in the field of triad prediction. It is evident that a situation which could be described as strategic gaming has emerged since the actions of any one firm are influenced not only by his own strategy but also by the actions of other competing firms and the customers who are acting on the advice of the strategy. The actions of both competing firms and the active customer base are indeed influencing the outcome of any individual strategy.

555 The extent to which customers reduced their demand in response to warnings is dealt with thoroughly in the following section. This represents a unique piece of analysis since numerous industrial/commercial categories of customer and size of customer are analysed to assess the demand responsiveness of their electricity consumption to triad warnings. The results of this analysis emphasise the extent to which certain types of customer did indeed respond to triad warnings. If this experience was repeated country wide it provides an important degree of explanation and justification for the assumption that demand forecasts were subject to severely abnormal circumstances.

Summary

556 This section has described how the subject of forecasting triads emerged as a business requirement, how a modelling solution was devised and how a procedure was enacted by one REC alongside an analysis of this procedure in practise over two winter periods. It has also described how the success of the procedure over the first year of operation led to both a proliferation in the number of RECs offering triad warning services

and how the increase in the number of customers subscribing to these services severely distorted the outcome of the initial analysis upon which the procedure was developed and consequently the overall effectiveness of the service.

557 Furthermore, an attempt has been made to place the situation into the context of a strategic game, based upon the academic literature which supports both classical game theory analysis and the area of statistical decision theory. The initial modelling solution was based more around the mathematical relationships between electricity demand, weather conditions, and time in response to a real business environment and little attempt was made (on the basis of no empirical evidence) to formally model the situation in a classical game theory manner. Even the experience of the first year of operation suggested this was not necessarily needed. However, the circumstances of the second year of operation, 1992/93, suggested that a strategic gaming situation was at least emerging since the initial solution had a diminished effect with the interaction of more RECs offering triad warning services and substantially more non franchise customers acting to reduce demand upon the receipt of triad warnings.

558 The concept of forecasting peak demand periods and expecting customers to reduce their demand for electricity in response to warnings without taking into account this reduction in electricity inevitably effects the results of the strategy to the extent that the whole concept may prove self defeating. When a peak demand period was forecast (and when this period could have qualified for triad status) warnings were provided to customers who were expected to reduce their demand in order to avoid or reduce triad charges. However, in 1992/93 it appeared that sufficient demand was reduced across the country to ensure that the forecast peak demand period did not occur to the extent that was initially predicted. In a market with only few RECs offering this service and with fewer non franchise customers responding to triad warnings, this situation did not emerge. However, following the success of the initial service and with more

"players" and "participating agents" acting in the arena, the predicted outcome of the strategy was severely distorted.

559 The gaming situation as defined above has been developed following the analysis of empirical data, rather than being devised prior to developing the triad forecasting strategy. This represents an interesting way of analysing the situation although classical game theory techniques have little to offer. Nevertheless, the concept of "players" remains useful in the context of competing RECs and electricity generating companies striving to offer successful triad warning services in order to gain the rewards of unregulated income from the sale of such services and in terms of competitive advantage by offering more successful triad warning services to customers. The added concept of "participating agents" into the game arena is also particularly interesting since these agents are clearly participating in the wider "game", they too reap financial benefits as a result of involvement in the game in terms of potentially lower electricity charges, and their interaction has served to influence the outcome of the game. However, the influence of the participating agents could be described as passive since they care little about the other agents operating in the game - they merely wish to reduce their own costs. It is the players who are the true strategists and who have the potential to control the game situation.

560 In this context, it appears that for future successful strategies to be adopted within this arena, a formal gaming solution needs to be modelled and incorporated into the strategy. The experience of 1992/93 suggests that the initial modelling solution is now insufficient in itself as a means of successfully forecasting triads. By incorporating a gaming element into he strategy, ie by recognising the interdependencies and accounting for them, a revised forecasting solution needs to be developed. These results could serve to provide a rudimentary framework for such analysis and could form the basis for a future solution.

6 CUSTOMER DEMAND RESPONSIVENESS

Overview

601 The relative success of the triad forecasting service in the winter of 1991/92 ensured that substantially more customers became interested in the service in 1992/93. Indeed the number of customer sites subscribing to Norweb's service increased from around 60 in 1991/92 to 230 by 1993/94 (although this years data is not available for analysis). Nationwide, the increase in customer participation and responsiveness could have been tremendous. Consequently, the added effect of customers' responses to the triad warnings of various RECs significantly effected the accuracy of demand forecasts. If a demand forecast was particularly high and the probability of a triad occurring high then warnings were issued and a significant number and variety of customers reduced their load by varying amounts, in relative and absolute terms. This had implications, not only for the procedures adopted in forecasting triads, but for the pattern and size of customer demands. These load profiles and customer demands available to the supplying REC often formed the basis upon which contracts and tariffs were designed. The effect of customers reducing or shifting their electricity requirements on the basis of attempting to reduce their costs associated with the triads therefore changed the known profiles and demands of participating customers.

602 Consequently, an analysis has been undertaken of the demand/price responsiveness of a number of categories and sizes of customers to triad warnings. This has been undertaken according to different categories of industry in order to evaluate costs savings for various customers, calculate demand elasticities and to assess the consequences of these responses for the triad forecasting system itself. The results of this analysis can be interpreted in two ways;

- they provide an insight into the respective cost-benefit decisions taken by customers in their own assessment of the importance of electricity costs as a proportion of total controllable costs; and
- the results have implications for the supply companies whose aim is to design contracts tailored to meet the different needs of customers. Groups of customers could be targeted on the basis of these results for whom load management or triad related contracts are applicable. For other customers, the response to triad warnings may prove negligible and different contract frames may be more appropriate to these customers.

603 Thus, this analysis details the effect that the triad warning service has had upon a number of customers in respect of their demand for electricity, changes to their load profiles and ability to respond to calls for demand reductions.

Format of analysis

604 Thirty customers were selected from a stratified sample of Norweb customers subscribing to the triad forecasting service in both the winters of 1991/92 and 1992/93. These customers were selected according to Standard Industrial Classification (SIC) codes and maximum demands to ensure a mix of customers representing the competitive customer base of Norweb. Table 11 details the industry types examined and the number of customers analysed by each category.

Table 11: SIC analysis of customers responding to triad warnings		
SIC Code	**Broad Industry Type**	**Number of Customers**
111	Solid Fuel Manufacture	1
171	Energy and water supply industries	1
251	Chemical products manufacture	2
257	Chemical products manufacture	1
258	Chemical products manufacture	1
311	Metal goods manufacturing	1
312	Metal goods manufacturing	1
341	Electrical equipment manufacturing	1
342	Electrical equipment manufacturing	1
344	Electrical equipment manufacturing	1
347	Electrical equipment manufacturing	1
350	Motor vehicle equipment manufacture	1
364	Aerospace equipment manufacture	1
412	Food industry	2
419	Food industry	1
428	Textile industry	1
462	Timber industry	1
471	Paper manufacture/processing	4
481	Rubber industry	2
483	Plastics processing	2
617	Wholesale premises	1
644	Communications	1
652	Offices	1

605 Each of the selected customers, to ensure confidentiality, is referred to according to each of these categorisations and is assigned a number where more than one customer exists for each broad SIC category. Analysis has been undertaken for both winters' demands 1991/92 and 1992/93 with a comparison of customer demand shapes and warning

responses for both years. Appendix 5 contains the extensive results for each customer analysed by reference number 1 to 30, examples of which are illustrated in figures 8 to 10. In each case, the first page of analysis refers to the experience of the winter of 1991/92 (as in figure 8). Three graphs display the customers demand in MW by half hour on the day of the 1991/92 triads (21/11/91, 11/12/91 and 23/01/92). These are compared with the customers "typical" daily profiles for the winter based upon averaging demands by each day type ie. of relevance to this winter are the day types Wednesday and Thursday since it was on these days that the triads fell. These typical profiles are constructed by averaging all relevant Wednesday and Thursday demands for the period November 1 1991 to February 29 1992, excluding the demands at the time of and on the dates of the triads and also excluding the demands during the full Christmas period ie. 24 December to 1 January. The table corresponding to each customer and year compares the actual demand at the time of the triads with the typical daily demand in the corresponding half hour. The percentage difference between the two demands may provide an indication of the reduction in demand when a triad warning was provided (and hence a rudimentary estimate of the elasticity of the customers demand to the triad warning). This subsequently enables one to calculate cost savings to the customer where demand at the time of the triads was avoided.

606 Obviously, this estimate of elasticity has to be treated with some caution. One must refer to the graphs to observe any demand trend and indication of response to triad warnings and inevitably an element of judgement is required within this analysis.

607 This analysis has been repeated for each customer on the basis of demand data referring to the winter of 1992/93 in the second page of customer specific analysis (figure 9). However, in both years only 2 out of the 3 triads were identified by the Norweb forecasting system. Consequently, demand at the time of the "unidentified" triads may not display any sign of load reduction if the customer was reacting to Norweb

TRIAD DEMAND ANALYSIS : WINTER 1991/92

CUSTOMER REF : 5

NAME : CHEMICAL PRODUCTS MANUFACTURING 3

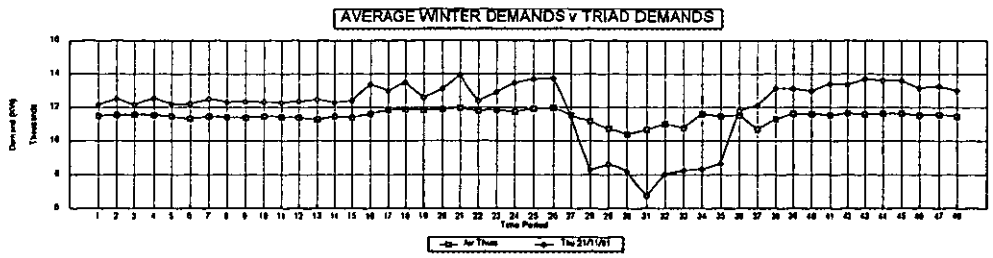
SIC CODE : 257

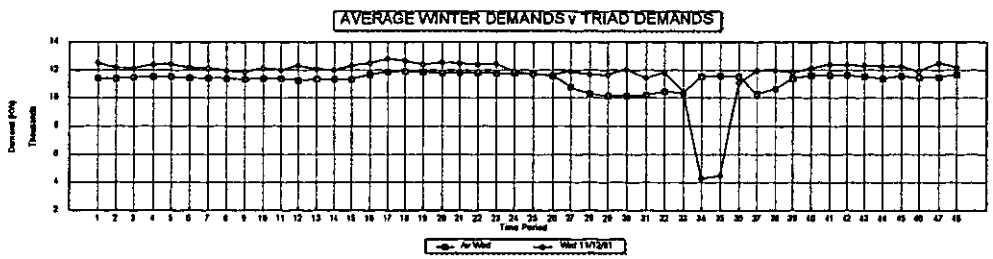
UNITS : KW

DAY	DATE	TP	ACTUAL DEMAND	TYPICAL DEMAND	DIFF	% DIFF
THU	11/21/91	35	8,660	11,457	2,797	24.41%
WED	12/11/91	35	4,476	11,582	7,106	61.36%
THU	01/23/92	35	188	11,457	11,269	98.36%

Typical daily demands are calculated for each day type for the period November to February, excluding the full Christmas period.

The typical demands also exclude the period between time periods 34 and 36 for the Triad warning days





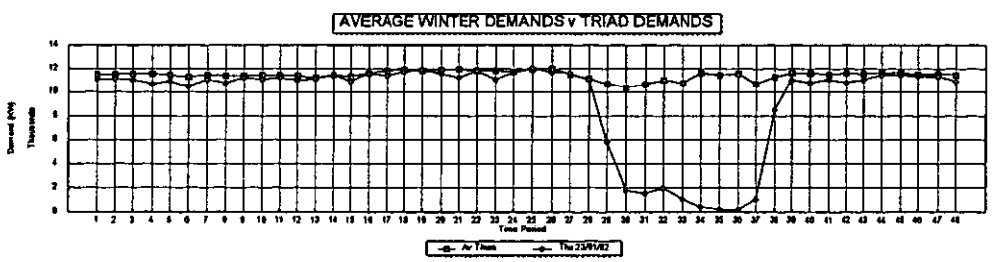


Figure 8

TRIAD DEMAND ANALYSIS : WINTER 1992/93

CUSTOMER REF : 5

NAME : CHEMICAL PRODUCTS MANUFACTURING 3

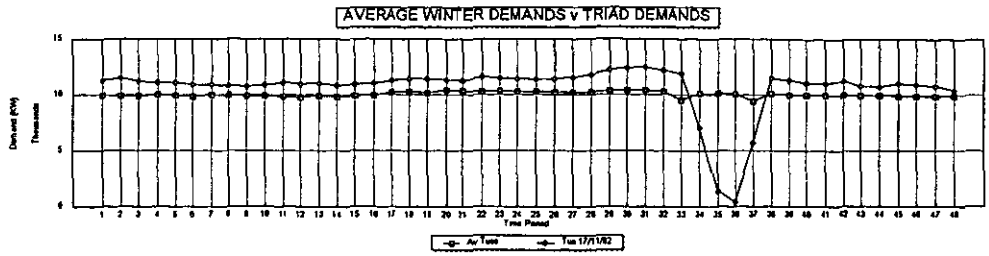
SIC CODE : 257

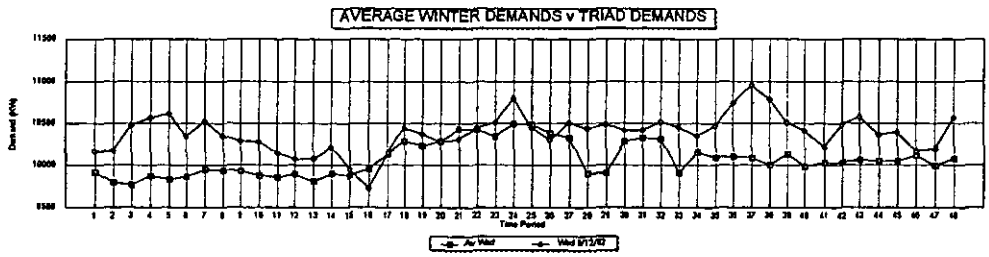
UNITS : KW

DAY	DATE	TP	ACTUAL DEMAND	TYPICAL DEMAND	DIFF	% DIFF
TUE	11/17/92	35	1,328	10,154	8,826	86.92%
WED	12/09/92	35	10,468	10,096	(372)	-3.68%
MON	01/04/93	35	76	10,154	10,078	99.25%

Typical daily demands are calculated for each day type for the period November to February, excluding the full Christmas period.

The typical demands also exclude the period between time periods 34 and 36 for the Triad warning days.





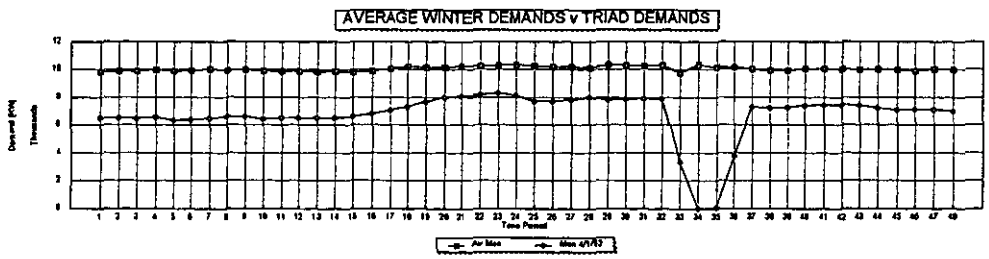


Figure 9

TRIAD DEMAND ANALYSIS : WINTER 1991/92 & 1992/93

CUSTOMER REF : 5

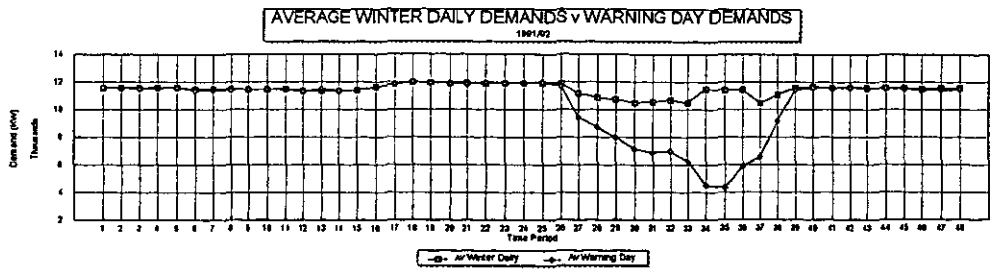
NAME : CHEMICAL PRODUCTS MANUFACTURING 3

SIC CODE : 257

UNITS : KW

WINTER 91/92	32	33	34	35	36	37	38
AV DAILY	10,687	10,490	11,464	11,402	11,418	10,444	11,052
AV WARNING DAY	6,960	6,267	4,493	4,290	5,910	6,547	9,157
Unit Reduction	3,727	4,223	6,970	7,112	5,508	3,897	1,895
% age Reduction	35%	40%	61%	62%	48%	37%	17%

WINTER 92/93	32	33	34	35	36	37	38
AV DAILY	10,287	9,783	10,195	10,132	10,126	9,905	9,988
AV WARNING DAY	10,192	8,710	5,812	4,520	7,177	9,448	9,908
Unit Reduction	95	1,073	4,383	5,612	2,950	458	80
% age Reduction	1%	11%	43%	55%	29%	5%	1%



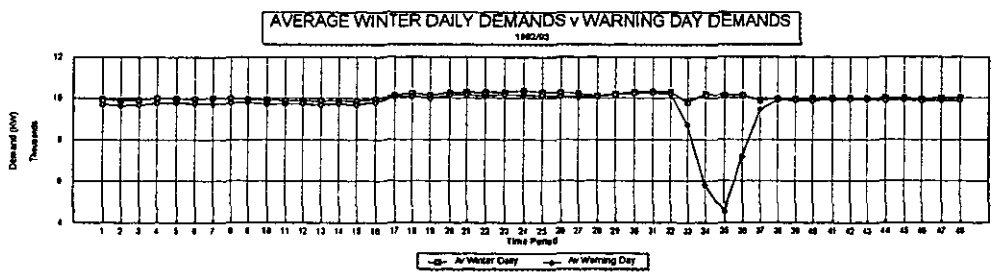


Figure 10

warnings only (some customers were in receipt of warnings from other RECs). For this reason a third page of customer specific analysis (figure 10) compares, for each winter, the average winter daily demands (the average of each days demands by half hour excluding the days for which triad warnings were issued and the full Christmas period) with the average demands by half hour for which Norweb triad warnings were issued. Individual tables compare demands between time periods 32 and 38 (the half hours between 16:00 to 19:00) for the average winter weekdays and the days for which triad warnings were issued. This again, when referring to the graphs, enables one to judge the typical reduction in demand (if any) a customer made upon the receipt of a triad warning.

608 A summary of this final analysis is made within Table 12, looking specifically at time periods 34, 35 and 36 in both winters by customer.

Table 12: Customer demand responsiveness to triad warnings, winters 1991/92 and 1992/93

Cust. Ref	SIC	Year	Typical Daily Demand (MW)			Demand Reduction upon Warning (%)		
Time Periods:			34	35	36	34	35	36
1	111	91/92	1.23	1.26	1.29	-10	-6	-6
		92/93	0.74	0.75	0.79	0	-1	3
2	171	91/92	0.33	0.32	0.32	93	96	96
		92/93	0.70	0.69	0.70	2	2	3
3	251	91/92	24.92	24.88	24.88	-5	-5	-3
		92/93	24.20	24.34	24.36	3	4	4
4	251	91/92	10.52	10.54	10.53	43	43	43
		92/93	11.86	11.95	12.07	51	55	49
5	257	91/92	11.46	11.40	11.42	61	62	48
		92/93	10.20	10.13	10.13	43	55	29
6	258	91/92	9.83	9.77	9.81	-17	17	-18
		92/93	7.19	7.13	7.14	2	3	4
7	311	91/92	1.03	0.97	1.11	36	38	26
		92/93	1.32	1.35	1.36	17	30	24
8	312	91/92	1.34	1.16	1.07	12	12	8
		92/93	1.53	1.40	1.32	8	5	3
9	341	91/92	3.08	2.88	2.86	-1	-2	-3
		92/93	2.93	2.74	2.72	1	2	3
10	342	91/92	0.97	0.93	0.92	2	2	2
		92/93	0.92	0.90	0.87	-2	-2	-2
11	344	91/92	0.65	0.63	0.60	-5	-5	-7
		92/93	0.67	0.64	0.62	0	0	-1
12	347	91/92	2.71	2.71	2.61	-2	-1	-2
		92/93	2.78	2.77	2.66	3	4	3
13	350	91/92	3.96	3.78	3.74	66	99	91
		92/93	3.35	3.12	3.11	48	89	12
14	364	91/92	9.40	8.48	7.79	2	-1	-3
		92/93	9.01	8.13	7.44	9	12	3
15	412	91/92	1.59	1.61	1.55	24	31	17
		92/93	1.55	1.56	1.52	11	13	8
16	412	91/92	1.32	1.31	1.30	12	13	12
		92/93	1.37	1.35	1.34	8	9	7

17	419	91/92 92/93	11.81 10.78	11.82 10.80	11.79 10.79	0 2	0 2	0 2
18	428	91/92 92/93	0.64 0.62	0.62 0.61	0.51 0.50	29 2	33 9	22 4
19	462	91/92 92/93	1.01 0.91	0.97 0.85	0.95 0.82	8 2	12 13	-2 -14
20	471	91/92 92/93	7.88 11.22	7.84 11.32	7.96 11.31	-2 33	-4 36	-1 31
21	471	91/92 92/93	5.30 5.19	5.30 5.22	5.30 5.23	6 2	6 2	6 2
22	471	91/92 92/93	3.14 3.59	2.82 3.49	2.68 3.39	33 -1	40 2	30 2
23	471	91/92 92/93	2.01 3.59	1.96 3.49	2.07 3.39	16 -1	22 2	3 2
24	481	91/92 92/93	2.34 2.14	2.20 2.05	2.06 1.93	-12 -3	-11 -2	-8 -3
25	481	91/92 92/93	5.71 5.49	5.56 5.36	5.67 5.40	1 8	2 10	-2 5
26	483	91/92 92/93	2.24 2.47	2.23 2.44	2.22 2.41	3 11	6 13	4 10
27	483	91/92 92/93	0.52 4.04	0.49 4.08	0.46 4.09	96 4	100 7	98 6
28	617	91/92 92/93	1.35 1.37	1.19 1.21	1.13 1.16	2 4	2 4	2 4
29	644	91/92 92/93	2.40 2.40	2.36 2.37	2.33 2.35	0 1	0 1	0 1
30	652	91/92 92/93	1.02 1.02	1.03 1.03	1.02 1.03	-1 -1	-2 0	-2 0

609 The final three columns of table 12 show the percentage response of the customers to the triad warnings provided when compared to the "typical" daily demand (and hence an estimate of the demand elasticity of the customer to the triad warnings issued). Hence a negative figure inversely suggests no actual reduction in demand in response to the triad warnings. Instead Demand at these particular time periods on the dates of the triad warning was higher than normal. Conversely, a positive figure

suggests a genuine reduction in demand as a result of the triad warning issued. This data is now interpreted alongside the graphical representation of the full analysis detailed in Appendix 5.

Analysis of results

610 Of the sample of 30 customers, a substantial proportion of the customers display responses of varying size to the triad warnings issued in one or both of the two winters examined. Table 12 provides an indication of those customers whose response was to significantly or marginally reduce their demand for electricity at the times of the triad warnings. For example, Customer 4 (a manufacturer of chemical products) reduced demand at the time of the triad warnings by up to and beyond 50% in both winters. This demand reduction is clearly visible as a dip in the otherwise rather stable load profile. On the other hand, Customer 28 (a wholesale premise) displays a response to the triad warnings but of a marginal nature (with a 2% to 4% reduction at the times of the warnings) reflecting the differences in operation, the extent to which demand for electricity can be controlled and/or the different emphasis placed upon electricity costs as a proportion of total controllable costs. There now follows an analysis of demand responsiveness according to customer type, with the results reflecting the varying demand elasticities of different categories of customers.

611 It should be noted that in 1991/92 a triad warning was not issued for Thursday 21 November when a triad occurred and that in 1992/93 a warning was not issued by Norweb for Wednesday 9 December. Consequently, the profiles for responding customers may display little or no deviation from the typical daily profile for these days unless the customer was in receipt of triad warnings from other RECs who correctly forecast triads on those particular days.

612 The manufacturer of solid fuel (Customer 1) displays no reaction to the triad warnings issued in both 1991/92 and 1992/93. The load profiles display a degree of consistency across the days, with variation in the scale of demand and dips at particular half hours (time periods 23, 30 and 39) reflecting no doubt the companies pattern of production. However demand on the days of the triads was generally above typical demand with no variation in profile at the times of the peaks.

613 Customer 2 however, from the water supply sector, appears to have responded by altering the pattern of operation for substantial periods about the times of the triads and triad warnings in 1991/92 only. This is visible as demand was reduced by up to 100% at the time of the triad occurring on 23 January 1992 for the full afternoon and evening period. This reflects perhaps the companies capacity to alter production patterns and even shift demand (signified by the huge increase in demand at time period 46 on 23 January) in response to calls for reductions and thus represents the type of customer that is capable of taking full advantage of the benefits accruing from load management. Indeed, this company was actively involved in the use of electricity for pumping water supplies to various locations when required. Significant interest was noted by the customer in the triad forecasting service and the customer indicated that as a result of the potential cost savings, the timing of pumping activities was altered without too much disruption, in order to take advantage of lower electricity charges. the pumping and transfer of water was not a continual operation allowing such changes to take place.

614 Customer 3, a manufacturer of chemical products has a very regular load profile and shows no response to the triad warnings in 1991/92. However in the following year, demand is reduced around the anticipated and actual "tea time" peaks in electricity demand, particularly on 4 January 1993. Whereas Table 12 suggests the demand elasticity for this customer is only some 4% in comparison to typical daily demands, it can be observed that demand reduced substantially around the time of the

January triad for a period comprising approximately 3.5 hours. Customer 4, another manufacturer of chemical products displays a similar response to the triad warnings with reductions in typical demand of around 50% in both winters. This is clearly visible as a dip in demand from a usually stable load profile. The final manufacturer of chemical products, Customer 5, displays the same tendencies from an equally stable load profile with reductions in demand of almost 100% at the time of the triad warnings. In this case, the customer is more specific about the time of the greatest demand reduction however there is a "wind down" and "wind up" period for operation in the half hours surrounding the tea time half hours for which warnings were issued. The final manufacturer of chemical products, Customer 6, displays less of a tendency for demand reduction, however in 1992/93 a reduction in the region of 2 to 4% is evident. This customer may also have responded to the price signals from the pool but is less capable of reducing overall demand significantly.

615 Thus analysis suggests that this category of customer is particularly suited to take advantage of required demand reductions in recognition of potential electricity cost savings. In some cases, large demands reductions at specific half hours can be clearly recognised. The scale of the demand reductions (in excess of 10 MW in the case of customers 4 and 5) suggests electricity costs are an important component of total costs and that these customers are keen to actively manage these costs.

616 Customer 7, a manufacturer of metal goods, displays a very specific response to the triad warnings in both winters. Typically demand was reduced by up to and above 50% upon receipt of the warnings for the days of the triads, representing a cut in demand of between 0.4 and 1 MW. This customer was able to reduce demand specifically at the time periods for which warnings were issued and the customer reduced demand from around time period 33 for the duration of the evening period. Consequently, this customer is capable of controlling demand at specific times and made substantial monetary savings in both winters. Customer 8,

a further manufacturer of metal goods also made slight adjustments to demand at the time of the triad warnings. Reductions of up to 12% represents 0.1 MW of demand but this reduction is less visible from the analysis than is the case with Customer 7.

617 Customer 9, a manufacturer of electrical equipment displays a small reduction in demand at the time of the triads, however, these reductions are consistent with troughs in the typical daily demand profile. Nevertheless, on one occasion in 1992/93 demand was reduced by 16% (0.4MW) suggesting the customer is capable of load management but not necessarily on call and only at times suited to the individual company. The other electrical equipment manufacturers, customers 10, 11 and 12 display little, if any, response to the triad warnings issued. All display a regular load profile and perhaps had little opportunity to reduce demand in response to the warnings. The regularity of the profiles would suggest that this class of customer is not suitable for contracts enabling cost reductions by changing demand patterns and that electricity costs are not a controllable portion of these companies overall costs.

618 Customer 13 (a manufacturer of motor vehicle equipment) displays perhaps the clearest example of a customer who actively wishes to and can reduce demand in response to triad warnings. Demand is capable of a reduction of 100% at the specific time of the triad warnings, with no "wind down" or "wind up" period necessary. Indeed the average response to the triad warnings in 1991/92 was 99% at time period 35 and 89% in the same time period in 1992/93. The customer was capable of cutting 4 MW of demand on call in what appears to be a "tools down" response to the warnings. Consequently it was calculated that for this specific customer in 1991/92, a saving of around £30,000 was made given only two out of the three triads were correctly forecast. Savings of 100% would have been made if all three triads had been identified. Thus this customer is both capable and keen to control electricity costs where possible, suggesting that

the benefit to the customer of reducing electricity costs outweighs the cost of the loss of production for a short time period.

619 The manufacturer of aerospace equipment, Customer 14, displays only marginal reductions in response to triad warnings of up to 12%, however, in 1992/93. The regularity of the load profile suggests such reductions may prove difficult for this type of customer, however, 12% represents almost 1 MW of "controllable" electricity demand from a typical demand of 8 MW. Thus the customer took advantage of the forecasting service within the confines of it's production process.

620 Two examples of customers from the food industry (customers 15 and 16) displayed positive responses to the triad warnings in both winters. Customer 15 cut demand by up to 31% (0.5 MW) and Customer 16 by up to 13% on average (0.2 MW). Both customers display regular load profiles but are able to cut demand within the confines of these profiles specifically, and relatively significantly, if cost savings are perceived to be obtainable. Customer 17 however, displays no response to the warnings and a very different load profile can be observed from the other food industry examples. These results demonstrate the limitations of any analysis by Standard Industrial Classification as generalisations within categories of customer types do not recognise the priorities of individual companies. Thus for customer 15, electricity costs are regarded as controllable whereas this has either not been the case for customer 16 or the perceived benefits were not great enough to outweigh the disruption caused by reducing electricity demand.

621 Customer 18 represents the only example from the textiles industry in the analysis. Whereas demand reductions can be observed at time period 36 in both winters, it is more probable that this is concurrent with a change in the shift of work as a similar reduction occurs in tine period 12 and the demand on the warning days shows little if any change from the typical daily demand picture. Thus if the triads occur at the same time as

these periods, the customer benefits through good fortune rather than active load management.

622 This situation appears to be the case with Customer 19 (from the timber industry) with similar demand reductions at particular times of the day perhaps reflecting the process of production. However, the natural course of production appears to be to reduce demand in time period 36 over the typical winter daily demands. The customer appears to modify this production pattern and increase the extent of the demand reduction to time periods 34 and 35 on the days of triad warnings in order to save on electricity costs. Demand reductions of approximately 12% (0. 1 MW) occur at these times and suggest the customer is willing and able to make marginal changes to production if the financial benefits exceed the marginal costs of production.

623 The incidence of paper manufacturing in the North West is particularly high and consequently four customers from this groups are the subject of analysis. All customers 20, 21, 22, and 23 display positive responses to the triad warnings received from Norweb. Customer 20 displayed significant reductions in 1992/93 of beyond 4 MW (36% of demand) at the tea time period when demand was usually at it's highest. The reductions experienced by Customer 21 tended to be more marginal (2% in 1992/93, 0.8 MW) but still apparent. Customer 22 was more proactive in 1991/92 than 1992/93 with typical demand reductions of 40% (1.1 MW) compared with 2% (0.6 MW) in the following year. This suggests that the savings experienced by the company in the first year of triad forecasting were not of a sufficient scale to outweigh the costs resulting from loss of production and hence reductions in subsequent years, where carried out, were of a more marginal nature. This pattern is repeated by Customer 23, who reduced demand by an average of 0.4 MW (22%) at time period 35 in 1991/92 in response to the warnings but by only 2% (0.58 MW) in the following winter. Thus the paper industry serves as an example of where managers recognised the need and capability to save costs on

electricity but perhaps found the costs savings resulting from triad avoidance were small and did not outweigh the costs of loss of production. The industry is therefore capable of load managing on call but requires greater incentives for the process to be financially worthwhile.

624 Customer 24 representing the rubber industry displayed a very regular load profile in both years but no visible response to any of the triad warnings issued in either years. However, Customer 25 representing the second customer from the rubber industry displays more obvious demand reductions at the specific half hours suggested, with little or no "wind down" and "wind up" periods. Demand reductions of 10% (0.5 MW) were typically made, with the demand profile on triad warning days displaying an obvious dip at the allotted times. Again, these results perhaps point to the problems of generalising within industries.

625 The two examples of customer from the plastics processing industry (customers 26 and 27) both displayed signs of a demand reduction in response to the triad warnings issued. Customer 26 was capable of reducing typical demands at the appropriate times by on average 13% (0.3 MW) and customer 27 apparently by up to 100% but over a prolonged time period. Customer 27 has a different and more regular load profile in the winter of 1992/93 and made a different and more precise response to the triad warnings issued in this winter, characterised by the usual dip around the tea time period. This change in profile of consumption is undoubtedly a result of company specific operational changes rather than any response to triad warnings or more sophisticated price signals. Thus, the two examples initially display very different load profiles and significantly different responses to the warnings issued. Nevertheless, they represent customers capable and willing to manage electricity consumption if savings are possible.

626 Customer 28 represents the first commercial rather than industrial customer who subscribed to Norweb's triad forecasting service - SIC 617,

a wholesale premise. This provides an interesting example of the difference in type and scale of response to the triad warnings than that of the majority of industrial customers examined. The load profile associated with this type of operation displays a typical day and night pattern of demand. On the dates of the triad warnings in both winters, marginal reductions in demand were made in the order of 2% (0.03 MW) in 1991/92 and 4% (0.05 MW) in 1992/93. This type of customer is obviously unable to make the drastic reductions in demand which other customers are capable of in order to save on their electricity costs. Nevertheless, the marginal reductions in demand suggest the desire to make savings wherever possible by the limited means available. Customer 29, representing the communications industry displays similar regular load profiles and consequently a similar response to the triad warnings with marginal (typically 1%) reductions in demand.

627 The final customer in this analysis representing the office sector, Customer 30, displays no particular response to the triad warnings issued in either of the years and suggests the limited capacity of such type of customer to respond to calls for load management. Office practises cannot easily be disrupted at peak times in order to make small savings on electricity costs.

Conclusions

628 A number of conclusions can be drawn from the customer demand responsiveness analysis undertaken within the context of this thesis. The purpose of this section has been to identify which categories of customers actively participated in reducing demand for electricity as part of the triad warning services offered. The purpose of this is to identify which customers can actively seek to reduce demand for electricity on call with financial incentives in return. The identification of such customers could influence future policy when designing pricing contracts for such customers in line with electricity companies own electricity purchase portfolios.

629 This analysis also provides insight into the relative importance of electricity costs to individual companies total costs, and consequently whether these companies directly respond to opportunities to reduce these costs. Furthermore, if companies do respond to such cost saving opportunities, the response of customers when reducing their electricity demand is interesting. Some customers have demonstrated a desire and ability to physically halt or slow down production processes at the specific times of potential savings, some require longer periods to wind down their production and consequently return to normal production levels, others appear to have shifted peak demand periods away from the advisable times to time periods when costs are likely to be lower.

630 The insight into the respective cost-benefit decisions undertaken by this sample of customers in their own assessment of the importance of electricity costs as a proportion of total controllable costs has obvious implications for the type of contracts that should be designed to meet the needs of these customers.

631 Ultimately, this exercise provides particular insight into the consequences of the triad forecasting system devised and put into practise. It also provides some explanation as to how anticipated forecasts peaks in electricity demand were distorted by the actions of customers warned in advance about the occurrence of such peaks. The analysis demonstrates the success of the triad forecasting service at the individual customer level by demonstrating the real cost advantages associated with reducing demand at the time of the triads.

632 At the industry level, the analysis enables certain conclusions to be drawn with respect to the potential for these industries to reduce electricity demand at stated times and of the success of particular industries in reaping the successive financial benefits:

(a) the one manufacturer of solid fuels analysed displayed no response to the triad warnings in either 1991/92 or 1992/93. Indeed, the demand profiles observed on days when triad warnings were issued displayed no difference to typical demand profiles over the winter months. This therefore represents a class of customer that cannot take full advantages of such a service;

(b) the customer analysed from the energy and water supply industry showed a significant response to the triad warnings over both winters and confirmed that production processes were actively being altered to take advantage of cost savings;

(c) four customers from the chemicals were analysed and all showed distinct and large reductions in electricity demand in response to triad warnings. The large volumes of electricity consumed by this sector suggests the large contribution made by electricity costs to total costs and the opportunity to reduce these costs appears to have been particularly welcomed. The resulting load profiles of electricity demand displayed significant winding down and winding up periods to and from the potential triad time periods suggesting the industry cannot respond for small periods but has to make a significant change to it's production process in order to reap the benefits associated with reductions in demand. This also suggests that these benefits are worth the disruptions caused to production. Consequently, given the volumes of electricity consumed by customers in the chemicals sector, this represents a sector which can and actively will manage electricity consumption where financial incentives are made;

(d) the companies analysed from the electrical equipment manufacturing sector displayed some reductions in demand but only at times to suit the companies, not at the time of all triad warnings. These companies are not necessarily going to benefit from such a service;

(e) the one company from the motor vehicles sector displayed a "tools down" response to the triad warnings at the specific time periods for which warnings were called. This company both could and did make reductions to their electricity consumption and benefited from the avoidance of triad costs;

(f) the manufacturer of aerospace equipment made marginal reductions to it's electricity consumption at the time of triad warnings within the confines of it's own production processes;

(g) the textile company appears to have been fortunate in making cost savings by changing it's working shift at the time of the triads but does not appear to have made a conscious effort to reduce demand further at these times;

(h) of the food companies analysed, one actively responded to the triad warnings and the other did not. This highlights the limitations of generalising within industry sectors;

(i) the paper manufacturing and processing sector is important to the North West. These are also customers who use significant amounts of electricity as part of their production. All companies analysed displayed reductions in demand, especially in 1991/92. The response in 1992/93 was less, suggesting the cost savings did not outweigh the costs of losing production;

(j) in the rubber sector, one company appears to have responded to the triad warnings and the other not. Both of these companies display regular electricity demand profiles but do not display similar responses to potential cost saving and again highlights the problems of generalising within and across industry sectors;

(k) the two companies from the plastics processing industry are both capable of reducing electricity demand in response to warnings and do so;

(l) the company from the wholesale sector suggests a different scale of response to warnings than those companies from the industrial sectors analysed. This company displayed a desire to make electricity cost savings but with a very regular electricity demand profile is able to only make marginal changes to it's consumption pattern; and

(m) the one office based company analysed displayed no response to the triad warnings and highlights the limitations of this sector to manage electricity consumption in the way that other industrial companies are capable of doing.

633 The results of this analysis both provides further insight into the nationwide reductions in electricity demand at the times of triad warnings and consequently the problems associated with forecasting triads. The result also highlight those sectors of industry for who particular types of pricing contract could be designed to take advantage of the load reduction and responsiveness capacity of these companies. These issues are explored further in section 7.

7 CONCLUSIONS : FUTURE POLICY AND STRATEGY

Overview

701 This thesis has aimed to describe the inherent interdependencies between companies operating in the electricity supply arena and their active customer base. A number of important economic issues are addressed within the body of this research which arise from an initial business strategy. Indeed, the very business strategy which forms the core component of this research (the triad forecasting service operated by one REC in particular and numerous other electricity supply companies) arose as a result of the privatisation of the electricity supply industry. With the privatisation of the industry, competition was introduced into the market for electricity supply and consequently suppliers looked towards other ways of gaining competitive advantage over their rivals and ensuring additional contributions to their unregulated income by broadening their "product" range. From the perspective of the economist, such additional services enabling wider customer choice represent dynamic/innovation efficiency gains as a result of the privatisation. The triad forecasting service which has been described in detail within this thesis was one such service which ensured benefits accrued to those who offered the service (in the form of both additions to unregulated income and enhanced competitive advantage) and to the customers who subscribed to the service (in the form of potential reductions in a component of their overall electricity costs in return for reductions in their demand for electricity at particular time periods).

702 Hence a number of economic issues are explored within the context of this investigation and analysis of the background to and methodology devised for operating the triad forecasting service, as well as the effects of the service upon both customers own demand for electricity and indeed the effectiveness of the service itself. These concepts include:

- the arena of statistical decision theory as a means of and framework for developing optimum decisions and solutions to both theoretical and business problems in the face of uncertainty. Decision theory aims to break down a problem into a number of components in order to attempt to relate the uncertainty element to available statistical data to enable the situation to be modelled and combined with an appropriate optimality principal to aid the best decision;
- electricity demand modelling and forecasting which forms an integral part of both the area in which electricity is traded and in the context of this thesis, the methodology required for forecasting peak electricity demand periods in order to identify potential triads. Incorporated within this analysis are the econometric and times series relationships between electricity demand, weather conditions and time factors which are explained as part of the devised forecasting solution;
- the rudimentary concepts associated with the field of literature which embraces classical game theory are applied and discussed in conjunction with the analysis of the triad forecasting system in practise. Although the outcome described does not represent a "game" situation in the classical sense, the emergence of a strategic game have been both observed and described on the basis of the effect of the triad forecasting service. The "players" of the game have been described as the electricity companies who offer triad forecasting services and initiate the game strategy. A further dimension has been introduced into the equation - that of the "participating agents" who represent the customers who subscribe to the triad forecasting service and whose actions ultimately influence the outcome of the game and the actions of the players. This concept is used to illustrate the

interdependence between both electricity companies and each other **and** their customer bases; and finally

- the concept of elasticity of demand to overt "price" signals is described by analysing the response of a number of customers across different industry sectors and sizes to the triad warnings issued. Here, substantial modelling has been undertaken to profile 30 customers' electricity demand in order to examine the percentage reduction in typical demand which resulted from the response to triad warnings. This analysis provides insight into the relative cost-benefit decisions undertaken by the customers and illustrates those customers that both can and do reduce their electricity demand in return for potential financial savings.

703 The conclusions of this analysis are now discussed in the context of the above economic concepts. Following the resume of the conclusions, the implications for both future triad forecasting strategies are discussed alongside the wider implications for the electricity trading arena, including the implications for both new tailored customer contracts and for the generators of electricity.

The electricity trading mechanisms and the incentives for product diversification

704 This research has examined the demonstrable interdependence of electricity companies and their customers. A significant degree of this interdependence results from the competitive interrelationships arising from the structure of the relatively recently privatised electricity supply industry.

705 At present the business for the supply of electricity can be described as partially competitive (with competition being restricted to supply the large users of electricity whose demand for electricity exceeds 100kw). In

1998, competition will be introduced across all consumers of electricity the supply market. At present, competition between those offering supplies of electricity exists not only on price terms, but also in terms of the quality of service offered to customers and the overall "package" offered to customers by competing suppliers.

706 Prices and contract terms are now extremely flexible in comparison to those available under the nationalised industry, with many more contracts being "tailored" to suit the specific requirements of customers. Indeed, in the competitive market, suppliers are much more flexible and responsive to customer needs than under the previous regime. If one supplier cannot meet the requirements of a potentially lucrative large user of electricity, another supplier will be willing to do so. Some contracts are designed to enable customers to control their energy costs - customers may have the option of reducing their demand when prices are high and are notified of these circumstances by their supplier.

707 However, competition has promoted wider benefits than simply enabling more flexible contract terms. Indeed, competition cannot and does not exist on price terms alone. This research is based upon an example of a "value added" service provided by suppliers of electricity to their customers. The benefits of this service essentially accrue to the customer, however income and competitive advantage accrues to those who offer successful services.

708 The triad forecasting service may appear to simply exploit the mechanisms by which NGC recoups it s costs of offering a capacity service. These mechanisms are described in detail in section 3. Nevertheless, as a result of the privatisation of the industry, the incentive exists for suppliers to offer additional services. The triad forecasting service is one such service that has demonstrated obvious appeal to those customers who can and have saved significant sums of money based upon the advice of the REC offering the service. For the REC and the customer, there are advantages

associated with the triad forecasting service. Upon initial observation the service represents a dynamic efficiency gain as it represents the diversification of products offered by suppliers of electricity.

709 However, from the industry perspective, by avoiding the payment of charges associated with the cost of providing a system capable of coping with peaks in demand, the true efficiency gains are questionable. From the perspective of NGC, the avoidance of triad charges represents potential loss of income. In order to recoup any lost income, triad charges are likely to increase for those who cannot actually avoid the charges. Hence the loss and gain associated with avoiding triad charges may simply be redistributed amongst different sets of customer and at different (undoubtedly higher) prices. Thus further analysis would be required in order to estimate the true potential gain or loss associated with the triad forecasting service.

Modelling triads: method and experience

710 Sections 4 analysed the concepts of triads in detail following the initial interest by the electricity supply business of Norweb in offering a triad forecasting system. The aim was to identify the conditions associated with triads in order to attempt to predict the occurrence of triads in advance. Following an extensive programme of research involving empirical electricity demand and triad data, weather information, pool price data and the demand predictions made by NGC for the purpose of setting pool prices, the following conclusions were made:

- that triad tend to occur at the "tea time" peak period associated with the winter working days (Monday to Thursday) with slight variations in the actual time periods between months (November to February) associated with the hours of daylight over the period;
- that the peaks in maximum demand have increased over time and more specifically that the trend growth in the

"minimum" triad (the triad by definition with the lowest level of demand) was consistent to 1990/91;

- that triad demands were associated with cold weather conditions and that the maximum demand in any one year (by definition the maximum triad) occurs during the coldest period of any one year. However, the variation in the temperature range at which triads were found to occur was such that weather data in isolation cannot explain the timing of the triads;
- an attempt was made to "temperature correct" the triad demands to normalise the demand series and produce estimates of forecast triad demands at "normal" temperature conditions;
- pool prices were found to have little relationship with triad demands which could be a result of the supply driven approach to setting pool prices in the early years of privatisation; and
- that the forecasts of demand made by NGC Grid Control were a useful means of aiding the prediction of triad demands.

711 On the basis of this research, a triad forecasting system was devised with the aim of providing subscribing customers with at least 24 hours notice as to the likelihood of a triad occurring (classified according to high and low probabilities). This system was based around:

- the concept of making a predication about the level of demand associated with the "minimum" triad. This was calculated using simple time series techniques based around the observed trend growth in the series;
- incorporating forecasts of weather conditions into the system (although managerial policy decisions served to simplify the approach adopted in the business arena);

- providing triad warnings when the forecast of demand received from NGC Grid Control (following an adjustment for error) exceed the forecast level of demand of the minimum triad.

712 The system was tested using dummy data based upon the winter of 1990/91 and refined before being offered as a chargeable service to eligible and willing non franchise customers.

713 The warning which was printed on triad warnings actually sent to customers suggested that the interaction of both RECs and customers operating upon the instructions of triad forecasting services may reduce the effectiveness of the service. However, no attempt was made to model this effect given the lack of any empirical data or knowledge about the expected response of customers. Indeed, the service that was offered in 1991/92 was regarded as a success with 2 out of 3 triads correctly predicted and little noticeable effect of the service upon forecasts of demand and actual demand levels recorded.

The potential for strategic gaming

714 However, the experience of the winter of 1992/93 suggested a strategic gaming situation was emerging with the interaction of both electricity supply companies and their customers influencing both the strategies adopted and the effectiveness of these strategies.

715 In 1992/93 both the number of RECs offering triad warning services and the number of customers subscribing to and reducing their demand in accordance with the requirements of these services substantially increased. The combined effect of these factors had a major impact upon the accuracy of demand forecasts upon which triad predictions were made and the actions of RECs offering the services.

716 Significantly more triad warnings were issued than in 1991/92 and only 2 triads were predicted. Indeed, the "errors" associated with forecasts of demand at the time when triad warnings were issued by Norweb and other known RECs were such that it became evident that the reductions in demand made by customers were now of a sufficient scale to severely distort the situation.

717 In a strategic gaming context, those offering the triad forecasting service are described as the "players" who instigate the triad forecasting strategies. A further dimension has been introduced - that of the "participating agent" who are the non franchise customers acting upon the advice of the players but whose combined action is to reduce the effectiveness of the very service being offered to them by the players. Such interaction has been observed and placed into this framework to emphasise the inherent interdependencies which have arisen and to demonstrate the difficulty associated with developing a forecasting solution.

718 Indeed, an added dimension to the strategic game is the interaction of the players instigating the triad forecasting strategies. Given that the effect of customer demand reductions was very soon taken into account by the RECs, this and the knowledge about the actions of competing RECs influenced decisions being taken. An attempt was made to incorporate knowledge about the actions of other RECs into the triad forecasting strategy. If it was known that other RECs had issued triad warnings when the likelihood of a triad occurring was only marginal in comparison to other days, warnings were not necessarily issued. The reduction in demand resulting from customers elsewhere reducing their demand was likely to negate the likelihood of a triad occurring.

719 The significance of this interaction is such that the very act of Norweb not issuing a triad warning on one occasion when other RECs had done so meant Norweb's customer base did not reduce their demand and

a triad occurred. Had a warning been issued, the resulting reduction in demand may have meant the peak would not have qualified as a triad.

720 A strategic gaming situation appears to have been emerging since the actions of any one electricity company offering a triad forecasting service are influenced not only by his own strategy but also by the actions of other competing firms and the customers who are acting on the advise of the strategy. The gaming situation as described represents an interesting way of analysing the situation. It was concluded that for successful future triad forecasting strategies to be devised, a gaming element needs to be incorporated into the strategy. The interdependencies need to be recognised and accounted for and a framework for modelling these interdependencies devised.

Literature survey

721 The intention of the literature survey which is reviewed in section 2, is to provide a theoretical framework within which to analyse and develop both the required forecasting solution and the gaming situation. This literature survey concentrated on four areas, namely:

- statistical decision theory;
- game theory ideas and concepts;
- electricity demand modelling and forecasting; and
- the application of game theory principals to the electricity supply industry.

722 The statistical decision theory literature provides a useful framework for the using available statistical data in explaining uncertainties and aiding the decision making process in the face of these uncertainties. Bayesian decision theory could provide a potential means for developing an alternative solution for forecasting triads given it's use of both prior information and data in explaining the uncertainty element (which in this

case would be the use of previous demand data and empirical knowledge about the occurrence of triads with the uncertainty element being the timing of future triads). As Berger concludes, this approach to decision making is useful for solving a real decision problem given it's relative simplicity in terms of modelling. This is a particularly important feature given the volumes of data that are required to assist in forecasting triads.

723 Whereas this methodology has not been directly applied in the context of this research, the potential for such an application is appealing and may provide a sound framework within which to model future triad forecasting systems, given the strategic gaming element which appears to have emerged.

724 The analysis of game theory ideas and concepts within the literature search provides a further theoretical framework within which to model the interdependencies of both electricity supply companies and their customers and the strategic game situation described in detail in section 5.

725 Game theory, like statistical decision theory involves a set of ideas and concepts which are concerned with the logic of decision making in situations which depends upon the decisions of two or more autonomous agents who have a degree of control over the outcomes. A formal game theory model can only be described if all options available to decision makers and their possible consequences are well defined. By doing so, a solution to a particular game can be arrived at.

726 The game theory principals describe the autonomous agents as "players", a principal and description applied within this text. However, the outcomes of the decisions associated with autonomous agents offering triad waning services are not known quantities and hence solutions to the game situation described within this research have not been devised.

727 Nevertheless, game theory principals which embrace players "strategies" and information relating to competing strategies has proved a relevant framework in which to model the interdependencies of RECs and their customers. Indeed, this concept offers the potential for further development with the derivation of solutions based upon known strategies and the effect of actions undertaken. The concept of "participating agents" developed within this research is an interesting means of providing an added dimension to classical game theory.

728 A body of literature which describes the methodology employed in modelling electricity demand and formulating forecasts of demand has been reviewed as part of the literature survey, given that the initial problem (that of forecasting triads) was essentially a demand forecasting problem. Lang describes the relative advantages associated with both econometric techniques (useful for forecasting over longer time horizons) and time series methods (useful for shorter time horizons where cyclical variations are often time dependent).

729 The methodology applied by NGC in formulating forecasts of demand (described by Baker) is described in detail as the results of these forecasts are a vital component of the triad forecasting system described in this text. Thus, the methodology described combines complex multiple regression formulae with a pragmatic system of profiling daily electricity demands for time series interpolations.

730 Numerous economists have applied the concepts associated with game theory to the operation of the modern day electricity supply industry. Various examples are described in section 2 to illustrate the relevance of these frameworks to the operations of the industry. The literature tends to concentrate on the potential for oligopolistic behaviour between the generators of electricity (eg Powell, 1993) and the trading mechanisms of the "pool" for electricity (Newbery and Greene, 1991). Indeed, Exelby and Lucas (1993) use game theory analysis to explore the issue of collusion and

strategic interaction for mutual benefit on the part of the electricity generators. Whereas the examples used do not relate to the type of interaction described within this thesis, they represent examples of the way in which game theory techniques are increasingly being applied to real business situations.

731 Indeed, all of the concepts explored within the literature search provide a useful means for analysing the issues explained within this research and may provide a means for developing future strategies and formal modelling solutions.

Customer demand elasticity

732 Section 6 illustrates the effect that the triad warning service offered by Norweb had upon subscribing customers in both the winters of 1991/92 and 1992/93. This analysis suggests both the overall effect that reductions in customer demand had upon the effectiveness of the triad forecasting service, and provides insight into the "price elasticity" of various customers demand for electricity. The results of the analysis undertaken can be interpreted in two further ways:

- they provide insight into the respective cost-benefit decisions taken by customers in their own assessment of the importance of electricity costs as a proportion of total controllable costs; and
- the results have implications for electricity supply companies who design tariffs and contract tailored to meet the needs of different customers. Tariffs could be developed for customers who are capable of managing their electricity demand in accordance with triad warnings, or example.

733 Thirty sets of customer demands were analysed across a stratified sample reflecting both the industry and size mix typical of Norweb's non

franchise customer base in 1991/92 and 1992/93. The demand profiles constructed represent demand patterns on "typical" days and compare them with the profile following any reduction in demand in the event of a triad warning. This enables a simple calculation of percentage reduction in demand (a simple calculation of elasticity) upon receipt of triad warnings and further enables the calculation of costs savings as a result of the avoidance of triads.

734 The conclusions relating to the outcome of this analysis relate to the potential for certain industries to reduce their electricity demand at certain times and the method by which these demand reductions have been achieved. Some customers displayed a "tools down" response to triad warnings, other required longer periods to wind down their production and return to normal production levels, others appeared to have shifted peak demand periods to times when costs are likely to be lower.

735 Ultimately the variety of responses to triad warnings on the part of customers provides insight into the consequences of the triad forecasting system itself and introduces the dimension of the "participating agent" into the game situation. The customer has a passive impact upon the outcome of the triad forecasting strategy since it does not instigate the strategy and wishes only to reduce it's own costs. Nevertheless, the actions of the customers impact upon the effect of the strategies adopted by the various players.

Future triad strategies

736 Indeed, this very interaction on the part of both electricity supply companies and further, their customers, needs to be formally modelled for successful future triad forecasting strategies. In 1991/92, the forecasting of triads essentially involved forecasting peak demand periods and formulating an idea about the level of demand at which a triad was likely to occur in

order to ensure the triads could be predicted in advance of their occurrence.

737 However, these conclusions now suggest that customers responding to triad warnings by reducing their demand for electricity do indeed reduce the accuracy of demand forecasts. These demand forecasts had been formulated according to proven statistical relationships between demand, weather and time variables. The action of customers reducing their demand (as one expects) introduces an "abnormal" dimension into the equation which has not previously been accounted for or indeed modelled.

738 Furthermore, once the effect of these demand reductions had been recognised during the course of 1992/93, the actions of other RECs offering triad warning services were taken into account. If a forecast of demand was such that the occurrence of a triad was associated with a low probability, and other RECs had issued triad warnings, then it could be expected that a triad would no longer occur given the effect of anticipated reductions in demand. This REC therefore does not need to issue a triad warning. However, if this calculation is incorrect, the very act of not issuing a triad warning could mean a triad could occur.

739 The complexities of this situation are obvious, but it is likely that these interrelationships need to be modelled and future strategies should encompass principals based upon the results of such analysis in order that triads can be successfully forecast in future years.

Future contracts and policy

740 The implications of this research reach wider than the requirement for a new solution to forecasting triads. The new dimension offered to game theory analysis (that of the participating agents) is theoretically appealing, but there are implications for the business of trading electricity.

741 First of all, by analysing the response of customers to triad warnings, it is possible to assess which customers both wish to and can reduce for demand for electricity on request. This has obvious implications for new types of contracts which can be offered to such customers, where suppliers of electricity can offer further discounts in return for customers reducing their demand when prices are particularly high. The incorporation of such contract devices into an electricity supply businesses portfolio of supply contracts will further enable the management of "hedging" contracts against fluctuations in pool prices on behalf of the supplier. This is an issue that is increasingly becoming more relevant with the operation of demand side bidding practises as a means of setting pool prices in the continually developing electricity trading arena.

742 Such contracts could also provide suppliers of electricity with further competitive advantage over their rivals by offering more flexible arrangements to present and potential customers. A wider portfolio of contract and pricing arrangements for customers also represents a wider "product" range offered by electricity supply companies, and hence further potential additions to the overall economic efficiency of the electricity supply industry.

743 The potential also exists to introduce the benefits of avoiding triad charges into electricity generation. In the winter of 1993/94, Norweb introduced a "triad benefit sharing contract" which enabled intended to share the benefits of the triad warning service with a smaller generator of electricity with whom Norweb was contracted to purchase electricity from. This entailed providing triad warnings to the generator, who in turn intended to maximise it s generation of electricity during the warning periods. If the generator maximised it s output at the time of the triad periods the Norweb agreed to pay to the generator a proportion of the saving to itself to the generator. Suppliers of electricity, as well as certain non franchise customers also pay the expensive triad charges to NGC and thus any attempt at reducing the net import of electricity through NGC

offers potential savings to supply companies and other generators of electricity.

744 Thus, the experience of the triad forecasting service which forms the basis for this thesis has certain business implications alongside presenting an interesting example of the application of economic theory to a particular situation within the electricity supply industry.

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APPENDICES

Appendix 1

Triad demand history 1979/80 to 1992/93

TRIAD DEMAND HISTORY

NATIONAL DEMAND DATA (MW)

YEAR	DEMAND ORDER	TIME PERIOD	DATE	DAY	DEMAND (MW)
1979/80	1	1700	14/01/80	MON	44,225
	6	1700	03/01/80	THU	42,736
	17	1730	19/12/79	WED	42,253
1980/81	1	1730	13/01/81	TUE	42,600
	3	1700	01/12/80	MON	42,377
	23	1730	05/11/80	WED	40,582
1981/82	1	1730	12/01/82	TUE	42,597
	2	1700	10/12/81	THU	42,226
	67	1700	21/12/81	MON	40,589
1982/83	1	1700	14/12/82	TUE	42,067
	8	1700	02/12/82	THU	40,708
	13	1730	19/01/83	WED	40,356
1983/84	1	1700	07/12/83	WED	42,243
	4	1730	24/01/84	TUE	41,963
	7	1730	22/11/83	TUE	41,725
1984/85	1	1730	17/01/85	THU	46,219
	20	1800	12/02/85	TUE	43,306
	56	1700	18/12/84	TUE	42,080
1985/86	1	1700	07/01/86	TUE	45,185
	3	1700	20/11/85	WED	44,052
	4	1730	03/02/86	MON	44,015
1986/87	1	1730	12/01/87	MON	47,925
	105	1700	17/12/86	WED	43,444
	113	1730	27/01/87	TUE	43,187
1987/88	1	1700	15/12/87	TUE	46,935
	23	1730	01/12/87	TUE	44,965
	29	1730	12/01/88	TUE	44,486
1988/89	1	1730	22/11/88	TUE	46,880
	5	1730	06/12/88	TUE	46,020
	14	1730	25/01/89	WED	45,219
1989/90	1	1700	11/12/89	MON	46,714
	3	1700	28/11/89	TUE	46,650
	34	1730	29/01/90	MON	44,948
1990/91	1	1730	07/02/91	THU	47,035
	7	1730	15/01/91	TUE	46,570
	8	1700	18/12/90	TUE	46,556
1991/92	1	1730	11/12/91	WED	47,289
	11	1730	23/01/92	THU	45,766
	16	1730	21/11/91	THU	45,150
1992/93	1	1730	17/11/92	TUE	44,638
	3	1730	04/01/93	MON	44,334
	4	1700	09/12/92	WED	44,261

NATIONAL DEMAND DATA

YEAR : 79/80

DEMAND ORDER	TIME	DAY	MONTH	YEAR	DEMAND	
1	1700	14	1	80	44225	TRIAD
2	1730	14	1	80	44029	
3	1730	15	1	80	43562	
4	1730	16	1	80	42932	
5	1630	14	1	80	42783	
6	1700	3	1	80	42736	TRIAD
7	1700	15	1	80	42734	
8	1800	14	1	80	42668	
9	1800	15	1	80	42446	
10	1700	9	1	80	42435	
11	1200	14	1	80	42414	
12	1730	17	1	80	42409	
13	1230	14	1	80	42398	
14	1730	9	1	80	42373	
15	1730	21	1	80	42335	
16	1630	3	1	80	42274	
17	1730	19	12	79	42253	TRIAD
18	1700	19	12	79	42224	
19	1700	18	12	79	42213	
20	1730	13	11	79	42207	
21	1130	14	1	80	42160	
22	1700	15	11	79	42137	
23	1700	17	12	79	42119	
24	1730	18	12	79	42107	
25	1730	20	11	79	42098	
26	1730	10	1	80	42095	
27	1730	15	11	79	42062	
28	1000	14	1	80	42051	
29	1730	21	11	79	42040	
30	1700	16	1	80	42029	
31	1700	21	1	80	42011	
32	1730	8	1	80	41963	
33	1730	3	1	80	41949	
34	1100	14	1	80	41934	
35	1730	14	11	79	41922	
36	1730	17	12	79	41918	
37	1700	21	11	79	41882	
38	1700	20	11	79	41879	
39	1030	14	1	80	41861	
40	1800	16	1	80	41819	
41	1730	18	1	80	41814	
42	1700	13	11	79	41779	
43	1430	14	1	80	41773	
44	1730	22	1	80	41761	
45	1700	10	1	80	41759	
46	1400	14	1	80	41747	
47	1730	2	1	80	41742	
48	1700	8	1	80	41742	
49	1700	14	11	79	41705	
50	1800	19	12	79	41643	

NATIONAL DEMAND DATA

YEAR : 80/81

DEMAND ORDER	TIME	DAY	MONTH	YEAR	DEMAND	
1	1730	13	1	81	42600	TRIAD
2	1700	13	1	81	42569	
3	1700	1	12	80	42377	TRIAD
4	1700	8	12	80	42359	
5	1700	9	12	80	42195	
6	1700	3	12	80	41915	
7	1730	8	12	80	41877	
8	1730	9	12	80	41613	
9	1700	2	12	80	41574	
10	1730	1	12	80	41396	
11	1730	3	12	80	41360	
12	1630	1	12	80	41269	
13	1630	9	12	80	41113	
14	1800	13	1	81	41088	
15	1730	2	12	80	41061	
16	1730	12	1	81	41054	
17	1730	14	1	81	40829	
18	1800	8	12	80	40762	
19	1630	13	1	81	40702	
20	1700	10	12	80	40629	
21	1700	6	1	81	40625	
22	1700	14	1	81	40585	
23	1730	5	11	80	40582	TRIAD
24	1630	8	12	80	40568	
25	1700	7	1	81	40560	
26	1630	3	12	80	40531	
27	1700	4	12	80	40510	
28	1730	7	1	81	40465	
29	1700	12	1	81	40416	
30	1700	5	11	80	40399	
31	1730	4	12	80	40367	
32	1730	16	12	80	40336	
33	1730	6	1	81	40325	
34	1630	2	12	80	40255	
35	1800	9	12	80	40254	
36	1800	3	12	80	40245	
37	1700	16	12	80	40228	
38	1800	1	12	80	40170	
39	1730	15	1	81	40126	
40	1730	10	12	80	40053	
41	1730	20	1	81	40023	
42	1730	4	11	80	40006	
43	1700	6	11	80	39958	
44	1730	6	11	80	39947	
45	1800	2	12	80	39848	
46	1830	13	1	81	39847	
47	1700	28	11	80	39832	
48	1730	11	11	80	39818	
49	1700	26	11	80	39803	
50	1730	26	11	80	39799	

NATIONAL DEMAND DATA

YEAR : 81/82

DEMAND ORDER	TIME	DAY	MONTH	YEAR	DEMAND	
1	1730	12	1	82	42597	TRIAD
2	1700	10	12	81	42226	TRIAD
3	1730	14	1	82	42155	
4	1700	12	1	82	42070	
5	1800	14	1	82	41964	
6	1700	7	1	82	41911	
7	1700	9	12	81	41864	
8	1100	15	1	82	41862	
9	1730	10	12	81	41842	
10	1730	7	1	82	41802	
11	1130	15	1	82	41780	
12	1730	13	1	82	41677	
13	1830	14	1	82	41658	
14	1200	15	1	82	41657	
15	1030	15	1	82	41646	
16	1700	15	12	81	41613	
17	1230	15	1	82	41597	
18	1700	8	12	81	41541	
19	1730	9	12	81	41533	
20	1730	11	1	82	41490	
21	1700	14	1	82	41462	
22	1700	16	12	81	41448	
23	1300	15	1	82	41429	
24	1000	14	1	82	41419	
25	1800	12	1	82	41398	
26	1330	15	1	82	41398	
27	0930	15	1	82	41393	
28	1230	14	1	82	41372	
29	1000	15	1	82	41351	
30	1200	14	1	82	41345	
31	1700	17	12	81	41331	
32	1730	16	12	81	41297	
33	1400	15	1	82	41249	
34	0930	14	1	82	41236	
35	1730	17	12	81	41232	
36	1730	8	12	81	41227	
37	1730	15	12	81	41211	
38	1130	14	1	82	41163	
39	1900	14	1	82	41133	
40	1730	15	1	82	41117	
41	1800	13	1	82	41108	
42	1630	10	12	81	41030	
43	1030	14	1	82	41012	
44	1430	15	1	82	41000	
45	1700	11	1	82	40988	
46	1700	13	1	82	40947	
47	1800	15	1	82	40909	
48	1100	14	1	82	40908	
49	1800	16	12	81	40890	
50	1730	18	12	81	40869	
67	1700	21	12	81	40589	TRIAD

NATIONAL DEMAND DATA

YEAR : 82/83

DEMAND ORDER	TIME	DAY	MONTH	YEAR	DEMAND	
1	1700	14	12	82	42067	TRIAD
2	1700	7	12	82	41529	
3	1730	14	12	82	41308	
4	1630	14	12	82	41251	
5	1700	13	12	82	41073	
6	1730	7	12	82	40831	
7	1630	7	12	82	40743	
8	1700	2	12	82	40708	TRIAD
9	1730	13	12	82	40679	
10	1700	6	12	82	40656	
11	1700	8	12	82	40538	
12	1700	29	11	82	40478	
13	1730	19	1	83	40356	TRIAD
14	1700	9	12	82	40325	
15	1730	8	12	82	40307	
16	1730	20	1	83	40290	
17	1730	2	12	82	40242	
18	1800	10	2	83	40090	
19	1800	15	2	83	40068	
20	1730	29	11	82	40057	
21	1700	16	12	82	40049	
22	1800	9	2	83	40044	
23	1800	8	2	83	40025	
24	1730	18	1	83	40013	
25	1730	6	12	82	39985	
26	1700	20	12	82	39943	
27	1730	10	2	83	39920	
28	1800	14	12	82	39915	
29	1700	30	11	82	39894	
30	1730	8	2	83	39891	
31	1730	16	12	82	39744	
32	1630	2	12	82	39720	
33	1730	9	12	82	39654	
34	1800	13	12	82	39648	
35	1730	20	12	82	39645	
36	1730	9	2	83	39636	
37	1730	30	11	82	39594	
38	1700	20	1	83	39546	
39	1700	15	12	82	39504	
40	1730	7	2	83	39461	
41	1700	17	11	82	39459	
42	1730	15	2	83	39439	
43	1630	13	12	82	39434	
44	1730	13	1	83	39414	
45	1700	1	12	82	39370	
46	1730	15	12	82	39302	
47	1630	9	12	82	39241	
48	1800	20	1	83	39211	
49	1830	15	2	83	39210	
50	1800	19	1	83	39208	

NATIONAL DEMAND DATA

YEAR : 83/84

DEMAND ORDER	TIME	DAY	MONTH	YEAR	DEMAND	
1	1700	7	12	83	42243	TRIAD
2	1700	13	12	83	42186	
3	1700	14	12	83	42032	
4	1730	24	1	84	41963	TRIAD
5	1730	13	12	83	41748	
6	1700	12	12	83	41727	
7	1730	22	11	83	41725	TRIAD
8	1730	25	1	84	41705	
9	1730	7	12	83	41691	
10	1700	23	11	83	41635	
11	1730	23	11	83	41615	
12	1730	12	12	83	41606	
13	1730	17	1	84	41578	
14	1700	22	11	83	41528	
15	1730	14	12	83	41482	
16	1730	19	1	84	41436	
17	1700	24	11	83	41398	
18	1730	9	1	84	41210	
19	1700	9	1	84	41195	
20	1730	18	1	84	41177	
21	1700	6	12	83	41152	
22	1730	23	1	84	41136	
23	1800	24	1	84	41103	
24	1630	13	12	83	41061	
25	1730	24	11	83	41042	
26	1630	14	12	83	40998	
27	1730	6	12	83	40967	
28	1700	24	1	84	40808	
29	1630	7	12	83	40786	
30	1800	25	1	84	40752	
31	1700	17	1	84	40695	
32	1730	16	1	84	40624	
33	1730	12	1	84	40575	
34	1800	19	1	84	40568	
35	1700	16	1	84	40526	
36	1800	13	12	83	40504	
37	1800	12	12	83	40498	
38	1700	23	1	84	40495	
39	1800	23	11	83	40469	
40	1730	21	11	83	40465	
41	1730	15	11	83	40434	
42	1700	19	1	84	40428	
43	1730	30	1	84	40428	
44	1700	25	1	84	40424	
45	1800	7	12	83	40396	
46	1800	22	11	83	40376	
47	1800	17	1	84	40332	
48	1700	10	1	84	40272	
49	1700	21	11	83	40227	
50	1800	18	1	84	40227	

NATIONAL DEMAND DATA

YEAR : 84/85

DEMAND ORDER	TIME	DAY	MONTH	YEAR	DEMAND	
1	1730	17	1	85	46219	TRIAD
2	1700	17	1	85	45658	
3	1730	16	1	85	45441	
4	1700	16	1	85	45255	
5	1730	15	1	85	45050	
6	1800	17	1	85	44780	
7	1730	8	1	85	44748	
8	1700	14	1	85	44630	
9	1700	8	1	85	44625	
10	1730	14	1	85	44583	
11	1700	15	1	85	44422	
12	1730	7	1	85	43979	
13	1700	7	1	85	43910	
14	1730	9	1	85	43894	
15	1800	16	1	85	43840	
16	1630	17	1	85	43596	
17	1800	15	1	85	43581	
18	1630	16	1	85	43575	
19	1700	9	1	85	43563	
20	1800	12	2	85	43306	TRIAD
21	1730	10	1	85	43214	
22	1800	13	2	85	43186	
23	1830	17	1	85	43167	
24	1800	14	1	85	43092	
25	1800	11	2	85	43041	
26	1800	8	1	85	42876	
27	1630	14	1	85	42752	
28	1700	10	1	85	42747	
29	1730	24	1	85	42706	
30	1000	16	1	85	42684	
31	1230	16	1	85	42671	
32	1830	12	2	85	42654	
33	1200	16	1	85	42627	
34	1800	14	2	85	42560	
35	1730	18	1	85	42557	
36	1830	13	2	85	42516	
37	1830	11	2	85	42467	
38	1630	8	1	85	42450	
39	1630	15	1	85	42442	
40	1030	16	1	85	42427	
41	1130	16	1	85	42389	
42	1800	7	1	85	42369	
43	1730	13	2	85	42338	
44	1700	24	1	85	42331	
45	0930	16	1	85	42305	
46	1730	12	2	85	42284	
47	1800	9	1	85	42282	
48	1730	23	1	85	42210	
49	1830	14	2	85	42179	
50	1900	17	1	85	42174	
56	1700	18	12	84	42080	TRIAD

NATIONAL DEMAND DATA

YEAR : 85/86

DEMAND ORDER	TIME	DAY	MONTH	YEAR	DEMAND	
1	1700	7	1	86	45185	TRIAD
2	1730	7	1	86	44795	
3	1700	20	11	85	44052	TRIAD
4	1730	3	2	86	44015	TRIAD
5	1730	8	1	86	43988	
6	1700	8	1	86	43987	
7	1730	20	11	85	43910	
8	1630	7	1	86	43813	
9	1700	3	2	86	43710	
10	1800	11	2	86	43626	
11	1730	28	11	85	43454	
12	1730	4	2	86	43407	
13	1700	28	11	85	43374	
14	1730	27	11	85	43357	
15	1700	27	11	85	43347	
16	1730	6	2	86	43320	
17	1800	10	2	86	43294	
18	1800	6	2	86	43291	
19	1730	11	2	86	43231	
20	1730	6	1	86	43214	
21	1230	17	2	86	43148	
22	1200	17	2	86	43145	
23	1700	10	12	85	43143	
24	1730	26	11	85	43127	
25	1700	26	11	85	43104	
26	1730	29	1	86	43098	
27	1800	12	2	86	43077	
28	1730	9	1	86	43072	
29	1730	30	1	86	43007	
30	1700	21	11	85	42984	
31	1730	28	1	86	42929	
32	1700	6	1	86	42913	
33	1800	7	1	86	42908	
34	1730	27	1	86	42878	
35	1800	4	2	86	42866	
36	1700	9	1	86	42857	
37	1730	21	11	85	42806	
38	1000	17	2	86	42805	
39	1730	10	12	85	42787	
40	1130	17	2	86	42736	
41	1030	17	2	86	42714	
42	1630	20	11	85	42696	
43	1830	11	2	86	42669	
44	1830	10	2	86	42649	
45	1800	3	2	86	42642	
46	1800	17	2	86	42632	
47	1100	17	2	86	42615	
48	1700	25	11	85	42606	
49	1830	25	2	86	42604	
50	1730	5	2	86	42561	

NATIONAL DEMAND DATA

YEAR : 86/87

DEMAND ORDER	TIME	DAY	MONTH	YEAR	DEMAND	
1	1730	12	1	87	47925	TRIAD
2	1700	12	1	87	47897	
3	1730	14	1	87	47607	
4	1800	12	1	87	47330	
5	1730	13	1	87	47267	
6	1700	14	1	87	47240	
7	1230	14	1	87	47232	
8	1730	15	1	87	47181	
9	1700	13	1	87	47092	
10	1700	15	1	87	47084	
11	1200	14	1	87	46953	
12	1230	13	1	87	46669	
13	1730	19	1	87	46653	
14	1200	13	1	87	46611	
15	1130	14	1	87	46598	
16	1300	14	1	87	46494	
17	1100	14	1	87	46382	
18	1800	14	1	87	46313	
19	1830	12	1	87	46234	
20	1130	13	1	87	46142	
21	1700	19	1	87	46102	
22	1300	13	1	87	45998	
23	1230	15	1	87	45991	
24	1100	13	1	87	45983	
25	1030	14	1	87	45947	
26	1330	14	1	87	45931	
27	1800	13	1	87	45926	
28	1630	13	1	87	45880	
29	1000	13	1	87	45865	
30	1030	13	1	87	45839	
31	1800	15	1	87	45823	
32	1200	15	1	87	45770	
33	1000	14	1	87	45724	
34	1630	12	1	87	45702	
35	1330	13	1	87	45691	
36	1630	14	1	87	45623	
37	1400	14	1	87	45452	
38	1400	13	1	87	45431	
39	1630	15	1	87	45412	
40	0930	13	1	87	45312	
41	1300	15	1	87	45311	
42	1430	13	1	87	45247	
43	1130	15	1	87	45238	
44	1900	12	1	87	45197	
45	1830	13	1	87	45103	
46	1100	15	1	87	45091	
47	1800	19	1	87	45074	
48	1730	20	1	87	45062	
49	1030	15	1	87	45061	
50	1500	13	1	87	45051	
105	1700	17	12	86	43444	TRIAD
113	1730	27	1	87	43187	TRIAD

NATIONAL DEMAND DATA

YEAR : 87/88

DEMAND ORDER	TIME	DAY	MONTH	YEAR	DEMAND	
1	1700	15	12	87	46935	TRIAD
2	1730	15	12	87	46609	
3	1730	9	12	87	46517	
4	1730	8	12	87	46506	
5	1700	14	12	87	46446	
6	1700	9	12	87	46422	
7	1730	14	12	87	46289	
8	1700	8	12	87	46215	
9	1700	10	12	87	45761	
10	1700	3	12	87	45759	
11	1700	2	12	87	45751	
12	1730	10	12	87	45743	
13	1630	15	12	87	45730	
14	1730	2	12	87	45641	
15	1730	3	12	87	45496	
16	1800	8	12	87	45278	
17	1800	15	12	87	45174	
18	1800	9	12	87	45152	
19	1700	7	12	87	45121	
20	1730	7	12	87	45086	
21	1800	14	12	87	45040	
22	1630	14	12	87	44990	
23	1730	1	12	87	44965	TRIAD
24	1700	1	12	87	44841	
25	1800	10	12	87	44703	
26	1700	30	11	87	44611	
27	1630	3	12	87	44574	
28	1730	25	11	87	44497	
29	1730	12	1	88	44486	TRIAD
30	1730	30	11	87	44478	
31	1630	9	12	87	44367	
32	1700	25	11	87	44355	
33	1800	2	12	87	44171	
34	1700	12	1	88	44105	
35	1730	24	11	87	44099	
36	1800	3	12	87	44070	
37	1730	26	11	87	44062	
38	1630	10	12	87	44056	
39	1700	24	11	87	44048	
40	1730	23	11	87	44014	
41	1700	23	11	87	44008	
42	1630	8	12	87	43990	
43	1630	2	12	87	43986	
44	1730	6	1	88	43885	
45	1700	16	12	87	43866	
46	1700	6	1	88	43848	
47	1730	18	1	88	43848	
48	1730	27	1	88	43831	
49	1730	7	1	88	43788	
50	1730	21	1	88	43788	

NATIONAL DEMAND DATA

YEAR : 88/89

DEMAND ORDER	TIME	DAY	MONTH	YEAR	DEMAND	
1	1730	22	11	88	46880	TRIAD
2	1730	21	11	88	46614	
3	1700	22	11	88	46543	
4	1730	23	11	88	46195	
5	1730	6	12	88	46020	TRIAD
6	1700	21	11	88	45926	
7	1700	23	11	88	45785	
8	1730	7	12	88	45707	
9	1700	6	12	88	45595	
10	1730	24	11	88	45533	
11	1700	7	12	88	45460	
12	1700	24	11	88	45374	
13	1730	5	12	88	45257	
14	1730	25	1	89	45219	TRIAD
15	1800	22	11	88	45168	
16	1700	1	12	88	45087	
17	1700	5	12	88	44922	
18	1730	11	1	89	44888	
19	1730	1	12	88	44878	
20	1700	29	11	88	44845	
21	1730	29	11	88	44842	
22	1800	21	11	88	44805	
23	1730	28	11	88	44794	
24	1700	28	11	88	44676	
25	1700	5	1	89	44623	
26	1730	5	1	89	44597	
27	1730	18	1	89	44570	
28	1800	23	11	88	44532	
29	1730	19	1	89	44491	
30	1730	15	11	88	44405	
31	1700	8	12	88	44327	
32	1800	6	12	88	44252	
33	1730	8	12	88	44244	
34	1730	13	12	88	44212	
35	1730	8	11	88	44173	
36	1700	11	1	89	44126	
37	1700	13	12	88	44070	
38	1800	7	12	88	44044	
39	1800	25	1	89	44041	
40	1730	24	1	89	44040	
41	1700	14	12	88	43999	
42	1630	1	12	88	43966	
43	1700	25	1	89	43960	
44	1800	24	11	88	43953	
45	1730	20	12	88	43924	
46	1730	10	1	89	43919	
47	1730	14	14	88	43910	
48	1730	12	12	88	43881	
49	1730	12	12	89	43790	
50	1830	22	22	88	43757	

NATIONAL DEMAND DATA

YEAR : 89/90

DEMAND ORDER	TIME	DAY	MONTH	YEAR	DEMAND	
1	1700	11	12	89	46714	TRIAD
2	1730	11	12	89	46668	
3	1700	28	11	89	46650	TRIAD
4	1730	4	12	89	46641	
5	1730	28	11	89	46611	
6	1700	13	12	89	46575	
7	1700	4	12	89	46573	
8	1730	12	12	89	46493	
9	1700	12	12	89	46441	
10	1730	13	12	89	46351	
11	1730	27	11	89	46350	
12	1730	29	11	89	46267	
13	1700	27	11	89	46078	
14	1730	30	11	89	46025	
15	1730	5	12	89	45999	
16	1700	29	11	89	45989	
17	1700	5	12	89	45974	
18	1700	14	12	89	45880	
19	1700	30	11	89	45814	
20	1730	6	12	89	45561	
21	1700	19	12	89	45555	
22	1730	14	12	89	45536	
23	1700	6	12	89	45504	
24	1730	19	12	89	45497	
25	1700	18	12	89	45470	
26	1730	18	12	89	45362	
27	1630	13	12	89	45208	
28	1800	11	12	89	45172	
29	1730	7	12	89	45164	
30	1700	7	12	89	45104	
31	1800	4	12	89	45027	
32	1730	23	11	89	45016	
33	1630	11	12	89	44960	
34	1730	29	1	90	44948	TRIAD
35	1630	28	11	89	44933	
36	1800	28	11	89	44897	
37	1630	12	12	89	44866	
38	1800	12	12	89	44861	
39	1630	14	12	89	44777	
40	1800	13	12	89	44758	
41	1730	24	1	90	44732	
42	1730	8	1	90	44682	
43	1730	8	11	89	44668	
44	1800	29	11	89	44667	
45	1730	1	12	89	44665	
46	1730	9	1	90	44658	
47	1800	27	11	89	44649	
48	1800	30	11	89	44614	
49	1730	3	1	90	44595	
50	1700	1	12	89	44540	

NATIONAL DEMAND DATA

YEAR : 90/91

DEMAND ORDER	TIME	DAY	MONTH	YEAR	DEMAND	
1	1730	7	2	91	47035	TRIAD
2	1230	7	2	91	47033	
3	1200	7	2	91	46879	
4	1800	6	2	91	46824	
5	1800	7	2	91	46818	
6	1730	6	2	91	46593	
7	1730	15	1	91	46570	TRIAD
8	1700	18	12	90	46556	TRIAD
9	1730	18	12	90	46514	
10	1300	7	2	91	46513	
11	1130	7	2	91	46466	
12	1730	29	1	91	46449	
13	1730	12	12	90	46387	
14	1700	12	12	90	46386	
15	1730	17	12	90	46331	
16	1730	14	1	91	46294	
17	1730	16	1	91	46274	
18	1700	17	12	90	46249	
19	1730	4	2	91	46220	
20	1830	6	2	91	46178	
21	1730	19	12	90	46145	
22	1100	7	2	91	46106	
23	1700	7	2	91	46095	
24	1830	7	2	91	46057	
25	1330	7	2	91	46053	
26	1730	90	1	91	46051	
27	1030	7	2	91	46033	
28	1700	8	1	91	46027	
29	1000	7	2	91	46010	
30	1800	5	2	91	45966	
31	1800	4	2	91	45962	
32	1700	11	12	90	45955	
33	1700	19	12	90	45912	
34	1730	13	12	90	45885	
35	1700	29	1	91	45854	
36	1730	11	12	90	45792	
37	1700	6	12	90	45779	
38	1700	13	12	90	45737	
39	1730	6	12	90	45712	
40	1730	8	1	91	45712	
41	1730	28	1	91	45703	
42	1730	26	11	90	45699	
43	1730	28	11	90	45688	
44	1730	31	1	91	45680	
45	1700	26	11	90	45674	
46	1730	5	2	91	45634	
47	0930	7	2	91	45627	
48	1400	7	2	91	45573	
49	1800	11	2	91	45548	
50	1900	7	2	91	45547	

Appendix 2

Long run average effective temperature series

N LEAP YEAR

TE	NORMAL	RUN AV
01-Nov	8.49	8.49
02-Nov	8.32	8.41
03-Nov	8.16	8.32
04-Nov	8	8.24
05-Nov	7.84	8.16
06-Nov	7.68	8.08
07-Nov	7.53	8.00
08-Nov	7.38	7.93
09-Nov	7.23	7.85
10-Nov	7.09	7.77
11-Nov	6.95	7.70
12-Nov	6.82	7.62
13-Nov	6.7	7.55
14-Nov	6.58	7.48
15-Nov	6.47	7.42
16-Nov	6.36	7.35
17-Nov	6.26	7.29
18-Nov	6.16	7.22
19-Nov	6.06	7.16
20-Nov	5.98	7.10
21-Nov	5.89	7.05
22-Nov	5.82	6.99
23-Nov	5.74	6.94
24-Nov	5.67	6.88
25-Nov	5.6	6.83
26-Nov	5.54	6.78
27-Nov	5.47	6.73
28-Nov	5.41	6.69
29-Nov	5.36	6.64
30-Nov	5.3	6.60
01-Dec	5.24	6.55
02-Dec	5.18	6.51
03-Dec	5.13	6.47
04-Dec	5.07	6.43
05-Dec	5.01	6.39
06-Dec	4.96	6.35
07-Dec	4.9	6.31
08-Dec	4.85	6.27
09-Dec	4.79	6.23
10-Dec	4.74	6.19
11-Dec	4.68	6.16
12-Dec	4.63	6.12
13-Dec	4.57	6.08
14-Dec	4.52	6.05
15-Dec	4.47	6.01
16-Dec	4.41	5.98
17-Dec	4.36	5.94
18-Dec	4.31	5.91
19-Dec	4.26	5.88
20-Dec	4.22	5.84
21-Dec	4.18	5.81
22-Dec	4.13	5.78
23-Dec	4.09	5.75
24-Dec	4.05	5.72
25-Dec	4.01	5.68
26-Dec	3.98	5.65
27-Dec	3.94	5.62
28-Dec	3.91	5.59
29-Dec	3.87	5.56
30-Dec	3.84	5.54
31-Dec	3.81	5.51

DATE	NORMAL	RUN AV
01-Jan	3.77	5.48
02-Jan	3.74	5.45
03-Jan	3.71	5.42
04-Jan	3.68	5.40
05-Jan	3.65	5.37
06-Jan	3.62	5.35
07-Jan	3.59	5.32
08-Jan	3.56	5.29
09-Jan	3.53	5.27
10-Jan	3.51	5.24
11-Jan	3.49	5.22
12-Jan	3.46	5.20
13-Jan	3.44	5.17
14-Jan	3.42	5.15
15-Jan	3.4	5.13
16-Jan	3.38	5.10
17-Jan	3.36	5.08
18-Jan	3.35	5.06
19-Jan	3.34	5.04
20-Jan	3.33	5.02
21-Jan	3.32	5.00
22-Jan	3.31	4.98
23-Jan	3.3	4.96
24-Jan	3.29	4.94
25-Jan	3.28	4.92
26-Jan	3.27	4.90
27-Jan	3.26	4.88
28-Jan	3.25	4.86
29-Jan	3.25	4.84
30-Jan	3.24	4.82
31-Jan	3.23	4.81
01-Feb	3.22	4.79
02-Feb	3.22	4.77
03-Feb	3.21	4.76
04-Feb	3.21	4.74
05-Feb	3.21	4.73
06-Feb	3.21	4.71
07-Feb	3.21	4.69
08-Feb	3.21	4.68
09-Feb	3.22	4.67
10-Feb	3.23	4.65
11-Feb	3.25	4.64
12-Feb	3.26	4.62
13-Feb	3.29	4.61
14-Feb	3.31	4.60
15-Feb	3.34	4.59
16-Feb	3.38	4.58
17-Feb	3.42	4.57
18-Feb	3.46	4.56
19-Feb	3.51	4.55
20-Feb	3.56	4.54
21-Feb	3.62	4.53
22-Feb	3.68	4.52
23-Feb	3.75	4.52
24-Feb	3.82	4.51
25-Feb	3.9	4.50
26-Feb	3.98	4.50
27-Feb	4.06	4.50
28-Feb	4.14	4.49

AP YEAR

ATE	NORMAL	RUN AV
01-Nov	8.49	8.49
02-Nov	8.32	8.41
03-Nov	8.16	8.32
04-Nov	8	8.24
05-Nov	7.84	8.16
06-Nov	7.68	8.08
07-Nov	7.53	8.00
08-Nov	7.38	7.93
09-Nov	7.23	7.85
10-Nov	7.09	7.77
11-Nov	6.95	7.70
12-Nov	6.82	7.62
13-Nov	6.7	7.55
14-Nov	6.58	7.48
15-Nov	6.47	7.42
16-Nov	6.36	7.35
17-Nov	6.26	7.29
18-Nov	6.16	7.22
19-Nov	6.06	7.16
20-Nov	5.98	7.10
21-Nov	5.89	7.05
22-Nov	5.82	6.99
23-Nov	5.74	6.94
24-Nov	5.67	6.88
25-Nov	5.6	6.83
26-Nov	5.54	6.78
27-Nov	5.47	6.73
28-Nov	5.41	6.69
29-Nov	5.36	6.64
30-Nov	5.3	6.60
01-Dec	5.24	6.55
02-Dec	5.18	6.51
03-Dec	5.13	6.47
04-Dec	5.07	6.43
05-Dec	5.01	6.39
06-Dec	4.96	6.35
07-Dec	4.9	6.31
08-Dec	4.85	6.27
09-Dec	4.79	6.23
10-Dec	4.74	6.19
11-Dec	4.68	6.16
12-Dec	4.63	6.12
13-Dec	4.57	6.08
14-Dec	4.52	6.05
15-Dec	4.47	6.01
16-Dec	4.41	5.98
17-Dec	4.36	5.94
18-Dec	4.31	5.91
19-Dec	4.26	5.88
20-Dec	4.22	5.84
21-Dec	4.18	5.81
22-Dec	4.13	5.78
23-Dec	4.09	5.75
24-Dec	4.05	5.72
25-Dec	4.01	5.68
26-Dec	3.98	5.65
27-Dec	3.94	5.62
28-Dec	3.91	5.59
29-Dec	3.87	5.56
30-Dec	3.84	5.54
31-Dec	3.81	5.51

DATE	NORMAL	RUN AV
01-Jan	3.77	5.48
02-Jan	3.74	5.45
03-Jan	3.71	5.42
04-Jan	3.68	5.40
05-Jan	3.65	5.37
06-Jan	3.62	5.35
07-Jan	3.59	5.32
08-Jan	3.56	5.29
09-Jan	3.53	5.27
10-Jan	3.51	5.24
11-Jan	3.48	5.22
12-Jan	3.46	5.20
13-Jan	3.44	5.17
14-Jan	3.42	5.15
15-Jan	3.4	5.13
16-Jan	3.38	5.10
17-Jan	3.36	5.08
18-Jan	3.35	5.06
19-Jan	3.34	5.04
20-Jan	3.33	5.02
21-Jan	3.32	5.00
22-Jan	3.31	4.97
23-Jan	3.3	4.95
24-Jan	3.29	4.94
25-Jan	3.28	4.92
26-Jan	3.27	4.90
27-Jan	3.26	4.88
28-Jan	3.26	4.86
29-Jan	3.25	4.84
30-Jan	3.24	4.82
31-Jan	3.23	4.81
01-Feb	3.23	4.79
02-Feb	3.22	4.77
03-Feb	3.22	4.76
04-Feb	3.21	4.74
05-Feb	3.21	4.73
06-Feb	3.2	4.71
07-Feb	3.2	4.69
08-Feb	3.21	4.68
09-Feb	3.21	4.67
10-Feb	3.22	4.65
11-Feb	3.23	4.64
12-Feb	3.25	4.62
13-Feb	3.27	4.61
14-Feb	3.29	4.60
15-Feb	3.32	4.59
16-Feb	3.35	4.58
17-Feb	3.39	4.56
18-Feb	3.43	4.55
19-Feb	3.47	4.54
20-Feb	3.52	4.54
21-Feb	3.58	4.53
22-Feb	3.64	4.52
23-Feb	3.7	4.51
24-Feb	3.77	4.51
25-Feb	3.84	4.50
26-Feb	3.92	4.49
27-Feb	4	4.49
28-Feb	4.08	4.49
29-Feb	4.16	4.48

Appendix 3

National half hourly demands and effective temperatures
1985/86 to 1990/91

ACTUALS 1990/91

		1700	1730	1800	MAX DEM	EFF ACT	EFF NORM	TEMP DEV
4	07-Feb THU	46096	47035	46818	47034.698	-1.84	3.21	-5.05
7	06-Feb WED	45471	46593	46824	46824.402	-0.27	3.21	-3.48
15	15-Jan TUE	45410	46570	45405	46570.022	1.58	3.4	-1.82
19	18-Dec TUE	46556	46514	45500	46555.688	1.99	4.31	-2.32
16	29-Jan TUE	45854	46449	45473	46448.992	1.73	3.25	-1.52
38	12-Dec WED	46386	46387	45177	46387.29	4.17	4.63	-0.46
23	17-Dec MON	46249	46331	45105	46330.544	2.31	4.36	-2.05
18	14-Jan MON	45059	46294	45289	46294.272	1.77	3.42	-1.65
14	16-Jan WED	45096	46274	45028	46274.142	1.51	3.38	-1.87
9	04-Feb MON	44651	46220	45962	46219.546	0.31	3.21	-2.9
21	19-Dec WED	45912	46145	45154	46145.328	2.13	4.26	-2.13
13	30-Jan WED	45049	46051	45388	46050.788	1.46	3.24	-1.78
49	08-Jan TUE	46027	45712	44202	46027.298	5.08	3.56	1.52
8	05-Feb TUE	44196	45634	45966	45966.326	0.28	3.21	-2.93
37	11-Dec TUE	45955	45792	44592	45954.934	4.01	4.68	-0.67
36	13-Dec THU	45737	45885	44783	45884.652	3.92	4.57	-0.65
33	06-Dec THU	45779	45712	44407	45778.564	3.76	4.96	-1.2
20	28-Jan MON	44842	45703	44619	45702.788	2.08	3.25	-1.17
43	26-Nov MON	45674	45699	44211	45699.478	4.88	5.54	-0.66
46	28-Nov WED	45468	45688	44125	45688.278	4.96	5.41	-0.43
11	31-Jan THU	44615	45680	45102	45679.6	1.17	3.23	-2.06
1	11-Feb MON	42987	44496	45548	45548.168	-2.13	3.25	-5.38
30	10-Dec MON	45456	45218	43962	45456.114	3.26	4.74	-1.48
50	09-Jan WED	45190	45420	44076	45419.646	5.15	3.53	1.62
40	22-Jan TUE	43857	45312	44444	45312.352	4.39	3.31	1.08
45	05-Dec WED	44944	45302	44195	45301.574	4.9	5.01	-0.11
32	23-Jan WED	43895	45225	44301	45225.12	3.73	3.3	0.43
52	27-Nov TUE	44995	45220	44077	45220.224	5.31	5.47	-0.16
44	07-Jan MON	44885	45209	43788	45209.226	4.9	3.59	1.31
53	04-Dec TUE	44940	45167	43710	45166.832	5.37	5.07	0.3
42	29-Nov THU	44950	45143	43754	45143.214	4.81	5.36	-0.55
29	24-Jan THU	43966	45108	44303	45107.556	3.22	3.29	-0.07
27	14-Dec FRI	44632	45049	44031	45048.726	3.03	4.52	-1.49
41	22-Nov THU	44675	44997	43986	44997.08	4.48	5.82	-1.34
2	08-Feb FRI	42228	44258	44981	44980.632	-2.11	3.21	-5.32
3	12-Feb TUE	43693	44730	44923	44923.47	-1.98	3.26	-5.24
56	10-Jan THU	43914	44850	43621	44849.68	5.59	3.51	2.08
25	17-Jan THU	43437	44831	43836	44831.404	2.58	3.36	-0.78
28	20-Dec THU	44736	44666	43498	44736.094	3.18	4.22	-1.04
6	13-Feb WED	42312	43494	44725	44724.862	-1.19	3.29	-4.48
57	21-Nov WED	44475	44723	43475	44723.254	5.6	5.89	-0.29
58	03-Dec MON	44461	44688	43221	44688.104	5.88	5.13	0.75
68	20-Nov TUE	44008	44544	43242	44544.43	7.07	5.98	1.09
5	14-Feb THU	41803	43198	44457	44457.208	-1.35	3.31	-4.66
60	06-Nov TUE	42840	44233	42974	44232.778	6.22	7.68	-1.46
39	07-Dec FRI	44217	44157	42831	44216.728	4.22	4.9	-0.68
24	25-Jan FRI	42879	44215	43550	44215.398	2.41	3.28	-0.87
54	21-Jan MON	42090	44124	43497	44124.396	5.41	3.32	2.09
74	19-Nov MON	43760	44116	42767	44116.14	8.72	6.06	2.66
65	07-Nov WED	42587	44075	42906	44074.604	6.55	7.53	-0.98
31	18-Jan FRI	43623	44013	42905	44012.928	3.49	3.35	0.14
34	23-Nov FRI	43720	43941	42576	43941.462	3.83	5.74	-1.91
63	08-Nov THU	43017	43892	42885	43892.484	6.43	7.38	-0.95
61	03-Jan THU	43300	43575	42396	43575.228	6.22	3.71	2.51
12	01-Feb FRI	41491	43410	43533	43532.702	1.46	3.22	-1.76
62	05-Nov MON	42023	43504	42212	43503.906	6.43	7.84	-1.41
51	11-Jan FRI	42539	43464	42703	43464.092	5.23	3.49	1.74
48	30-Nov FRI	43108	43279	42155	43279.116	5.07	5.3	-0.23
78	14-Nov WED	42388	43146	41727	43146.32	11.12	6.58	4.54
76	15-Nov THU	42636	42969	41679	42969.37	10.73	6.47	4.26
35	21-Feb FRI	42121	42916	42912	42916.228	3.92	3.62	0.3
26	20-Feb THU	41466	42229	42850	42850.278	2.59	3.56	-0.97
75	12-Nov MON	42101	42834	41477	42833.892	9.83	6.82	3.01
77	13-Nov TUE	41889	42785	41655	42785.154	11.1	6.7	4.4
17	19-Feb TUE	40384	41434	42773	42773.242	1.75	3.51	-1.76
55	04-Jan FRI	41791	42700	41765	42700.164	5.45	3.68	1.77
66	02-Jan WED	41926	42403	41251	42402.584	6.7	3.74	2.96
10	15-Feb FRI	40281	41723	42331	42331.286	0.61	3.34	-2.73
64	09-Nov FRI	41666	42256	41254	42256.15	6.48	7.23	-0.75
22	18-Feb MON	40237	41022	42190	42189.772	2.26	3.46	-1.2
73	01-Nov THU	39775	41851	41188	41850.54	8.52	8.49	0.03
67	27-Feb THU	40863	41383	41452	41452.108	6.8	4.06	2.74
70	02-Nov FRI	39251	40852	40153	40852.156	7.51	8.32	-0.81
79	16-Nov FRI	40301	40799	39633	40798.74	11.54	6.36	5.18
69	25-Feb TUE	38181	38983	39586	39586.286	7.34	3.9	3.44
59	28-Feb FRI	38340	38778	39504	39503.808	5.92	4.14	1.78
71	26-Feb WED	38414	38800	38994	38994.444	7.86	3.98	3.88
47	21-Dec FRI	38209	38786	38337	38786.074	5.05	4.18	0.87
72	24-Feb MON	28863	29994	31466	31466.126	8.24	3.82	4.42

ACTUALS 1990/91

		1700	1730	1800	MAX DEM	EFF ACT	EFF NORM	TEMP DEV
1	11-Feb MON	42987	44496	45548	45548.168	-2.13	3.25	-5.38
2	08-Feb FRI	42228	44258	44981	44980.632	-2.11	3.21	-5.32
3	12-Feb TUE	43693	44730	44923	44923.47	-1.98	3.26	-5.24
4	07-Feb THU	46095	47035	46818	47034.698	-1.84	3.21	-5.05
5	14-Feb THU	41803	43198	44457	44457.208	-1.35	3.31	-4.66
6	13-Feb WED	42312	43494	44725	44724.862	-1.19	3.29	-4.48
7	06-Feb WED	45471	46593	46824	46824.402	-0.27	3.21	-3.48
8	05-Feb TUE	44196	45634	45966	45966.326	0.28	3.21	-2.93
9	04-Feb MON	44651	46220	45962	46219.546	0.31	3.21	-2.9
10	15-Feb FRI	40281	41723	42331	42331.286	0.61	3.34	-2.73
11	31-Jan THU	44615	45680	45102	45679.6	1.17	3.23	-2.06
13	30-Jan WED	45049	46051	45388	46050.788	1.46	3.24	-1.78
12	01-Feb FRI	41491	43410	43533	43532.702	1.46	3.22	-1.76
14	16-Jan WED	45098	46274	45028	46274.142	1.51	3.38	-1.87
15	15-Jan TUE	45410	46570	45405	46570.022	1.58	3.4	-1.82
16	29-Jan TUE	45854	46449	45473	46448.992	1.73	3.25	-1.52
17	19-Feb TUE	40384	41434	42773	42773.242	1.75	3.51	-1.76
18	14-Jan MON	45059	46294	45289	46294.272	1.77	3.42	-1.65
19	18-Dec TUE	46556	46514	45500	46555.688	1.99	4.31	-2.32
20	28-Jan MON	44842	45703	44619	45702.788	2.08	3.25	-1.17
21	19-Dec WED	45912	46145	45154	46145.328	2.13	4.26	-2.13
22	18-Feb MON	40237	41022	42190	42189.772	2.26	3.46	-1.2
23	17-Dec MON	46249	46331	45105	46330.544	2.31	4.36	-2.05
24	25-Jan FRI	42879	44215	43550	44215.398	2.41	3.28	-0.87
25	17-Jan THU	43437	44831	43836	44831.404	2.58	3.36	-0.78
26	20-Feb THU	41466	42229	42850	42850.278	2.59	3.56	-0.97
27	14-Dec FRI	44632	45049	44031	45048.726	3.03	4.52	-1.49
28	20-Dec THU	44736	44666	43498	44736.094	3.18	4.22	-1.04
29	24-Jan THU	43966	45108	44303	45107.556	3.22	3.29	-0.07
30	10-Dec MON	45456	45218	43962	45456.114	3.26	4.74	-1.48
31	18-Jan FRI	43623	44013	42905	44012.928	3.49	3.35	0.14
32	23-Jan WED	43895	45225	44301	45225.12	3.73	3.3	0.43
33	06-Dec THU	45779	45712	44407	45778.564	3.76	4.96	-1.2
34	23-Nov FRI	43720	43941	42576	43941.462	3.83	5.74	-1.91
35	21-Feb FRI	42121	42916	42912	42916.228	3.92	3.62	0.3
36	13-Dec THU	45737	45885	44783	45884.652	3.92	4.57	-0.65
37	11-Dec TUE	45955	45792	44592	45954.934	4.01	4.68	-0.67
38	12-Dec WED	46386	46387	45177	46387.29	4.17	4.63	-0.46
39	07-Dec FRI	44217	44157	42831	44216.728	4.22	4.9	-0.68
40	22-Jan TUE	43857	45312	44444	45312.352	4.39	3.31	1.08
41	22-Nov THU	44675	44997	43986	44997.08	4.48	5.82	-1.34
42	29-Nov THU	44950	45143	43754	45143.214	4.81	5.36	-0.55
43	26-Nov MON	45674	45699	44211	45699.478	4.88	5.54	-0.66
44	07-Jan MON	44885	45209	43788	45209.226	4.9	3.59	1.31
45	05-Dec WED	44944	45302	44195	45301.574	4.9	5.01	-0.11
46	28-Nov WED	45468	45688	44125	45688.278	4.98	5.41	-0.43
47	21-Dec FRI	38209	38786	38337	38786.074	5.05	4.18	0.87
48	30-Nov FRI	43108	43279	42155	43279.116	5.07	5.3	-0.23
49	08-Jan TUE	46027	45712	44202	46027.298	5.08	3.56	1.52
50	09-Jan WED	45190	45420	44078	45419.646	5.15	3.53	1.62
51	11-Jan FRI	42539	43464	42703	43464.092	5.23	3.49	1.74
52	27-Nov TUE	44995	45220	44077	45220.224	5.31	5.47	-0.16
53	04-Dec TUE	44940	45167	43710	45166.832	5.37	5.07	0.3
54	21-Jan MON	42090	44124	43497	44124.398	5.41	3.32	2.09
55	04-Jan FRI	41791	42700	41765	42700.164	5.45	3.68	1.77
56	10-Jan THU	43914	44850	43621	44849.68	5.59	3.51	2.08
57	21-Nov WED	44475	44723	43475	44723.254	5.6	5.89	-0.29
58	03-Dec MON	44461	44686	43221	44686.104	5.88	5.13	0.75
59	28-Feb FRI	38340	38778	39504	39503.808	5.92	4.14	1.78
61	03-Jan THU	43300	43575	42396	43575.228	6.22	3.71	2.51
60	06-Nov TUE	42840	44233	42974	44232.778	6.22	7.68	-1.46
62	05-Nov MON	42023	43504	42212	43503.906	6.43	7.84	-1.41
63	08-Nov THU	43017	43892	42885	43892.484	6.43	7.38	-0.95
64	09-Nov FRI	41866	42256	41254	42256.15	6.48	7.23	-0.75
65	07-Nov WED	42587	44075	42906	44074.604	6.55	7.53	-0.98
66	02-Jan WED	41926	42403	41251	42402.584	6.7	3.74	2.96
67	27-Feb THU	40863	41383	41452	41452.106	6.8	4.06	2.74
68	20-Nov TUE	44008	44544	43242	44544.43	7.07	5.98	1.09
69	25-Feb TUE	38181	38983	39586	39586.286	7.34	3.9	3.44
70	02-Nov FRI	39251	40852	40153	40852.156	7.51	8.32	-0.81
71	26-Feb WED	38414	38800	38994	38994.444	7.86	3.98	3.88
72	24-Feb MON	28863	29994	31466	31466.126	8.24	3.82	4.42
73	01-Nov THU	39775	41851	41188	41850.54	8.52	8.49	0.03
74	19-Nov MON	43760	44116	42767	44116.14	8.72	6.06	2.66
75	12-Nov MON	42101	42834	41477	42833.892	9.83	6.82	3.01
76	15-Nov THU	42636	42969	41679	42969.37	10.73	6.47	4.26
77	13-Nov TUE	41889	42785	41655	42785.154	11.1	6.7	4.4
78	14-Nov WED	42388	43146	41727	43146.32	11.12	6.58	4.54
79	16-Nov FRI	40301	40799	39633	40798.74	11.54	6.36	5.18

ACTUALS 1989/90

		1700	1730	1800	MAX DEM	EFF ACT	EFF NORM	
8	11-Dec MON	46714	46668	45172	46714	3.73	4.66	-0.93
3	28-Nov TUE	46650	46611	44897	46650	2.55	5.41	-2.86
1	04-Dec MON	46573	46641	45027	46641	2.41	5.07	-2.66
10	13-Dec WED	46575	46351	44758	46575	3.95	4.57	-0.62
7	12-Dec TUE	46441	46493	44861	46493	3.61	4.63	-1.02
2	27-Nov MON	46078	46350	44649	46350	2.48	5.47	-2.99
6	29-Nov WED	45989	46267	44667	46267	3.11	5.36	-2.25
5	30-Nov THU	45814	46025	44614	46025	2.93	5.3	-2.37
9	05-Dec TUE	45974	45999	44421	45999	3.77	5.01	-1.24
18	14-Dec THU	45880	45536	44154	45880	4.79	4.52	0.27
15	06-Dec WED	45504	45561	44085	45561	4.52	4.96	-0.44
25	19-Dec TUE	45555	45497	44313	45555	5.57	4.26	1.31
43	18-Dec MON	45470	45362	43810	45470	6.89	4.31	2.58
19	07-Dec THU	45104	45164	43881	45164	4.91	4.9	0.01
30	23-Nov THU	44377	45016	43547	45016	6	5.74	0.26
22	29-Jan MON	44195	44948	43744	44948	5.08	3.25	1.83
34	01-Feb THU	43497	44744	43630	44744	6.45	3.22	3.23
38	24-Jan WED	42757	44732	43794	44732	6.63	3.29	3.34
29	08-Jan MON	43856	44682	43082	44682	5.84	3.56	2.28
51	08-Nov WED	43988	44668	43139	44668	7.36	7.38	-0.02
4	01-Dec FRI	44540	44665	43389	44665	2.66	5.24	-2.58
31	09-Jan TUE	43995	44658	43037	44658	6.08	3.53	2.55
12	03-Jan WED	44407	44595	43088	44595	4.27	3.71	0.56
53	22-Nov WED	43916	44525	43219	44525	7.77	5.82	1.95
32	30-Jan TUE	42799	44443	43721	44443	6.19	3.24	2.95
48	10-Jan WED	44072	44424	42708	44424	7.23	3.51	3.72
56	17-Jan WED	42543	44360	43203	44360	7.93	3.36	4.57
42	25-Jan THU	42927	44290	43012	44290	6.88	3.28	3.6
37	18-Jan THU	42879	44256	43226	44256	6.6	3.35	3.25
65	21-Nov TUE	43889	44222	42532	44222	8.48	5.89	2.59
24	13-Feb TUE	43235	44204	43824	44204	5.53	3.29	2.24
67	23-Jan TUE	42842	44201	42945	44201	8.56	3.3	5.26
69	16-Jan TUE	43255	44111	42684	44111	8.68	3.38	5.3
49	15-Jan MON	43231	44103	42650	44103	7.27	3.4	3.87
36	31-Jan WED	42294	44071	43529	44071	6.55	3.23	3.32
16	04-Jan THU	43518	44024	42711	44024	4.6	3.68	0.92
35	20-Dec WED	43914	43813	42509	43914	6.48	4.22	2.26
20	08-Dec FRI	43773	43841	42520	43841	4.95	4.85	0.1
59	14-Nov TUE	43201	43806	42337	43806	8.24	6.58	1.66
46	09-Nov THU	42830	43717	42515	43717	7.12	7.23	-0.11
63	11-Jan THU	42796	43703	42270	43703	8.46	3.49	4.97
60	15-Nov WED	43246	43643	42283	43643	8.26	6.47	1.79
66	20-Nov MON	43226	43599	42182	43599	8.53	5.98	2.55
44	07-Nov TUE	42484	43508	42281	43508	6.9	7.53	-0.63
39	06-Nov MON	42012	43480	42296	43480	6.67	7.68	-1.01
57	16-Nov THU	42585	43408	42252	43408	7.98	6.36	1.62
75	07-Feb WED	42254	43403	42647	43403	9.37	3.21	6.16
17	15-Dec FRI	43233	43392	42335	43392	4.71	4.47	0.24
26	14-Feb WED	41707	43345	43372	43372	5.58	3.31	2.27
13	24-Nov FRI	42956	43364	42230	43364	4.32	5.67	-1.35
73	13-Nov MON	42280	43099	41742	43099	9.13	6.7	2.43
71	22-Jan MON	41127	43034	42042	43034	8.83	3.31	5.52
27	12-Feb MON	40279	41937	42879	42879	5.76	3.26	2.5
11	02-Jan TUE	42457	42791	41450	42791	4.11	3.74	0.37
40	19-Jan FRI	41454	42672	41721	42672	6.76	3.34	3.42
28	26-Jan FRI	40763	42537	42159	42537	5.83	3.27	2.56
58	12-Jan FRI	42057	42473	41261	42473	8.17	3.46	4.71
70	06-Feb TUE	40433	42468	42343	42468	8.79	3.21	5.58
21	15-Feb THU	39685	41024	42325	42325	5.05	3.34	1.71
47	17-Nov FRI	41899	42319	40989	42319	7.15	6.26	0.89
23	05-Jan FRI	41724	42136	41104	42136	5.32	3.65	1.67
62	05-Feb MON	38603	41075	41907	41907	8.45	3.21	5.24
33	02-Feb FRI	39438	41504	41731	41731	6.25	3.22	3.03
61	08-Feb THU	38592	40814	41564	41564	8.44	3.21	5.23
50	19-Feb MON	39996	41243	41460	41460	7.29	3.51	3.78
79	02-Nov THU	40142	41445	40611	41445	10.87	8.32	2.55
41	28-Feb WED	41124	41441	41429	41441	6.82	4.14	2.68
64	10-Nov FRI	40668	41402	40380	41402	8.47	7.09	1.38
80	01-Nov WED	39462	41343	40586	41343	11.18	8.49	2.69
55	21-Dec THU	40960	41324	40288	41324	7.87	4.18	3.69
45	27-Feb TUE	40222	40596	41018	41018	7.1	4.06	3.04
54	09-Feb FRI	38068	39901	40624	40624	7.85	3.22	4.63
74	20-Feb TUE	38683	39582	40170	40170	9.26	3.56	5.7
14	16-Feb FRI	36840	38294	39999	39999	4.37	3.38	0.99
68	26-Feb MON	39069	39530	39992	39992	8.59	3.98	4.61
77	03-Nov FRI	37853	39703	39247	39703	10.04	8.16	1.88
72	21-Feb WED	37019	37915	39144	39144	8.95	3.62	5.33
76	22-Feb THU	35651	36511	37864	37864	9.41	3.68	5.73
52	22-Dec FRI	35420	36813	36472	36813	7.38	4.13	3.25
78	23-Feb FRI	33472	34704	36407	36407	10.27	3.75	6.52

ACTUALS 1989/90

		1700	1730	1800	MAX DEM	EFF ACT	EFF NORM	
1	04-Dec MON	46573	46641	45027	46641	2.41	5.07	-2.66
2	27-Nov MON	46078	46350	44649	46350	2.48	5.47	-2.99
3	28-Nov TUE	46650	46611	44897	46650	2.55	5.41	-2.86
4	01-Dec FRI	44540	44665	43389	44665	2.66	5.24	-2.58
5	30-Nov THU	45814	46025	44614	46025	2.93	5.3	-2.37
6	29-Nov WED	45989	46267	44667	46267	3.11	5.36	-2.25
7	12-Dec TUE	46441	46493	44861	46493	3.61	4.63	-1.02
8	11-Dec MON	46714	46668	45172	46714	3.75	4.68	-0.93
9	05-Dec TUE	45974	45999	44421	45999	3.77	5.01	-1.24
10	13-Dec WED	46575	46351	44758	46575	3.95	4.57	-0.62
11	02-Jan TUE	42457	42791	41450	42791	4.11	3.74	0.37
12	03-Jan WED	44407	44595	43088	44595	4.27	3.71	0.56
13	24-Nov FRI	42956	43364	42230	43364	4.32	5.67	-1.35
14	16-Feb FRI	36840	38294	39999	39999	4.37	3.38	0.99
15	06-Dec WED	45504	45561	44065	45561	4.52	4.96	-0.44
16	04-Jan THU	43518	44024	42711	44024	4.6	3.68	0.92
17	15-Dec FRI	43233	43392	42335	43392	4.71	4.47	0.24
18	14-Dec THU	45880	45536	44154	45880	4.79	4.52	0.27
19	07-Dec THU	45104	45164	43881	45164	4.91	4.9	0.01
20	08-Dec FRI	43773	43841	42520	43841	4.95	4.85	0.1
21	15-Feb THU	39685	41024	42325	42325	5.05	3.34	1.71
22	29-Jan MON	44195	44948	43744	44948	5.08	3.25	1.83
23	05-Jan FRI	41724	42136	41104	42136	5.32	3.65	1.67
24	13-Feb TUE	43235	44204	43824	44204	5.53	3.29	2.24
25	19-Dec TUE	45555	45497	44313	45555	5.57	4.26	1.31
26	14-Feb WED	41707	43345	43372	43372	5.58	3.31	2.27
27	12-Feb MON	40279	41937	42879	42879	5.76	3.26	2.5
28	26-Jan FRI	40763	42537	42159	42537	5.83	3.27	2.56
29	08-Jan MON	43856	44682	43082	44682	5.84	3.56	2.28
30	23-Nov THU	44377	45016	43547	45016	6	5.74	0.26
31	09-Jan TUE	43995	44658	43037	44658	6.08	3.53	2.55
32	30-Jan TUE	42799	44443	43721	44443	6.19	3.24	2.95
33	02-Feb FRI	39438	41504	41731	41731	6.25	3.22	3.03
34	01-Feb THU	43497	44744	43630	44744	6.45	3.22	3.23
35	20-Dec WED	43914	43813	42509	43914	6.48	4.22	2.26
36	31-Jan WED	42294	44071	43529	44071	6.55	3.23	3.32
37	18-Jan THU	42879	44256	43226	44256	6.6	3.35	3.25
38	24-Jan WED	42757	44732	43794	44732	6.63	3.29	3.34
39	06-Nov MON	42012	43480	42296	43480	6.67	7.68	-1.01
40	19-Jan FRI	41454	42672	41721	42672	6.76	3.34	3.42
41	28-Feb WED	41124	41441	41429	41441	6.82	4.14	2.68
42	25-Jan THU	42927	44290	43012	44290	6.88	3.28	3.6
43	18-Dec MON	45470	45362	43810	45470	6.89	4.31	2.58
44	07-Nov TUE	42484	43508	42281	43508	6.9	7.53	-0.63
45	27-Feb TUE	40222	40596	41018	41018	7.1	4.06	3.04
46	09-Nov THU	42830	43717	42515	43717	7.12	7.23	-0.11
47	17-Nov FRI	41899	42319	40989	42319	7.15	6.26	0.89
48	10-Jan WED	44072	44424	42708	44424	7.23	3.51	3.72
49	15-Jan MON	43231	44103	42650	44103	7.27	3.4	3.87
50	19-Feb MON	39996	41243	41460	41460	7.29	3.51	3.78
51	08-Nov WED	43988	44668	43139	44668	7.36	7.38	-0.02
52	22-Dec FRI	35420	36813	36472	36813	7.38	4.13	3.25
53	22-Nov WED	43916	44525	43219	44525	7.77	5.82	1.95
54	09-Feb FRI	38068	39901	40624	40624	7.85	3.22	4.63
55	21-Dec THU	40960	41324	40288	41324	7.87	4.18	3.69
56	17-Jan WED	42543	44360	43203	44360	7.93	3.36	4.57
57	16-Nov THU	42585	43408	42252	43408	7.98	6.36	1.62
58	12-Jan FRI	42057	42473	41261	42473	8.17	3.46	4.71
59	14-Nov TUE	43201	43806	42337	43806	8.24	6.58	1.66
60	15-Nov WED	43246	43643	42283	43643	8.26	6.47	1.79
61	08-Feb THU	38592	40814	41564	41564	8.44	3.21	5.23
62	05-Feb MON	38603	41075	41907	41907	8.45	3.21	5.24
63	11-Jan THU	42796	43703	42270	43703	8.46	3.49	4.97
64	10-Nov FRI	40668	41402	40380	41402	8.47	7.09	1.38
65	21-Nov TUE	43889	44222	42532	44222	8.48	5.89	2.59
66	20-Nov MON	43226	43599	42182	43599	8.53	5.98	2.55
67	23-Jan TUE	42842	44201	42945	44201	8.56	3.3	5.26
68	26-Feb MON	39069	39530	39992	39992	8.59	3.98	4.61
69	16-Jan TUE	43255	44111	42684	44111	8.68	3.38	5.3
70	06-Feb TUE	40433	42468	42343	42468	8.79	3.21	5.58
71	22-Jan MON	41127	43034	42042	43034	8.83	3.31	5.52
72	21-Feb WED	37019	37915	39144	39144	8.95	3.62	5.33
73	13-Nov MON	42280	43099	41742	43099	9.13	6.7	2.43
74	20-Feb TUE	38683	39582	40170	40170	9.26	3.56	5.7
75	07-Feb WED	42254	43403	42647	43403	9.37	3.21	6.16
76	22-Feb THU	35651	36511	37864	37864	9.41	3.68	5.73
77	03-Nov FRI	37853	39703	39247	39703	10.04	8.16	1.88
78	23-Feb FRI	33472	34704	36407	36407	10.27	3.75	6.52
79	02-Nov THU	40142	41445	40611	41445	10.87	8.32	2.55
80	01-Nov WED	39462	41343	40586	41343	11.18	8.49	2.69

ACTUALS 1988/89

		1700	1730	1800	EFF ACT	EFF NORM	
2	22-Nov-88 TUE	46543	46880	45168	2.09	5.82	-3.73
5	21-Nov-88 MON	45926	46614	44805	3.22	5.89	-2.67
1	23-Nov-88 WED	45785	46195	44532	2.03	5.74	-3.71
26	06-Dec-88 TUE	45595	46020	44252	5.58	4.96	0.62
15	07-Dec-88 WED	45460	45707	44044	4.85	4.9	-0.05
3	24-Nov-88 THU	45374	45533	43953	2.52	5.67	-3.15
34	05-Dec-88 MON	44922	45257	43631	5.9	5.01	0.89
19	25-Jan-89 WED	43960	45219	44041	5.06	3.28	1.78
42	01-Dec-88 THU	45087	44878	43296	6.21	5.24	0.97
32	11-Jan-89 WED	44126	44888	43210	5.78	3.49	2.29
22	29-Nov-88 TUE	44845	44842	43090	5.46	5.36	0.1
7	28-Nov-88 MON	44676	44794	42911	4.34	5.41	-1.07
37	05-Jan-89 THU	44623	44597	42795	6.09	3.65	2.44
31	18-Jan-89 WED	42513	44570	43475	5.7	3.35	2.35
10	19-Jan-89 THU	43016	44491	43382	4.4	3.34	1.06
46	15-Nov-88 TUE	43458	44405	42776	6.42	6.47	-0.05
33	08-Dec-88 THU	44327	44244	42679	5.87	4.85	1.02
69	13-Dec-88 TUE	44070	44212	42495	7.84	4.57	3.27
28	08-Nov-88 TUE	43489	44173	42289	5.65	7.38	-1.73
38	24-Jan-89 TUE	42091	44040	42874	6.13	3.29	2.84
64	14-Dec-88 WED	43999	43910	42296	7.54	4.52	3.02
48	20-Dec-88 TUE	43687	43924	42525	6.6	4.22	2.38
57	10-Jan-89 TUE	42633	43919	42528	7.2	3.51	3.69
75	12-Dec-88 MON	43505	43881	42430	8.86	4.63	4.03
47	12-Jan-89 THU	42287	43790	42526	6.53	3.46	3.07
63	17-Jan-89 TUE	41923	43741	42629	7.53	3.36	4.17
49	16-Nov-88 WED	42774	43735	42313	6.61	6.36	0.25
54	30-Nov-88 WED	43316	43672	42069	6.92	5.3	1.62
17	02-Dec-88 FRI	43568	43657	42352	4.95	5.18	-0.23
4	25-Nov-88 FRI	43237	43646	42224	2.71	5.6	-2.89
24	23-Jan-89 MON	42003	43639	42501	5.51	3.3	2.21
60	24-Jan-89 THU	43634	43557	42069	7.41	4.47	2.94
72	16-Jan-89 MON	42249	43602	42004	8.05	3.38	4.67
62	19-Dec-88 MON	43185	43543	42275	7.47	4.26	3.21
50	04-Jan-89 WED	42852	43500	42243	6.65	3.68	2.97
20	07-Nov-88 MON	41936	43387	41991	5.19	7.53	-2.34
39	30-Jan-89 MON	41126	43323	42722	6.14	3.24	2.9
67	14-Nov-88 MON	42026	43288	41838	7.81	6.58	1.23
40	03-Jan-89 TUE	43061	43277	41757	6.18	3.71	2.47
43	31-Jan-89 TUE	41196	43232	42765	6.22	3.23	2.99
23	01-Feb-89 WED	41143	43161	42971	5.47	3.22	2.25
11	02-Feb-89 THU	41104	43152	43069	4.48	3.22	1.26
27	26-Jan-89 THU	40757	43148	42320	5.59	3.27	2.32
18	03-Nov-88 THU	40837	43001	42242	5.02	8.16	-3.14
76	09-Jan-89 MON	42359	42969	41114	8.74	3.53	5.21
65	17-Nov-88 THU	42167	42932	41508	7.55	6.26	1.29
25	01-Nov-88 TUE	40397	42720	41980	5.55	8.49	-2.94
29	02-Nov-88 WED	40470	42653	41818	5.87	8.32	-2.65
12	20-Jan-89 FRI	41472	42535	41517	4.5	3.33	1.17
41	13-Jan-89 FRI	42130	42512	41081	6.2	3.44	2.76
70	09-Nov-88 WED	41257	42324	40935	7.87	7.23	0.64
66	21-Dec-88 WED	41868	42052	40760	7.62	4.18	3.44
55	22-Dec-88 FRI	41603	41968	40929	6.94	4.41	2.53
44	14-Feb-89 TUE	39164	40970	41715	6.27	3.31	2.96
59	09-Dec-88 FRI	41371	41668	40584	7.32	4.79	2.53
81	10-Nov-88 THU	40880	41597	40209	9.8	7.09	2.71
71	18-Nov-88 FRI	41014	41541	40304	8.03	6.16	1.87
8	04-Nov-88 FRI	39324	41515	40978	4.35	8	-3.65
51	06-Jan-89 FRI	40715	41210	39954	6.65	3.62	3.03
45	13-Feb-89 MON	39151	40340	41158	6.29	3.29	3
73	08-Feb-89 WED	38359	40350	41051	8.39	3.21	5.18
68	09-Feb-89 THU	37803	39934	40948	7.81	3.22	4.59
58	15-Feb-89 WED	38908	39926	40883	7.24	3.34	3.9
80	07-Feb-89 TUE	38251	40170	40840	9.54	3.21	6.33
77	06-Feb-89 MON	38240	40369	40704	9.01	3.21	5.8
53	27-Jan-89 FRI	38563	40699	40399	6.88	3.26	3.62
13	24-Feb-89 FRI	39588	40315	40682	4.51	3.82	0.69
30	16-Feb-89 THU	38104	39093	40536	5.69	3.38	2.31
21	03-Feb-89 FRI	38178	40350	40402	5.21	3.21	2
9	28-Feb-89 TUE	39569	40151	40300	4.38	4.14	0.24
16	23-Feb-89 THU	38626	39279	40289	4.89	3.75	1.14
79	11-Nov-88 FRI	38676	39975	39159	9.3	6.95	2.35
36	22-Feb-89 WED	38895	39197	39851	6.08	3.68	2.4
6	27-Feb-89 MON	38966	39409	39844	4.13	4.06	0.07
74	22-Dec-88 THU	39575	39816	38796	8.39	4.13	4.26
35	21-Feb-89 TUE	37589	38647	39727	6.03	3.62	2.41
14	17-Feb-89 FRI	37681	38790	39714	4.59	3.42	1.17
56	20-Feb-89 MON	36968	37779	39061	7.19	3.56	3.63
61	10-Feb-89 FRI	36000	37522	38988	7.43	3.23	4.2
78	23-Dec-88 FRI	33933	34920	34707	9.02	4.09	4.93
52	02-Jan-89 MON	31709	33205	32746	6.79	3.74	3.05

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		1700	1730	1800 EFF ACT	EFF NORM		
1	23-Nov-88 WED	45785	46195	44532	2.03	5.74	-3.71
2	22-Nov-88 TUE	46543	46880	45168	2.09	5.82	-3.73
3	24-Nov-88 THU	45374	45533	43953	2.52	5.67	-3.15
4	25-Nov-88 FRI	43237	43646	42224	2.71	5.6	-2.89
5	21-Nov-88 MON	45926	46614	44805	3.22	5.89	-2.67
6	27-Feb-89 MON	38966	39409	39844	4.13	4.06	0.07
7	28-Nov-88 MON	44676	44794	42911	4.34	5.41	-1.07
8	04-Nov-88 FRI	39324	41515	40978	4.35	8	-3.65
9	28-Feb-89 TUE	39569	40151	40300	4.38	4.14	0.24
10	19-Jan-89 THU	43016	44491	43382	4.4	3.34	1.06
11	02-Feb-89 THU	41104	43152	43069	4.48	3.22	1.26
12	20-Jan-89 FRI	41472	42535	41517	4.5	3.33	1.17
13	24-Feb-89 FRI	39588	40315	40682	4.51	3.82	0.69
14	17-Feb-89 FRI	37681	38790	39714	4.59	3.42	1.17
15	07-Dec-88 WED	45460	45707	44044	4.85	4.9	-0.05
16	23-Feb-89 THU	38626	39279	40289	4.89	3.75	1.14
17	02-Dec-88 FRI	43568	43657	42352	4.95	5.18	-0.23
18	03-Nov-88 THU	40837	43001	42242	5.02	8.16	-3.14
19	25-Jan-89 WED	43960	45219	44041	5.06	3.28	1.78
20	07-Nov-88 MON	41936	43387	41991	5.19	7.53	-2.34
21	03-Feb-89 FRI	38178	40350	40402	5.21	3.21	2
22	29-Nov-88 TUE	44845	44842	43090	5.46	5.36	0.1
23	01-Feb-89 WED	41143	43161	42971	5.47	3.22	2.25
24	23-Jan-89 MON	42003	43639	42501	5.51	3.3	2.21
25	01-Nov-88 TUE	40397	42720	41980	5.55	8.49	-2.94
26	06-Dec-88 TUE	45595	46020	44252	5.58	4.96	0.62
27	26-Jan-89 THU	40757	43148	42320	5.59	3.27	2.32
28	08-Nov-88 TUE	43489	44173	42289	5.65	7.38	-1.73
29	02-Nov-88 WED	40470	42653	41818	5.67	8.32	-2.65
30	16-Feb-89 THU	38104	39093	40536	5.69	3.38	2.31
31	18-Jan-89 WED	42513	44570	43475	5.7	3.35	2.35
32	11-Jan-89 WED	44126	44888	43210	5.78	3.49	2.29
33	08-Dec-88 THU	44327	44244	42679	5.87	4.85	1.02
34	05-Dec-88 MON	44922	45257	43631	5.9	5.01	0.89
35	21-Feb-89 TUE	37589	38647	39727	6.03	3.62	2.41
36	22-Feb-89 WED	38895	39197	39851	6.08	3.68	2.4
37	05-Jan-89 THU	44623	44597	42795	6.09	3.65	2.44
38	24-Jan-89 TUE	42091	44040	42874	6.13	3.29	2.84
39	30-Jan-89 MON	41126	43323	42722	6.14	3.24	2.9
40	03-Jan-89 TUE	43061	43277	41757	6.18	3.71	2.47
41	13-Jan-89 FRI	42130	42512	41081	6.2	3.44	2.76
42	01-Dec-88 THU	45087	44878	43296	6.21	5.24	0.97
43	31-Jan-89 TUE	41196	43232	42765	6.22	3.23	2.99
44	14-Feb-89 TUE	39164	40970	41715	6.27	3.31	2.96
45	13-Feb-89 MON	39151	40340	41158	6.29	3.29	3
46	15-Nov-88 TUE	43458	44405	42778	6.42	6.47	-0.05
47	12-Jan-89 THU	42287	43790	42526	6.53	3.46	3.07
48	20-Dec-88 TUE	43687	43924	42525	6.6	4.22	2.38
49	16-Nov-88 WED	42774	43735	42313	6.61	6.36	0.25
50	04-Jan-89 WED	42852	43500	42243	6.65	3.68	2.97
51	06-Jan-89 FRI	40715	41210	39954	6.65	3.62	3.03
52	02-Jan-89 MON	31709	33205	32746	6.79	3.74	3.05
53	27-Jan-89 FRI	38563	40699	40399	6.88	3.26	3.62
54	30-Nov-88 WED	43316	43672	42069	6.92	5.3	1.62
55	01-Dec-88 FRI	41603	41968	40929	6.94	4.41	2.53
56	20-Feb-89 MON	36968	37779	39061	7.19	3.56	3.63
57	10-Jan-89 TUE	42633	43919	42528	7.2	3.51	3.69
58	15-Feb-89 WED	38908	39926	40883	7.24	3.34	3.9
59	09-Dec-88 FRI	41371	41668	40584	7.32	4.79	2.53
60	10-Dec-88 THU	43634	43557	42069	7.41	4.47	2.94
61	10-Feb-89 FRI	36000	37522	38988	7.43	3.23	4.2
62	19-Dec-88 MON	43185	43543	42275	7.47	4.26	3.21
63	17-Jan-89 TUE	41923	43741	42629	7.53	3.36	4.17
64	14-Dec-88 WED	43999	43910	42296	7.54	4.52	3.02
65	17-Nov-88 THU	42167	42932	41508	7.55	6.26	1.29
66	21-Dec-88 WED	41868	42052	40760	7.62	4.18	3.44
67	14-Nov-88 MON	42026	43288	41838	7.81	6.58	1.23
68	09-Feb-89 THU	37803	39934	40948	7.81	3.22	4.59
69	13-Dec-88 TUE	44070	44212	42495	7.84	4.57	3.27
70	09-Nov-88 WED	41257	42324	40935	7.87	7.23	0.64
71	18-Nov-88 FRI	41014	41541	40304	8.03	6.16	1.87
72	16-Jan-89 MON	42249	43602	42004	8.05	3.38	4.67
73	08-Feb-89 WED	38359	40350	41051	8.39	3.21	5.18
74	22-Dec-88 THU	39575	39816	38796	8.39	4.13	4.26
75	12-Dec-88 MON	43505	43881	42430	8.66	4.63	4.03
76	09-Jan-89 MON	42359	42969	41114	8.74	3.53	5.21
77	06-Feb-89 MON	38240	40369	40704	9.01	3.21	5.8
78	23-Dec-88 FRI	33933	34920	34707	9.02	4.09	4.93
79	11-Nov-88 FRI	38676	39975	39159	9.3	6.95	2.35
80	07-Feb-89 TUE	38251	40170	40840	9.54	3.21	6.33
81	10-Nov-88 THU	40880	41597	40209	9.8	7.09	2.71

ACTUALS 1987/88

		1700	1730	1800	EFF ACT	EFF NORM	
5	15-Dec-87 TUE	46935	46609	45174	1.93	4.47	-2.54
4	09-Dec-87 WED	46422	46517	45152	1.87	4.79	-2.92
6	08-Dec-87 TUE	46215	46508	45278	2.68	4.85	-2.17
3	14-Dec-87 MON	46446	46289	45040	1.74	4.52	-2.78
1	10-Dec-87 THU	45761	45743	44703	1.26	4.74	-3.48
14	03-Dec-87 THU	45759	45496	44070	3.77	5.13	-1.36
20	02-Dec-87 WED	45751	45641	44171	4.08	5.18	-1.1
23	07-Dec-87 MON	45121	45086	43647	4.29	4.9	-0.61
16	01-Dec-87 TUE	44841	44965	43567	3.9	5.24	-1.34
8	30-Nov-87 MON	44611	44478	43301	3.36	5.3	-1.94
51	25-Nov-87 WED	44355	44497	43146	5.85	5.6	0.25
42	12-Jan-88 TUE	44105	44486	42911	5.52	3.46	2.06
53	24-Nov-87 TUE	44048	44099	42802	6.15	5.67	0.48
39	26-Nov-87 THU	43741	44062	42903	5.31	5.54	-0.23
54	23-Nov-87 MON	44008	44014	42763	6.31	5.74	0.57
56	06-Jan-88 WED	43848	43885	42333	6.37	3.62	2.75
26	16-Dec-87 WED	43866	43729	42564	4.42	4.41	0.01
19	18-Jan-88 MON	43210	43848	42587	4.05	3.35	0.7
29	27-Jan-88 WED	42630	43831	42925	4.88	3.26	1.62
22	21-Jan-88 THU	42160	43788	42945	4.18	3.32	0.86
43	07-Jan-88 THU	42993	43788	42481	5.56	3.59	1.97
35	20-Jan-88 WED	41961	43607	42663	5.23	3.33	1.9
28	28-Jan-88 THU	42584	43587	42613	4.79	3.26	1.53
50	13-Jan-88 WED	43052	43586	42226	5.85	3.44	2.41
2	11-Dec-87 FRI	43432	43510	42747	1.58	4.68	-3.1
34	19-Jan-88 TUE	42377	43439	42260	5.21	3.34	1.87
46	11-Jan-88 MON	42841	43342	42096	5.63	3.48	2.15
45	02-Feb-88 TUE	41367	43121	43033	5.62	3.22	2.4
15	04-Dec-87 FRI	42974	43096	42077	3.8	5.07	-1.27
21	10-Feb-88 WED	41826	43087	42852	4.11	3.22	0.89
48	14-Jan-88 THU	41708	43053	41970	5.71	3.42	2.29
17	09-Feb-88 TUE	41628	42959	43035	3.92	3.21	0.71
41	03-Feb-88 WED	41428	43029	42199	5.51	3.22	2.29
38	01-Feb-88 MON	41538	42993	42378	5.3	3.23	2.07
65	11-Nov-87 WED	42587	42900	41785	7.04	6.95	0.09
59	05-Jan-88 TUE	42534	42898	41469	6.61	3.65	2.96
44	26-Jan-88 TUE	41146	42769	42022	5.59	3.27	2.32
37	25-Jan-88 MON	41736	42686	41746	5.25	3.28	1.97
62	12-Nov-87 THU	41660	42682	41656	6.76	6.82	-0.06
11	08-Feb-88 MON	40240	41991	42620	3.53	3.21	0.32
30	04-Feb-88 THU	40930	42560	42272	4.97	3.21	1.76
63	10-Nov-87 TUE	41396	42475	41514	6.83	7.09	-0.26
66	04-Jan-88 MON	42247	42436	41220	7.48	3.68	3.8
61	09-Nov-87 MON	41696	42361	41414	6.64	7.23	-0.59
76	18-Nov-87 WED	41900	42308	40823	8.97	6.16	2.81
79	19-Nov-87 THU	42077	42284	41020	9.7	6.06	3.64
72	17-Nov-87 TUE	41488	42255	41224	8.62	6.26	2.36
9	22-Jan-88 FRI	40311	42244	41709	3.49	3.31	0.18
64	17-Dec-87 THU	42203	42031	40994	6.93	4.36	2.57
27	08-Jan-88 FRI	41921	42128	40984	4.76	3.56	1.2
69	16-Nov-87 MON	41475	42080	41051	8.27	6.36	1.91
25	27-Nov-87 FRI	41552	41996	41347	4.41	5.47	-1.06
33	15-Jan-88 FRI	40614	41629	40647	5.19	3.4	1.79
70	03-Nov-87 TUE	39750	41343	40525	8.43	8.16	0.27
74	04-Nov-87 WED	39880	41322	40424	8.72	8	0.72
60	13-Nov-87 FRI	39850	40977	40189	6.62	6.7	-0.08
32	29-Jan-88 FRI	39079	40702	40584	5.09	3.25	1.84
77	20-Nov-87 FRI	39989	40627	39824	8.98	5.98	3
71	05-Nov-87 THU	38961	40607	39991	8.61	7.84	0.77
75	02-Nov-87 MON	39057	40604	40108	8.72	8.32	0.4
68	22-Dec-87 TUE	40237	40598	40036	8.16	4.13	4.03
78	21-Dec-87 MON	40272	40500	39733	9.53	4.18	5.35
47	18-Feb-88 THU	38694	39912	40421	5.71	3.43	2.28
31	05-Feb-88 FRI	37597	39865	40318	4.98	3.21	1.77
24	24-Feb-88 WED	39224	39686	40229	4.36	3.77	0.59
13	29-Feb-88 MON	39746	39668	40085	3.67	4.16	-0.49
67	06-Nov-87 FRI	38577	40039	39475	7.71	7.68	0.03
36	23-Feb-88 TUE	38557	39371	39951	5.24	3.7	1.54
73	18-Dec-87 FRI	39574	39923	39329	8.68	4.31	4.37
40	17-Feb-88 WED	37277	38621	39904	5.49	3.39	2.1
49	16-Feb-88 TUE	37232	38328	39860	5.75	3.35	2.4
10	12-Feb-88 FRI	36625	38093	39695	3.49	3.25	0.24
55	15-Feb-88 MON	36564	38118	39625	6.32	3.32	3
52	22-Feb-88 MON	37488	38322	39391	6.03	3.64	2.39
12	25-Feb-88 THU	38101	38487	39188	3.6	3.84	-0.24
18	11-Feb-88 THU	37396	38255	39176	3.95	3.23	0.72
57	23-Dec-87 WED	38052	38512	38065	6.47	4.09	2.38
7	26-Feb-88 FRI	36994	37607	38357	2.86	3.92	-1.06
58	19-Feb-88 FRI	34681	35871	37256	8.59	3.47	3.12

ACTUALS 1987/88

		1700	1730	1800	EFF ACT	EFF NORM	
1	10-Dec-87 THU	45761	45743	44703	1.26	4.74	-3.48
2	11-Dec-87 FRI	43432	43510	42747	1.58	4.68	-3.1
3	14-Dec-87 MON	46446	46289	45040	1.74	4.52	-2.78
4	09-Dec-87 WED	46422	46517	45152	1.87	4.79	-2.92
5	15-Dec-87 TUE	46935	46609	45174	1.93	4.47	-2.54
6	08-Dec-87 TUE	46215	46506	45278	2.68	4.85	-2.17
7	26-Feb-88 FRI	36994	37607	38357	2.86	3.92	-1.06
8	30-Nov-87 MON	44611	44478	43301	3.36	5.3	-1.94
9	22-Jan-88 FRI	40311	42244	41709	3.49	3.31	0.18
10	12-Feb-88 FRI	36625	38093	39695	3.49	3.25	0.24
11	08-Feb-88 MON	40240	41991	42620	3.53	3.21	0.32
12	25-Feb-88 THU	38101	38467	39188	3.6	3.84	-0.24
13	29-Feb-88 MON	39746	39668	40085	3.67	4.16	-0.49
14	03-Dec-87 THU	45759	45496	44070	3.77	5.13	-1.36
15	04-Dec-87 FRI	42974	43096	42077	3.8	5.07	-1.27
16	01-Dec-87 TUE	44841	44965	43567	3.9	5.24	-1.34
17	09-Feb-88 TUE	41628	42959	43035	3.92	3.21	0.71
18	11-Feb-88 THU	37396	38255	39176	3.95	3.23	0.72
19	18-Jan-88 MON	43210	43848	42567	4.05	3.35	0.7
20	02-Dec-87 WED	45751	45641	44171	4.08	5.18	-1.1
21	10-Feb-88 WED	41828	43087	42852	4.11	3.22	0.89
22	21-Jan-88 THU	42160	43788	42945	4.18	3.32	0.86
23	07-Dec-87 MON	45121	45086	43647	4.29	4.9	-0.61
24	24-Feb-88 WED	39224	39688	40229	4.36	3.77	0.59
25	27-Nov-87 FRI	41552	41996	41347	4.41	5.47	-1.06
26	16-Dec-87 WED	43866	43729	42564	4.42	4.41	0.01
27	08-Jan-88 FRI	41921	42128	40984	4.76	3.56	1.2
28	28-Jan-88 THU	42584	43587	42613	4.79	3.26	1.53
29	27-Jan-88 WED	42630	43831	42925	4.88	3.26	1.62
30	04-Feb-88 THU	40930	42560	42272	4.97	3.21	1.76
31	05-Feb-88 FRI	37597	39865	40318	4.98	3.21	1.77
32	29-Jan-88 FRI	39079	40702	40584	5.09	3.25	1.84
33	15-Jan-88 FRI	40614	41629	40647	5.19	3.4	1.79
34	19-Jan-88 TUE	42377	43439	42260	5.21	3.34	1.87
35	20-Jan-88 WED	41961	43607	42663	5.23	3.33	1.9
36	23-Feb-88 TUE	38557	39371	39951	5.24	3.7	1.54
37	25-Jan-88 MON	41736	42686	41746	5.25	3.28	1.97
38	01-Feb-88 MON	41536	42993	42378	5.3	3.23	2.07
39	26-Nov-87 THU	43741	44062	42903	5.31	5.54	-0.23
40	17-Feb-88 WED	37277	38621	39904	5.49	3.39	2.1
41	03-Feb-88 WED	41428	43029	42199	5.51	3.22	2.29
42	12-Jan-88 TUE	44105	44486	42911	5.52	3.46	2.06
43	07-Jan-88 THU	42993	43786	42481	5.56	3.59	1.97
44	26-Jan-88 TUE	41146	42769	42022	5.59	3.27	2.32
45	02-Feb-88 TUE	41367	43121	43033	5.62	3.22	2.4
46	11-Jan-88 MON	42841	43342	42096	5.63	3.48	2.15
47	18-Feb-88 THU	38694	39912	40421	5.71	3.43	2.28
48	14-Jan-88 THU	41706	43053	41970	5.71	3.42	2.29
49	16-Feb-88 TUE	37232	38328	39860	5.75	3.35	2.4
50	13-Jan-88 WED	43052	43586	42226	5.85	3.44	2.41
51	25-Nov-87 WED	44355	44497	43146	5.85	5.6	0.25
52	22-Feb-88 MON	37488	38322	39391	6.03	3.64	2.39
53	24-Nov-87 TUE	44048	44099	42802	6.15	5.67	0.48
54	23-Nov-87 MON	44008	44014	42763	6.31	5.74	0.57
55	15-Feb-88 MON	36564	38118	39625	6.32	3.32	3
56	06-Jan-88 WED	43848	43885	42333	6.37	3.62	2.75
57	23-Dec-87 WED	38052	38512	38065	6.47	4.09	2.38
58	19-Feb-88 FRI	34681	35871	37256	6.59	3.47	3.12
59	05-Jan-88 TUE	42534	42898	41469	6.61	3.65	2.96
60	13-Nov-87 FRI	39850	40977	40189	6.62	6.7	-0.08
61	09-Nov-87 MON	41698	42361	41414	6.64	7.23	-0.59
62	12-Nov-87 THU	41660	42682	41656	6.76	6.82	-0.06
63	10-Nov-87 TUE	41396	42475	41514	6.83	7.09	-0.26
64	17-Dec-87 THU	42203	42031	40994	6.93	4.36	2.57
65	11-Nov-87 WED	42587	42900	41785	7.04	6.95	0.09
66	04-Jan-88 MON	42247	42436	41220	7.48	3.68	3.8
67	06-Nov-87 FRI	38577	40039	39475	7.71	7.68	0.03
68	22-Dec-87 TUE	40237	40598	40036	8.16	4.13	4.03
69	16-Nov-87 MON	41475	42080	41051	8.27	6.36	1.91
70	03-Nov-87 TUE	39750	41343	40525	8.43	8.16	0.27
71	05-Nov-87 THU	38981	40607	39991	8.61	7.84	0.77
72	17-Nov-87 TUE	41488	42255	41224	8.62	6.26	2.36
73	18-Dec-87 FRI	39574	39923	39329	8.68	4.31	4.37
74	04-Nov-87 WED	39880	41322	40424	8.72	8	0.72
75	02-Nov-87 MON	39057	40604	40108	8.72	8.32	0.4
76	18-Nov-87 WED	41900	42308	40823	8.97	6.16	2.81
77	20-Nov-87 FRI	39989	40627	39824	8.98	5.98	3
78	21-Dec-87 MON	40272	40500	39733	9.53	4.18	5.35
79	19-Nov-87 THU	42077	42284	41020	9.7	6.06	3.64

ACTUALS 1986/87

		1700	1730	1800	EFF ACT	EFF NORM	
3	12-Jan-87 MON	47897	47925	47330	-4.04	3.46	-7.5
2	14-Jan-87 WED	47240	47607	46313	-4.58	3.42	-8
1	13-Jan-87 TUE	47092	47267	45926	-5.04	3.44	-8.48
4	15-Jan-87 THU	47084	47181	45823	-3.07	3.4	-6.47
6	19-Jan-87 MON	46102	46653	45074	-1.4	3.34	-4.74
7	20-Jan-87 TUE	44230	45062	43847	-0.22	3.33	-3.55
5	16-Jan-87 FRI	43696	44515	43571	-1.64	3.38	-5.02
15	08-Jan-87 THU	44041	44230	42874	1.42	3.56	-2.14
16	21-Jan-87 WED	42928	43772	42401	1.59	3.32	-1.73
28	07-Jan-87 WED	42949	43550	42259	3.19	3.59	-0.4
37	06-Jan-87 TUE	43183	43492	42031	4.49	3.62	0.87
38	17-Dec-86 WED	43444	43317	41893	4.78	4.36	0.42
33	16-Dec-86 TUE	43298	43287	42298	4.17	4.41	-0.24
30	27-Jan-87 TUE	42219	43187	42644	3.42	3.26	0.16
13	02-Feb-87 MON	41875	43095	42641	1.31	3.22	-1.91
27	28-Jan-87 WED	40637	42829	42704	3.03	3.25	-0.22
19	29-Jan-87 THU	40389	42600	42826	2.34	3.25	-0.91
46	10-Dec-86 WED	42700	42693	41405	5.67	4.74	0.93
36	15-Dec-86 MON	42498	42674	41551	4.34	4.47	-0.13
29	22-Jan-87 THU	41557	42587	41639	3.23	3.31	-0.08
8	09-Jan-87 FRI	42279	42585	41263	0.71	3.53	-2.82
35	26-Jan-87 MON	41387	42395	41670	4.2	3.27	0.93
41	05-Jan-87 MON	41837	42142	40885	4.99	3.65	1.34
11	30-Jan-87 FRI	39034	41597	42106	1.08	3.24	-2.18
43	18-Dec-86 THU	42077	41767	40597	5.53	4.31	1.22
59	09-Dec-86 TUE	41974	42015	40659	7.56	4.79	2.77
48	11-Dec-86 THU	41875	41930	40622	5.96	4.68	1.28
14	17-Feb-87 TUE	40051	40771	41911	1.36	3.42	-2.06
18	16-Feb-87 MON	39885	40848	41796	1.77	3.38	-1.61
58	18-Nov-86 TUE	41561	41724	40176	7.54	6.16	1.38
68	26-Nov-86 WED	41155	41567	40358	8.42	5.54	2.88
50	01-Dec-86 MON	41549	41458	40155	6.89	5.24	1.65
52	20-Nov-86 THU	41005	41406	40166	6.98	5.98	1
24	03-Feb-87 TUE	39459	41309	41354	2.91	3.21	-0.3
71	03-Dec-86 WED	41341	41111	39872	9.05	5.13	3.92
64	17-Nov-86 MON	40675	41330	40013	7.84	6.26	1.58
69	08-Dec-86 MON	41329	41171	39749	8.43	4.85	3.58
26	22-Dec-86 MON	41131	41292	40410	2.96	4.13	-1.17
32	04-Feb-87 WED	39703	41278	41028	3.94	3.21	0.73
10	19-Feb-87 THU	39482	40320	41268	0.96	3.51	-2.55
12	18-Feb-87 WED	39098	39975	41260	1.3	3.46	-2.16
62	02-Dec-86 TUE	41107	41242	39886	7.75	5.18	2.57
72	25-Nov-86 TUE	41031	41167	39578	9.33	5.6	3.73
56	24-Nov-86 MON	40932	41040	39742	7.38	5.67	1.71
65	27-Nov-86 THU	40736	40968	39810	7.95	5.47	2.48
42	12-Dec-86 FRI	40910	40904	39889	5.1	4.63	0.47
66	19-Nov-86 WED	40846	40858	39607	8.11	6.06	2.05
44	05-Feb-87 THU	39035	40611	40494	5.65	3.21	2.44
53	04-Nov-86 TUE	39094	40575	39745	7	8	-1
23	26-Feb-87 THU	40252	40544	40437	2.81	3.98	-1.17
47	11-Feb-87 WED	38513	39977	40539	5.69	3.25	2.44
34	23-Jan-87 FRI	39213	40511	40091	4.18	3.3	0.88
57	09-Feb-87 MON	39364	40494	40149	7.49	3.22	4.27
39	19-Dec-86 FRI	39900	40458	39815	4.82	4.26	0.56
40	12-Feb-87 THU	38369	39677	40445	4.89	3.26	1.63
70	12-Nov-86 WED	39542	40438	39419	8.66	6.82	1.84
51	10-Feb-87 TUE	37725	39341	40336	6.92	3.23	3.69
63	05-Nov-86 WED	39334	40329	39124	7.84	7.84	0
20	24-Feb-87 TUE	38783	39193	40255	2.35	3.82	-1.47
77	04-Dec-86 THU	40222	40114	38850	10.23	5.07	5.16
17	25-Feb-87 WED	38587	39225	40204	1.75	3.9	-2.15
55	03-Nov-86 MON	38667	40193	39470	7.33	8.16	-0.83
21	23-Feb-87 MON	38759	39439	40142	2.66	3.75	-1.09
76	11-Nov-86 TUE	38958	40091	38997	10.01	6.95	3.06
74	13-Nov-86 THU	39897	40084	38901	9.56	6.7	2.86
49	21-Nov-86 FRI	39393	39820	38855	5.97	5.89	0.08
61	06-Nov-86 THU	37666	39582	39117	7.6	7.68	-0.08
9	20-Feb-87 FRI	37175	38033	39495	0.96	3.56	-2.6
73	10-Nov-86 MON	38117	39253	38449	9.44	7.09	2.35
31	13-Feb-87 FRI	36743	38029	39220	3.86	3.29	0.57
60	28-Nov-86 FRI	38590	39199	38560	7.59	5.41	2.18
78	05-Dec-86 FRI	38832	38870	38119	10.74	5.01	5.73
22	23-Dec-86 TUE	38260	38614	38034	2.8	4.09	-1.29
54	06-Feb-87 FRI	35853	37767	38434	7.27	3.21	4.06
75	14-Nov-86 FRI	38044	38305	37485	9.65	6.58	3.07
67	07-Nov-86 FRI	36945	37938	37109	8.14	7.53	0.61
45	27-Feb-87 FRI	33943	34321	35431	5.67	4.06	1.61
25	24-Dec-86 WED	32643	33054	32758	2.92	4.05	-1.13

TUALS 1986/87

	1700	1730	1800	EFF ACT	EFF NORM	
-Jan-87 TUE	47092	47267	45926	-5.04	3.44	-8.48
-Jan-87 WED	47240	47607	46313	-4.58	3.42	-8
-Jan-87 MON	47897	47925	47330	-4.04	3.46	-7.5
-Jan-87 THU	47084	47181	45823	-3.07	3.4	-6.47
-Jan-87 FRI	43696	44515	43571	-1.64	3.38	-5.02
-Jan-87 MON	46102	46653	45074	-1.4	3.34	-4.74
-Jan-87 TUE	44230	45062	43847	-0.22	3.33	-3.55
-Jan-87 FRI	42279	42585	41263	0.71	3.53	-2.82
-Feb-87 FRI	37175	38033	39495	0.96	3.56	-2.6
-Feb-87 THU	39482	40320	41268	0.96	3.51	-2.55
-Jan-87 FRI	39034	41597	42106	1.06	3.24	-2.18
-Feb-87 WED	39098	39975	41260	1.3	3.46	-2.16
-Feb-87 MON	41875	43095	42641	1.31	3.22	-1.91
-Feb-87 TUE	40051	40771	41911	1.36	3.42	-2.06
-Jan-87 THU	44041	44230	42874	1.42	3.56	-2.14
-Jan-87 WED	42928	43772	42401	1.59	3.32	-1.73
-Feb-87 WED	38587	39225	40204	1.75	3.9	-2.15
-Feb-87 MON	39885	40848	41796	1.77	3.38	-1.61
-Jan-87 THU	40389	42600	42826	2.34	3.25	-0.91
-Feb-87 TUE	38783	39193	40255	2.35	3.82	-1.47
-Feb-87 MON	38759	39439	40142	2.66	3.75	-1.09
-Dec-86 TUE	38260	38614	38034	2.8	4.09	-1.29
-Feb-87 THU	40252	40544	40437	2.81	3.98	-1.17
-Feb-87 TUE	39459	41309	41354	2.91	3.21	-0.3
-Dec-86 WED	32643	33054	32758	2.92	4.05	-1.13
-Dec-86 MON	41131	41292	40410	2.96	4.13	-1.17
-Jan-87 WED	40637	42829	42704	3.03	3.25	-0.22
-Jan-87 WED	42949	43550	42259	3.19	3.59	-0.4
-Jan-87 THU	41557	42587	41639	3.23	3.31	-0.08
-Jan-87 TUE	42219	43187	42644	3.42	3.26	0.16
-Feb-87 FRI	36743	38029	39220	3.86	3.29	0.57
-Feb-87 WED	39703	41278	41028	3.94	3.21	0.73
-Dec-86 TUE	43298	43287	42298	4.17	4.41	-0.24
-Jan-87 FRI	39213	40511	40091	4.18	3.3	0.88
-Jan-87 MON	41387	42395	41670	4.2	3.27	0.93
-Dec-86 MON	42498	42674	41551	4.34	4.47	-0.13
-Jan-87 TUE	43183	43492	42031	4.49	3.62	0.87
-Dec-86 WED	43444	43317	41893	4.78	4.36	0.42
-Dec-86 FRI	39900	40458	39815	4.82	4.26	0.56
-Feb-87 THU	38369	39677	40445	4.89	3.26	1.63
-Jan-87 MON	41837	42142	40885	4.99	3.65	1.34
-Dec-86 FRI	40910	40904	39889	5.1	4.63	0.47
-Dec-86 THU	42077	41767	40597	5.53	4.31	1.22
-Feb-87 THU	39035	40611	40494	5.65	3.21	2.44
-Feb-87 FRI	33943	34321	35431	5.67	4.06	1.61
-Dec-86 WED	42700	42693	41405	5.67	4.74	0.93
-Feb-87 WED	38513	39977	40539	5.69	3.25	2.44
-Dec-86 THU	41875	41930	40622	5.96	4.68	1.28
-Nov-86 FRI	39393	39820	38855	5.97	5.89	0.08
-Dec-86 MON	41549	41458	40155	6.89	5.24	1.65
-Feb-87 TUE	37725	39341	40336	6.92	3.23	3.69
-Nov-86 THU	41005	41406	40166	6.98	5.98	1
-Nov-86 TUE	39094	40575	39745	7	8	-1
-Feb-87 FRI	35853	37767	38434	7.27	3.21	4.06
-Nov-86 MON	38667	40193	39470	7.33	8.16	-0.83
-Nov-86 MON	40932	41040	39742	7.38	5.67	1.71
-Feb-87 MON	39364	40494	40149	7.49	3.22	4.27
-Nov-86 TUE	41561	41724	40176	7.54	6.16	1.38
-Dec-86 TUE	41974	42015	40659	7.56	4.79	2.77
-Nov-86 FRI	38590	39199	38560	7.59	5.41	2.18
-Nov-86 THU	37666	39582	39117	7.6	7.68	-0.08
-Dec-86 TUE	41107	41242	39886	7.75	5.18	2.57
-Nov-86 WED	39334	40329	39124	7.84	7.84	0
-Nov-86 MON	40675	41330	40013	7.84	6.26	1.58
-Nov-86 THU	40736	40968	39810	7.95	5.47	2.48
-Nov-86 WED	40846	40858	39607	8.11	6.06	2.05
-Nov-86 FRI	36945	37938	37109	8.14	7.53	0.61
-Nov-86 WED	41155	41567	40358	8.42	5.54	2.88
-Dec-86 MON	41329	41171	39749	8.43	4.85	3.58
-Nov-86 WED	39542	40438	39419	8.68	6.82	1.84
-Dec-86 WED	41341	41111	39872	9.05	5.13	3.92
-Nov-86 TUE	41031	41167	39578	9.33	5.6	3.73
-Nov-86 MON	38117	39253	38449	9.44	7.09	2.35
-Nov-86 THU	39697	40084	38901	9.56	6.7	2.86
-Nov-86 FRI	38044	38305	37485	9.65	6.58	3.07
Nov-86 TUE	38958	40091	38997	10.01	6.95	3.06
Dec-86 THU	40222	40114	38850	10.23	5.07	5.16
Dec-86 FRI	38832	38870	38119	10.74	5.01	5.73

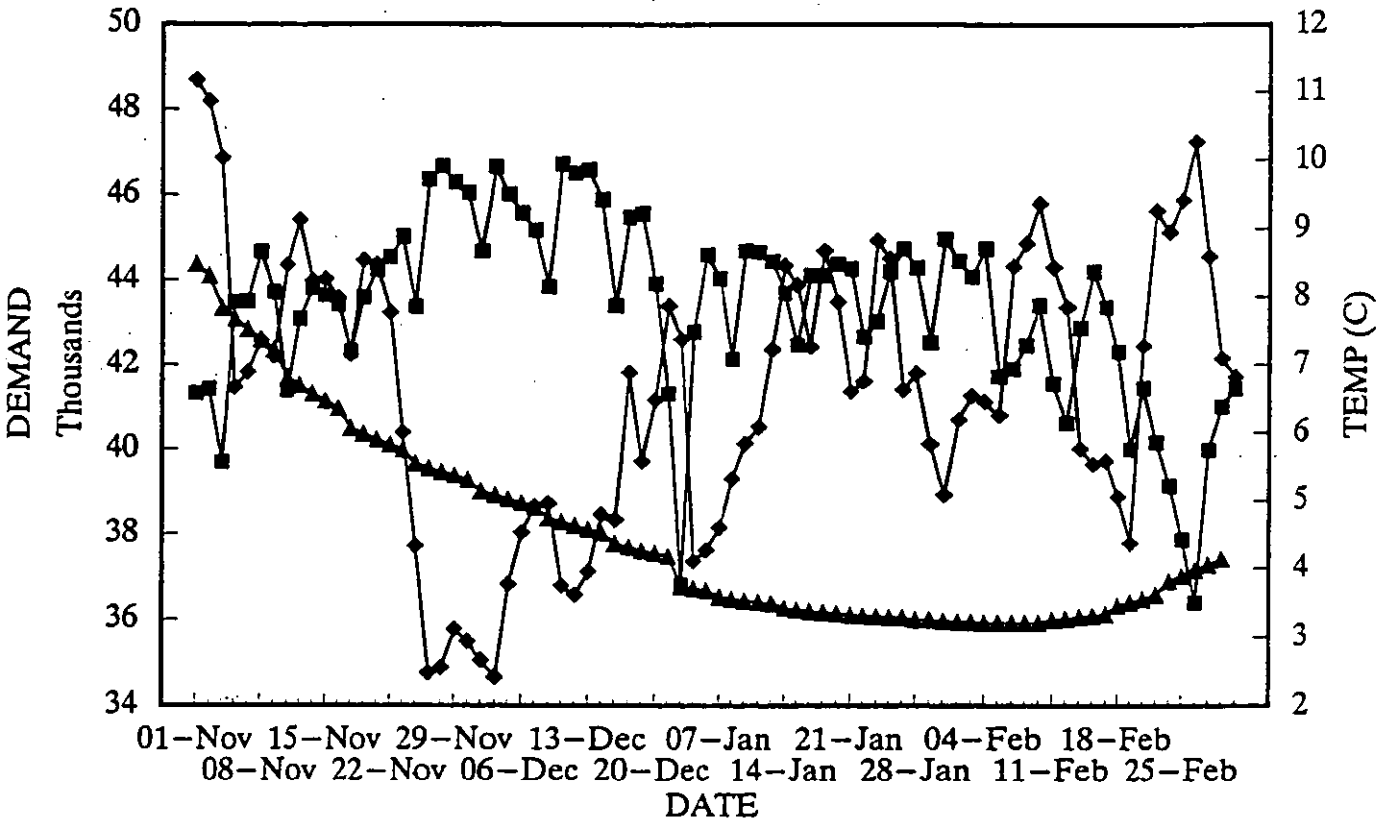
ACTUALS 1985/86

		1700	1730	1800	EFF ACT	EFF NORM	
19	07-Jan-86 TUE	45185	44795	42906	0.72	3.59	-2.87
36	20-Nov-85 WED	44052	43910	42339	2.65	5.98	-3.33
29	03-Feb-86 MON	43710	44015	42642	2.14	3.21	-1.07
20	08-Jan-86 WED	43987	43988	42255	1.11	3.56	-2.45
1	11-Feb-86 TUE	42078	43231	43626	-2.33	3.25	-5.58
23	28-Nov-85 THU	43374	43454	42104	1.47	5.41	-3.94
28	04-Feb-86 TUE	42448	43407	42866	2.01	3.21	-1.2
34	27-Nov-85 WED	43347	43357	42061	2.56	5.47	-2.91
17	06-Feb-86 THU	41972	43320	43291	0.37	3.21	-2.84
2	10-Feb-86 MON	40805	42214	43294	-2.05	3.23	-5.28
21	06-Jan-86 MON	42913	43214	41686	1.27	3.62	-2.35
48	10-Dec-85 TUE	43143	42787	41327	4.26	4.74	-0.48
41	26-Nov-85 TUE	43104	43127	41580	3.36	5.54	-2.18
26	29-Jan-86 WED	42393	43098	41993	1.68	3.25	-1.57
6	12-Feb-86 WED	41083	42325	43077	-1.56	3.26	-4.82
27	09-Jan-86 THU	42857	43072	41537	1.75	3.53	-1.78
30	30-Jan-86 THU	42228	43007	42075	2.19	3.24	-1.05
39	21-Nov-85 THU	42984	42806	41281	3.09	5.89	-2.8
24	28-Jan-86 TUE	41782	42929	42153	1.5	3.25	-1.75
25	27-Jan-86 MON	41762	42878	41818	1.53	3.26	-1.73
14	17-Feb-86 MON	41162	41865	42632	0.02	3.42	-3.4
47	25-Nov-85 MON	42606	42548	41006	4.04	5.6	-1.56
22	05-Feb-86 WED	41072	42561	42558	1.42	3.21	-1.79
7	25-Feb-86 TUE	41929	42137	42514	-1.55	3.9	-5.45
61	14-Jan-86 TUE	41745	42465	41183	6.29	3.42	2.87
38	19-Nov-85 TUE	42443	42014	40710	3.02	6.06	-3.04
50	16-Jan-86 THU	41671	42408	41267	4.32	3.38	0.94
10	14-Feb-86 FRI	40784	41910	42391	-1.01	3.31	-4.32
16	18-Feb-86 TUE	41101	41714	42300	0.09	3.46	-3.37
11	13-Feb-86 THU	39350	40790	42268	-0.96	3.29	-4.25
35	14-Nov-85 THU	41955	42190	40663	2.58	6.58	-4
53	09-Dec-85 MON	42169	42015	40661	5.2	4.79	0.41
44	18-Nov-85 MON	41752	42132	40845	3.73	6.16	-2.43
32	31-Jan-86 FRI	41446	41960	41374	2.43	3.23	-0.8
58	15-Jan-86 WED	40899	41940	40858	5.97	3.4	2.57
13	07-Feb-86 FRI	39888	41617	41902	-0.18	3.21	-3.39
18	29-Nov-85 FRI	41866	41770	40714	0.48	5.36	-4.88
52	11-Dec-85 WED	41678	41612	40283	5.18	4.68	0.5
57	22-Jan-86 WED	40569	41611	40517	5.77	3.31	2.46
37	13-Nov-85 WED	40675	41572	40502	2.76	6.7	-3.94
4	26-Feb-86 WED	40572	40879	41566	-1.77	3.98	-5.75
59	20-Jan-86 MON	40520	41444	40195	6.13	3.33	2.8
55	23-Jan-86 THU	39608	41352	40699	5.48	3.3	2.18
62	13-Jan-86 MON	41241	41344	39763	6.35	3.44	2.91
60	21-Jan-86 TUE	39977	41318	40312	6.28	3.32	2.96
51	11-Nov-85 MON	40359	41316	40080	5.09	6.95	-1.86
15	19-Feb-86 WED	39836	40522	41312	0.05	3.51	-3.46
5	27-Feb-86 THU	40188	40434	41076	-1.72	4.06	-5.78
56	12-Dec-85 THU	41072	40884	39619	5.71	4.63	1.08
43	12-Nov-85 TUE	39818	40947	40197	3.67	6.82	-3.15
12	20-Feb-86 THU	39250	39937	40760	-0.79	3.56	-4.35
8	24-Feb-86 MON	39680	40068	40751	-1.42	3.82	-5.24
42	22-Nov-85 FRI	40544	40731	39676	3.51	5.82	-2.31
40	17-Jan-86 FRI	39830	40590	39810	3.27	3.36	-0.09
74	17-Dec-85 TUE	40396	40222	38990	9.34	4.36	4.98
9	28-Feb-86 FRI	39292	39745	40379	-1.15	4.14	-5.29
49	24-Jan-86 FRI	38172	40334	40168	4.31	3.29	1.02
73	18-Dec-85 WED	39807	40251	39093	9.18	4.31	4.87
63	06-Nov-85 WED	38773	40225	39223	6.5	7.68	-1.18
3	21-Feb-86 FRI	38430	39158	40121	-2.05	3.62	-5.67
78	04-Dec-85 WED	40082	39799	38470	10.34	5.07	5.27
76	05-Dec-85 THU	40061	39887	38801	10.01	5.01	5
77	03-Dec-85 TUE	39755	39755	39977	10.07	5.13	4.94
75	16-Dec-85 MON	39738	39862	38641	9.76	4.41	5.35
64	05-Nov-85 TUE	38569	39832	38709	6.86	7.84	-0.98
69	02-Dec-85 MON	39815	39666	38250	8.32	5.18	3.14
68	19-Dec-85 THU	39539	39648	38698	8.07	4.26	3.81
46	10-Jan-86 FRI	38727	39600	38846	4.01	3.51	0.5
54	04-Nov-85 MON	38357	39594	38803	5.24	8	-2.76
71	06-Dec-85 FRI	39523	39301	38429	8.68	4.96	3.72
45	15-Nov-85 FRI	38731	39504	38523	3.75	6.47	-2.72
31	03-Jan-86 FRI	38425	39117	38596	2.42	3.71	-1.29
67	07-Nov-85 THU	37541	38749	38116	7.72	7.53	0.19
33	02-Jan-86 THU	38627	38662	37751	2.5	3.74	-1.24
66	13-Dec-85 FRI	38452	38434	37661	7.48	4.57	2.91
65	01-Nov-85 FRI	34505	36646	36580	7.18	8.49	-1.31
72	08-Nov-85 FRI	35214	36434	35949	9.09	7.38	1.71
70	20-Dec-85 FRI	36235	36290	35819	8.46	4.22	4.24

ACTUALS 1985/86

		1700	1730	1800	EFF ACT	EFF NORM
1	11-Feb-86 TUE	42078	43231	43626	-2.33	3.25
2	10-Feb-86 MON	40805	42214	43294	-2.05	3.23
3	21-Feb-86 FRI	38430	39158	40121	-2.05	3.62
4	26-Feb-86 WED	40572	40879	41566	-1.77	3.98
5	27-Feb-86 THU	40188	40434	41076	-1.72	4.06
6	12-Feb-86 WED	41083	42325	43077	-1.56	3.26
7	25-Feb-86 TUE	41929	42137	42514	-1.55	3.9
8	24-Feb-86 MON	39680	40068	40751	-1.42	3.82
9	28-Feb-86 FRI	39292	39745	40379	-1.15	4.14
10	14-Feb-86 FRI	40784	41910	42391	-1.01	3.31
11	13-Feb-86 THU	39350	40790	42268	-0.96	3.29
12	20-Feb-86 THU	39250	39937	40760	-0.79	3.56
13	07-Feb-86 FRI	39888	41617	41902	-0.18	3.21
14	17-Feb-86 MON	41162	41865	42632	0.02	3.42
15	19-Feb-86 WED	39836	40522	41312	0.05	3.51
16	18-Feb-86 TUE	41101	41714	42300	0.09	3.46
17	06-Feb-86 THU	41972	43320	43291	0.37	3.21
18	29-Nov-85 FRI	41866	41770	40714	0.48	5.36
19	07-Jan-86 TUE	45185	44795	42908	0.72	3.59
20	08-Jan-86 WED	43987	43988	42255	1.11	3.58
21	06-Jan-86 MON	42913	43214	41686	1.27	3.62
22	05-Feb-86 WED	41072	42561	42558	1.42	3.21
23	28-Nov-85 THU	43374	43454	42104	1.47	5.41
24	28-Jan-86 TUE	41782	42929	42153	1.5	3.25
25	27-Jan-86 MON	41762	42878	41818	1.53	3.26
26	29-Jan-86 WED	42393	43098	41993	1.68	3.25
27	09-Jan-86 THU	42857	43072	41537	1.75	3.53
28	04-Feb-86 TUE	42448	43407	42866	2.01	3.21
29	03-Feb-86 MON	43710	44015	42642	2.14	3.21
30	30-Jan-86 THU	42228	43007	42075	2.19	3.24
31	03-Jan-86 FRI	38425	39117	38596	2.42	3.71
32	31-Jan-86 FRI	41446	41960	41374	2.43	3.23
33	02-Jan-86 THU	38627	38662	37751	2.5	3.74
34	27-Nov-85 WED	43347	43357	42061	2.56	5.47
35	14-Nov-85 THU	41955	42190	40663	2.58	6.58
36	20-Nov-85 WED	44052	43910	42339	2.65	5.98
37	13-Nov-85 WED	40675	41572	40502	2.76	6.7
38	19-Nov-85 TUE	42443	42014	40710	3.02	6.06
39	21-Nov-85 THU	42984	42806	41281	3.09	5.89
40	17-Jan-86 FRI	39830	40590	39810	3.27	3.36
41	26-Nov-85 TUE	43104	43127	41580	3.36	5.54
42	22-Nov-85 FRI	40544	40731	39676	3.51	5.82
43	12-Nov-85 TUE	39818	40947	40197	3.67	6.82
44	18-Nov-85 MON	41752	42132	40845	3.73	6.16
45	15-Nov-85 FRI	38731	39504	38523	3.75	6.47
46	10-Jan-86 FRI	38727	39600	38846	4.01	3.51
47	25-Nov-85 MON	42606	42548	41006	4.04	5.6
48	10-Dec-85 TUE	43143	42787	41327	4.26	4.74
49	24-Jan-86 FRI	38172	40334	40168	4.31	3.29
50	16-Jan-86 THU	41671	42408	41267	4.32	3.38
51	11-Nov-85 MON	40359	41316	40080	5.09	6.95
52	11-Dec-85 WED	41678	41612	40283	5.18	4.68
53	09-Dec-85 MON	42169	42015	40661	5.2	4.79
54	04-Nov-85 MON	38357	39594	38803	5.24	8
55	23-Jan-86 THU	39608	41352	40699	5.48	3.3
56	12-Dec-85 THU	41072	40884	39619	5.71	4.63
57	22-Jan-86 WED	40569	41611	40517	5.77	3.31
58	15-Jan-86 WED	40899	41940	40858	5.97	3.4
59	20-Jan-86 MON	40520	41444	40195	6.13	3.33
60	21-Jan-86 TUE	39977	41318	40312	6.28	3.32
61	14-Jan-86 TUE	41745	42465	41183	6.29	3.42
62	13-Jan-86 MON	41241	41344	39763	6.35	3.44
63	06-Nov-85 WED	38773	40225	39223	6.5	7.68
64	05-Nov-85 TUE	38569	39832	38709	6.86	7.84
65	01-Nov-85 FRI	34505	36646	36580	7.18	8.49
66	13-Dec-85 FRI	38452	38434	37661	7.48	4.57
67	07-Nov-85 THU	37541	38749	38116	7.72	7.53
68	19-Dec-85 THU	39539	39648	38698	8.07	4.26
69	02-Dec-85 MON	39815	39666	38250	8.32	5.18
70	20-Dec-85 FRI	36235	36290	35819	8.46	4.22
71	06-Dec-85 FRI	39523	39301	38429	8.68	4.96
72	08-Nov-85 FRI	35214	36434	35949	9.09	7.38
73	18-Dec-85 WED	39807	40251	39093	9.18	4.31
74	17-Dec-85 TUE	40396	40222	38990	9.34	4.36
75	16-Dec-85 MON	39738	39862	38641	9.76	4.41
76	05-Dec-85 THU	40061	39887	38801	10.01	5.01
77	03-Dec-85 TUE	39755	39755	39977	10.07	5.13
78	04-Dec-85 WED	40082	39799	38470	10.34	5.07

MAXIMUM DEMAND V EFFECTIVE UK TEMPERATURES
WINTER 1989/90 17:00 TO 18:00 HRS



Appendix 4

Norweb triad warnings (example proforma)

NORWEB

TRIAD WARNING INSTRUCTIONS

PLEASE PASS ON IMMEDIATELY

CATEGORY 1 WARNING

ON TUESDAY 15-02-94 THE PROBABILITY OF A TRIAD OCCURRING IS SIGNIFICANT BETWEEN 17:00 AND 18:30.

IF YOU REDUCE YOUR DEMAND WITHIN THIS TIME PERIOD THERE IS A SIGNIFICANT POSSIBILITY OF REDUCING YOUR TRANSMISSION CHARGES.

FROM: NORWEB ELECTRICITY SUPPLY

FAX NUMBER: 061 875 7089

TEL NUMBER: 061 875 7343

CONTACT: DAMIAN NELSON

IMPORTANT

It should be noted that the "normal" circumstances under which the TRIAD forecasts are made will be subject to the "abnormal" influence of customers acting on TRIAD warnings. As such the effectiveness and accuracy of the issued warnings may be affected.

Therefore, whilst the information is given in good faith NORWEB will not be held responsible for any error in the forecast

NORWEB

TRIAD WARNING INSTRUCTIONS

PLEASE PASS ON IMMEDIATELY

CATEGORY 2 WARNING

ON THURSDAY 20-01-94 THERE IS A POSSIBILITY OF A TRIAD OCCURRING BETWEEN 16:30 AND 17:30 BUT LESS THAN THAT OF A CATEGORY 1 WARNING.

IF YOU REDUCE YOUR DEMAND WITHIN THIS TIME PERIOD THERE IS A POSSIBILITY OF REDUCING YOUR TRANSMISSION CHARGES.

FROM: NORWEB ELECTRICITY SUPPLY

FAX NUMBER: 061 875 7089

TEL NUMBER: 061 875 7343

CONTACT: DAMIAN NELSON

IMPORTANT

It should be noted that the "normal" circumstances under which the TRIAD forecasts are made will be subject to the "abnormal" influence of customers acting on TRIAD warnings. As such the effectiveness and accuracy of the issued warnings may be affected.

Therefore, whilst the information is given in good faith NORWEB will not be held responsible for any error in the forecast

Appendix 5

Customer demand responsiveness analysis

TRIAD DEMAND ANALYSIS : WINTER 1991/92

CUSTOMER REF : 1

NAME : SOLID FUEL MANUFACTURING AND/OR EXTRACTION 1

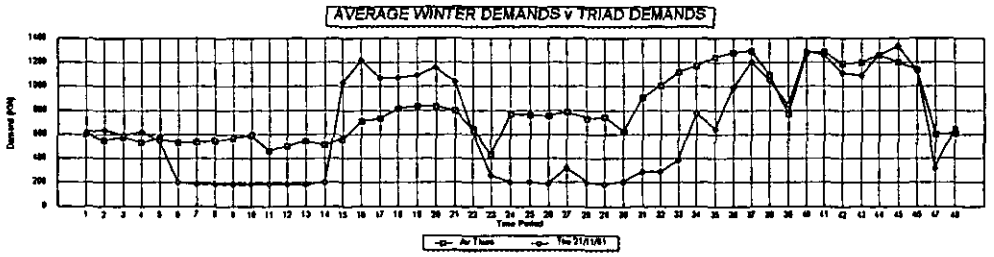
SIC CODE : 111

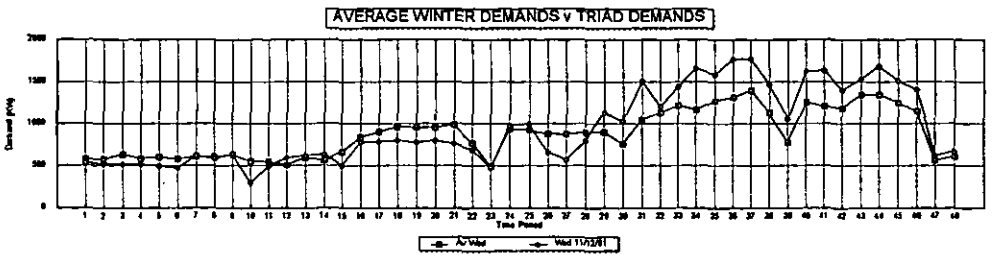
UNITS : KW

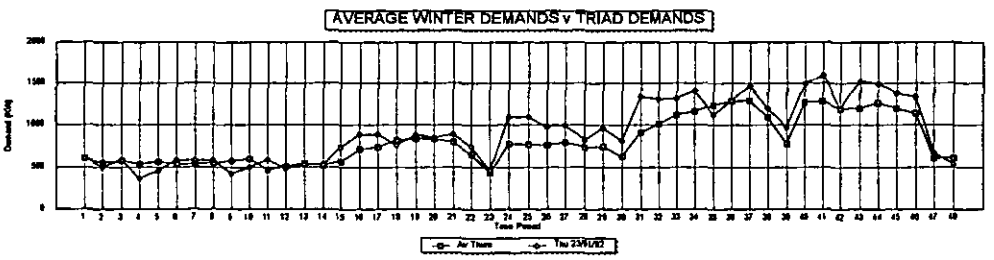
DAY	DATE	TP	ACTUAL DEMAND	TYPICAL DEMAND	DIFF	% DIFF
THU	21/11/91	35	640	1,242	602	48.48%
WED	11/12/91	35	1,580	1,264	(316)	-24.96%
THU	23/01/92	35	1,120	1,242	122	9.83%

Typical daily demands are calculated for each day type for the period November to February, excluding the full Christmas period.

The typical demands also exclude the period between time periods 34 and 36 for the Triad warning days







TRIAD DEMAND ANALYSIS : WINTER 1992/93

CUSTOMER REF : 1

NAME : SOLID FUEL MANUFACTURING AND/OR EXTRACTION 1

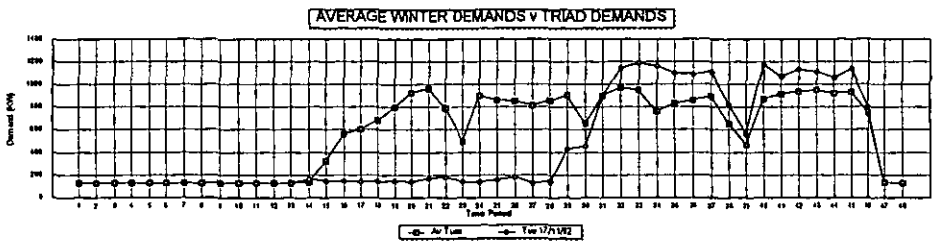
SIC CODE : 111

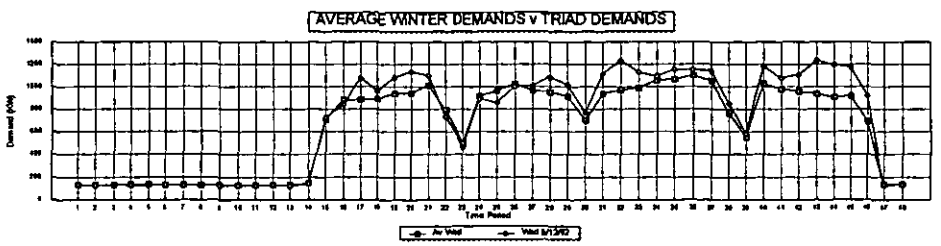
UNITS : KW

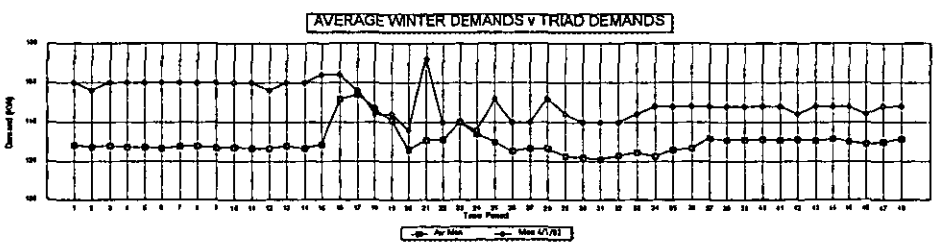
DAY	DATE	TP	ACTUAL DEMAND	TYPICAL DEMAND	DIFF	% DIFF
TUE	17/11/92	35	1,100	967	(133)	-13.71%
WED	09/12/92	35	1,152	1,071	(81)	-7.55%
MON	04/01/93	35	148	967	819	84.70%

Typical daily demands are calculated for each day type for the period November to February, excluding the full Christmas period.

The typical demands also exclude the period between time periods 34 and 36 for the Triad warning days.







TRIAD DEMAND ANALYSIS : WINTER 1991/92 & 1992/93

CUSTOMER REF : 1

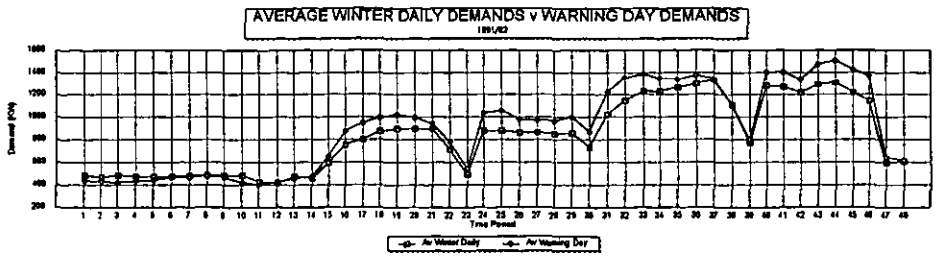
NAME : SOLID FUEL MANUFACTURING AND/OR EXTRACTION I

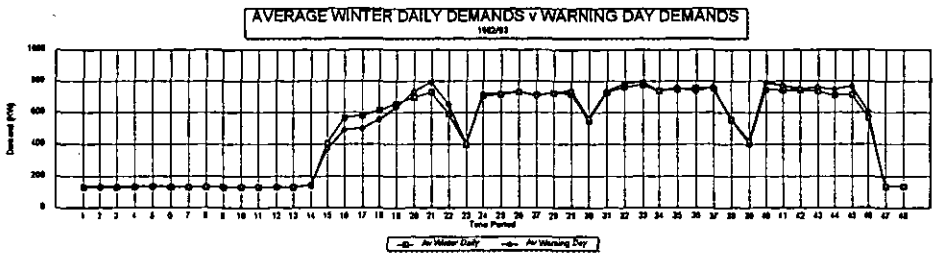
SIC CODE : 111

UNITS : KW

WINTER 91/92	33	33	34	35	36	37	38
AV DAILY	1,147	1,229	1,228	1,264	1,295	1,328	1,107
AV WARNING DAY	1,353	1,386	1,350	1,339	1,374	1,342	1,115
Unit Reduction	(206)	(156)	(122)	(75)	(78)	(14)	(7)
Wage Reduction	-18%	-13%	-10%	-6%	-6%	-1%	-1%

WINTER 92/93	33	33	34	35	36	37	38
AV DAILY	786	775	741	748	758	752	557
AV WARNING DAY	795	799	738	759	737	766	562
Unit Reduction	(10)	(24)	2	(11)	22	(14)	(5)
Wage Reduction	-3%	-3%	0%	-1%	3%	-2%	-1%





TRIAD DEMAND ANALYSIS : WINTER 1991/92

CUSTOMER NO : 2

NAME : ENERGY AND WATER SUPPLY INDUSTRIES 1

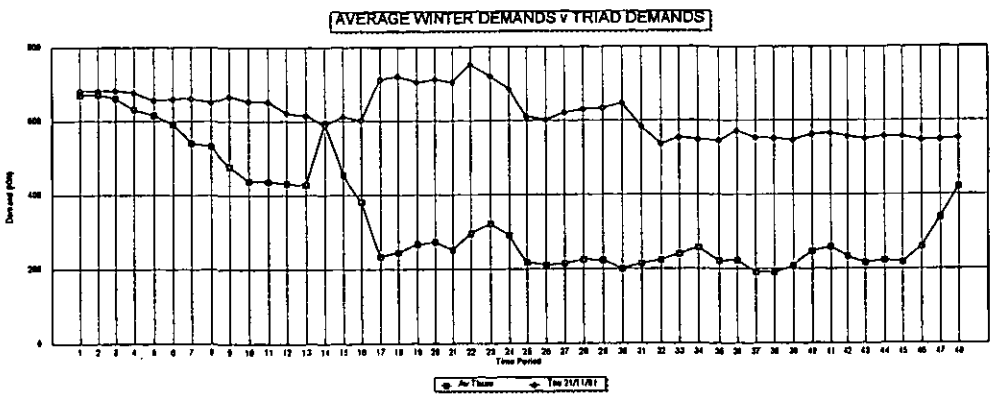
SIC CODE : 171

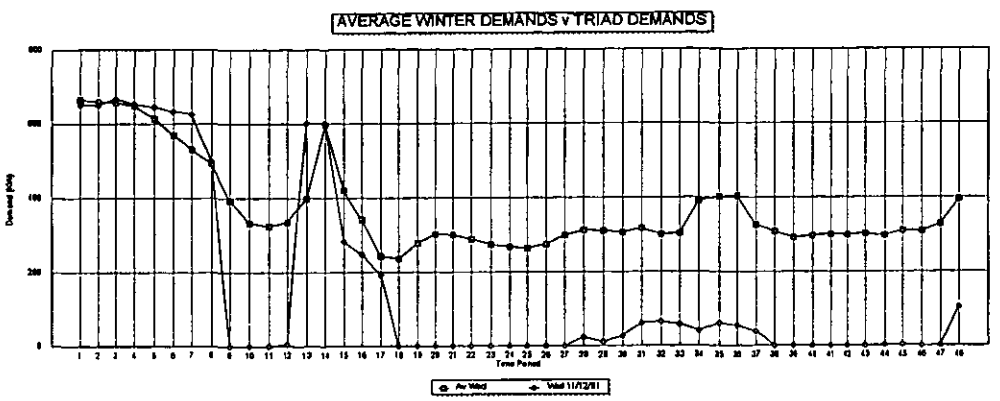
UNITS : KW

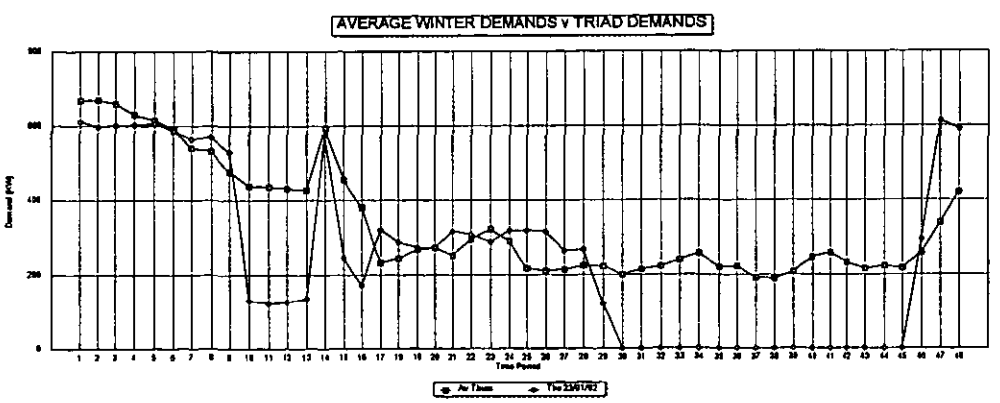
DAY	DATE	TP	ACTUAL DEMAND	TYPICAL DEMAND	DIFF	% DIFF
THU	21/11/91	35	546	220	(326)	-147.84%
WED	11/12/91	35	60	401	341	85.04%
THU	23/01/92	35	0	220	220	100.00%

Typical daily demands are calculated for each day type for the period November to February, excluding the full Christmas period.

The typical demands also exclude the period between time periods 34 and 36 for the Triad warning days







TRIAD DEMAND ANALYSIS : WINTER 1992/93

CUSTOMER REF : 2

NAME : ENERGY AND WATER SUPPLY INDUSTRIES 1

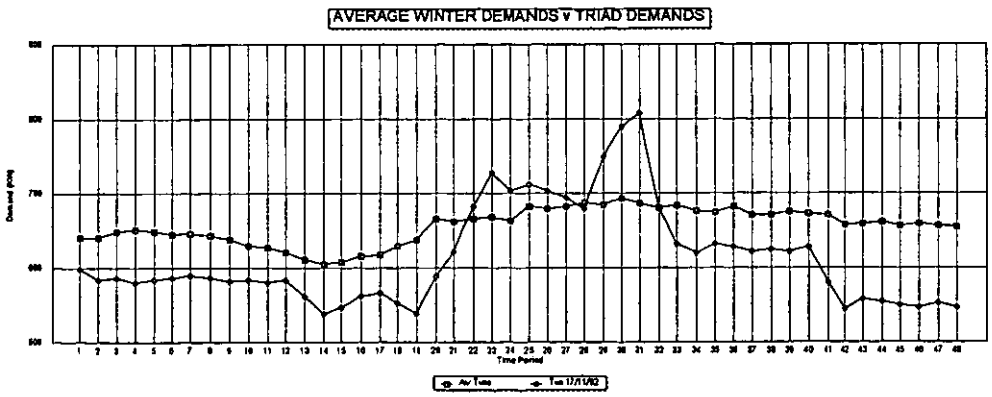
SIC CODE : 171

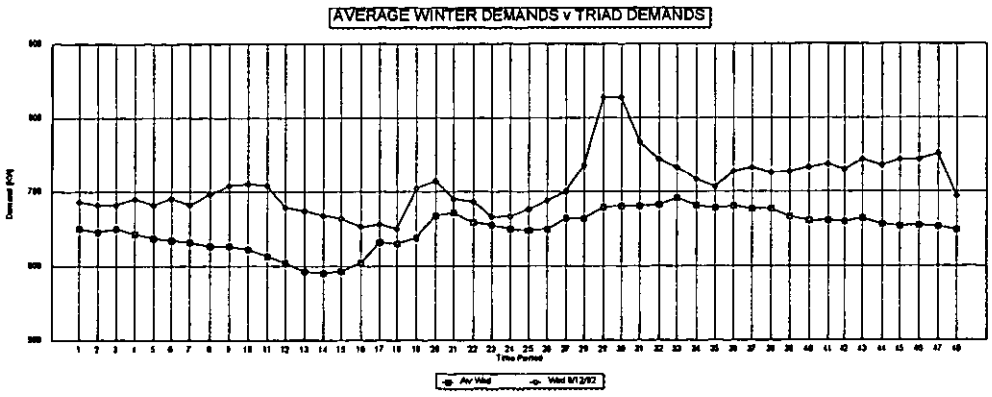
UNITS : KW

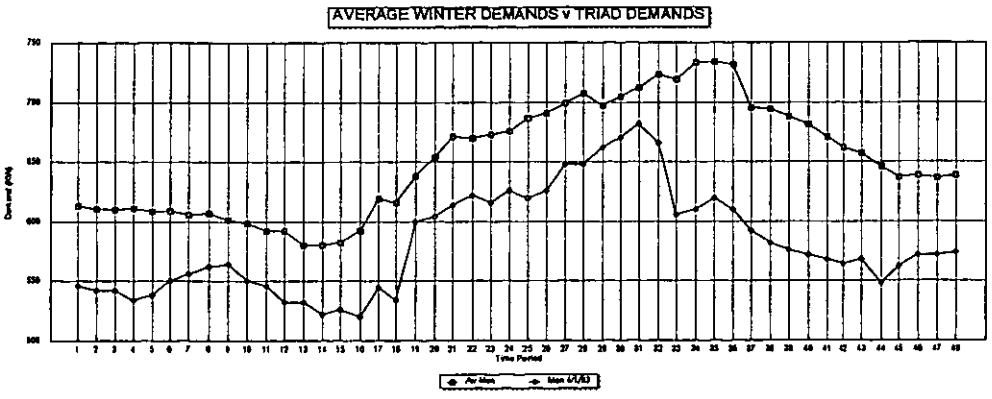
DAY	DATE	TP	ACTUAL DEMAND	TYPICAL DEMAND	DIFF	% DIFF
TUE	17/11/92	35	632	684	52	7.58%
WED	09/12/92	35	706	677	(29)	-4.23%
MON	04/01/93	35	620	684	64	9.34%

Typical daily demands are calculated for each day type for the period November to February, excluding the full Christmas period.

The typical demands also exclude the period between time periods 34 and 36 for the Triad warning days.







TRIAD DEMAND ANALYSIS : WINTER 1991/92 & 1992/93

CUSTOMER NO : 2

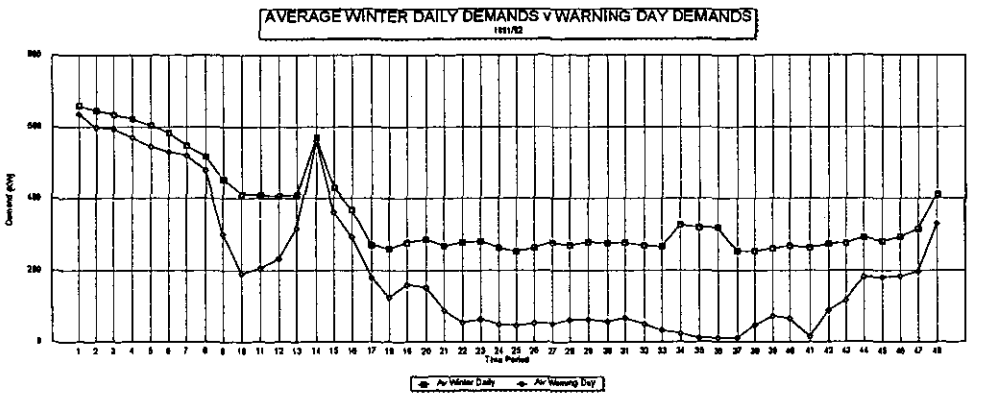
NAME : ENERGY AND WATER SUPPLY INDUSTRIES 1

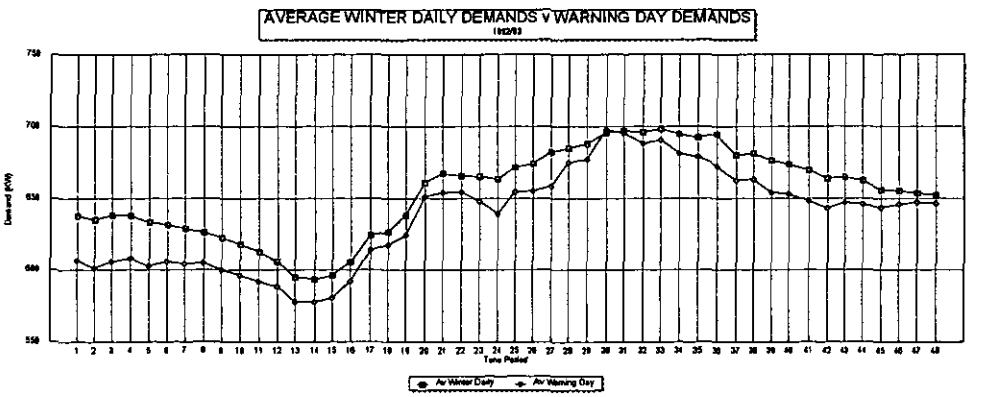
SIC CODE : 171

UNITS : KW

WINTER 91/92	32	33	34	35	36	37	38
AV DAILY	268	266	327	320	320	253	254
AV WARNING DAY	49	33	24	12	12	12	47
Unit Reduction	219	233	303	308	308	241	207
%age Reduction	82%	88%	93%	96%	96%	95%	81%

WINTER 92/93	32	33	34	35	36	37	38
AV DAILY	696	698	695	692	695	680	681
AV WARNING DAY	688	690	681	679	672	662	663
Unit Reduction	8	8	14	14	22	18	18
%age Reduction	1%	1%	2%	2%	3%	3%	3%





TRIAD DEMAND ANALYSIS : WINTER 1991/92

CUSTOMER NO : 3

NAME : CHEMICAL PRODUCTS MANUFACTURING 1

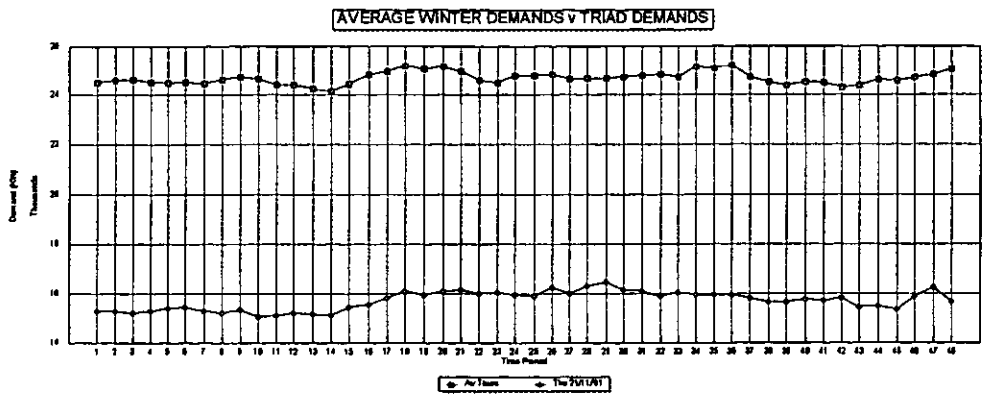
SIC CODE : 251

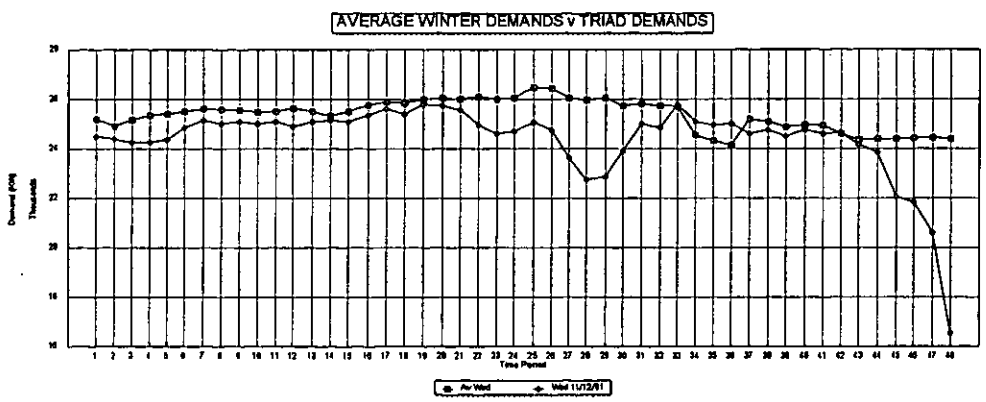
UNITS : KW

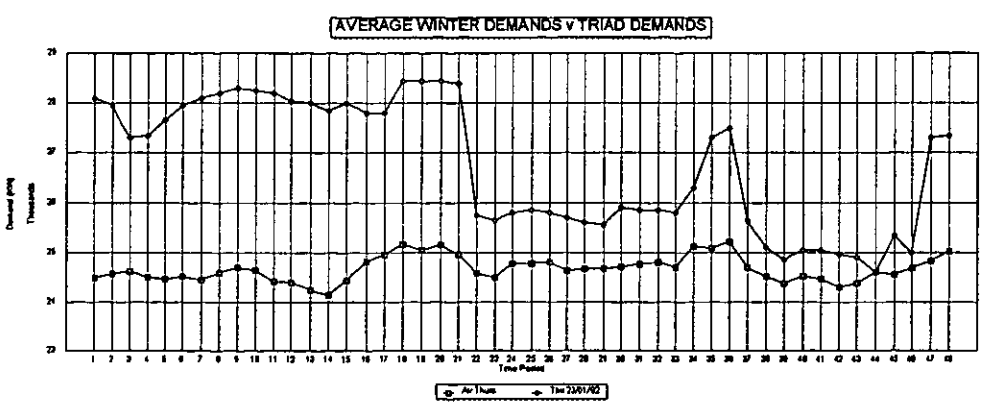
DAY	DATE	TP	ACTUAL DEMAND	TYPICAL DEMAND	DIFF	% DIFF
THU	11/21/91	35	15,950	25,088	9,138	36.42%
WED	12/11/91	35	24,950	24,315	(635)	-2.61%
THU	01/23/92	35	27,300	25,088	(2,212)	-8.81%

Typical daily demands are calculated for each day type for the period November to February, excluding the full Christmas period.

The typical demands also exclude the period between time periods 34 and 36 for the Triad warning days







TRIAD DEMAND ANALYSIS : WINTER 1992/93

CUSTOMER REF : 3

NAME : CHEMICAL PRODUCTS MANUFACTURING 1

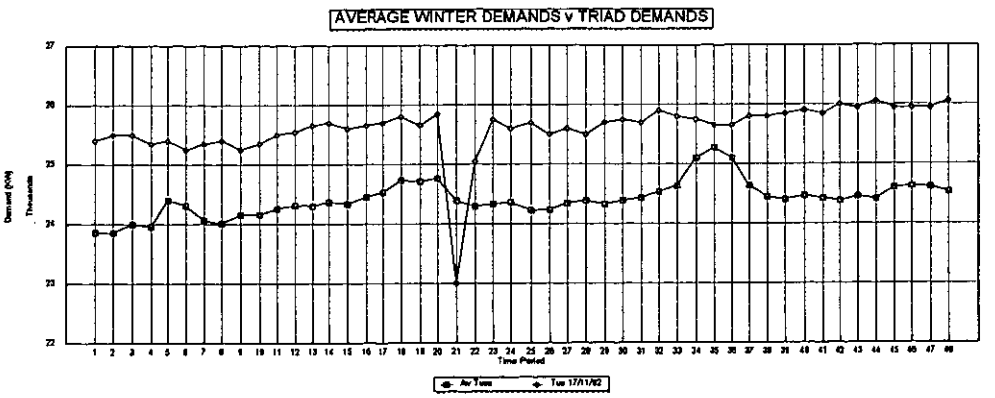
SIC CODE : 251

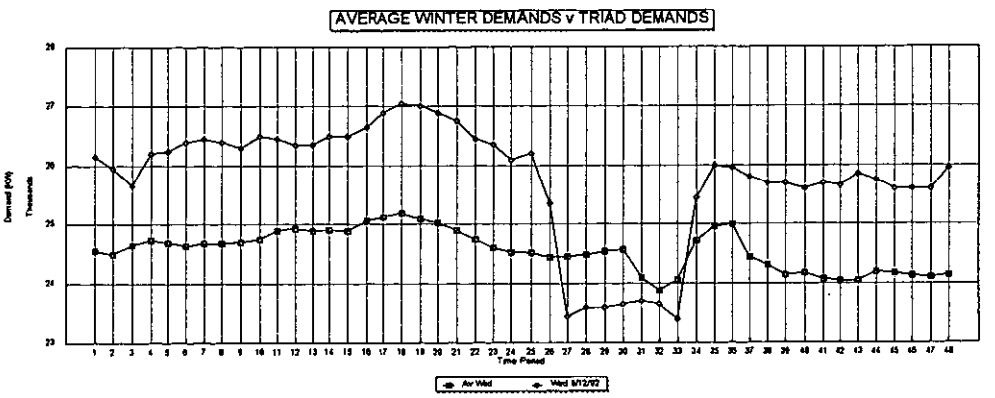
UNITS : KW

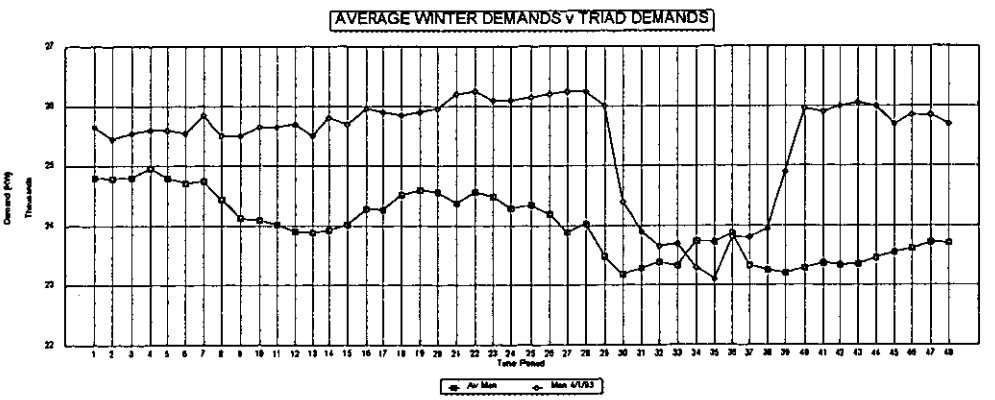
DAY	DATE	TP	ACTUAL DEMAND	TYPICAL DEMAND	DIFF	% DIFF
TUE	11/17/92	35	25,650	23,415	(2,235)	-9.54%
WED	12/09/92	35	26,000	24,956	(1,044)	-4.19%
MON	01/04/93	35	23,100	23,415	315	1.35%

Typical daily demands are calculated for each day type for the period November to February, excluding the full Christmas period.

The typical demands also exclude the period between time periods 34 and 36 for the Triad warning days.







TRIAD DEMAND ANALYSIS : WINTER 1991/92 & 1992/93

CUSTOMER NO : 3

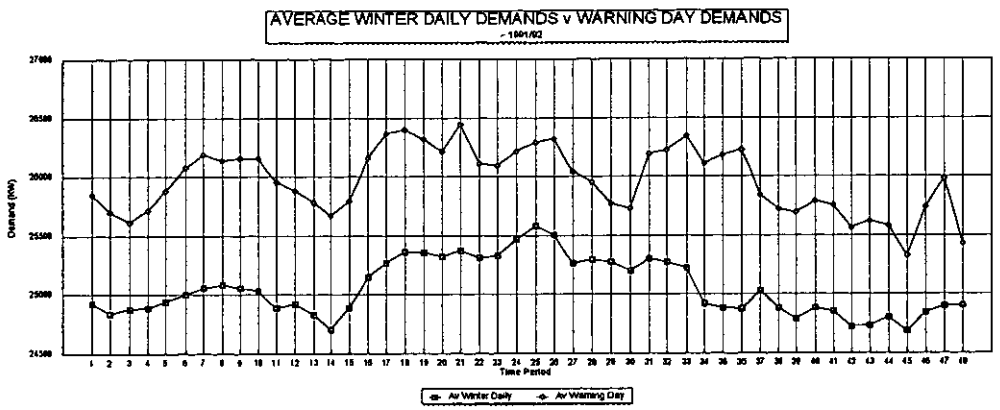
NAME : CHEMICAL PRODUCTS MANUFACTURING 1

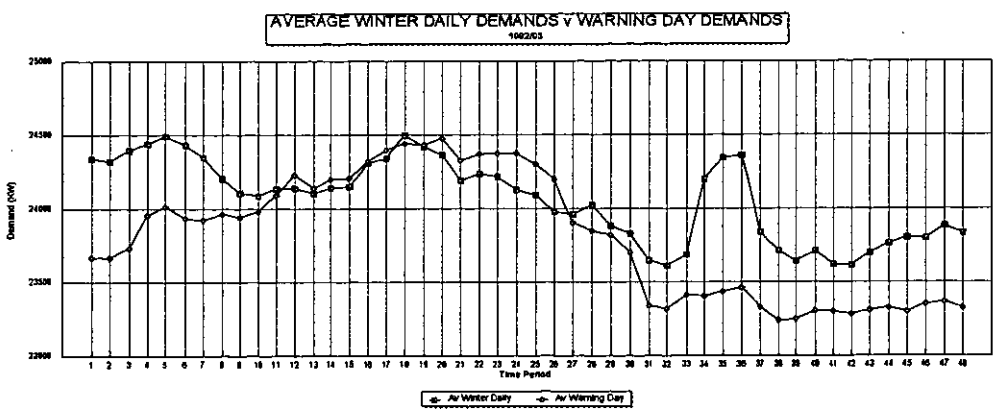
SIC CODE : 251

UNITS : KW

WINTER 91/92	32	33	34	35	36	37	38
AV DAILY	25278	25222	24919	24881	24879	25033	24884
AV WARNING DAY	26225	26346	26108	26179	26225	25842	25721
Unit Reduction	-948	-1124	-1189	-1299	-1346	-809	-837
%age Reduction	-3.75%	-4.46%	-4.77%	-5.22%	-5.41%	-3.23%	-3.36%

WINTER 92/93	32	33	34	35	36	37	38
AV DAILY	23609	23683	24201	24343	24361	23838	23710
AV WARNING DAY	23316	23413	23403	23434	23463	23329	23237
Unit Reduction	293.4	269.3	798.4	909.1	898	509.4	473.2
%age Reduction	1.24%	1.14%	3.30%	3.73%	3.69%	2.14%	2.00%





TRIAD DEMAND ANALYSIS : WINTER 1991/92

CUSTOMER NO : 4

NAME : CHEMICAL PRODUCTS MANUFACTURING 2

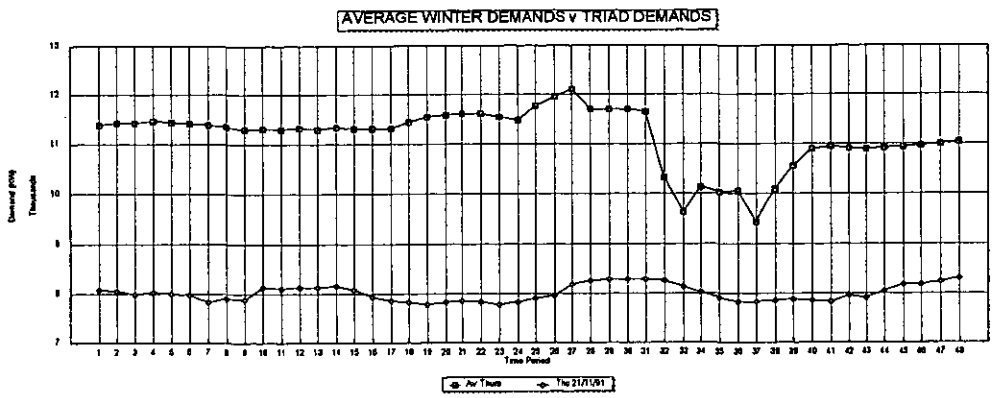
SIC CODE : 251

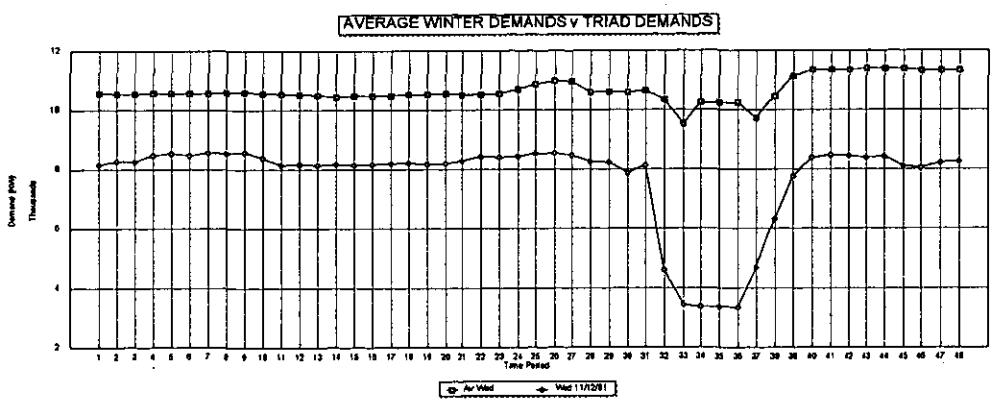
UNITS : KW

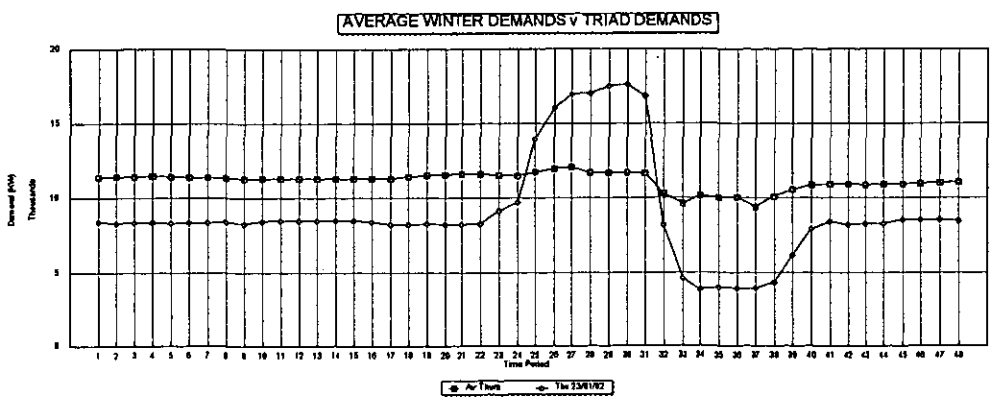
DAY	DATE	TP	ACTUAL DEMAND	TYPICAL DEMAND	DIFF	% DIFF
THU	11/21/91	35	7,900	10,033	2,133	21.26%
WED	12/11/91	35	3,376	10,237	6,861	67.02%
THU	01/23/92	35	4,000	10,033	6,033	60.13%

Typical daily demands are calculated for each day type for the period November to February, excluding the full Christmas period.

The typical demands also exclude the period between time periods 34 and 36 for the Triad warning days







TRIAD DEMAND ANALYSIS : WINTER 1992/93

CUSTOMER REF : 4

NAME : CHEMICAL PRODUCTS MANUFACTURING 2

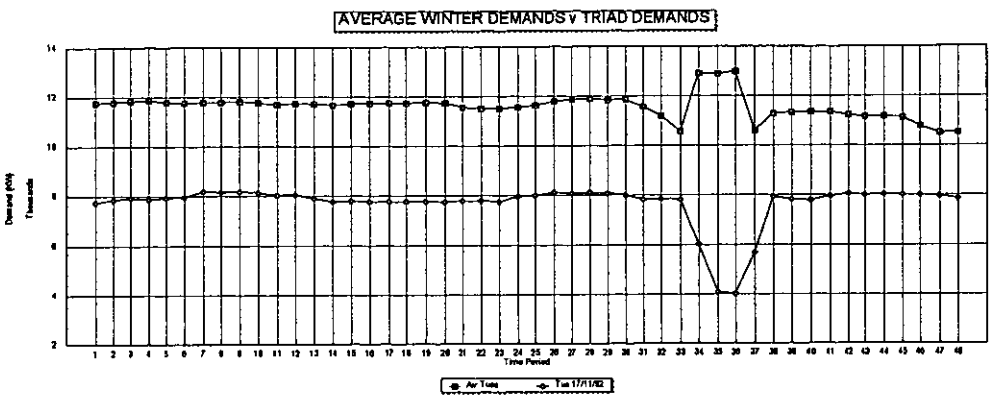
SIC CODE : 251

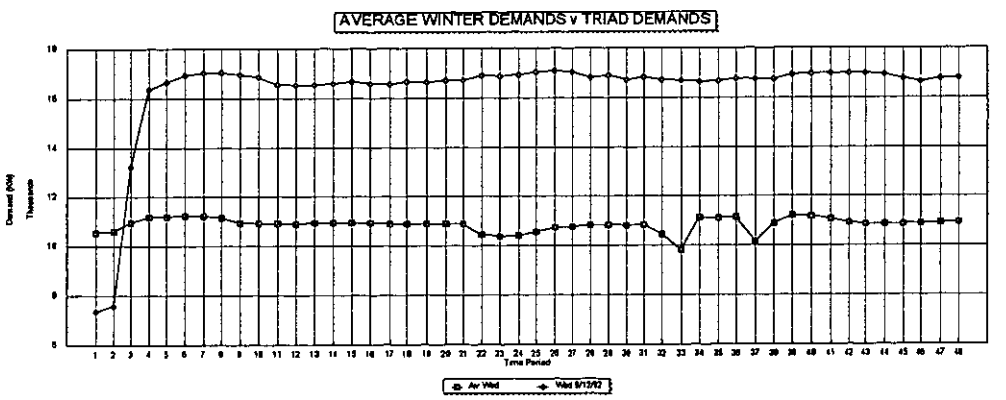
UNITS : KW

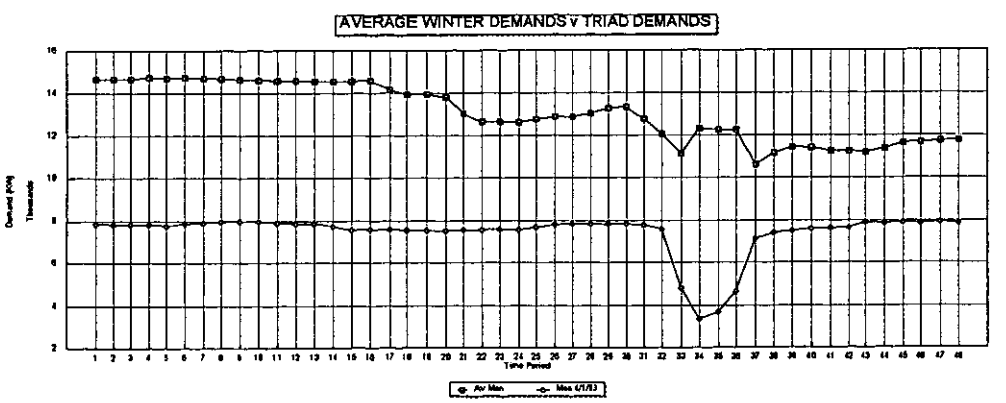
DAY	DATE	TP	ACTUAL DEMAND	TYPICAL DEMAND	DIFF	% DIFF
TUE	11/17/92	35	4,076	11,581	7,505	64.80%
WED	12/09/92	35	16,676	11,077	(5,599)	-50.54%
MON	01/04/93	35	3,676	11,581	7,905	68.26%

Typical daily demands are calculated for each day type for the period November to February, excluding the full Christmas period.

The typical demands also exclude the period between time periods 34 and 36 for the Triad warning days.







TRIAD DEMAND ANALYSIS : WINTER 1991/92 & 1992/93

CUSTOMER NO : 4

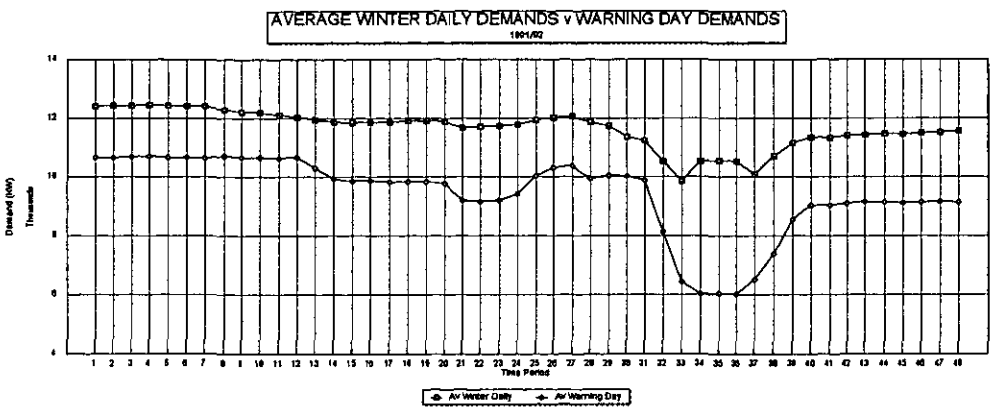
NAME : CHEMICAL PRODUCTS MANUFACTURING 2

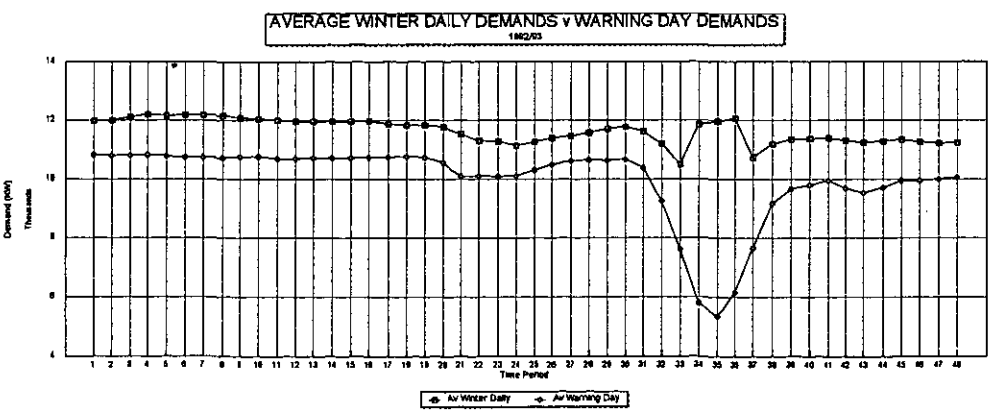
SIC CODE : 251

UNITS : KW

WINTER 91/92	32	33	34	35	36	37	38
AV DAILY	10,536	9,860	10,523	10,544	10,528	10,092	10,709
AV WARNING DAY	8,123	6,442	6,027	6,056	6,043	6,509	7,387
Unit Reduction	2,413	3,418	4,496	4,488	4,485	3,583	3,322
%age Reduction	23%	35%	43%	43%	43%	36%	31%

WINTER 92/93	32	33	34	35	36	37	38
AV DAILY	11,196	10,508	11,857	11,954	12,075	10,749	11,201
AV WARNING DAY	9,253	7,614	5,799	5,340	6,147	7,655	9,174
Unit Reduction	1,944	2,894	6,059	6,614	5,928	3,094	2,027
%age Reduction	17%	28%	51%	55%	49%	29%	18%





TRIAD DEMAND ANALYSIS : WINTER 1991/92

CUSTOMER REF : 5

NAME : CHEMICAL PRODUCTS MANUFACTURING 3

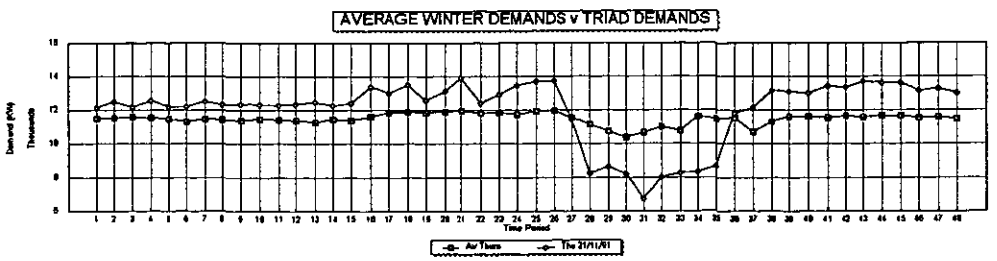
SIC CODE : 257

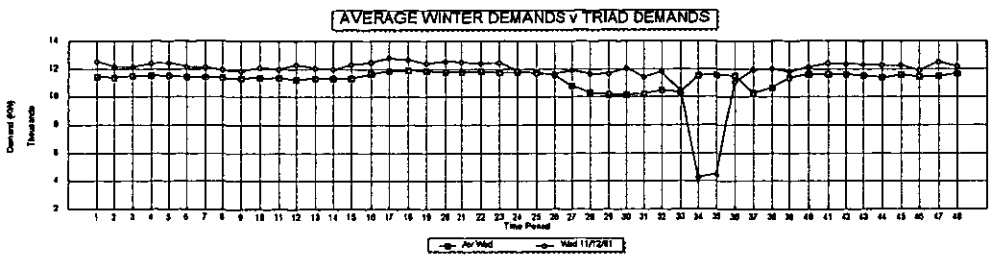
UNITS : KW

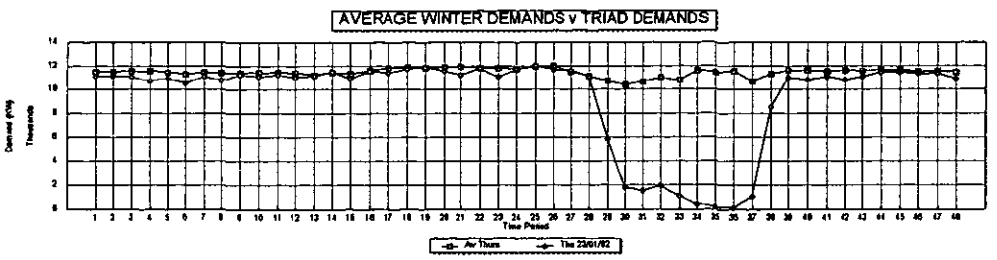
DAY	DATE	TP	ACTUAL DEMAND	TYPICAL DEMAND	DIFF	% DIFF
THU	11/21/91	35	8,660	11,457	2,797	24.41%
WED	12/11/91	35	4,476	11,582	7,106	61.36%
THU	01/23/92	35	188	11,457	11,269	98.36%

Typical daily demands are calculated for each day type for the period November to February, excluding the full Christmas period.

The typical demands also exclude the period between time periods 34 and 36 for the Triad warning days







TRIAD DEMAND ANALYSIS : WINTER 1992/93

CUSTOMER REF : 5

NAME : CHEMICAL PRODUCTS MANUFACTURING 3

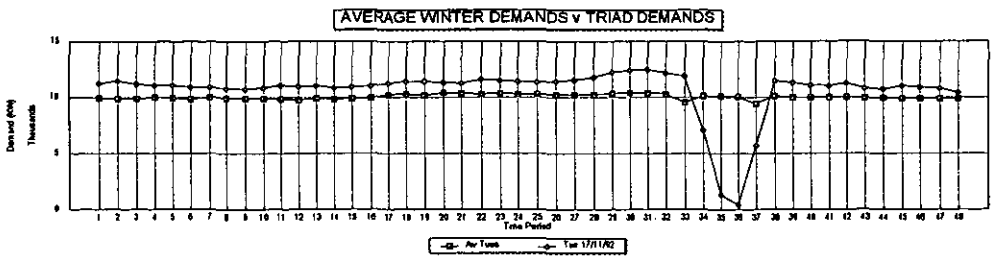
SIC CODE : 257

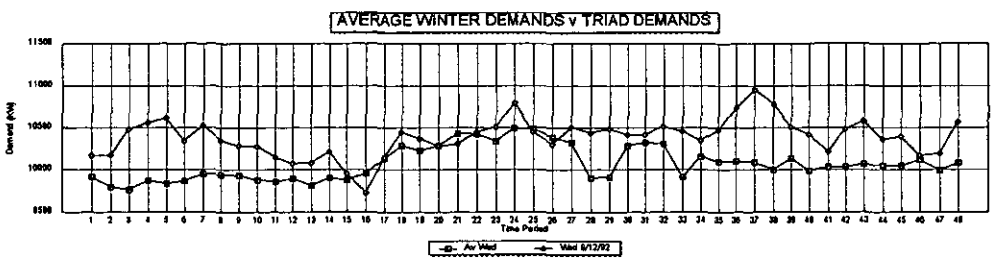
UNITS : KW

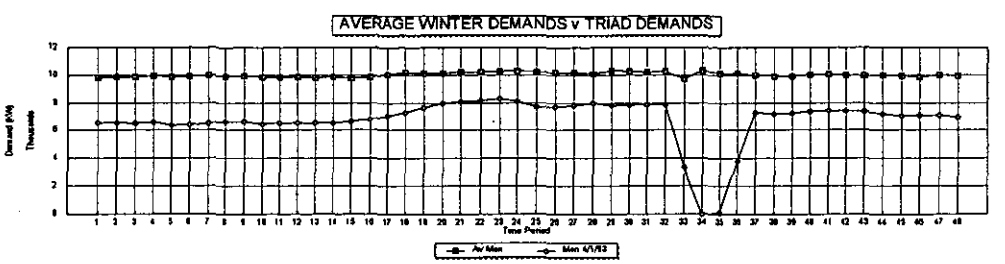
DAY	DATE	TP	ACTUAL DEMAND	TYPICAL DEMAND	DIFF	% DIFF
TUE	11/17/92	35	1,328	10,154	8,826	86.92%
WED	12/09/92	35	10,468	10,096	(372)	-3.68%
MON	01/04/93	35	76	10,154	10,078	99.25%

Typical daily demands are calculated for each day type for the period November to February, excluding the full Christmas period.

The typical demands also exclude the period between time periods 34 and 36 for the Triad warning days.







TRIAD DEMAND ANALYSIS : WINTER 1991/92 & 1992/93

CUSTOMER REF : 5

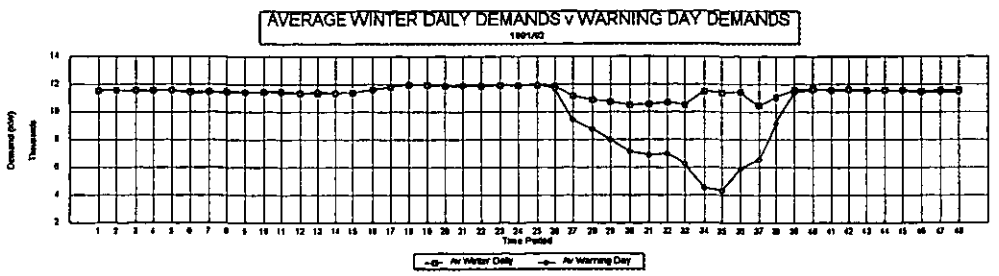
NAME : CHEMICAL PRODUCTS MANUFACTURING 3

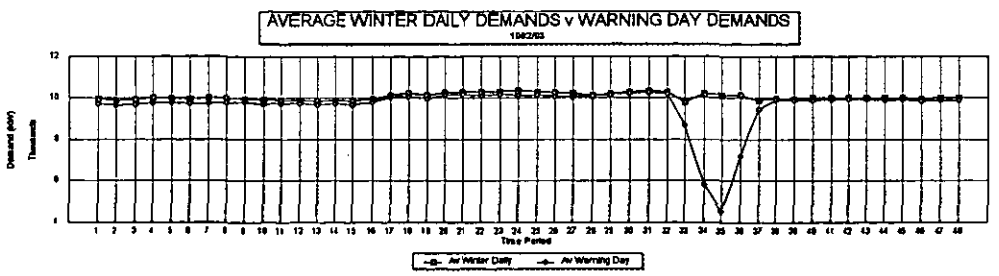
SIC CODE : 257

UNITS : KW

WINTER 91/92	33	33	34	35	36	37	38
AV DAILY	10,687	10,490	11,484	11,402	11,416	10,444	11,052
AV WARNING DAY	6,960	6,267	4,493	4,290	5,910	6,547	9,157
Unit Reduction	3,727	4,223	6,970	7,112	5,506	3,897	1,895
% age Reduction	35%	40%	61%	62%	48%	37%	17%

WINTER 92/93	32	33	34	35	36	37	38
AV DAILY	10,287	9,783	10,195	10,132	10,128	9,905	9,988
AV WARNING DAY	10,192	8,710	5,812	4,520	7,177	9,448	9,908
Unit Reduction	96	1,073	4,383	5,612	2,950	458	80
% age Reduction	1%	11%	43%	55%	29%	5%	1%





TRIAD DEMAND ANALYSIS : WINTER 1991/92

CUSTOMER NO : 6

NAME : CHEMICAL PRODUCTS MANUFACTURING 4

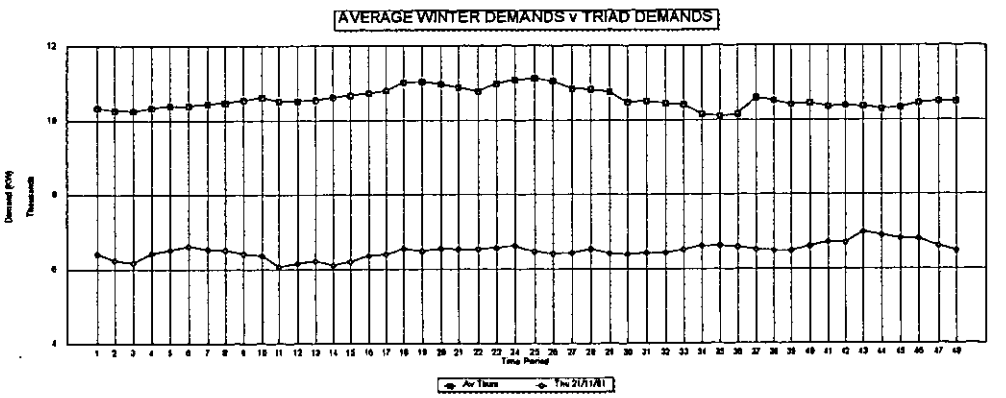
SIC CODE : 258

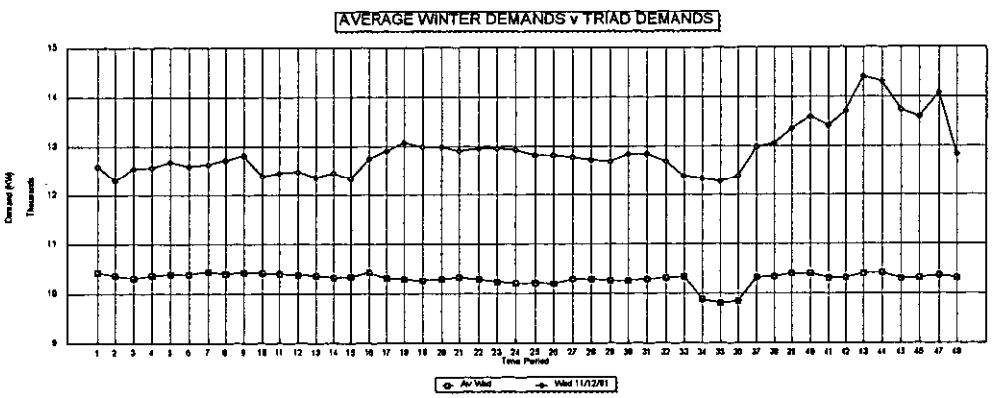
UNITS : KW

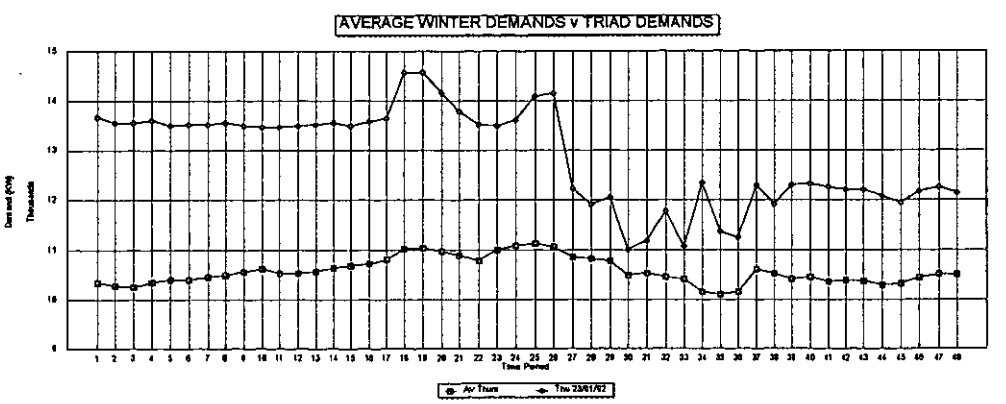
DAY	DATE	TP	ACTUAL DEMAND	TYPICAL DEMAND	DIFF	% DIFF
THU	11/21/91	35	6,630	10,102	3,472	34.37%
WED	12/11/91	35	12,270	9,804	(2,466)	-25.15%
THU	01/23/92	35	11,370	10,102	(1,268)	-12.55%

Typical daily demands are calculated for each day type for the period November to February, excluding the full Christmas period.

The typical demands also exclude the period between time periods 34 and 36 for the Triad warning days







TRIAD DEMAND ANALYSIS : WINTER 1992/93

CUSTOMER REF : 6

NAME : CHEMICAL PRODUCTS MANUFACTURING 4

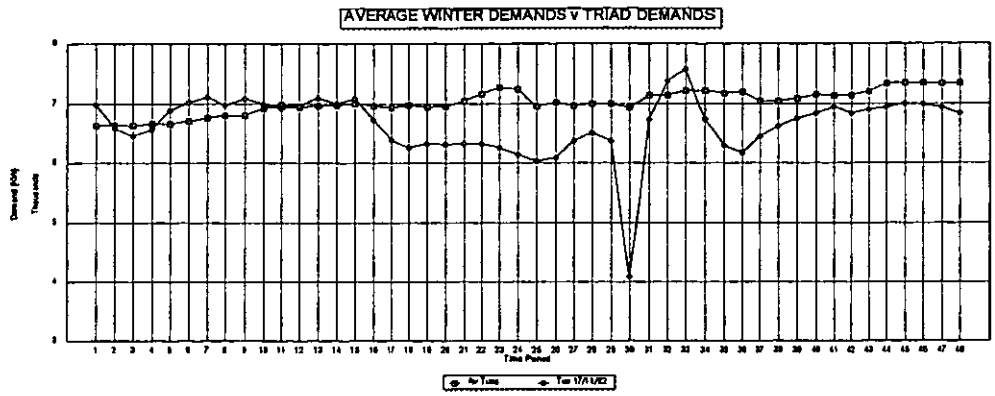
SIC CODE : 258

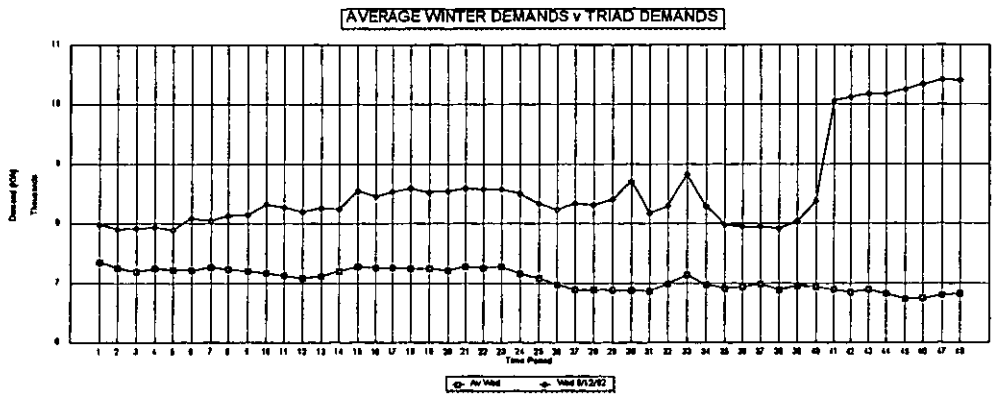
UNITS : KW

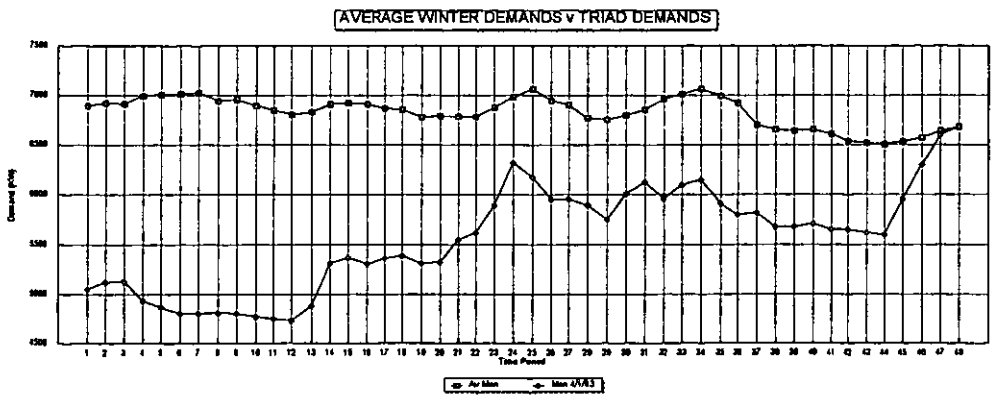
DAY	DATE	TP	ACTUAL DEMAND	TYPICAL DEMAND	DIFF	% DIFF
TUE	11/17/92	35	6,290	7,442	1,152	15.48%
WED	12/09/92	35	7,980	6,909	(1,071)	-15.50%
MON	01/04/93	35	5,910	7,442	1,532	20.59%

Typical daily demands are calculated for each day type for the period November to February, excluding the full Christmas period.

The typical demands also exclude the period between time periods 34 and 36 for the Triad warning days.







TRIAD DEMAND ANALYSIS : WINTER 1991/92 & 1992/93

CUSTOMER NO : 6

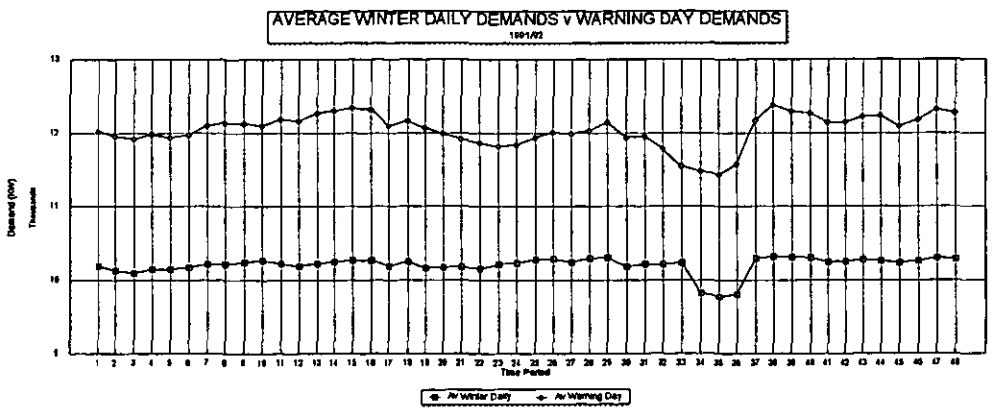
NAME : CHEMICAL PRODUCTS MANUFACTURING 4

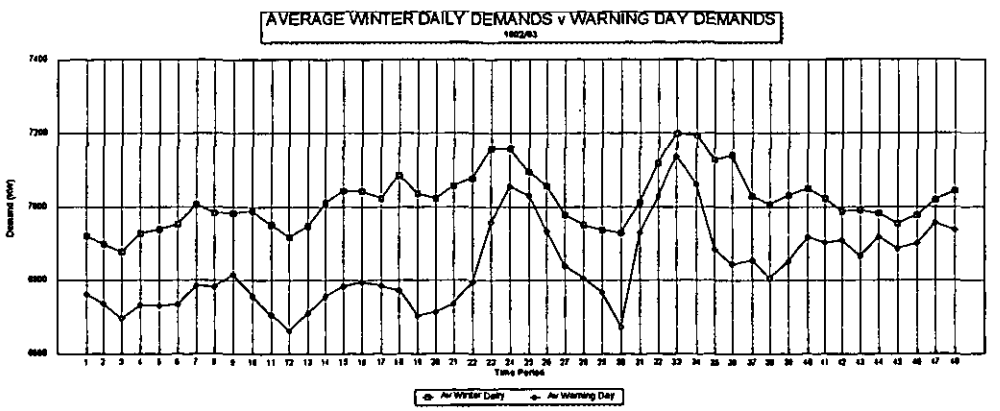
SIC CODE : 258

UNITS : KW

WINTER 91/92	32	33	34	35	36	37	38
AV DAILY	10,210	10,234	9,826	9,769	9,808	10,294	10,321
AV WARNING DA	11,788	11,543	11,478	11,425	11,578	12,173	12,378
Unit Reduction	(1,577)	(1,309)	(1,651)	(1,656)	(1,770)	(1,879)	(2,057)
%age Reduction	-15%	-13%	-17%	-17%	-18%	-18%	-20%

WINTER 92/93	32	33	34	35	36	37	38
AV DAILY	7,118	7,198	7,193	7,129	7,141	7,029	7,006
AV WARNING DA	7,027	7,138	7,061	6,884	6,845	6,854	6,805
Unit Reduction	91	60	132	245	297	175	202
%age Reduction	1%	1%	2%	3%	4%	2%	3%





TRIAD DEMAND ANALYSIS : WINTER 1991/92

CUSTOMER NO : 7

NAME : METAL GOODS MANUFACTURING 1

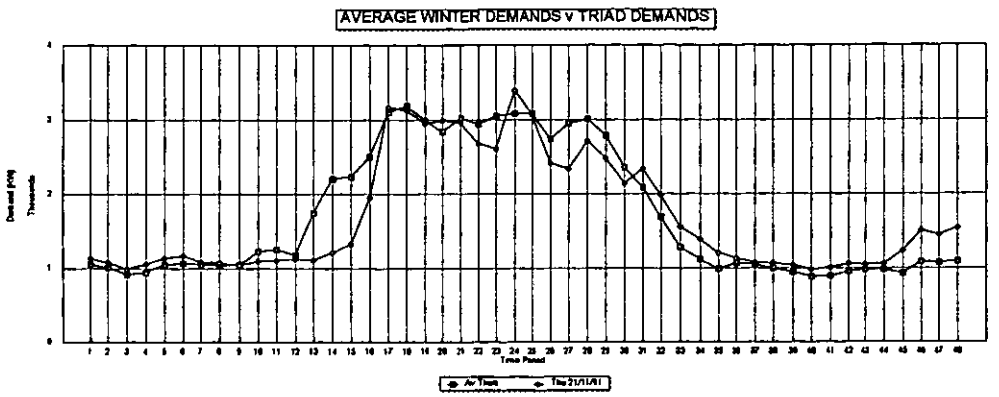
SIC CODE : 311

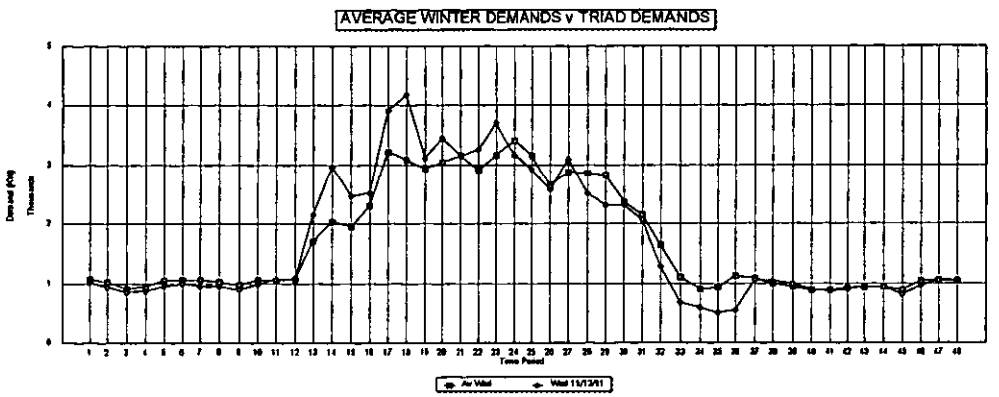
UNITS : KW

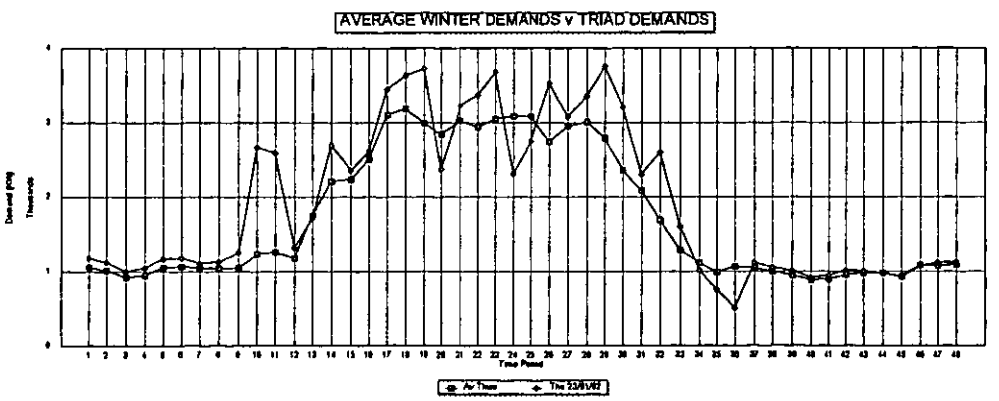
DAY	DATE	TP	ACTUAL DEMAND	TYPICAL DEMAND	DIFF	% DIFF
THU	11/21/91	35	1,210	989	(221)	-22.32%
WED	12/11/91	35	510	934	424	45.40%
THU	01/23/92	35	760	989	229	23.17%

Typical daily demands are calculated for each day type for the period November to February, excluding the full Christmas period.

The typical demands also exclude the period between time periods 34 and 35 for the Triad warning days







TRIAD DEMAND ANALYSIS : WINTER 1992/93

CUSTOMER REF : 7

NAME : METAL GOODS MANUFACTURING 1

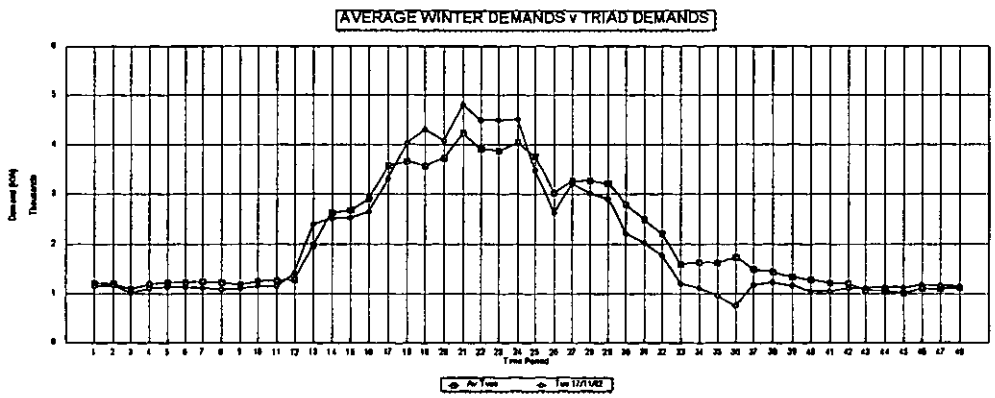
SIC CODE : 311

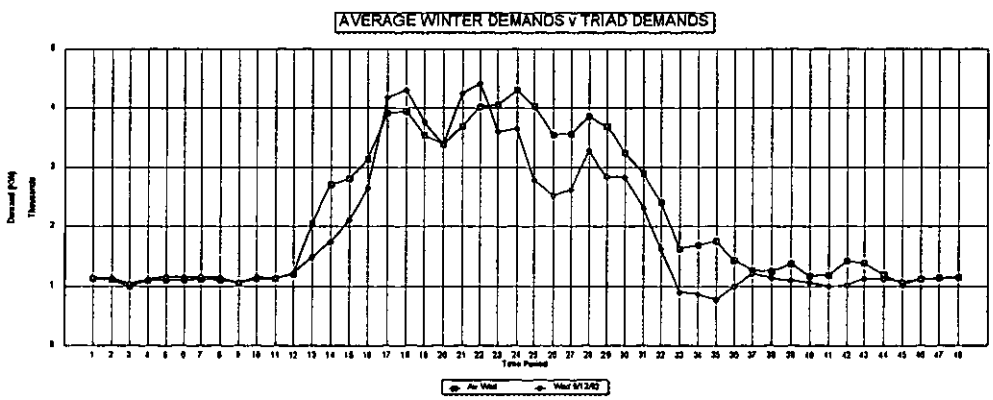
UNITS : KW

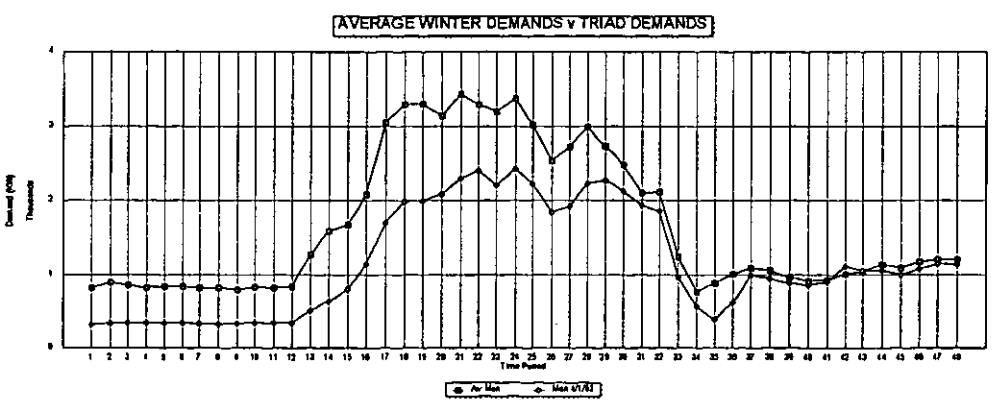
DAY	DATE	TP	ACTUAL DEMAND	TYPICAL DEMAND	DIFF	% DIFF
TUE	11/17/92	35	956	1,157	201	17.39%
WED	12/09/92	35	766	1,755	989	56.35%
MON	01/04/93	35	386	1,157	771	66.64%

Typical daily demands are calculated for each day type for the period November to February, excluding the full Christmas period.

The typical demands also exclude the period between time periods 34 and 36 for the Triad warning days.







TRIAD DEMAND ANALYSIS : WINTER 1991/92 & 1992/93

CUSTOMER NO : 7

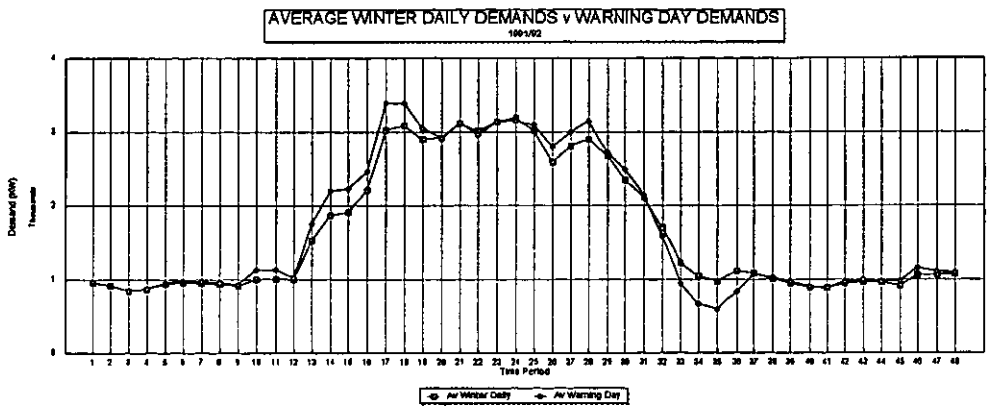
NAME : METAL GOODS MANUFACTURING 1

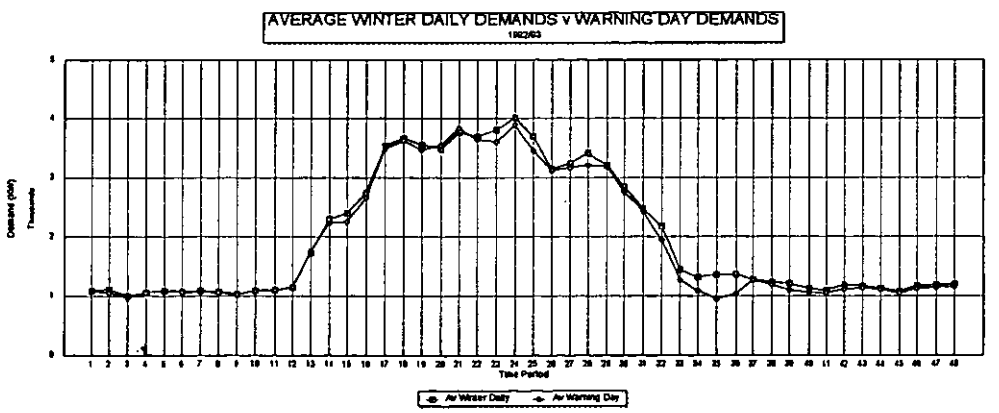
SIC CODE : 311

UNITS : KW

WINTER 91/92	32	33	34	35	36	37	38
AV DAILY	1,701	1,223	1,039	973	1,114	1,082	1,005
AV WARNING DA	1,579	948	663	599	827	1,068	1,028
Unit Reduction	121	275	377	374	287	13	(23)
%age Reduction	7%	22%	36%	38%	26%	1%	-2%

WINTER 92/93	32	33	34	35	36	37	38
AV DAILY	2,184	1,447	1,315	1,355	1,358	1,284	1,231
AV WARNING DA	1,951	1,268	1,085	947	1,035	1,272	1,186
Unit Reduction	233	179	230	407	323	12	46
%age Reduction	11%	12%	17%	30%	24%	1%	4%





TRIAD DEMAND ANALYSIS : WINTER 1991/92

CUSTOMER NO : 8

NAME : METAL GOODS MANUFACTURING 2

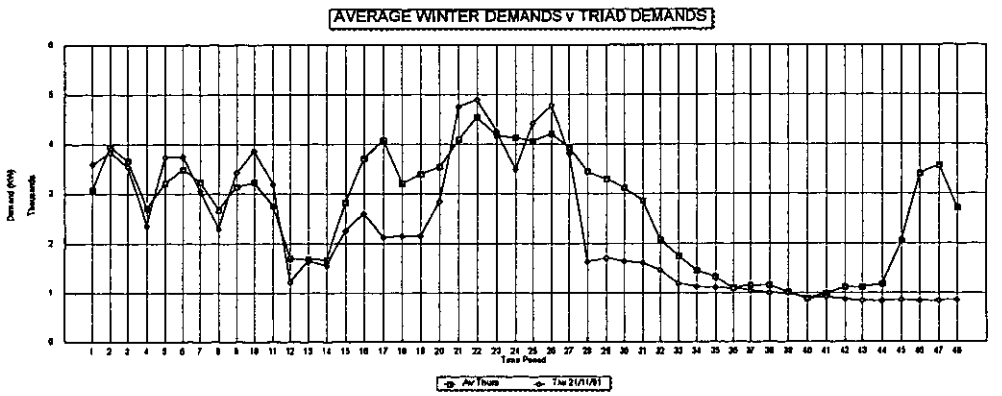
SIC CODE : 312

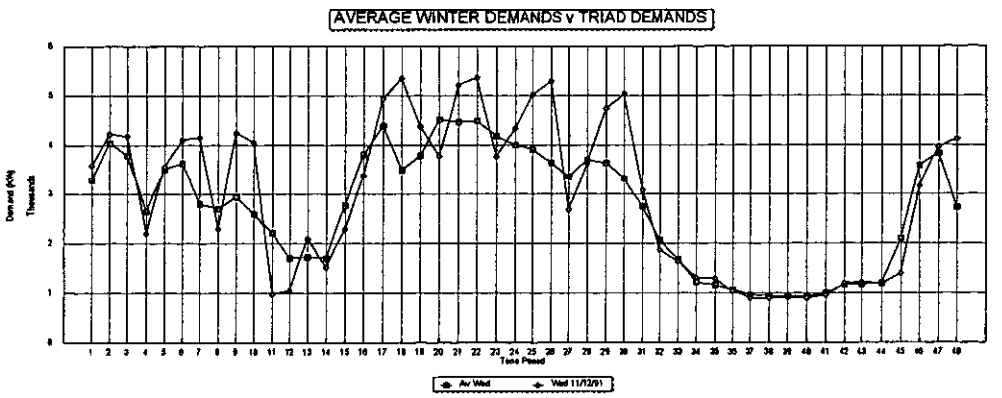
UNITS : KW

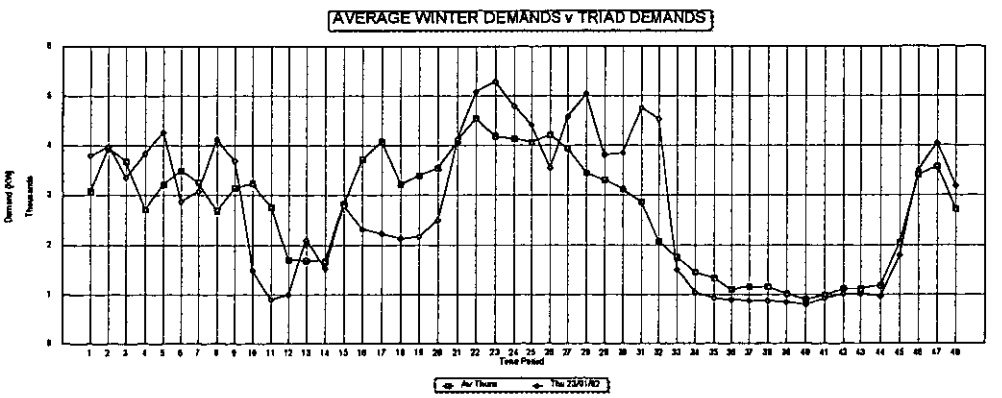
DAY	DATE	TP	ACTUAL DEMAND	TYPICAL DEMAND	DIFF	% DIFF
THU	11/21/91	35	1,104	1,319	215	16.32%
WED	12/11/91	35	1,280	1,152	(128)	-11.11%
THU	01/23/92	35	912	1,319	407	30.88%

Typical daily demands are calculated for each day type for the period November to February, excluding the full Christmas period.

The typical demands also exclude the period between time periods 34 and 36 for the Triad warning days







TRIAD DEMAND ANALYSIS : WINTER 1992/93

CUSTOMER REF : 8

NAME : METAL GOODS MANUFACTURING 2

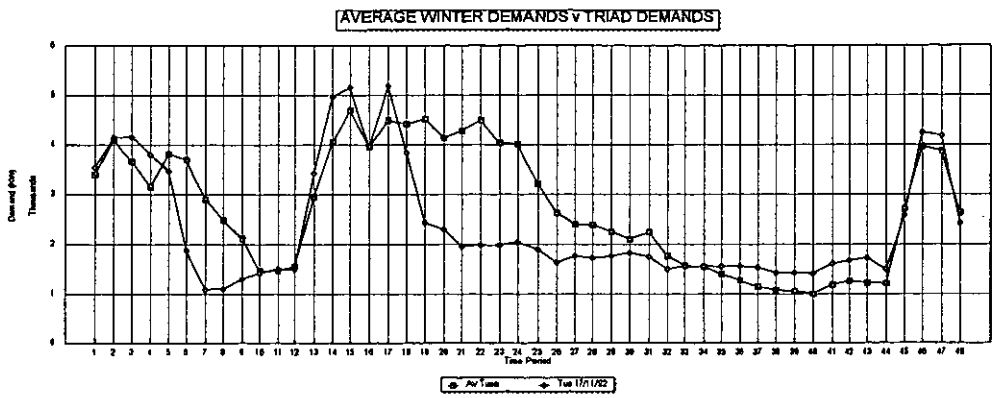
SIC CODE : 312

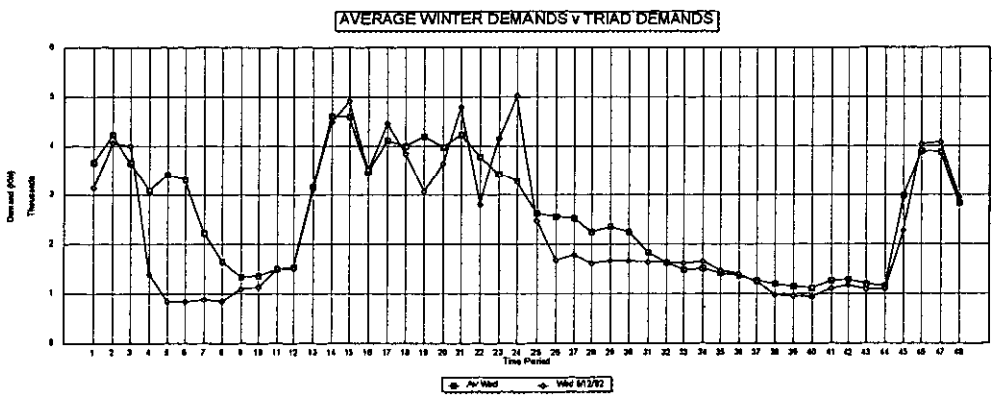
UNITS : KW

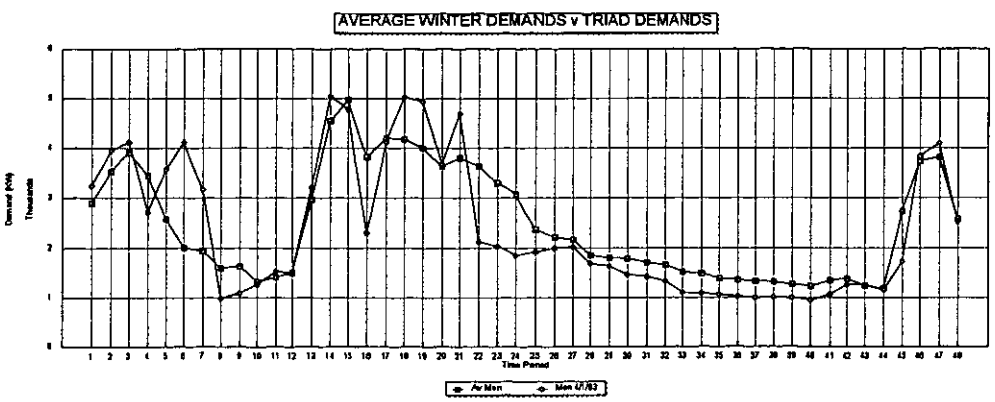
DAY	DATE	TP	ACTUAL DEMAND	TYPICAL DEMAND	DIFF	% DIFF
TUE	11/17/92	35	1,552	1,414	(138)	-9.75%
WED	12/09/92	35	1,472	1,410	(62)	-4.41%
MON	01/04/93	35	1,056	1,414	358	25.33%

Typical daily demands are calculated for each day type for the period November to February, excluding the full Christmas period.

The typical demands also exclude the period between time periods 34 and 36 for the Triad warning days.







TRIAD DEMAND ANALYSIS : WINTER 1991/92 & 1992/93

CUSTOMER NO : 8

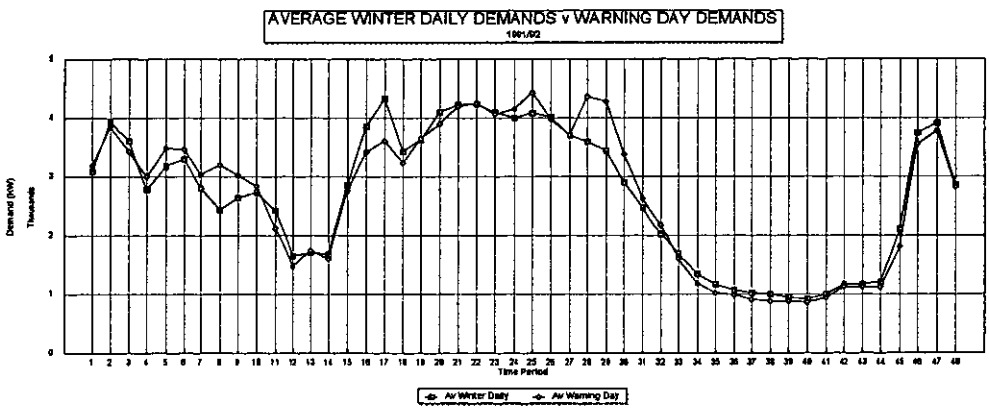
NAME : METAL GOODS MANUFACTURING 2

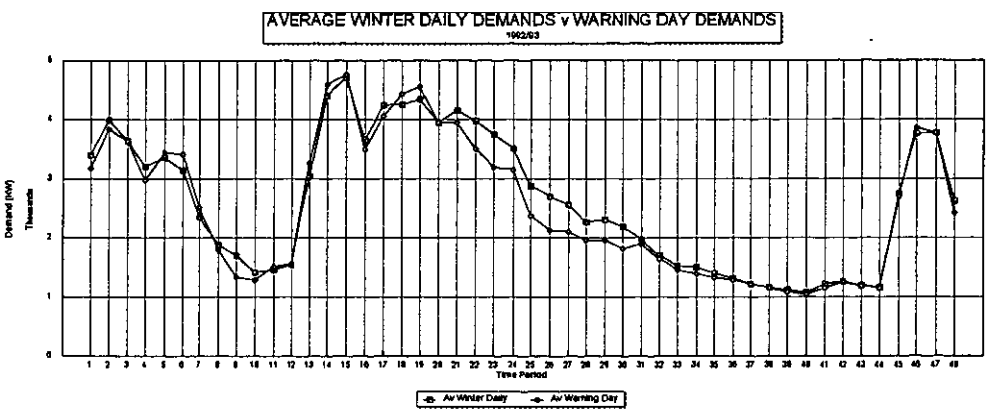
SIC CODE : 312

UNITS : KW

WINTER 91/92	32	33	34	35	36	37	38
AV DAILY	2,024	1,694	1,339	1,164	1,072	1,025	1,001
AV WARNING DA	2,179	1,604	1,176	1,025	991	913	883
Unit Reduction	(154)	90	163	138	82	112	118
%age Reduction	-8%	5%	12%	12%	8%	11%	12%

WINTER 92/93	32	33	34	35	36	37	38
AV DAILY	1,699	1,530	1,503	1,400	1,319	1,214	1,162
AV WARNING DA	1,644	1,453	1,390	1,330	1,281	1,217	1,157
Unit Reduction	56	76	113	71	38	(3)	5
%age Reduction	3%	5%	8%	5%	3%	-0%	0%





TRIAD DEMAND ANALYSIS : WINTER 1991/92

CUSTOMER NO : 9

NAME : ELECTRICAL EQUIPMENT MANUFACTURING 1

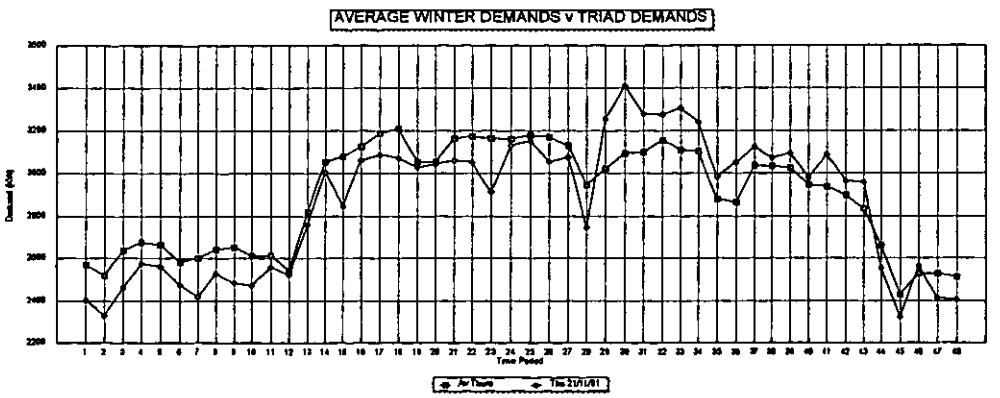
SIC CODE : 341

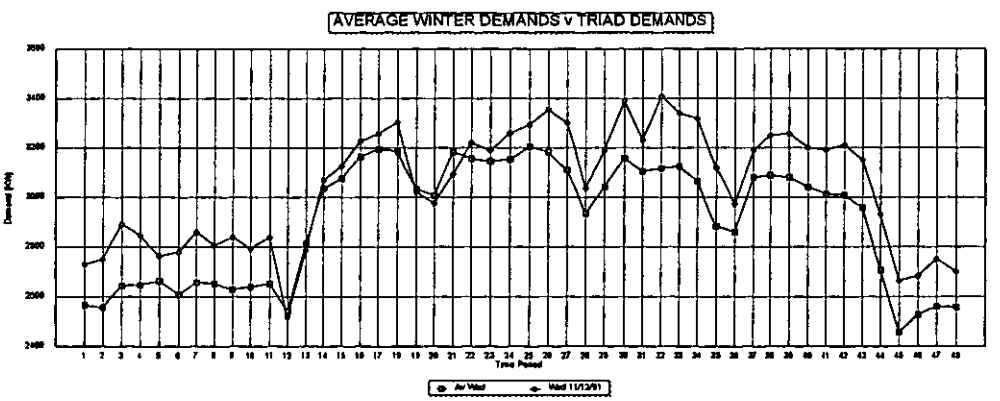
UNITS : KW

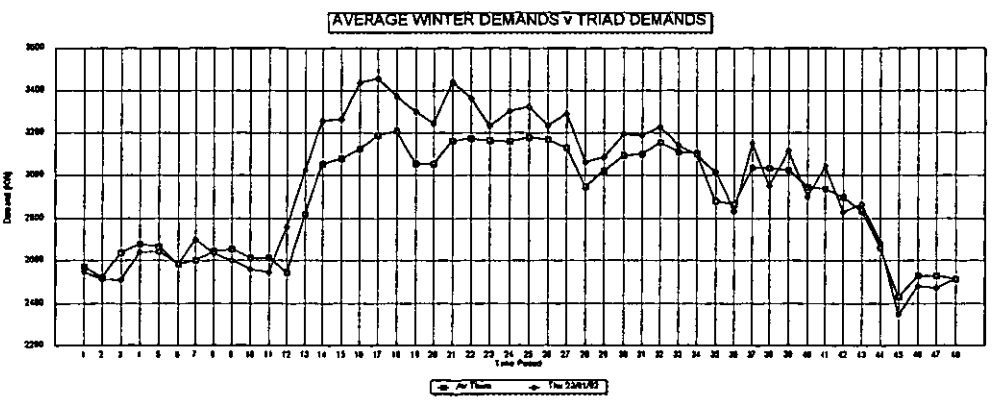
DAY	DATE	TP	ACTUAL DEMAND	TYPICAL DEMAND	DIFF	% DIFF
THU	11/21/91	35	2,986	2,881	(105)	-3.65%
WED	12/11/91	35	3,120	2,883	(237)	-8.24%
THU	01/23/92	35	3,016	2,881	(135)	-4.69%

Typical daily demands are calculated for each day type for the period November to February, excluding the full Christmas period.

The typical demands also exclude the period between time periods 34 and 36 for the Triad warning days







TRIAD DEMAND ANALYSIS : WINTER 1992/93

CUSTOMER REF : 9

NAME : ELECTRICAL EQUIPMENT MANUFACTURING 1

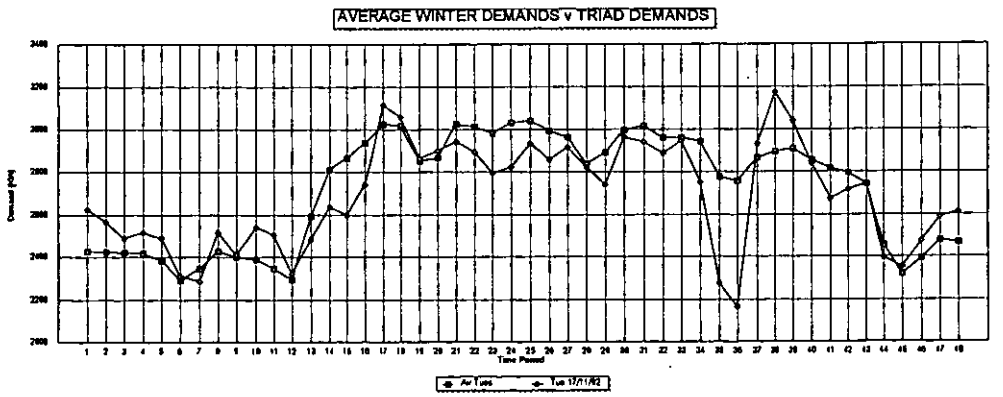
SIC CODE : 341

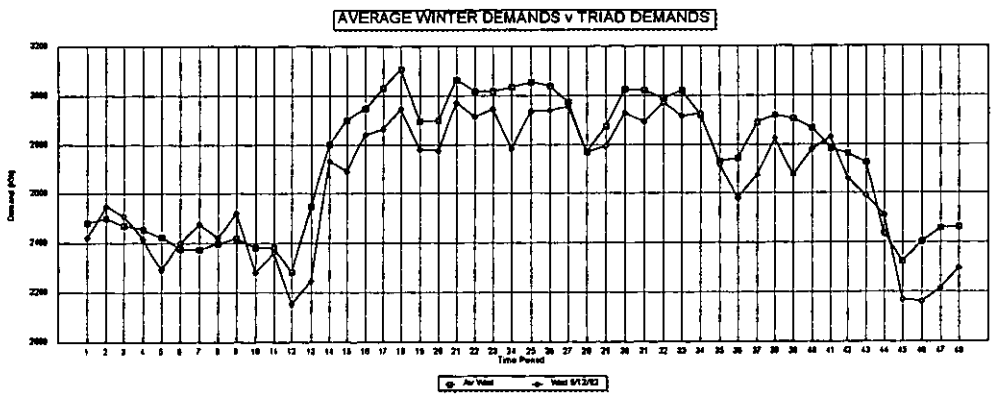
UNITS : KW

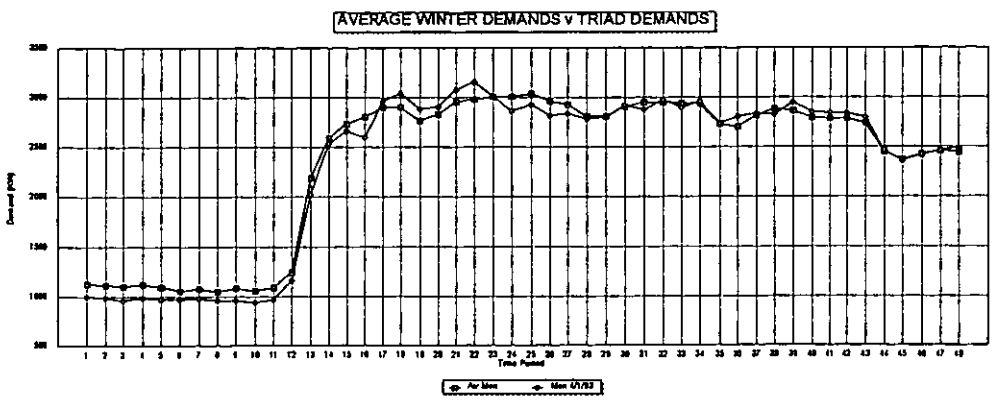
DAY	DATE	TP	ACTUAL DEMAND	TYPICAL DEMAND	DIFF	% DIFF
TUE	11/17/92	35	2,278	2,712	434	15.99%
WED	12/09/92	35	2,718	2,732	14	0.52%
MON	01/04/93	35	2,734	2,712	(22)	-0.83%

Typical daily demands are calculated for each day type for the period November to February, excluding the full Christmas period.

The typical demands also exclude the period between time periods 34 and 36 for the Triad warning days.







TRIAD DEMAND ANALYSIS : WINTER 1991/92 & 1992/93

CUSTOMER NO : 9

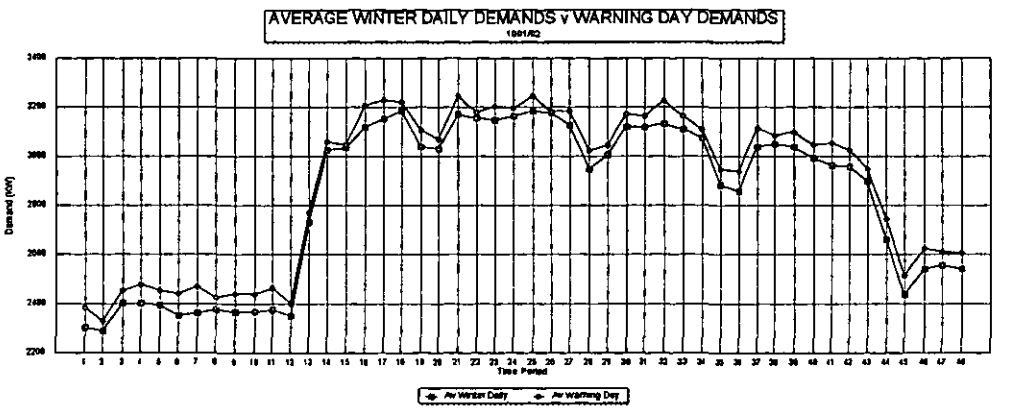
NAME : ELECTRICAL EQUIPMENT MANUFACTURING 1

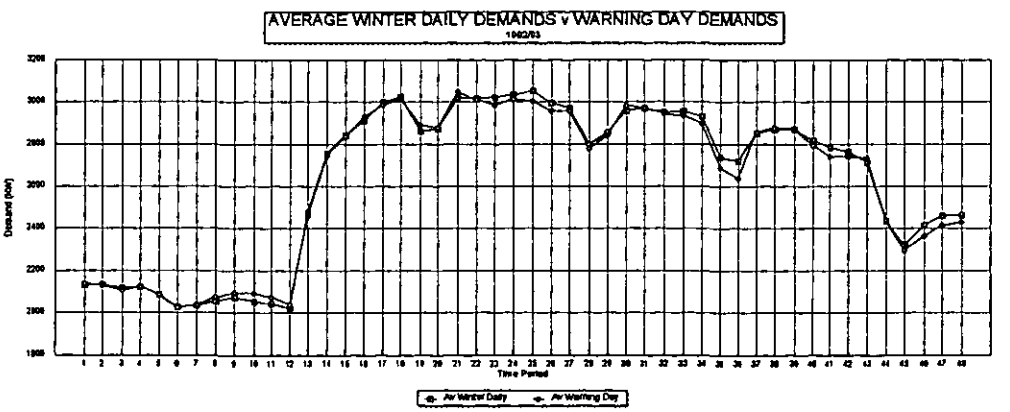
SIC CODE : 341

UNITS : KW

WINTER 91/92	32	33	34	35	36	37	38
AV DAILY	3,133	3,111	3,075	2,883	2,858	3,039	3,052
AV WARNING DAY	3,226	3,165	3,111	2,946	2,938	3,114	3,085
Unit Reduction	(94)	(54)	(35)	(63)	(80)	(74)	(33)
%age Reduction	-3%	-2%	-1%	-2%	-3%	-2%	-1%

WINTER 92/93	32	33	34	35	36	37	38
AV DAILY	2,952	2,953	2,930	2,737	2,720	2,851	2,870
AV WARNING DAY	2,945	2,934	2,896	2,689	2,637	2,855	2,879
Unit Reduction	7	19	33	49	84	(4)	(8)
%age Reduction	0%	1%	1%	2%	3%	-0%	-0%





TRIAD DEMAND ANALYSIS : WINTER 1991/92

CUSTOMER NO : 10

NAME : ELECTRICAL EQUIPMENT MANUFACTURING 2

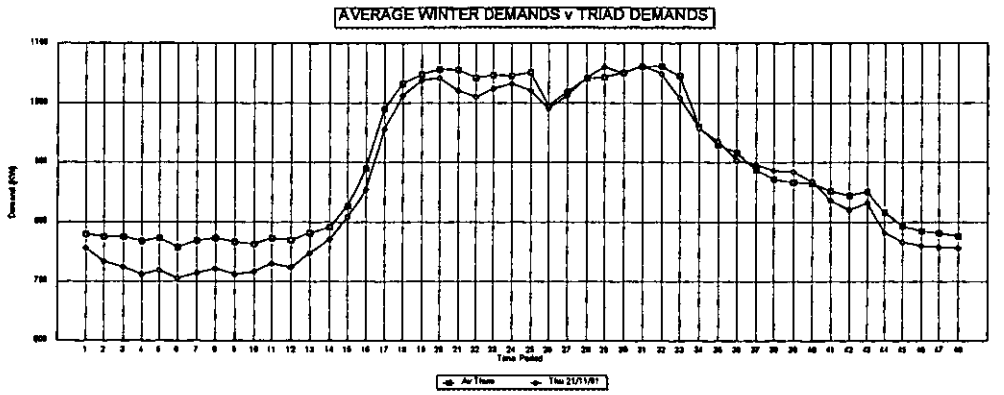
SIC CODE : 342

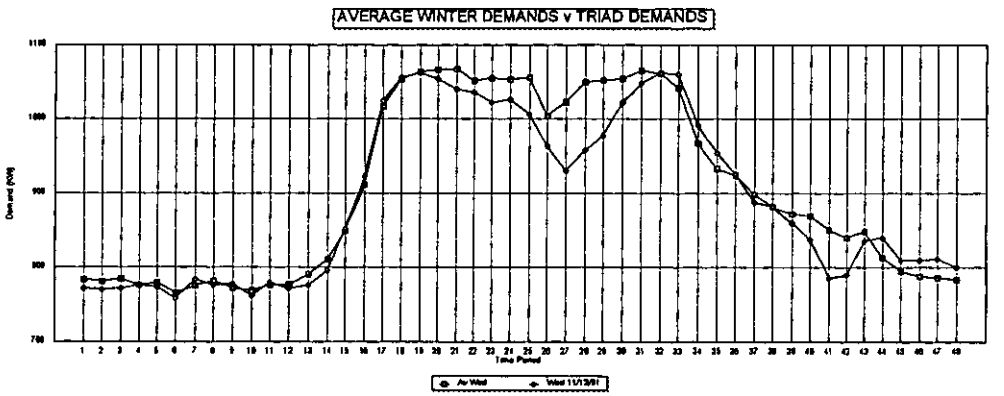
UNITS : KW

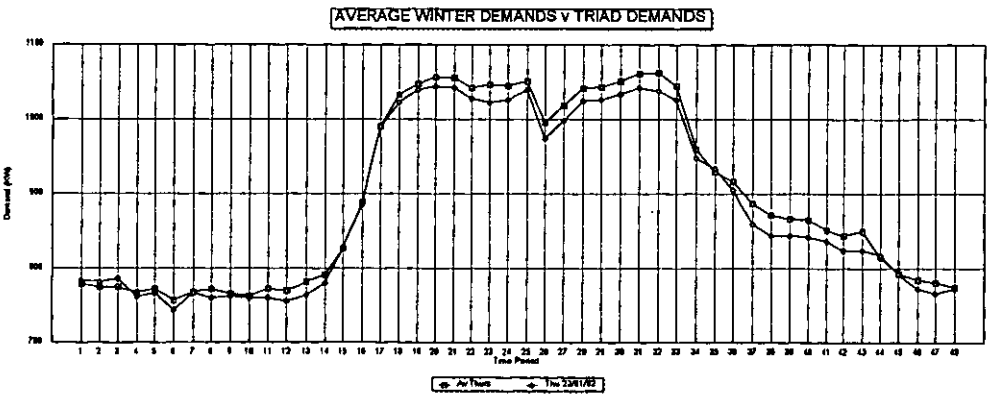
DAY	DATE	TP	ACTUAL DEMAND	TYPICAL DEMAND	DIFF	% DIFF
THU	11/21/91	35	936	930	(6)	-0.66%
WED	12/11/91	35	954	933	(21)	-2.23%
THU	01/23/92	35	934	930	(4)	-0.45%

Typical daily demands are calculated for each day type for the period November to February, excluding the full Christmas period.

The typical demands also exclude the period between time periods 34 and 36 for the Triad warning days







TRIAD DEMAND ANALYSIS : WINTER 1992/93

CUSTOMER REF : 10

NAME : ELECTRICAL EQUIPMENT MANUFACTURING 2

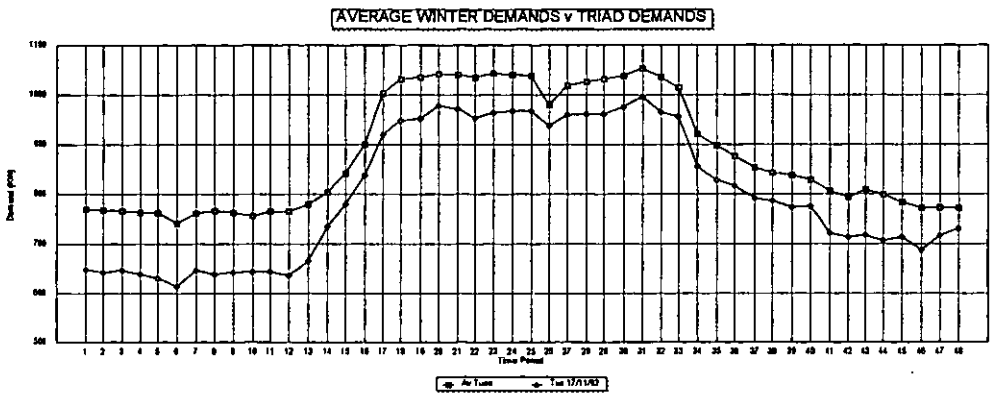
SIC CODE : 342

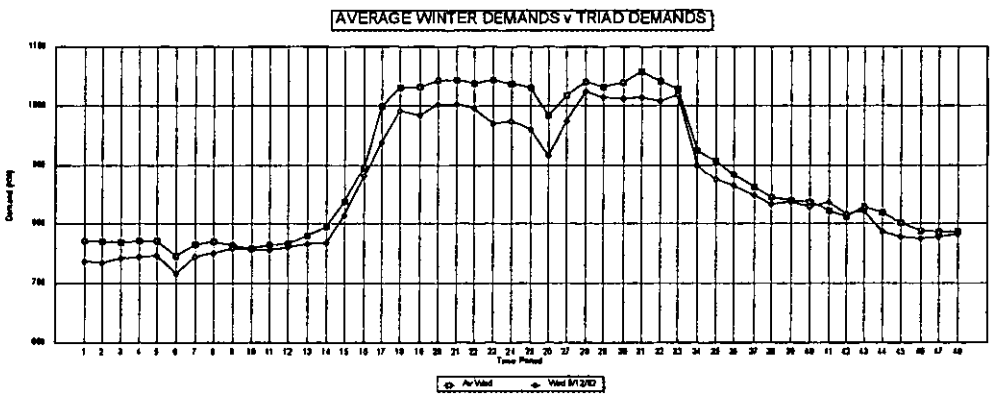
UNITS : KW

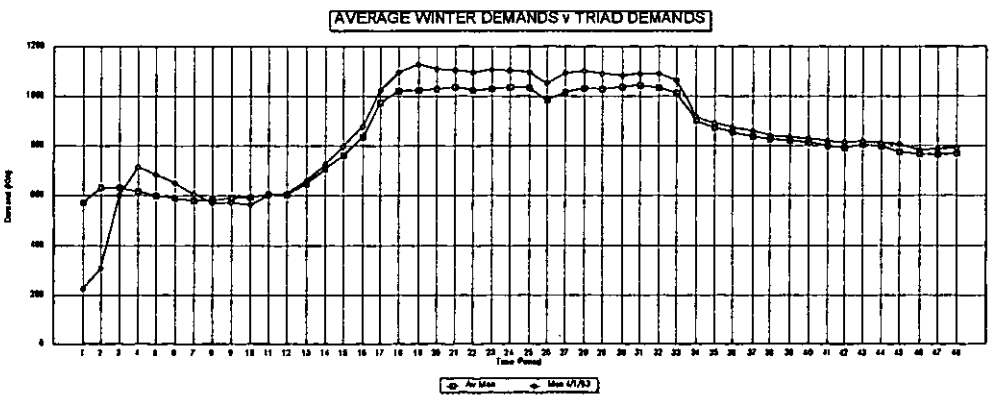
DAY	DATE	TP	ACTUAL DEMAND	TYPICAL DEMAND	DIFF	% DIFF
TUE	11/17/92	35	828	901	73	8.14%
WED	12/09/92	35	874	906	32	3.58%
MON	01/04/93	35	892	901	9	1.04%

Typical daily demands are calculated for each day type for the period November to February, excluding the full Christmas period.

The typical demands also exclude the period between time periods 34 and 36 for the Triad warning days.







TRIAD DEMAND ANALYSIS : WINTER 1991/92 & 1992/93

CUSTOMER NO : 10

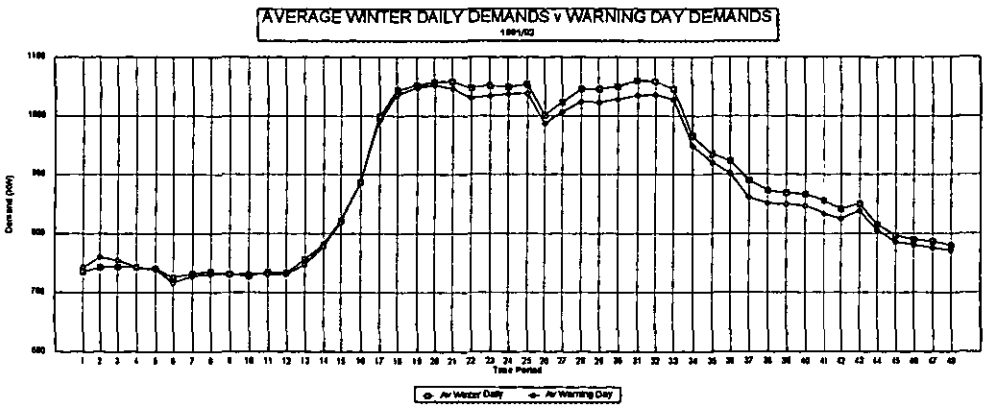
NAME : ELECTRICAL EQUIPMENT MANUFACTURING 2

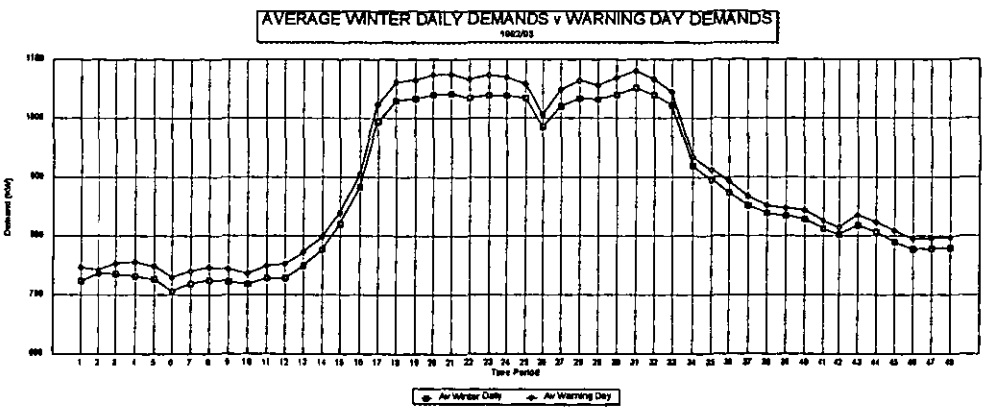
SIC CODE : 342

UNITS : KW

WINTER 91/92	32	33	34	35	36	37	38
AV DAILY	1,059	1,045	966	934	924	891	873
AV WARNING DA	1,035	1,028	950	920	902	861	852
Unit Reduction	24	18	16	14	21	29	22
%age Reduction	2%	2%	2%	2%	2%	3%	2%

WINTER 92/93	32	33	34	35	36	37	38
AV DAILY	1,040	1,022	920	895	873	852	838
AV WARNING DA	1,065	1,045	934	911	893	867	852
Unit Reduction	(26)	(23)	(15)	(16)	(20)	(15)	(14)
%age Reduction	-2%	-2%	-2%	-2%	-2%	-2%	-2%





TRIAD DEMAND ANALYSIS : WINTER 1991/92

CUSTOMER NO : 11

NAME : ELECTRICAL EQUIPMENT MANUFACTURING 3

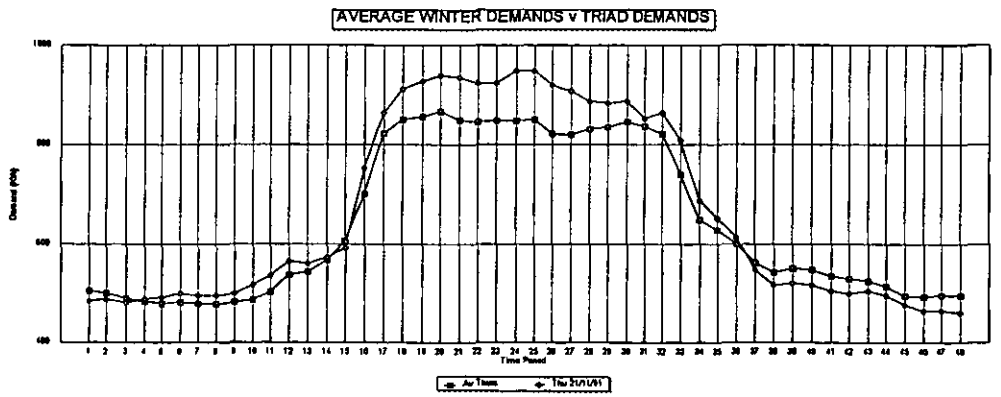
SIC CODE : 344

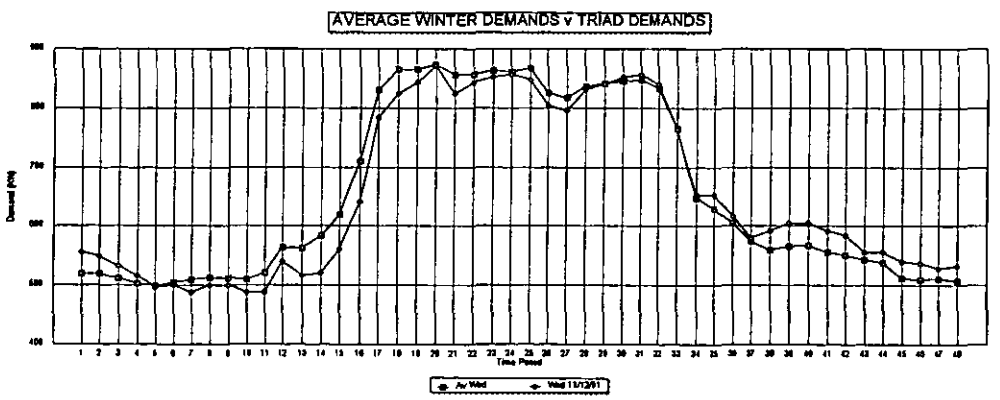
UNITS : KW

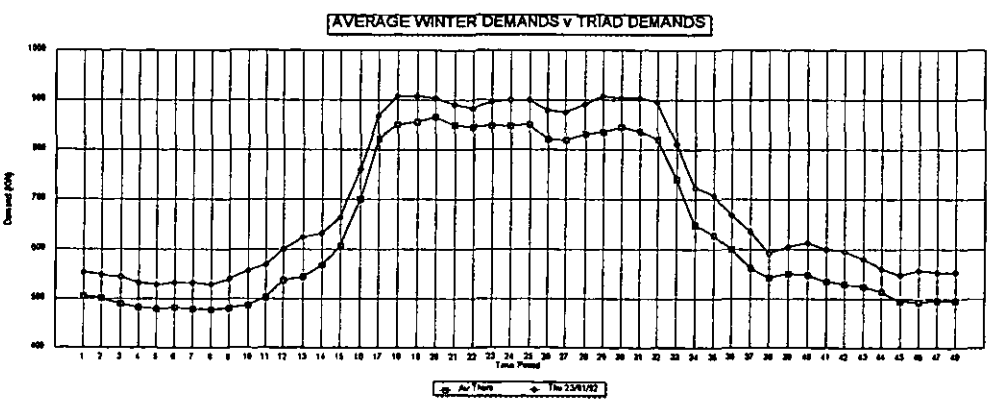
DAY	DATE	TP	ACTUAL DEMAND	TYPICAL DEMAND	DIFF	% DIFF
THU	11/21/91	35	652	628	(24)	-3.82%
WED	12/11/91	35	652	628	(24)	-3.82%
THU	01/23/92	35	708	628	(80)	-12.74%

Typical daily demands are calculated for each day type for the period November to February, excluding the full Christmas period.

The typical demands also exclude the period between time periods 34 and 36 for the Triad warning days







TRIAD DEMAND ANALYSIS : WINTER 1991/92 & 1992/93

CUSTOMER NO : 11

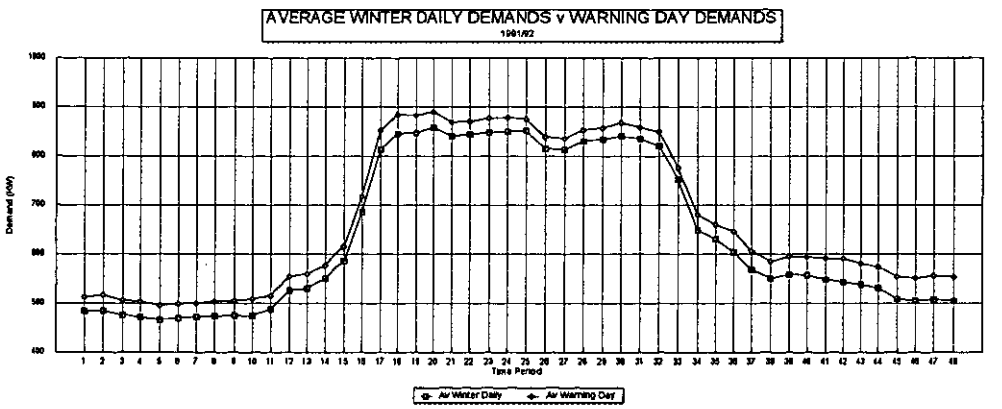
NAME : ELECTRICAL EQUIPMENT MANUFACTURING 3

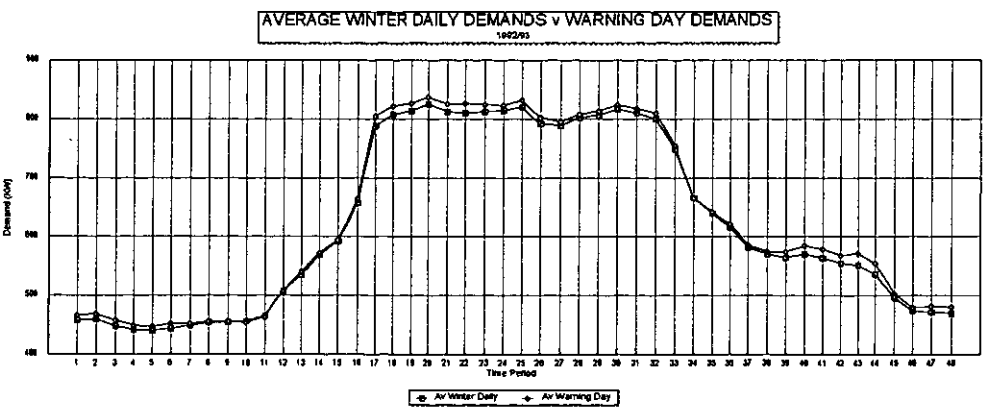
SIC CODE : 344

UNITS : KW

WINTER 91/92	32	33	34	35	36	37	38
AV DAILY	820	752	649	630	604	569	550
AV WARNING DA	850	776	681	661	646	608	585
Unit Reduction	(29)	(24)	(32)	(31)	(42)	(38)	(35)
%age Reduction	-4%	-3%	-5%	-5%	-7%	-7%	-6%

WINTER 92/93	32	33	34	35	36	37	38
AV DAILY	800	749	666	639	616	582	569
AV WARNING DA	811	756	666	642	621	586	574
Unit Reduction	(10)	(6)	(0)	(3)	(5)	(3)	(5)
%age Reduction	-1%	-1%	-0%	-0%	-1%	-1%	-1%





TRIAD DEMAND ANALYSIS : WINTER 1992/93

CUSTOMER REF : 11

NAME : ELECTRICAL EQUIPMENT MANUFACTURING 3

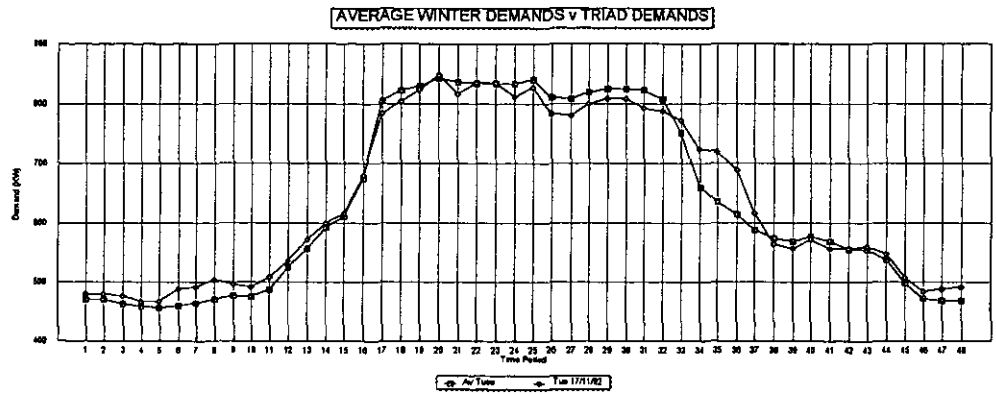
SIC CODE : 344

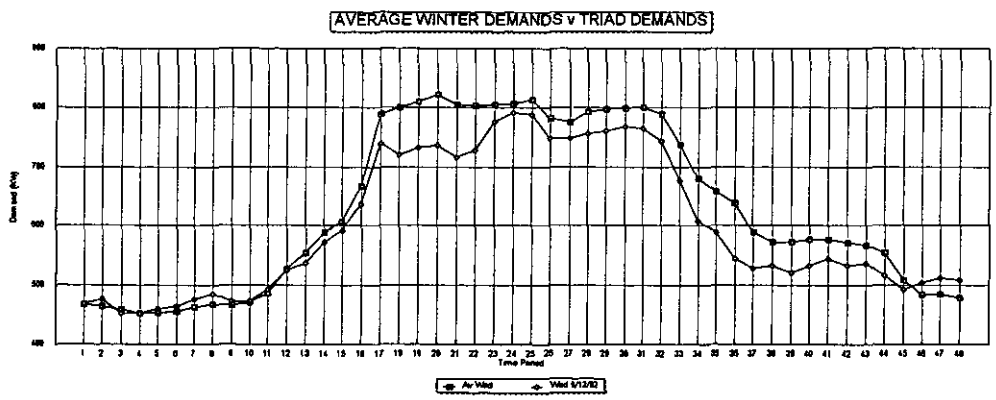
UNITS : KW

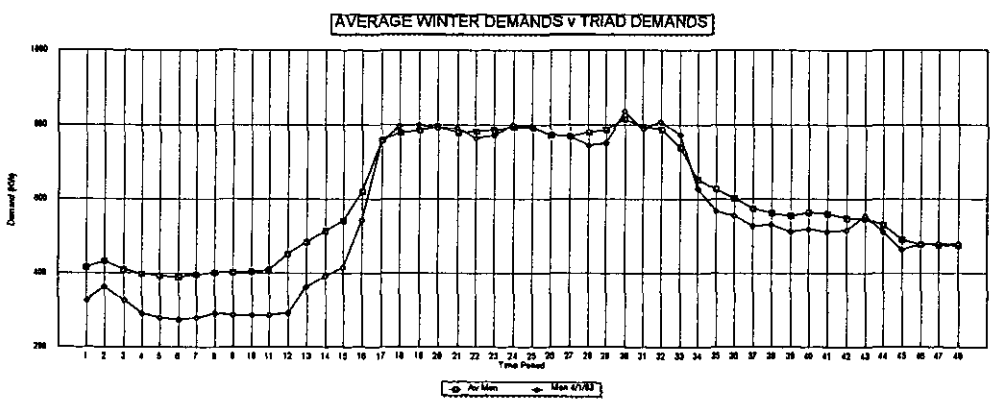
DAY	DATE	TP	ACTUAL DEMAND	TYPICAL DEMAND	DIFF	% DIFF
TUE	11/17/92	35	720	638	(82)	-12.77%
WED	12/09/92	35	588	657	69	10.55%
MON	01/04/93	35	568	638	70	11.04%

Typical daily demands are calculated for each day type for the period November to February, excluding the full Christmas period.

The typical demands also exclude the period between time periods 34 and 36 for the Triad warning days.







TRIAD DEMAND ANALYSIS : WINTER 1991/92

CUSTOMER NO : 12

NAME : ELECTRICAL EQUIPMENT MANUFACTURING 4

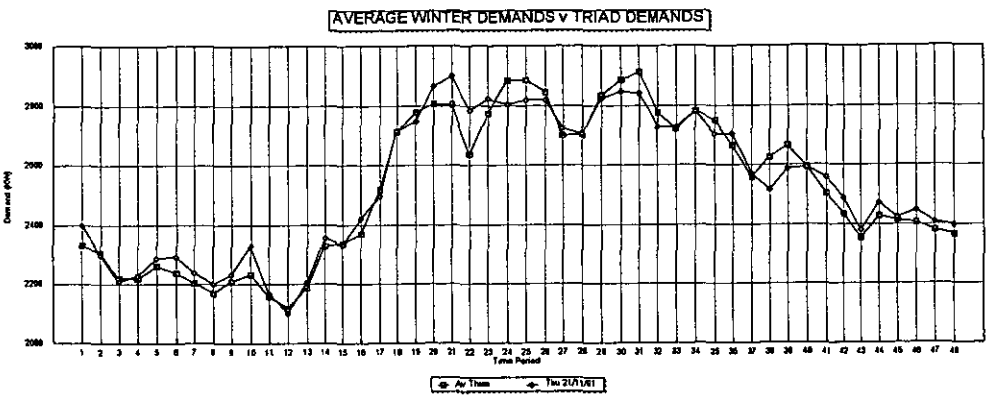
SIC CODE : 347

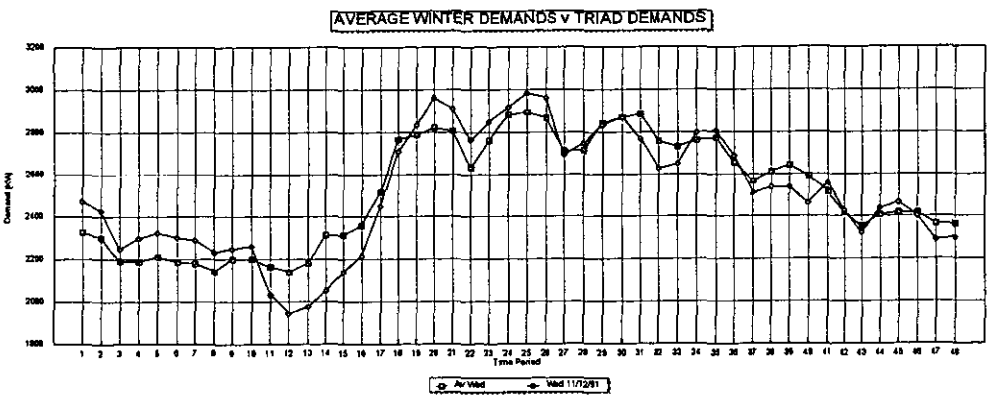
UNITS : KW

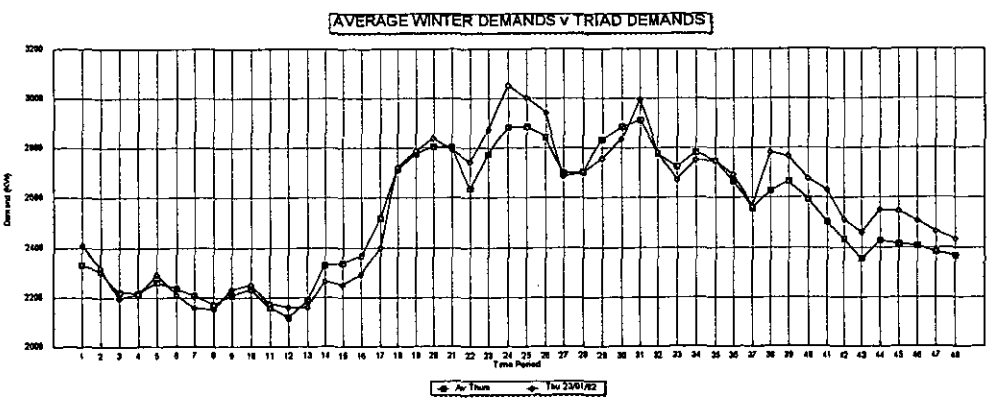
DAY	DATE	TP	ACTUAL DEMAND	TYPICAL DEMAND	DIFF	% DIFF
THU	11/21/91	35	2,704	2,750	46	1.67%
WED	12/11/91	35	2,804	2,772	(32)	-1.17%
THU	01/23/92	35	2,748	2,750	2	0.07%

Typical daily demands are calculated for each day type for the period November to February, excluding the full Christmas period.

The typical demands also exclude the period between time periods 34 and 36 for the Triad warning days







TRIAD DEMAND ANALYSIS : WINTER 1992/93

CUSTOMER REF : 12

NAME : ELECTRICAL EQUIPMENT MANUFACTURING 4

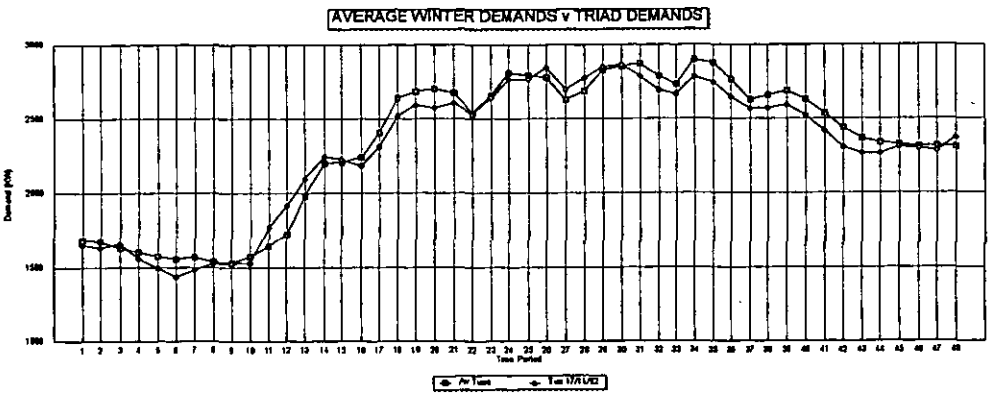
SIC CODE : 347

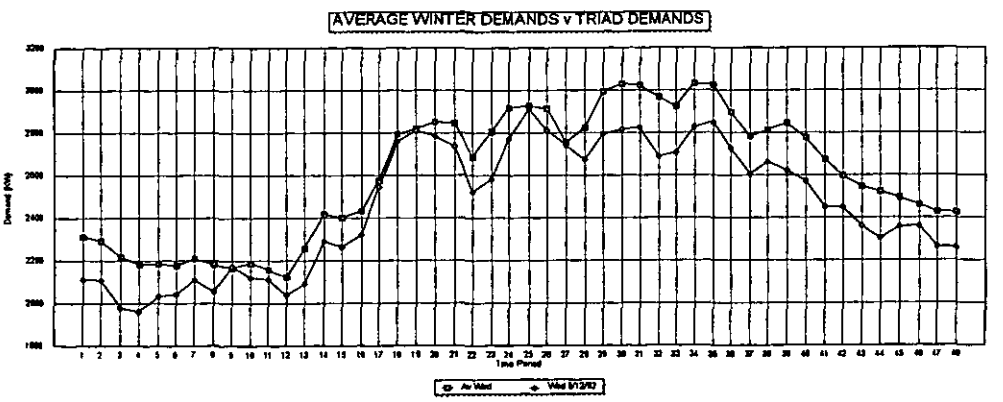
UNITS : KW

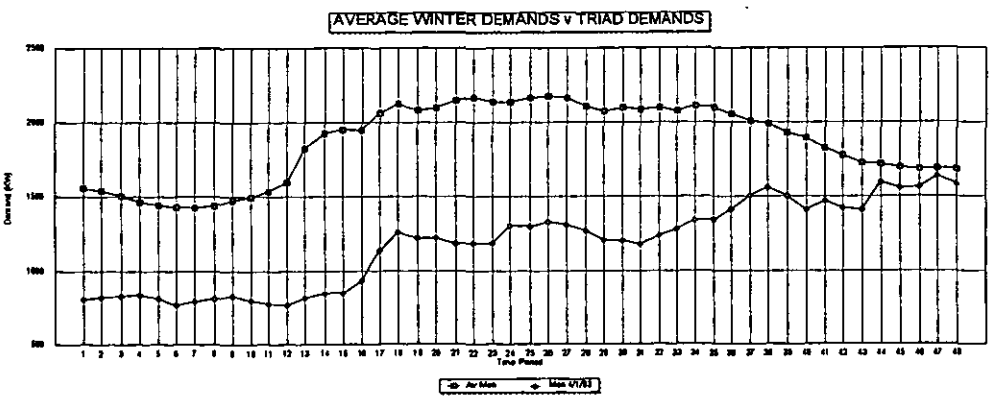
DAY	DATE	TP	ACTUAL DEMAND	TYPICAL DEMAND	DIFF	% DIFF
TUE	11/17/92	35	2,740	3,073	333	10.83%
WED	12/09/92	35	2,848	3,023	175	5.79%
MON	01/04/93	35	1,344	3,073	1,729	56.26%

Typical daily demands are calculated for each day type for the period November to February, excluding the full Christmas period.

The typical demands also exclude the period between time periods 34 and 36 for the Triad warning days.







TRIAD DEMAND ANALYSIS : WINTER 1991/92 & 1992/93

CUSTOMER NO : 12

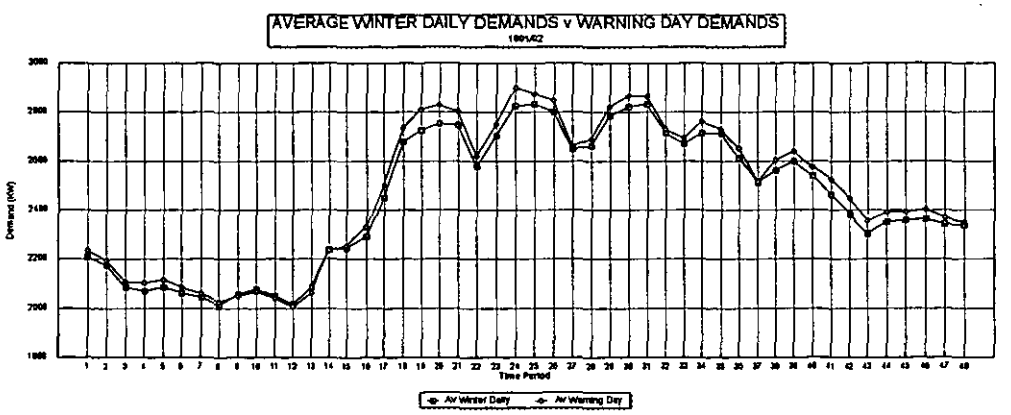
NAME : ELECTRICAL EQUIPMENT MANUFACTURING 4

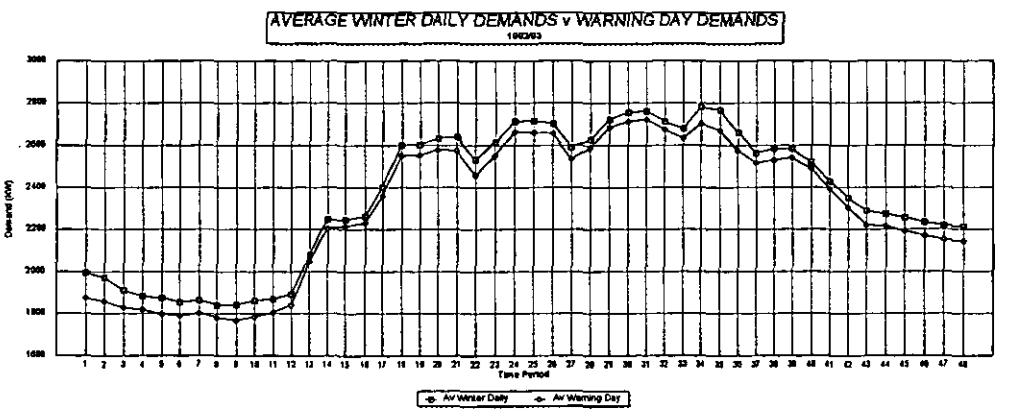
SIC CODE : 347

UNITS : KW

WINTER 91/92	32	33	34	35	36	37	38
AV DAILY	2,713	2,669	2,714	2,714	2,612	2,513	2,563
AV WARNING DAY	2,730	2,693	2,761	2,729	2,652	2,515	2,603
Unit Reduction	(17)	(23)	(47)	(15)	(40)	(2)	(40)
%age Reduction	-1%	-1%	-2%	-1%	-2%	-0%	-2%

WINTER 92/93	32	33	34	35	36	37	38
AV DAILY	2,710	2,677	2,780	2,767	2,661	2,562	2,582
AV WARNING DAY	2,674	2,631	2,701	2,668	2,575	2,515	2,530
Unit Reduction	36	46	79	99	86	47	52
%age Reduction	1%	2%	3%	4%	3%	2%	2%





TRIAD DEMAND ANALYSIS : WINTER 1991/92

CUSTOMER NO : 13

NAME : MOTOR VEHICLE EQUIPMENT MANUFACTURING 1

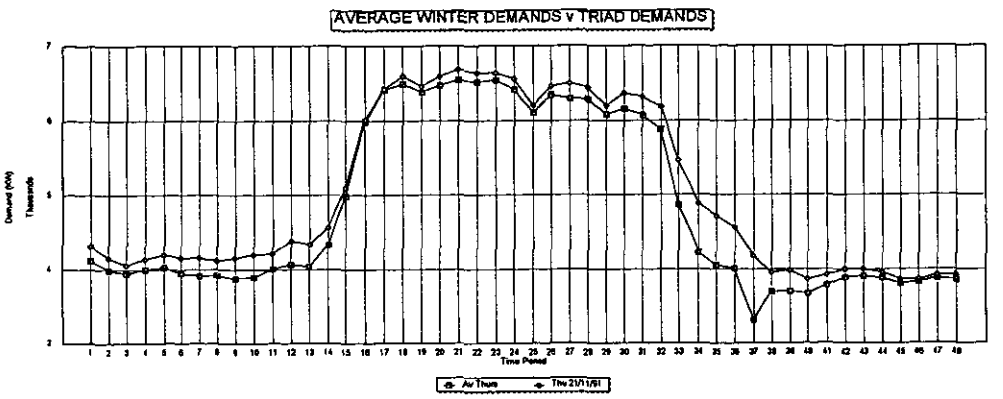
SIC CODE : 350

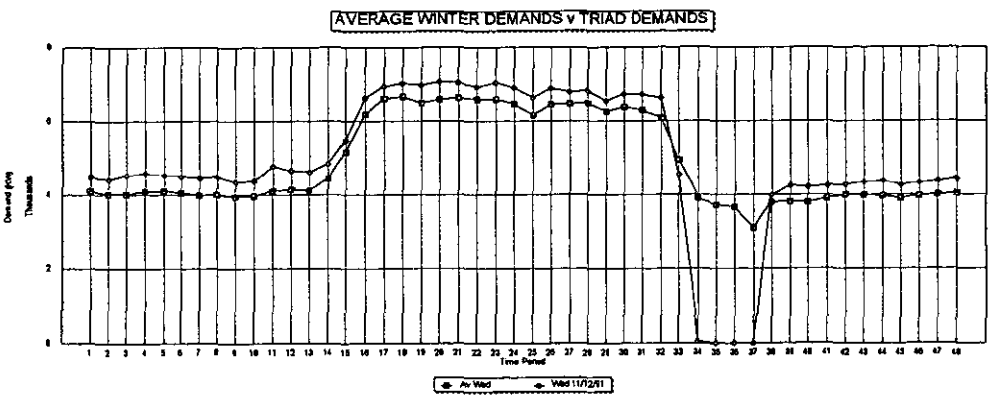
UNITS : KW

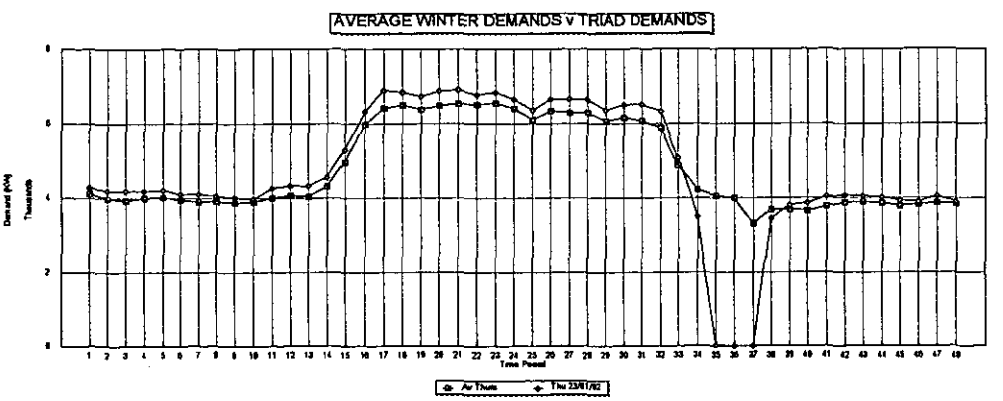
DAY	DATE	TP	ACTUAL DEMAND	TYPICAL DEMAND	DIFF	% DIFF
THU	11/21/91	35	4,720	4,055	(665)	-16.39%
WED	12/11/91	35	0	3,716	3,716	100.00%
THU	01/23/92	35	20	4,055	4,035	99.51%

Typical daily demands are calculated for each day type for the period November to February, excluding the full Christmas period.

The typical demands also exclude the period between time periods 34 and 36 for the Triad warning days







TRIAD DEMAND ANALYSIS : WINTER 1992/93

CUSTOMER REF : 13

NAME : MOTOR VEHICLE EQUIPMENT MANUFACTURING 1

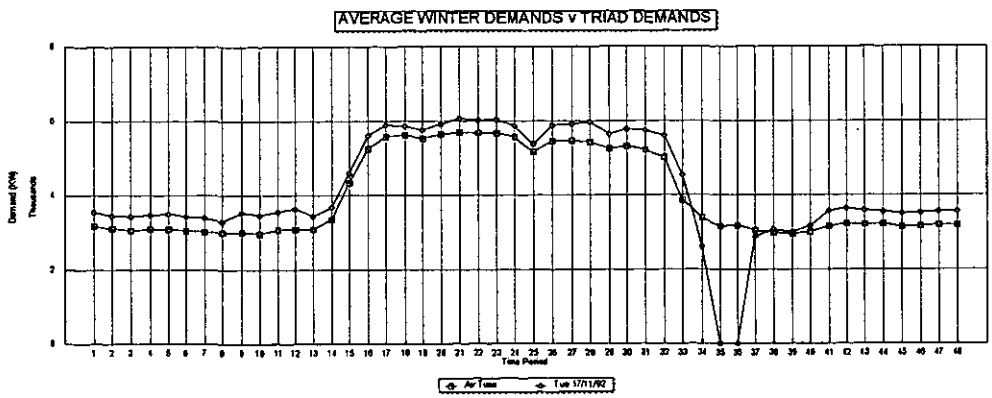
SIC CODE : 350

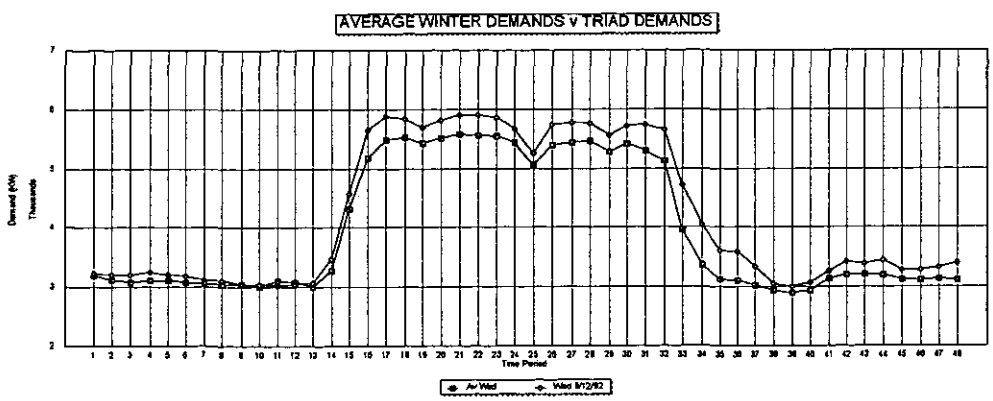
UNITS : KW

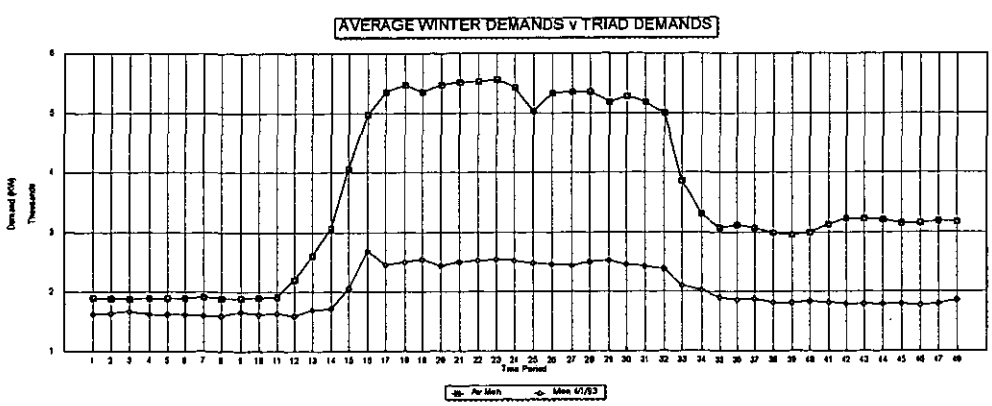
DAY	DATE	TP	ACTUAL DEMAND	TYPICAL DEMAND	DIFF	% DIFF
TUE	11/17/92	35	0	3,123	3,123	100.00%
WED	12/09/92	35	3,600	3,120	(480)	-15.38%
MON	01/04/93	35	1,900	3,123	1,223	39.16%

Typical daily demands are calculated for each day type for the period November to February, excluding the full Christmas period.

The typical demands also exclude the period between time periods 34 and 36 for the Triad warning days.







TRIAD DEMAND ANALYSIS : WINTER 1991/92 & 1992/93

CUSTOMER NO : 13

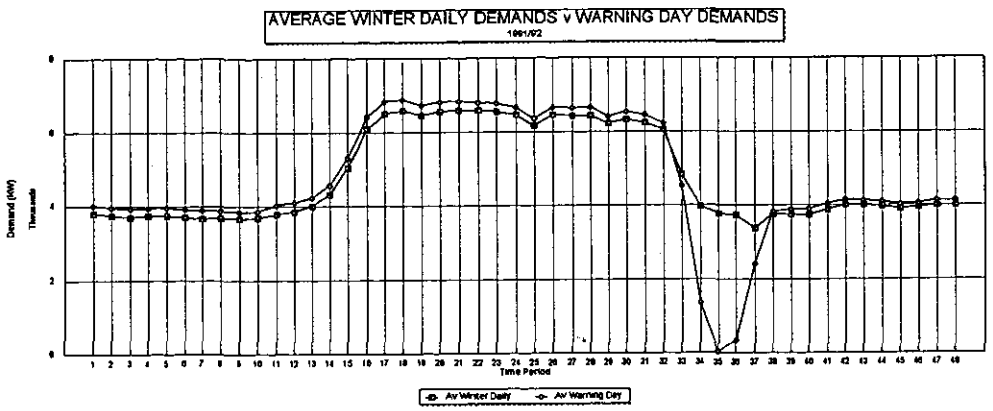
NAME : MOTOR VEHICLE EQUIPMENT MANUFACTURING 1

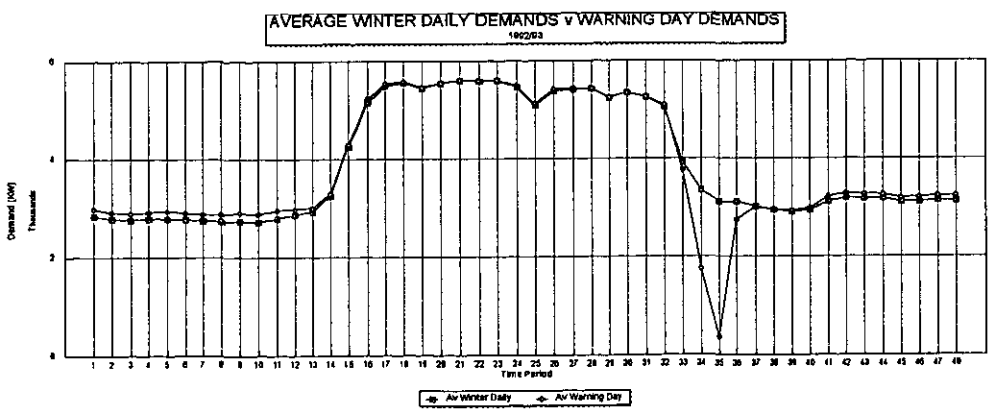
SIC CODE : 350

UNITS : KW

WINTER 91/92	32	33	34	35	36	37	38
AV DAILY	6,035	4,837	3,959	3,781	3,743	3,378	3,757
AV WARNING DA	6,227	4,525	1,358	43	327	2,408	3,818
Unit Reduction	(191)	312	2,601	3,737	3,416	970	(61)
%age Reduction	-3%	6%	66%	99%	91%	29%	-2%

WINTER 92/93	32	33	34	35	36	37	38
AV DAILY	5,057	3,919	3,354	3,118	3,114	3,028	2,940
AV WARNING DA	5,093	3,763	1,748	358	2,748	3,015	2,952
Unit Reduction	(36)	156	1,606	2,760	365	14	(12)
%age Reduction	-1%	4%	48%	89%	12%	0%	-0%





TRIAD DEMAND ANALYSIS : WINTER 1991/92

CUSTOMER NO : 14

NAME : AEROSPACE EQUIPMENT MANUFACTURING 1

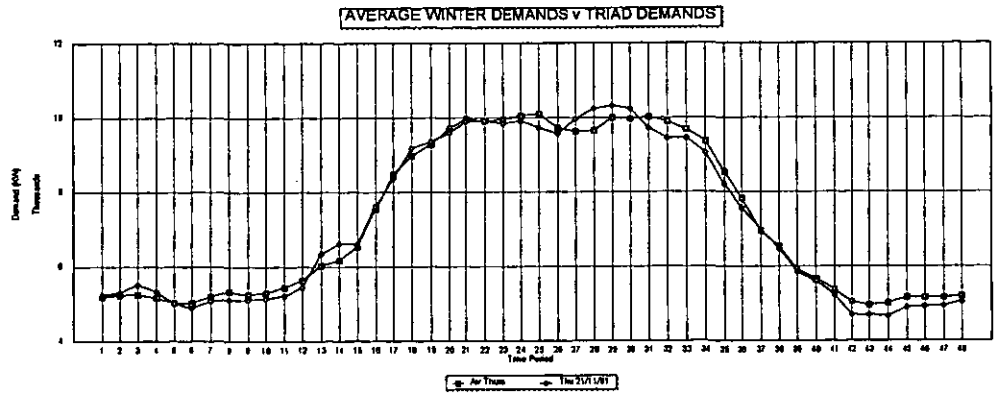
SIC CODE : 364

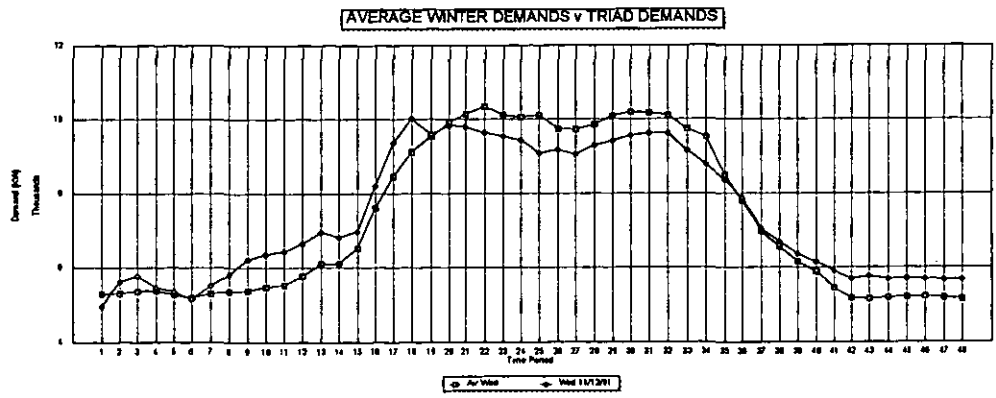
UNITS : KW

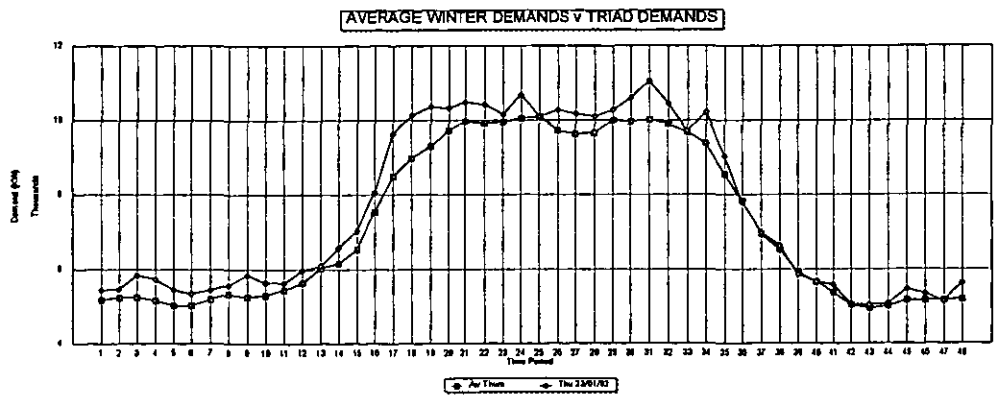
DAY	DATE	TP	ACTUAL DEMAND	TYPICAL DEMAND	DIFF	% DIFF
THU	11/21/91	35	8,220	8,543	323	3.78%
WED	12/11/91	35	8,360	8,504	144	1.69%
THU	01/23/92	35	9,020	8,543	(477)	-5.58%

Typical daily demands are calculated for each day type for the period November to February, excluding the full Christmas period.

The typical demands also exclude the period between time periods 34 and 36 for the Triad warning days







TRIAD DEMAND ANALYSIS : WINTER 1992/93

CUSTOMER REF : 14

NAME : AEROSPACE EQUIPMENT MANUFACTURING 1

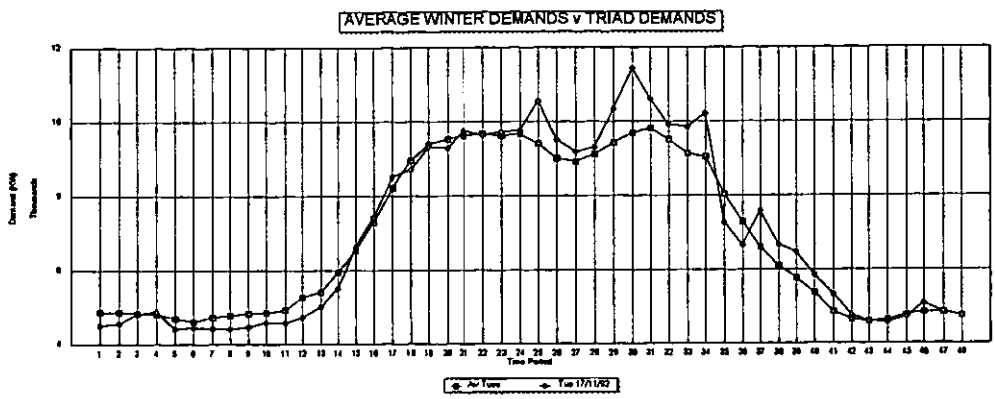
SIC CODE : 364

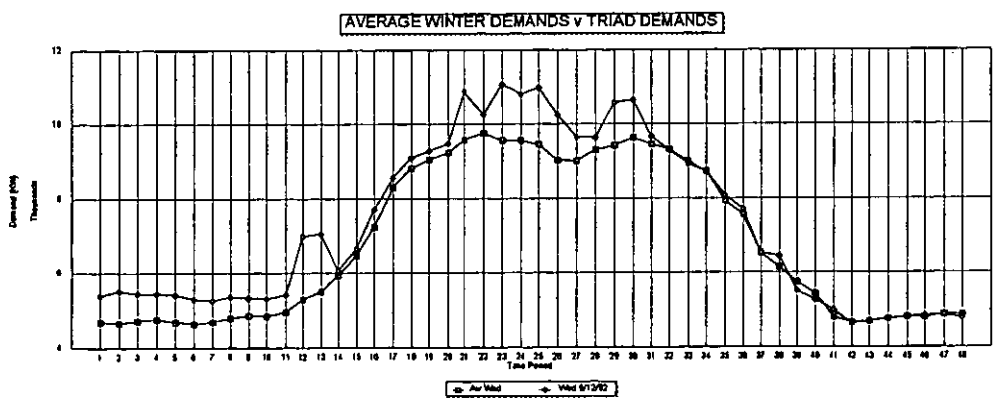
UNITS : KW

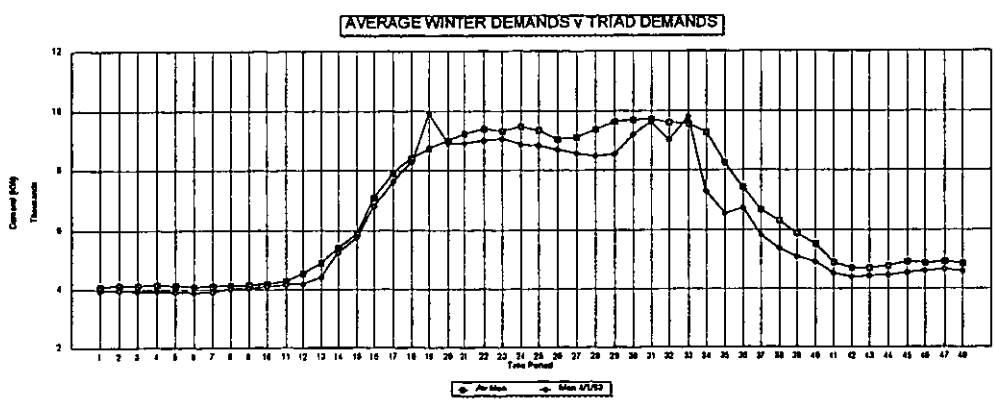
DAY	DATE	TP	ACTUAL DEMAND	TYPICAL DEMAND	DIFF	% DIFF
TUE	11/17/92	35	7,280	8,271	991	11.98%
WED	12/09/92	35	8,080	7,936	(144)	-1.82%
MON	01/04/93	35	6,540	8,271	1,731	20.93%

Typical daily demands are calculated for each day type for the period November to February, excluding the full Christmas period.

The typical demands also exclude the period between time periods 34 and 36 for the Triad warning days.







TRIAD DEMAND ANALYSIS : WINTER 1991/92 & 1992/93

CUSTOMER NO : 14

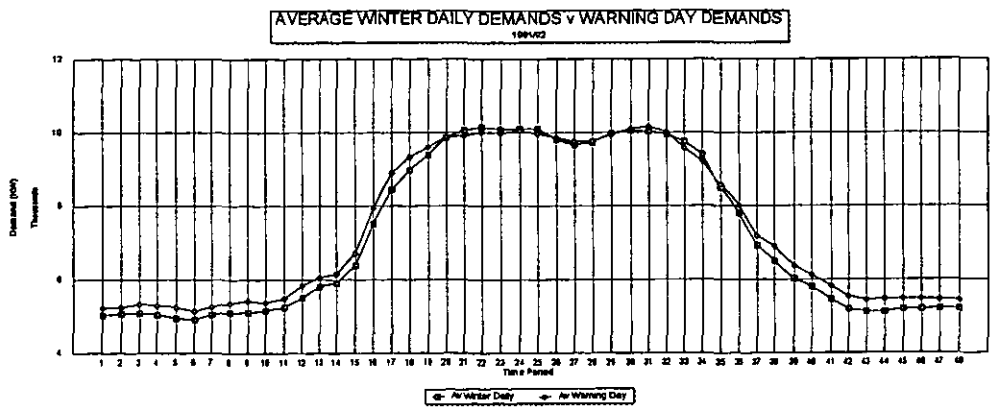
NAME : AEROSPACE EQUIPMENT MANUFACTURING 1

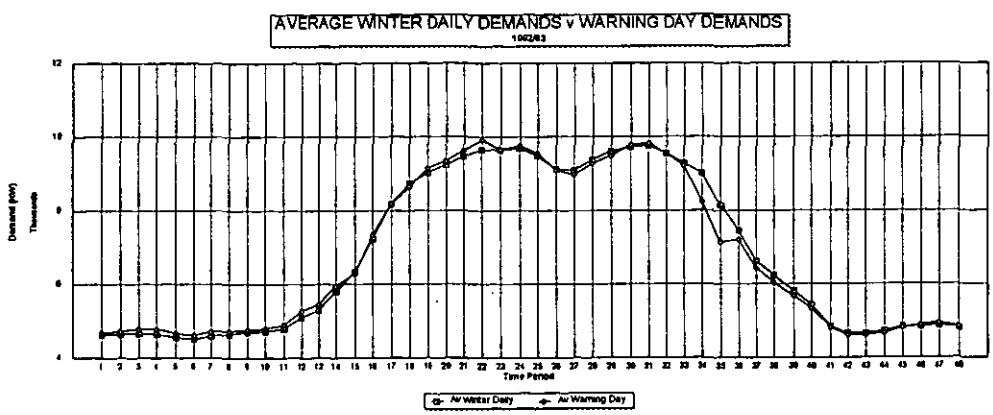
SIC CODE : 364

UNITS : KW

WINTER 91/92	32	33	34	35	36	37	38
AV DAILY	9,941	9,742	9,396	8,483	7,789	6,928	6,492
AV WARNING DA	10,005	9,572	9,212	8,583	8,010	7,177	6,903
Unit Reduction	(64)	170	184	(101)	(221)	(249)	(411)
%age Reduction	-1%	2%	2%	-1%	-3%	-4%	-6%

WINTER 92/93	32	33	34	35	36	37	38
AV DAILY	9,550	9,285	9,007	8,126	7,444	6,613	6,237
AV WARNING DA	9,553	9,209	8,237	7,135	7,209	6,429	6,036
Unit Reduction	(3)	75	770	991	234	184	202
%age Reduction	-0%	1%	9%	12%	3%	3%	3%





TRIAD DEMAND ANALYSIS : WINTER 1991/92

CUSTOMER NO : 15

NAME : FOOD INDUSTRY 1

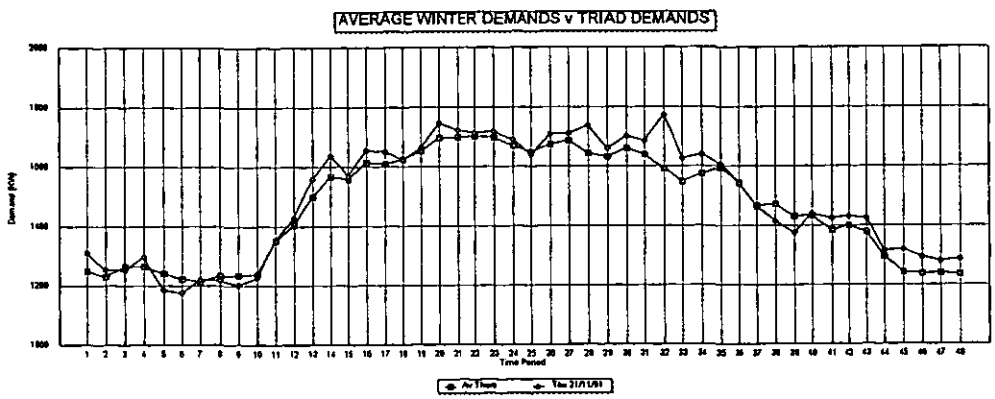
SIC CODE : 412

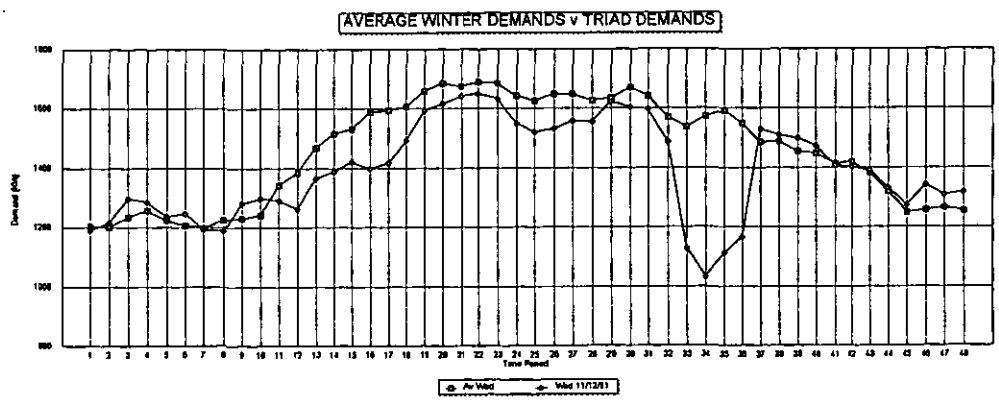
UNITS : KW

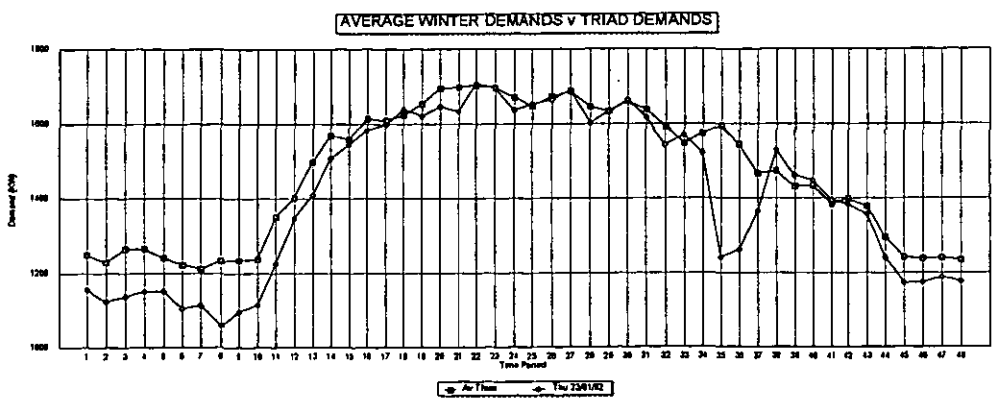
DAY	DATE	TP	ACTUAL DEMAND	TYPICAL DEMAND	DIFF	% DIFF
THU	11/21/91	35	1,608	1,595	(13)	-0.82%
WED	12/11/91	35	1,112	1,592	480	30.14%
THU	01/23/92	35	1,242	1,595	353	22.13%

Typical daily demands are calculated for each day type for the period November to February, excluding the full Christmas period.

The typical demands also exclude the period between time periods 34 and 36 for the Triad warning days







TRIAD DEMAND ANALYSIS : WINTER 1992/93

CUSTOMER REF : 15

NAME : FOOD INDUSTRY 1

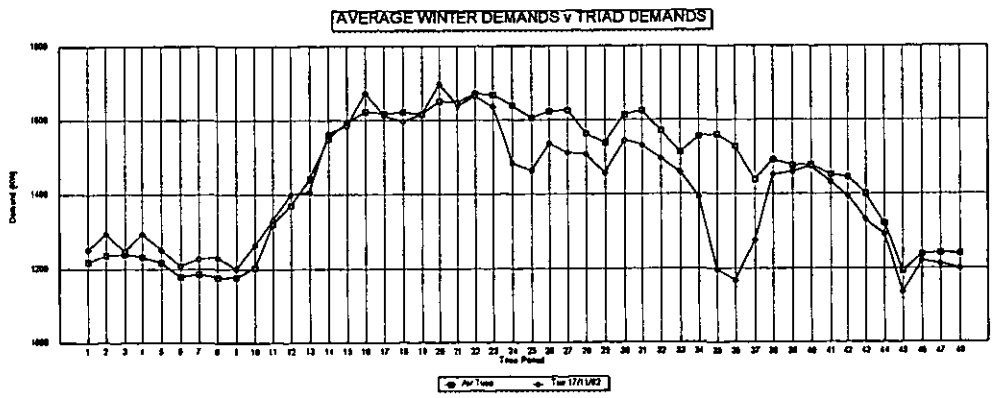
SIC CODE : 412

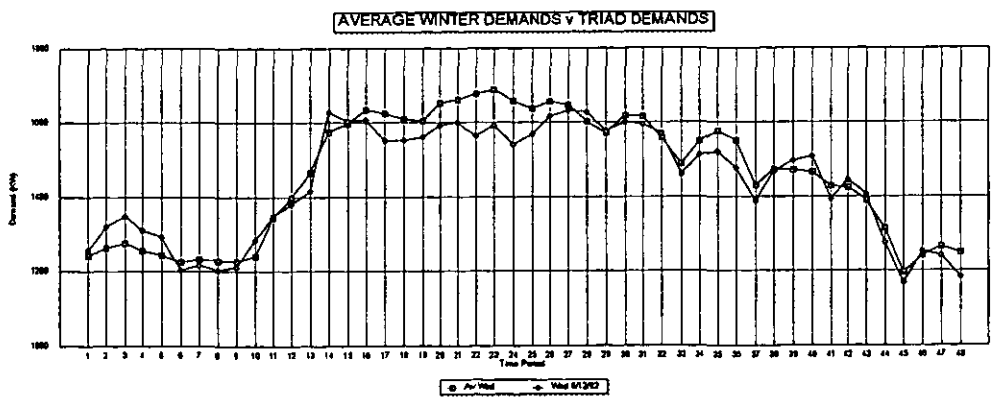
UNITS : KW

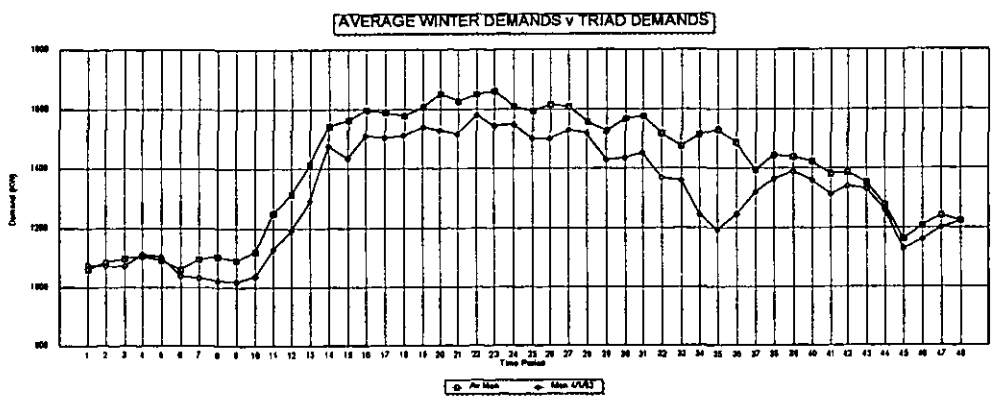
DAY	DATE	TP	ACTUAL DEMAND	TYPICAL DEMAND	DIFF	% DIFF
TUE	11/17/92	35	1,196	1,566	370	23.60%
WED	12/09/92	35	1,520	1,576	56	3.58%
MON	01/04/93	35	1,192	1,566	374	23.86%

Typical daily demands are calculated for each day type for the period November to February, excluding the full Christmas period.

The typical demands also exclude the period between time periods 34 and 36 for the Triad warning days.







TRIAD DEMAND ANALYSIS : WINTER 1991/92 & 1992/93

CUSTOMER NO : 15

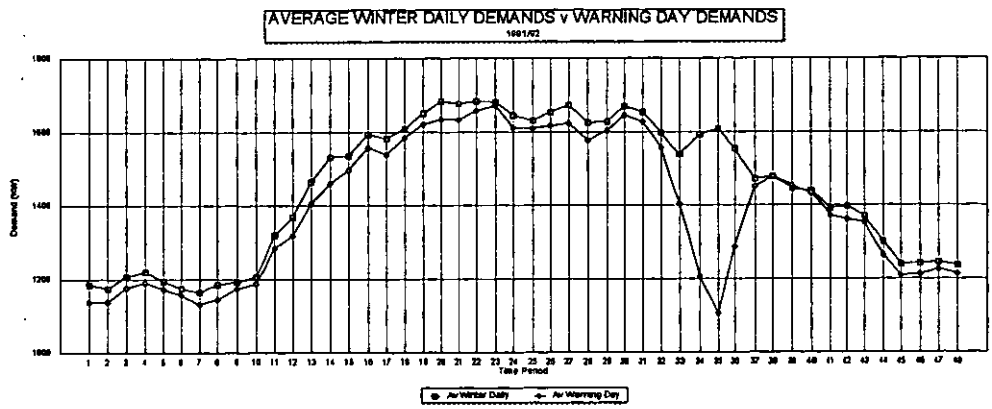
NAME : FOOD INDUSTRY 1

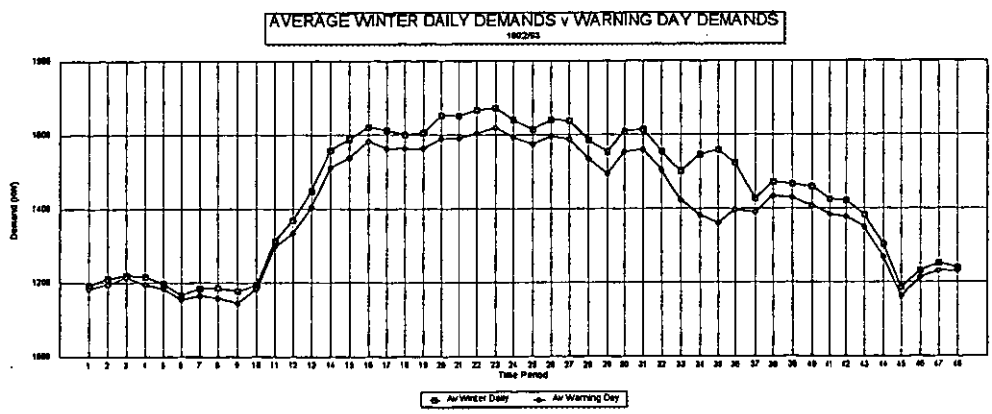
SIC CODE : 412

UNITS : KW

WINTER 91/92	32	33	34	35	36	37	38
AV DAILY	1,598	1,537	1,592	1,608	1,554	1,472	1,478
AV WARNING DA	1,558	1,403	1,206	1,106	1,287	1,450	1,479
Unit Reduction	40	134	386	502	267	22	(1)
%age Reduction	2%	9%	24%	31%	17%	1%	-0%

WINTER 92/93	32	33	34	35	36	37	38
AV DAILY	1,556	1,500	1,547	1,558	1,524	1,426	1,472
AV WARNING DA	1,504	1,421	1,381	1,360	1,396	1,389	1,432
Unit Reduction	51	78	165	198	128	37	39
%age Reduction	3%	5%	11%	13%	8%	3%	3%





TRIAD DEMAND ANALYSIS : WINTER 1991/92

CUSTOMER NO : 16

NAME : FOOD INDUSTRY 2

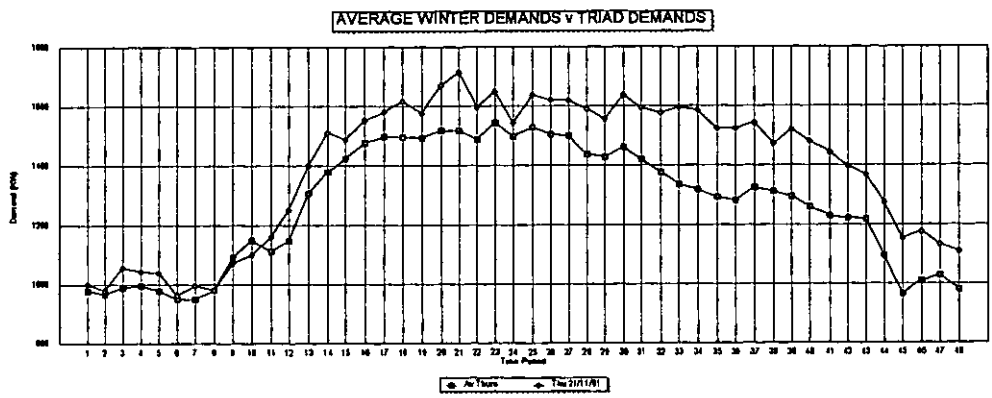
SIC CODE : 412

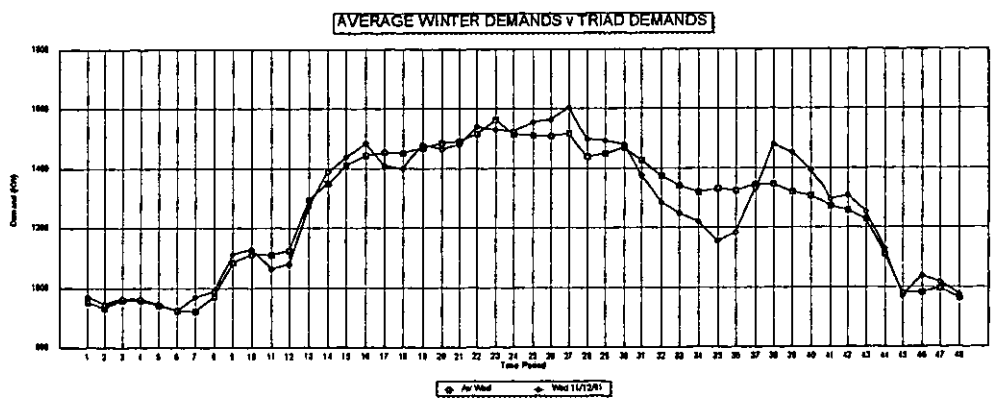
UNITS : KW

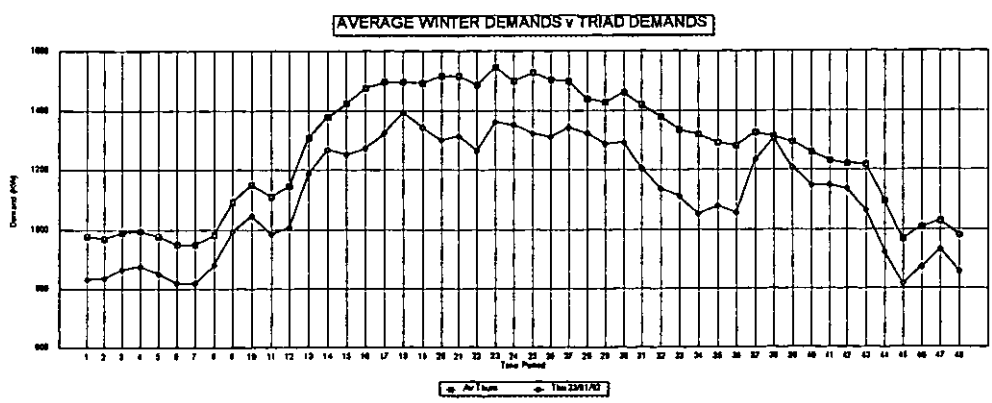
DAY	DATE	TP	ACTUAL DEMAND	TYPICAL DEMAND	DIFF	% DIFF
THU	11/21/91	35	1,524	1,292	(232)	-17.93%
WED	12/11/91	35	1,156	1,330	174	13.06%
THU	01/23/92	35	1,080	1,292	212	16.43%

Typical daily demands are calculated for each day type for the period November to February, excluding the full Christmas period.

The typical demands also exclude the period between time periods 34 and 36 for the Triad warning days







TRIAD DEMAND ANALYSIS : WINTER 1992/93

CUSTOMER REF : 16

NAME : FOOD INDUSTRY 2

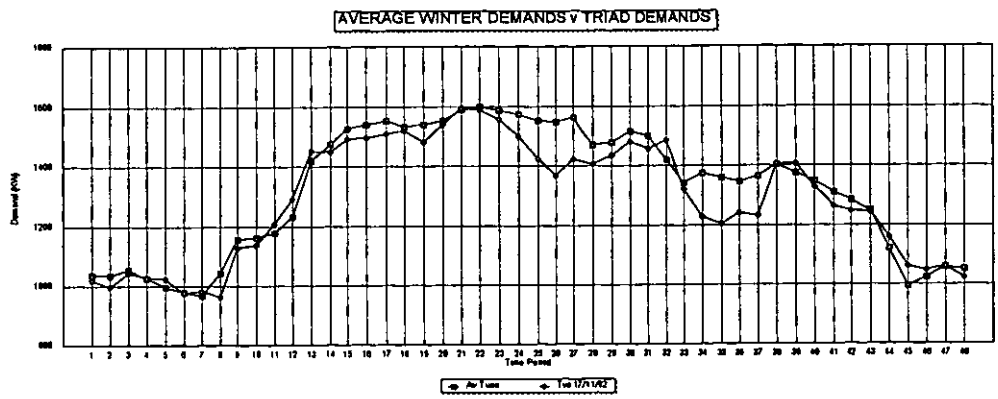
SIC CODE : 412

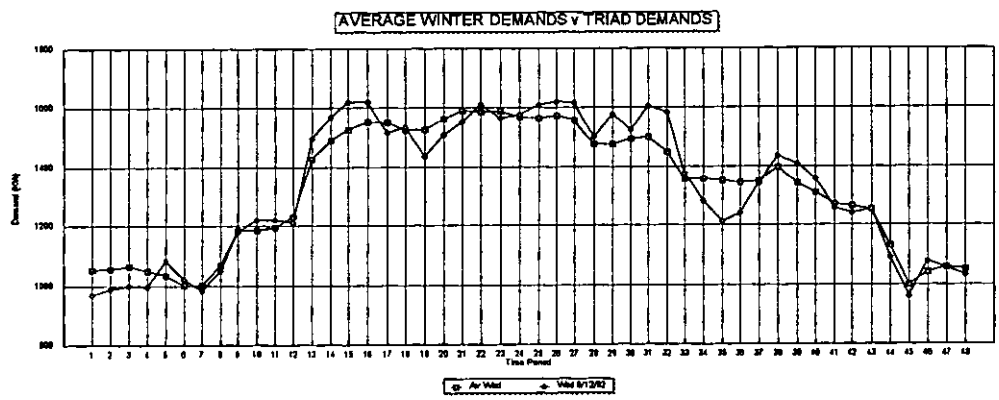
UNITS : KW

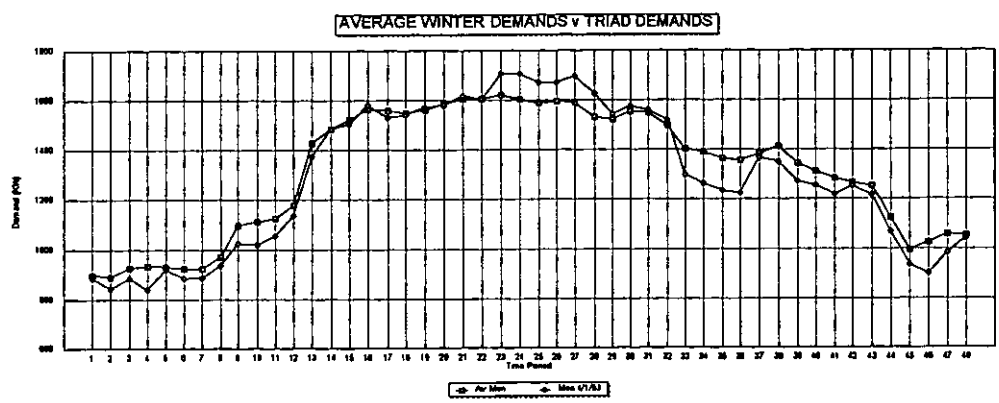
DAY	DATE	TP	ACTUAL DEMAND	TYPICAL DEMAND	DIFF	% DIFF
TUE	11/17/92	35	1,204	1,330	126	9.48%
WED	12/09/92	35	1,212	1,349	137	10.15%
MON	01/04/93	35	1,236	1,330	94	7.08%

Typical daily demands are calculated for each day type for the period November to February, excluding the full Christmas period.

The typical demands also exclude the period between time periods 34 and 36 for the Triad warning days.







TRIAD DEMAND ANALYSIS : WINTER 1991/92 & 1992/93

CUSTOMER NO : 16

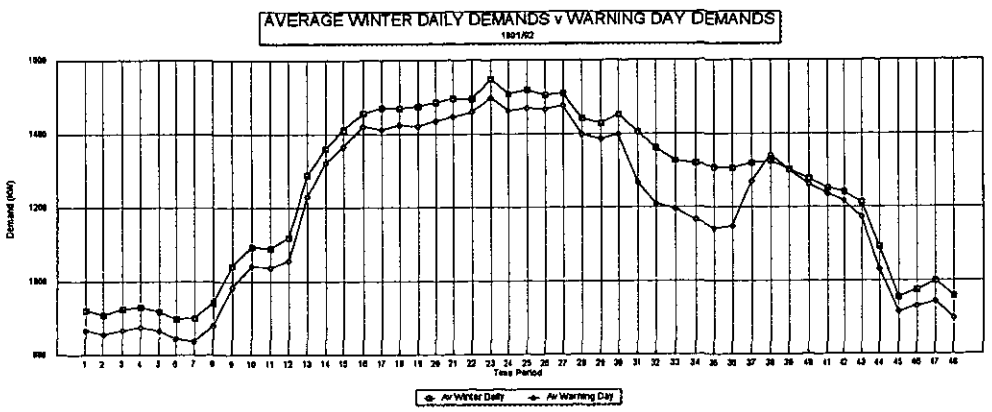
NAME : FOOD INDUSTRY 2

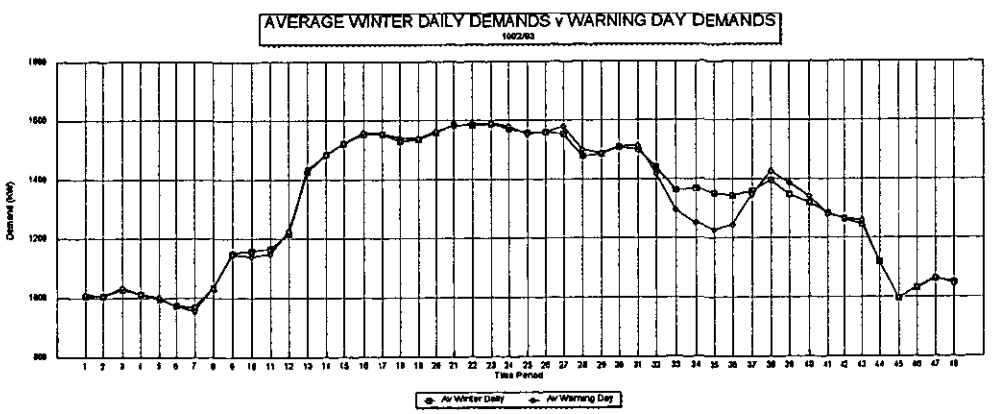
SIC CODE : 412

UNITS : KW

WINTER 91/92	32	33	34	35	36	37	38
AV DAILY	1,360	1,327	1,320	1,306	1,304	1,319	1,324
AV WARNING DA	1,209	1,195	1,166	1,140	1,148	1,270	1,342
Unit Reduction	152	132	154	166	156	49	(18)
%age Reduction	11%	10%	12%	13%	12%	4%	-1%

WINTER 92/93	32	33	34	35	36	37	38
AV DAILY	1,442	1,363	1,366	1,351	1,342	1,357	1,395
AV WARNING DA	1,420	1,296	1,252	1,227	1,245	1,347	1,427
Unit Reduction	22	67	114	124	97	10	(32)
%age Reduction	1%	5%	8%	9%	7%	1%	-2%





TRIAD DEMAND ANALYSIS : WINTER 1991/92

CUSTOMER NO : 17

NAME : FOOD INDUSTRY 3

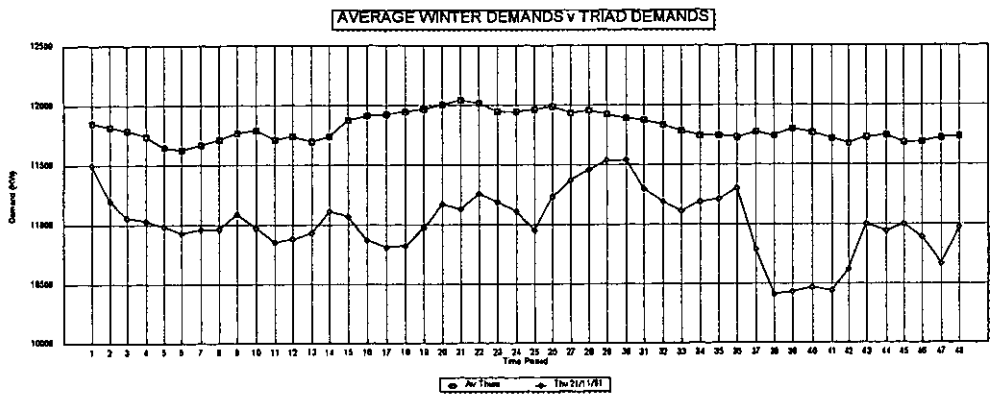
SIC CODE : 419

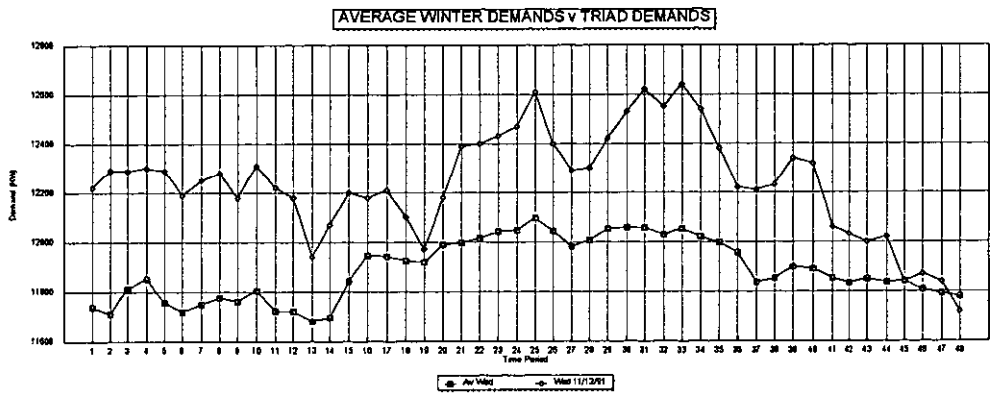
UNITS : KW

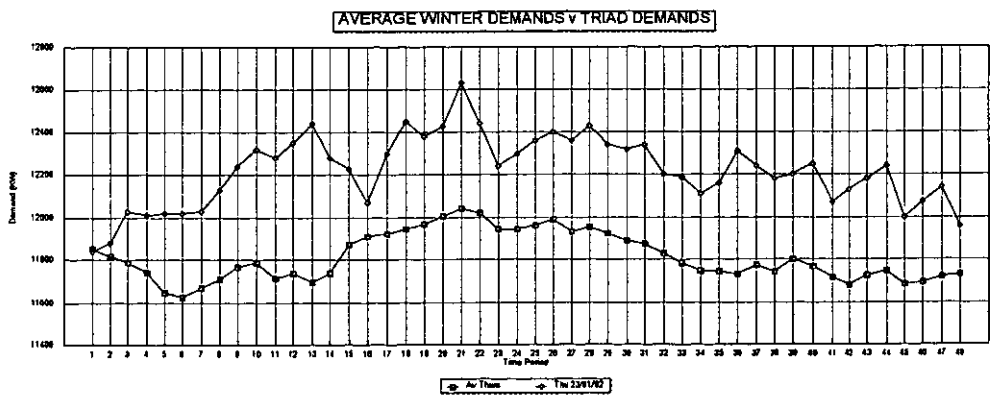
DAY	DATE	TP	ACTUAL DEMAND	TYPICAL DEMAND	DIFF	% DIFF
THU	11/21/91	35	11,210	11,745	535	4.56%
WED	12/11/91	35	12,380	11,996	(384)	-3.20%
THU	01/23/92	35	12,160	11,745	(415)	-3.53%

Typical daily demands are calculated for each day type for the period November to February, excluding the full Christmas period.

The typical demands also exclude the period between time periods 34 and 36 for the Triad warning days







TRIAD DEMAND ANALYSIS : WINTER 1992/93

CUSTOMER REF : 17

NAME : FOOD INDUSTRY 3

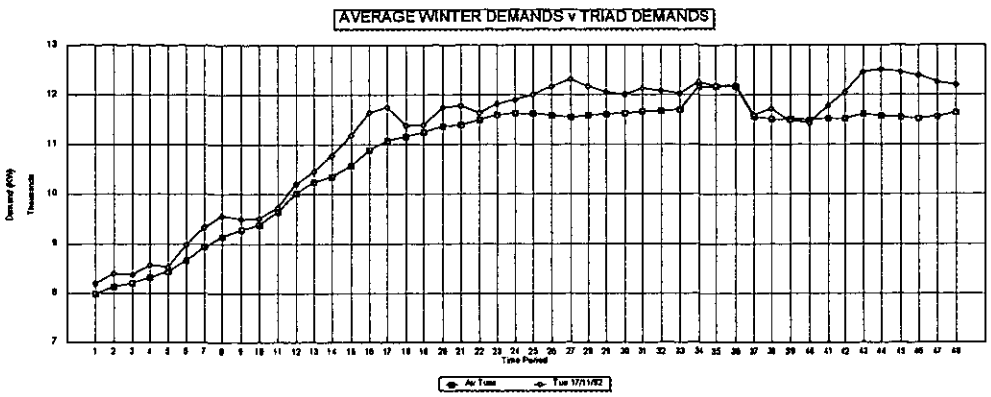
SIC CODE : 419

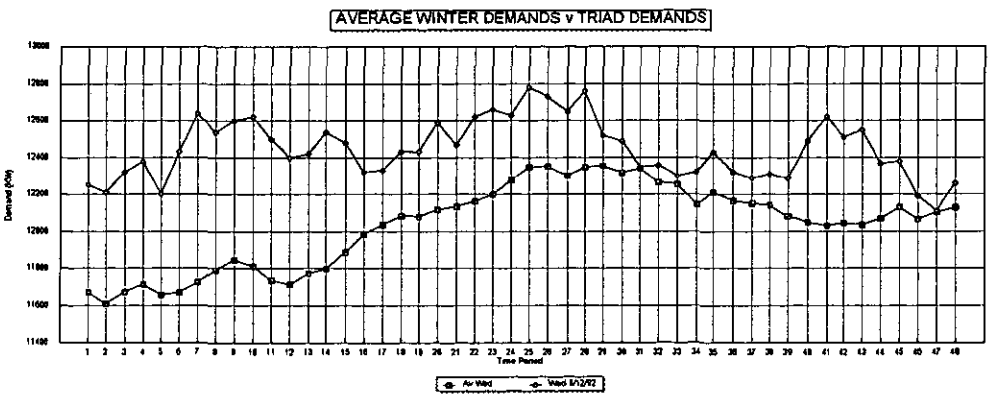
UNITS : KW

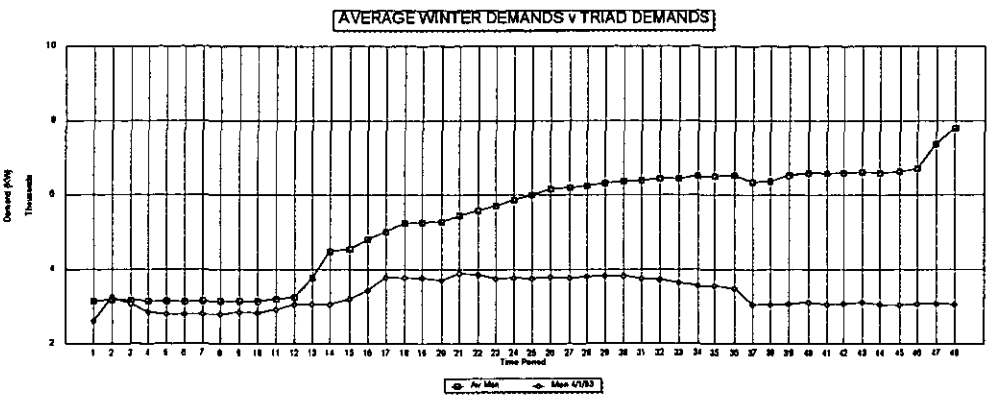
DAY	DATE	TP	ACTUAL DEMAND	TYPICAL DEMAND	DIFF	% DIFF
TUE	11/17/92	35	12,200	12,315	115	0.93%
WED	12/09/92	35	12,430	12,209	(221)	-1.81%
MON	01/04/93	35	3,560	12,315	8,755	71.09%

Typical daily demands are calculated for each day type for the period November to February, excluding the full Christmas period.

The typical demands also exclude the period between time periods 34 and 36 for the Triad warning days.







TRIAD DEMAND ANALYSIS : WINTER 1991/92 & 1992/93

CUSTOMER NO : 17

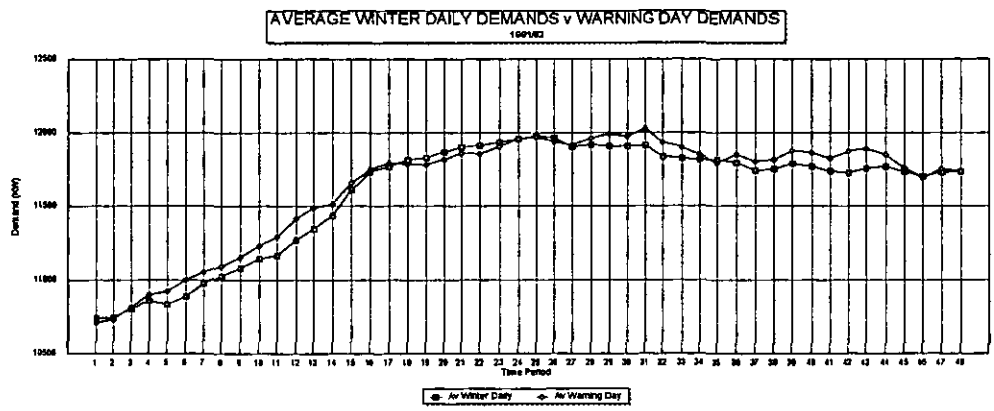
NAME : FOOD INDUSTRY 3

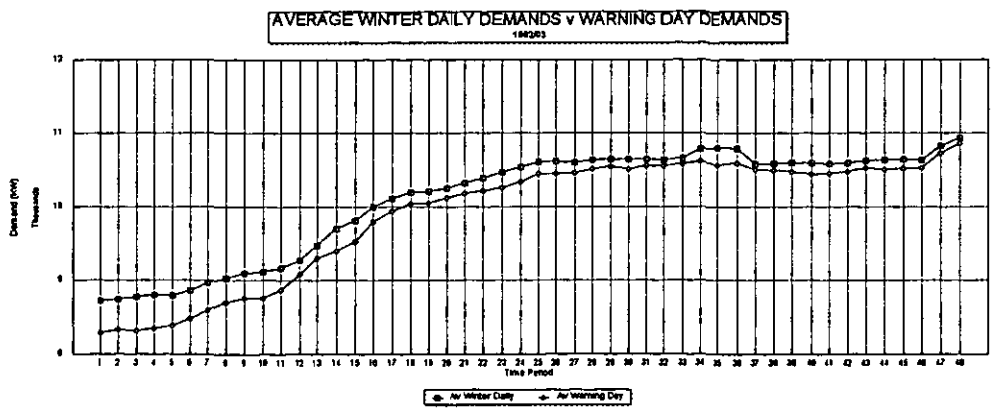
SIC CODE : 419

UNITS : KW

WINTER 91/92	32	33	34	35	36	37	38
AV DAILY	11,838	11,822	11,814	11,816	11,794	11,742	11,748
AV WARNING DA	11,933	11,896	11,850	11,788	11,848	11,803	11,815
Unit Reduction	(95)	(74)	(36)	28	(54)	(61)	(67)
%age Reduction	-1%	-1%	-0%	0%	-0%	-1%	-1%

WINTER 92/93	32	33	34	35	36	37	38
AV DAILY	10,633	10,659	10,782	10,800	10,793	10,585	10,580
AV WARNING DA	10,552	10,586	10,620	10,566	10,590	10,504	10,494
Unit Reduction	81	73	162	234	203	81	86
%age Reduction	1%	1%	2%	2%	2%	1%	1%





TRIAD DEMAND ANALYSIS : WINTER 1991/92

CUSTOMER NO : 18

NAME : TEXTILE INDUSTRY 1

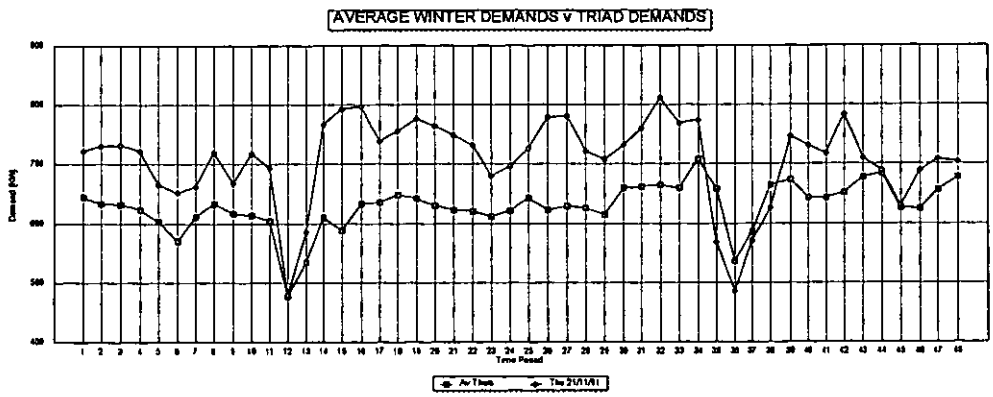
SIC CODE : 428

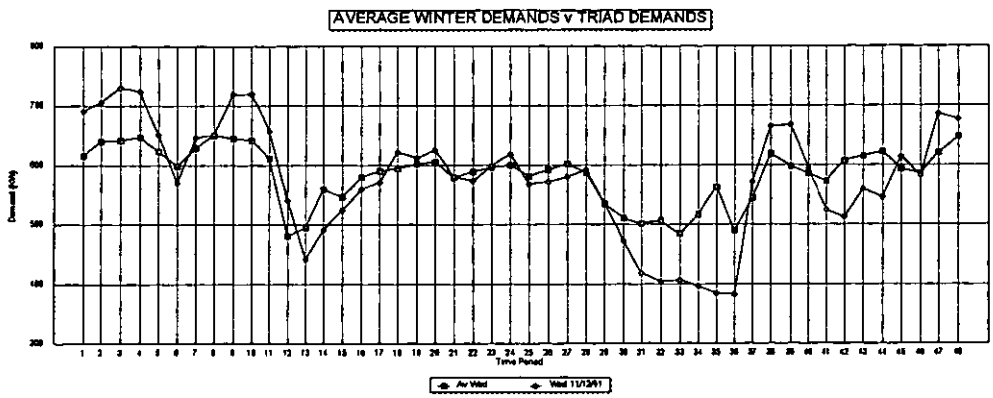
UNITS : KW

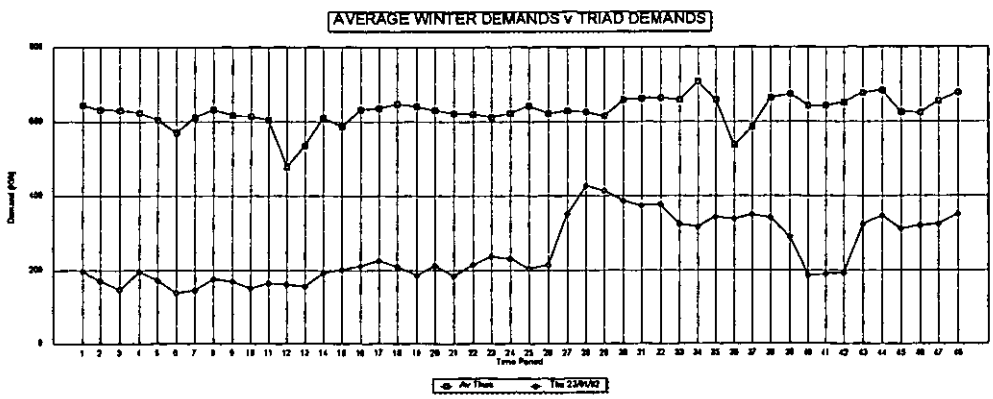
DAY	DATE	TP	ACTUAL DEMAND	TYPICAL DEMAND	DIFF	% DIFF
THU	11/21/91	35	568	658	90	13.74%
WED	12/11/91	35	384	563	179	31.79%
THU	01/23/92	35	344	658	314	47.76%

Typical daily demands are calculated for each day type for the period November to February, excluding the full Christmas period.

The typical demands also exclude the period between time periods 34 and 36 for the Triad warning days







TRIAD DEMAND ANALYSIS : WINTER 1992/93

CUSTOMER REF : 18

NAME : TEXTILE INDUSTRY 1

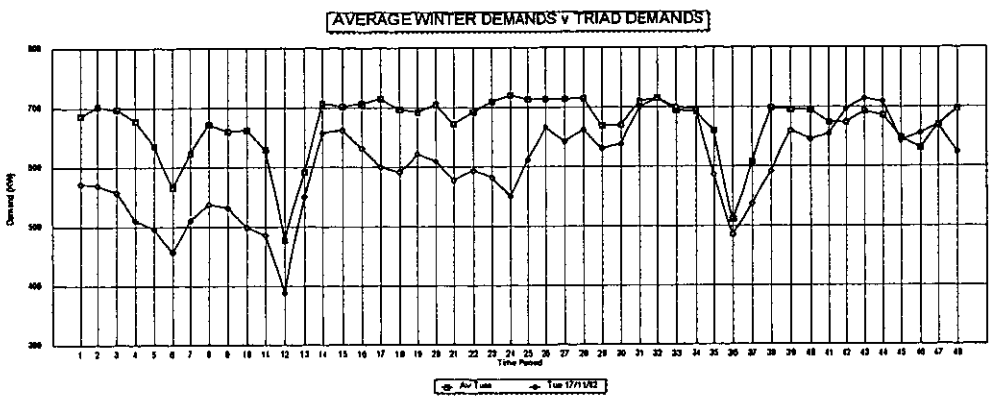
SIC CODE : 428

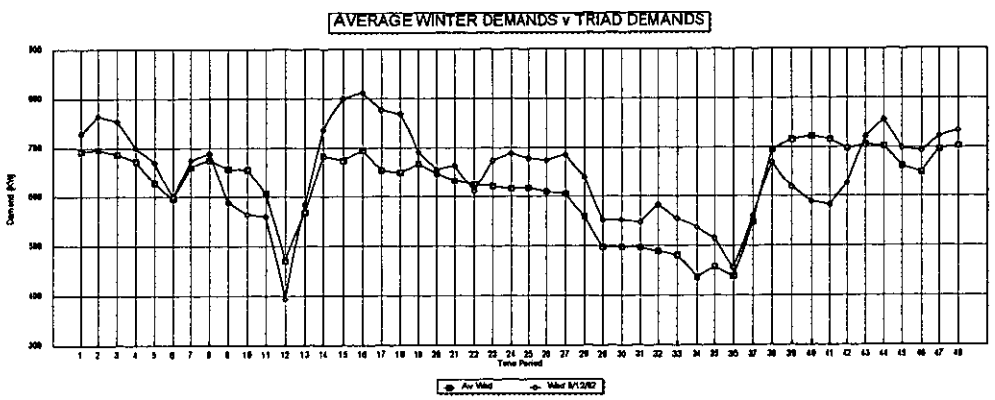
UNITS : KW

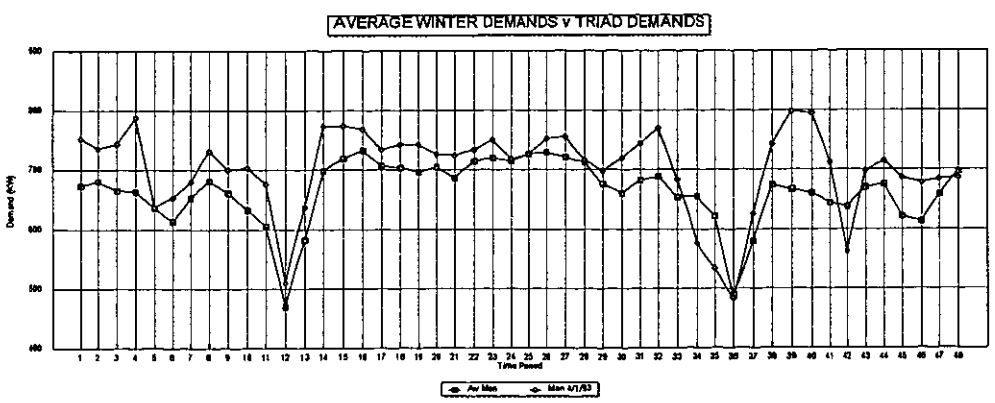
DAY	DATE	TP	ACTUAL DEMAND	TYPICAL DEMAND	DIFF	% DIFF
TUE	11/17/92	35	586	695	109	15.69%
WED	12/09/92	35	514	457	(57)	-12.55%
MON	01/04/93	35	534	695	161	23.17%

Typical daily demands are calculated for each day type for the period November to February, excluding the full Christmas period.

The typical demands also exclude the period between time periods 34 and 36 for the Triad warning days.







TRIAD DEMAND ANALYSIS : WINTER 1991/92 & 1992/93

CUSTOMER NO : 18

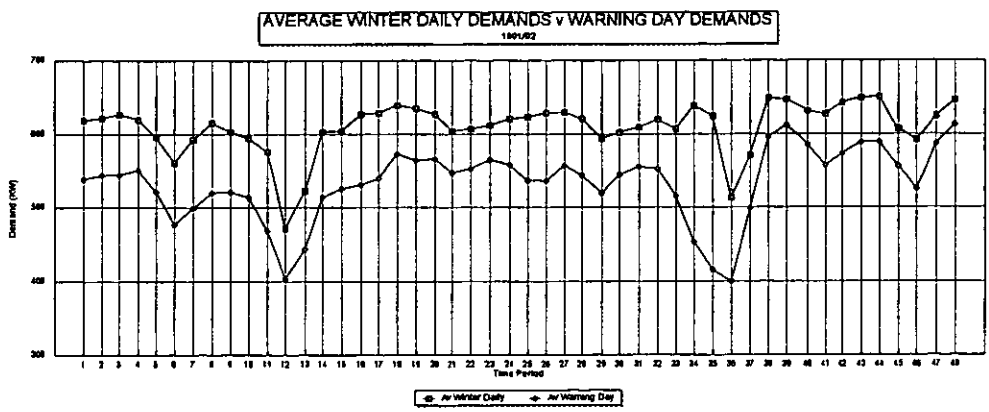
NAME : TEXTILE INDUSTRY I

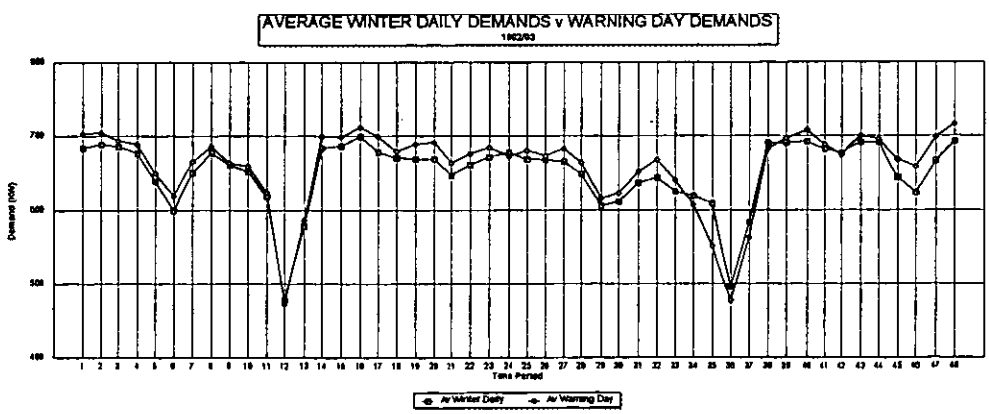
SIC CODE : 428

UNITS : KW

WINTER 91/92	32	33	34	35	36	37	38
AV DAILY	619	607	638	624	513	571	648
AV WARNING DA	552	516	454	415	399	500	595
Unit Reduction	67	91	185	209	114	71	53
%age Reduction	11%	15%	29%	33%	22%	12%	8%

WINTER 92/93	32	33	34	35	36	37	38
AV DAILY	643	625	619	608	495	583	691
AV WARNING DA	668	640	607	551	477	563	681
Unit Reduction	(25)	(15)	12	57	18	20	9
%age Reduction	-4%	-2%	2%	9%	4%	3%	1%





TRIAD DEMAND ANALYSIS : WINTER 1991/92

CUSTOMER NO : 19

NAME : TIMBER INDUSTRY 1

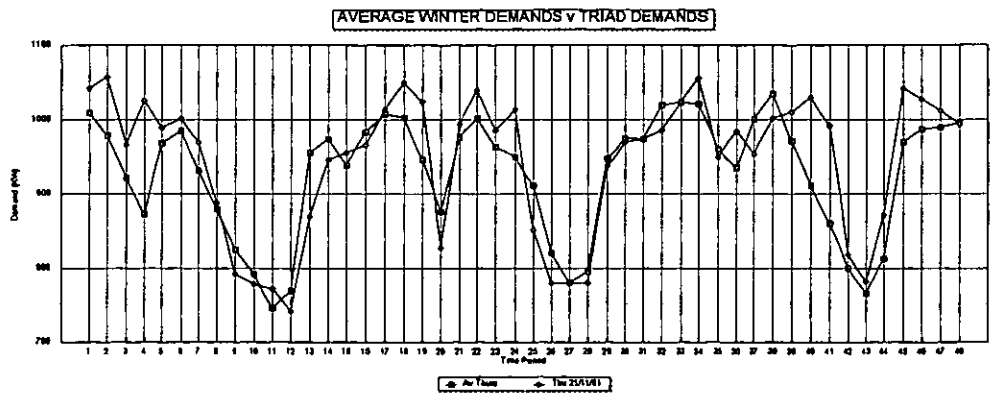
SIC CODE : 462

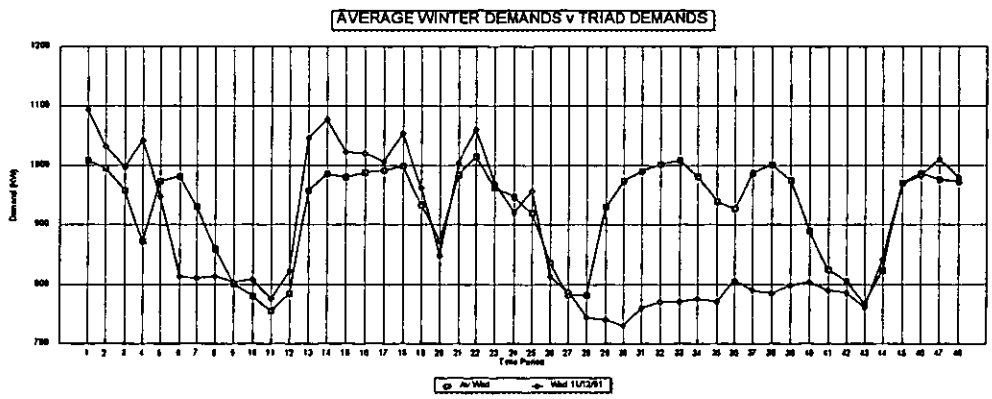
UNITS : KW

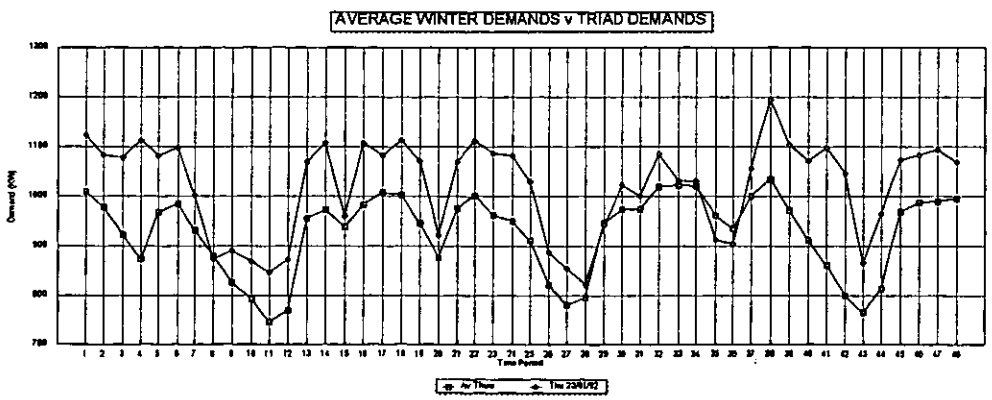
DAY	DATE	TP	ACTUAL DEMAND	TYPICAL DEMAND	DIFF	% DIFF
THU	11/21/91	35	950	961	11	1.15%
WED	12/11/91	35	770	939	169	18.00%
THU	01/23/92	35	912	961	49	5.11%

Typical daily demands are calculated for each day type for the period November to February, excluding the full Christmas period.

The typical demands also exclude the period between time periods 34 and 36 for the Triad warning days







TRIAD DEMAND ANALYSIS : WINTER 1992/93

CUSTOMER REF : 19

NAME : TIMBER INDUSTRY 1

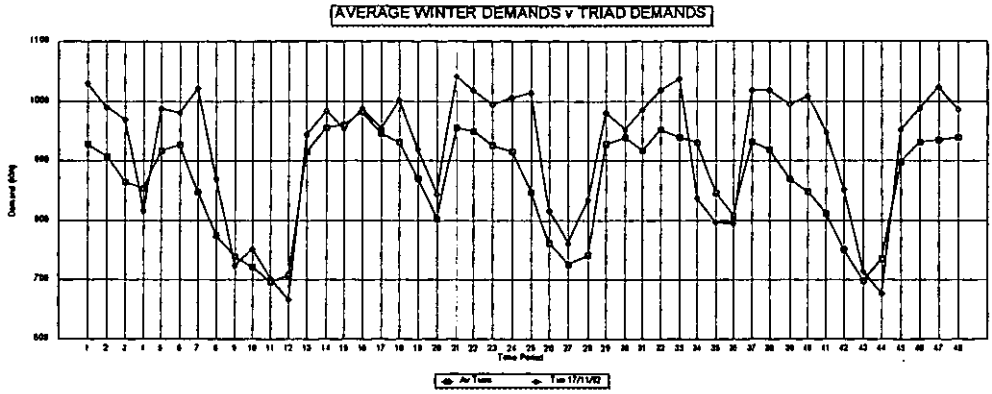
SIC CODE : 462

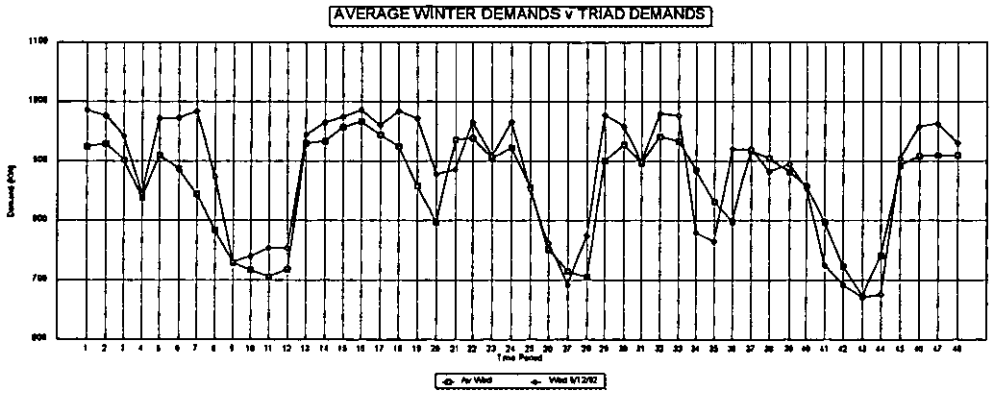
UNITS : KW

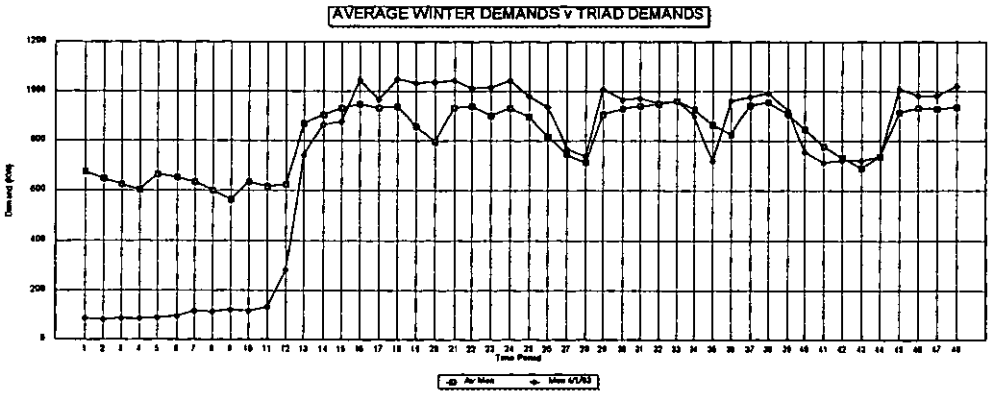
DAY	DATE	TP	ACTUAL DEMAND	TYPICAL DEMAND	DIFF	% DIFF
TUE	11/17/92	35	796	861	65	7.59%
WED	12/09/92	35	764	832	68	8.15%
MON	01/04/93	35	722	861	139	16.18%

Typical daily demands are calculated for each day type for the period November to February, excluding the full Christmas period.

The typical demands also exclude the period between time periods 34 and 36 for the Triad warning days.







TRIAD DEMAND ANALYSIS : WINTER 1991/92 & 1992/93

CUSTOMER NO : 19

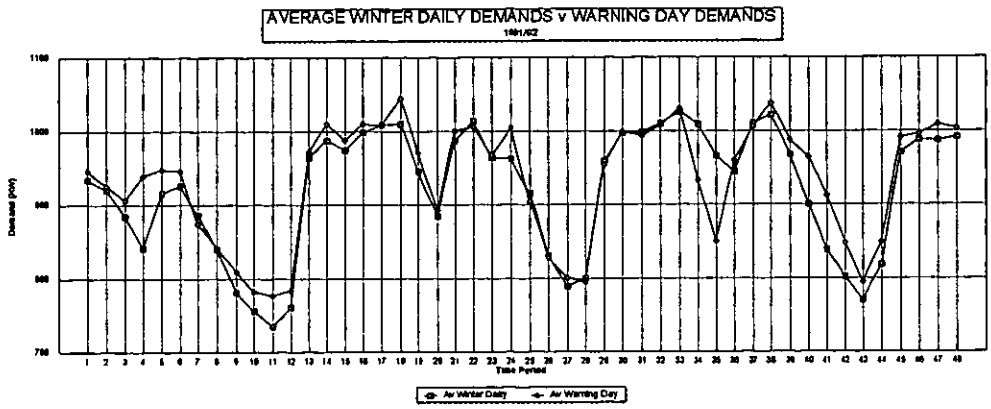
NAME : TIMBER INDUSTRY I

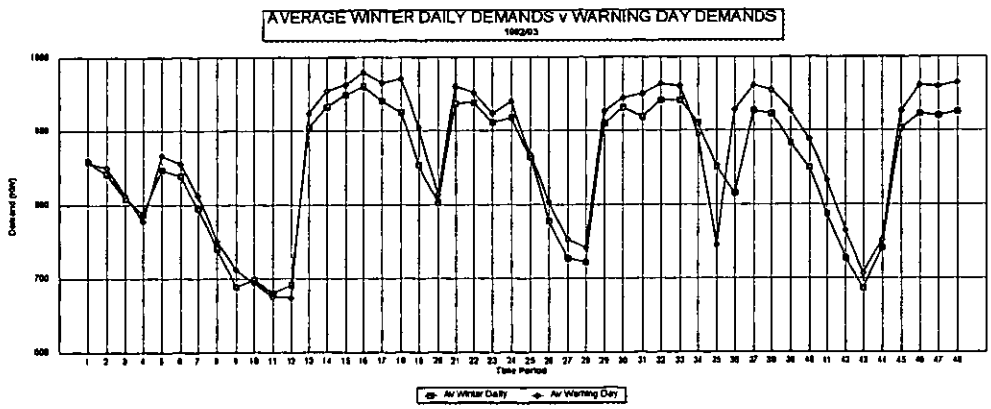
SIC CODE : 462

UNITS : KW

WINTER 91/92	32	33	34	35	36	37	38
AV DAILY	1,010	1,026	1,009	965	945	1,010	1,021
AV WARNING DA	1,008	1,030	933	851	959	1,006	1,037
Unit Reduction	3	(5)	76	115	(15)	4	(16)
%age Reduction	0%	-0%	8%	12%	-2%	0%	-2%

WINTER 92/93	32	33	34	35	36	37	38
AV DAILY	941	941	911	851	816	927	923
AV WARNING DA	963	960	895	745	929	962	955
Unit Reduction	(22)	(19)	16	106	(113)	(34)	(32)
%age Reduction	-2%	-2%	2%	13%	-14%	-4%	-4%





TRIAD DEMAND ANALYSIS : WINTER 1991/92

CUSTOMER NO : 20

NAME : PAPER MANUFACTURING / PROCESSING 1

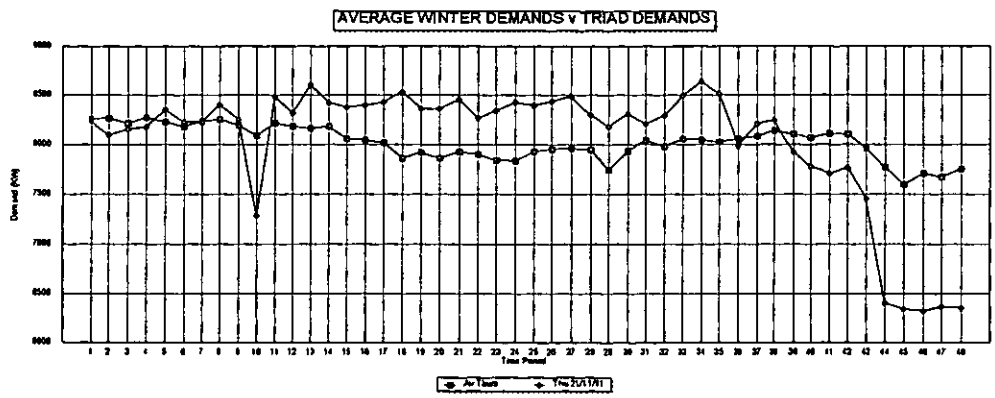
SIC CODE : 471

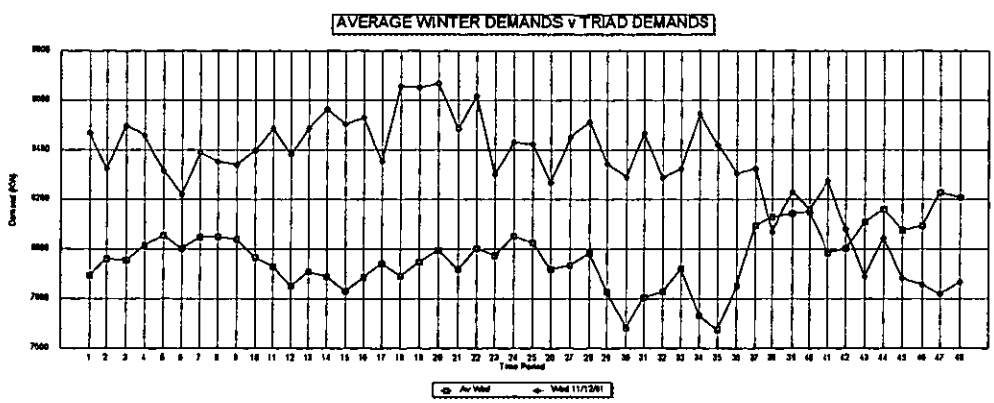
UNITS : KW

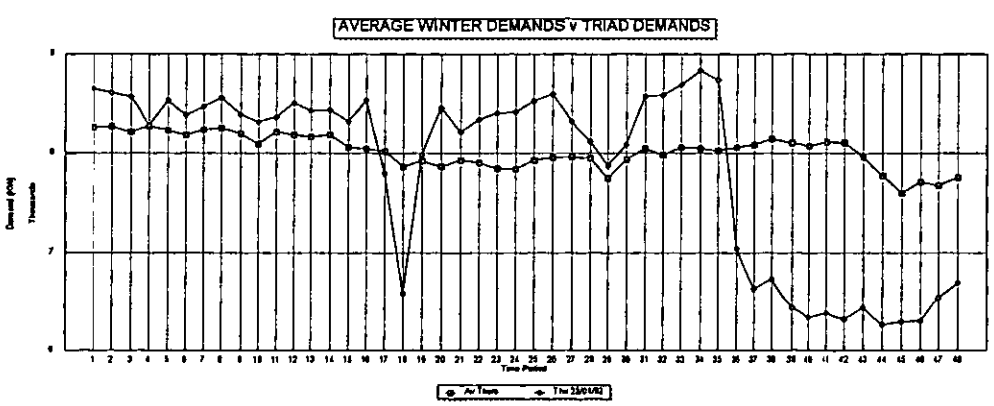
DAY	DATE	TP	ACTUAL DEMAND	TYPICAL DEMAND	DIFF	% DIFF
THU	11/21/91	35	8,516	8,030	(486)	-6.05%
WED	12/11/91	35	8,420	7,675	(745)	-9.70%
THU	01/23/92	35	8,740	8,030	(710)	-8.84%

Typical daily demands are calculated for each day type for the period November to February, excluding the full Christmas period.

The typical demands also exclude the period between time periods 34 and 36 for the Triad warning days







TRIAD DEMAND ANALYSIS : WINTER 1991/93

CUSTOMER REF : 20

NAME : PAPER MANUFACTURING / PROCESSING 1

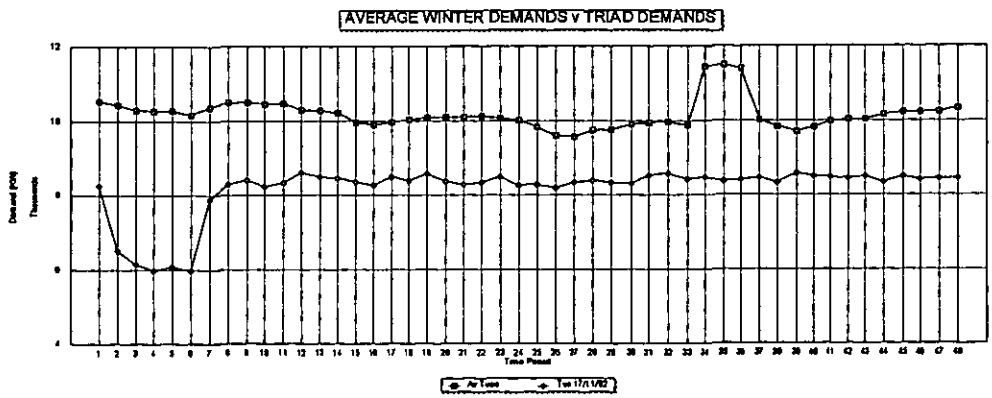
SIC CODE : 471

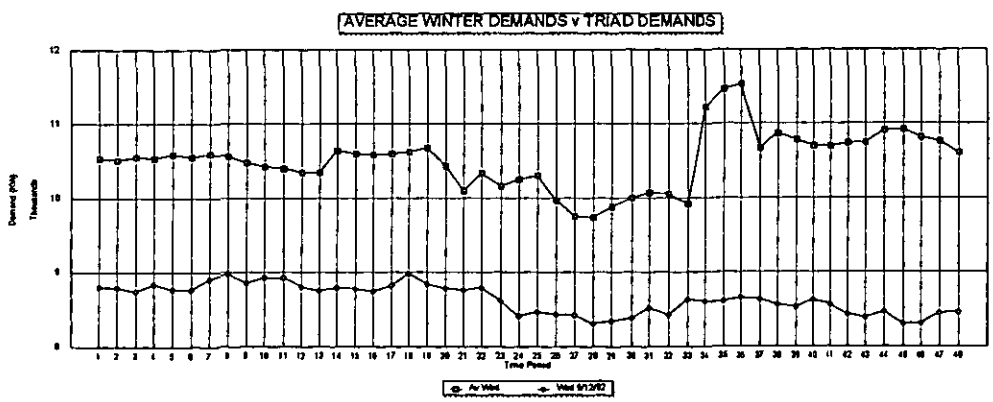
UNITS : KW

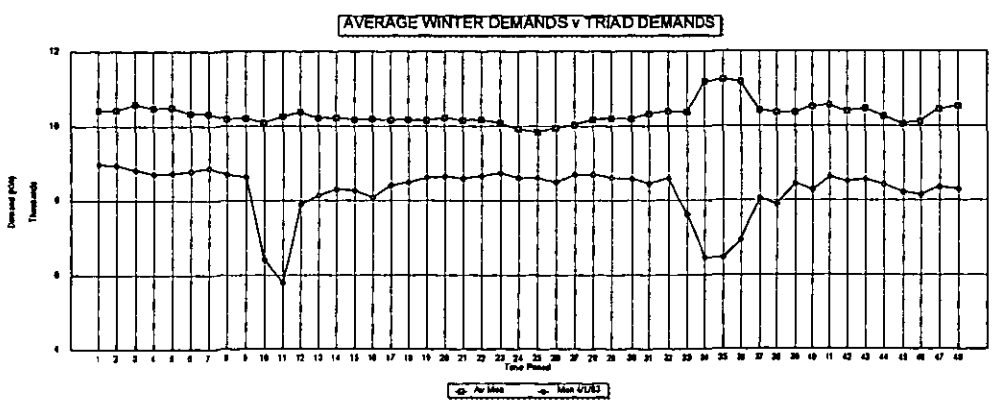
DAY	DATE	TP	ACTUAL DEMAND	TYPICAL DEMAND	DIFF	% DIFF
TUE	11/17/92	35	8,380	11,083	2,703	24.39%
WED	12/09/92	35	8,602	11,464	2,862	24.97%
MON	01/04/93	35	6,462	11,083	4,621	41.70%

Typical daily demands are calculated for each day type for the period November to February, excluding the full Christmas period.

The typical demands also exclude the period between time periods 34 and 36 for the Triad warning days.







TRIAD DEMAND ANALYSIS : WINTER 1991/92 & 1992/93

CUSTOMER NO : 20

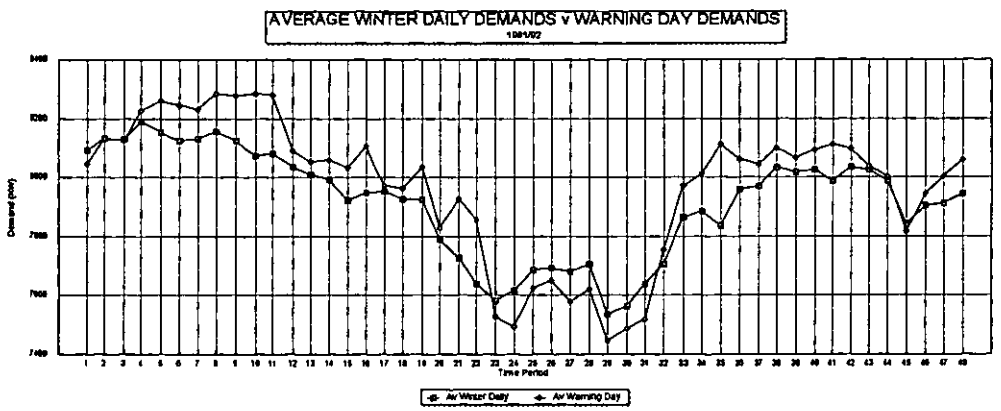
NAME : PAPER MANUFACTURING / PROCESSING 1

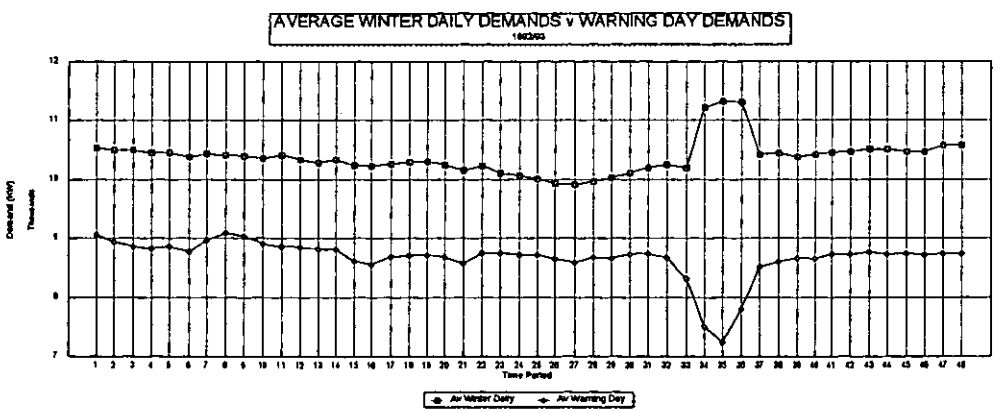
SIC CODE : 471

UNITS : KW

WINTER 91/92	32	33	34	35	36	37	38
AV DAILY	7,707	7,866	7,884	7,835	7,959	7,969	8,032
AV WARNING DAY	7,754	7,973	8,012	8,111	8,062	8,045	8,098
Unit Reduction	(47)	(107)	(128)	(276)	(103)	(76)	(66)
%age Reduction	-1%	-1%	-2%	-4%	-1%	-1%	-1%

WINTER 92/93	32	33	34	35	36	37	38
AV DAILY	10,249	10,192	11,221	11,318	11,306	10,420	10,446
AV WARNING DAY	8,673	8,323	7,504	7,235	7,800	8,509	8,597
Unit Reduction	1,576	1,869	3,716	4,083	3,506	1,911	1,849
%age Reduction	15%	18%	33%	36%	31%	18%	18%





TRIAD DEMAND ANALYSIS : WINTER 1991/92

CUSTOMER NO : 21

NAME : PAPER MANUFACTURING / PROCESSING 2

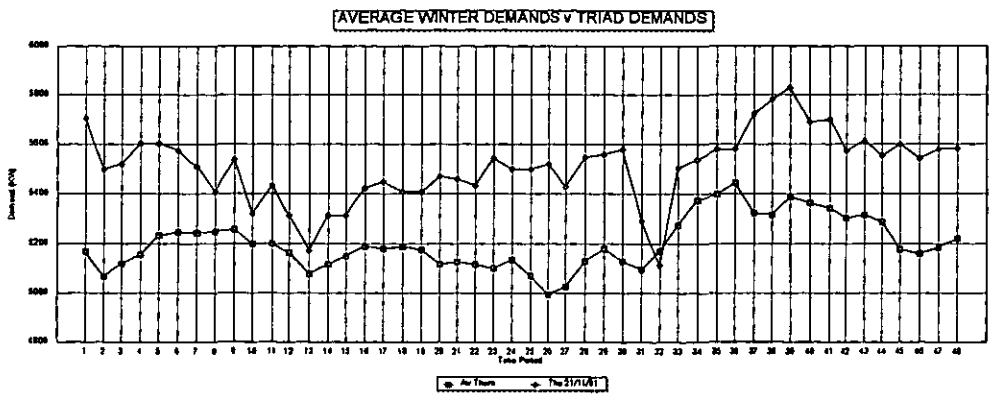
SIC CODE : 471

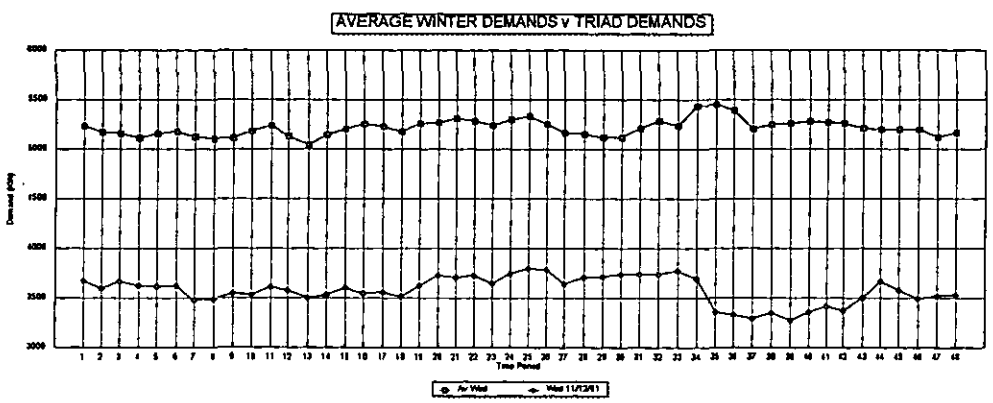
UNITS : KW

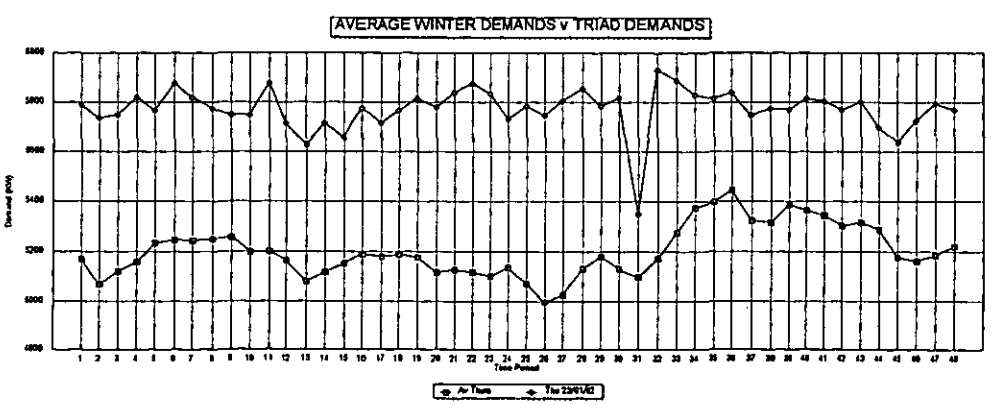
DAY	DATE	TP	ACTUAL DEMAND	TYPICAL DEMAND	DIFF	% DIFF
THU	11/21/91	35	5,580	5,400	(180)	-3.34%
WED	12/11/91	35	3,356	5,445	2,089	38.37%
THU	01/23/92	35	5,816	5,400	(416)	-7.71%

Typical daily demands are calculated for each day type for the period November to February, excluding the full Christmas period.

The typical demands also exclude the period between time periods 34 and 36 for the Triad warning days







TRIAD DEMAND ANALYSIS : WINTER 1992/93

CUSTOMER REF : 21

NAME : PAPER MANUFACTURING / PROCESSING 2

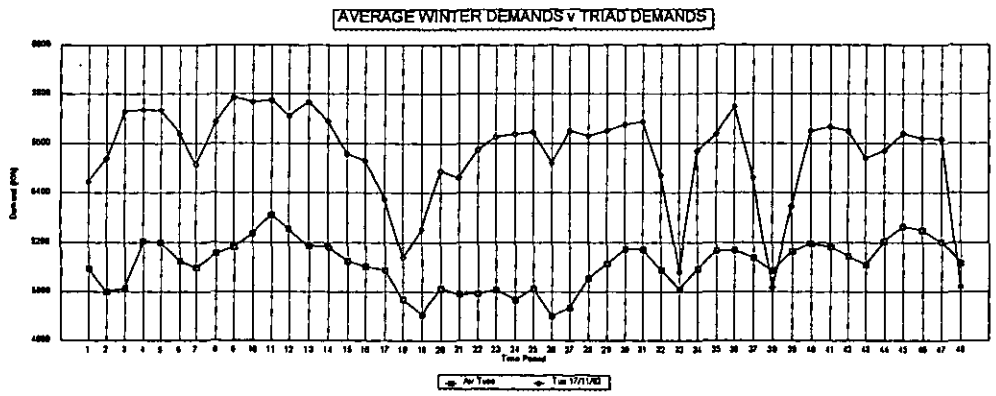
SIC CODE : 471

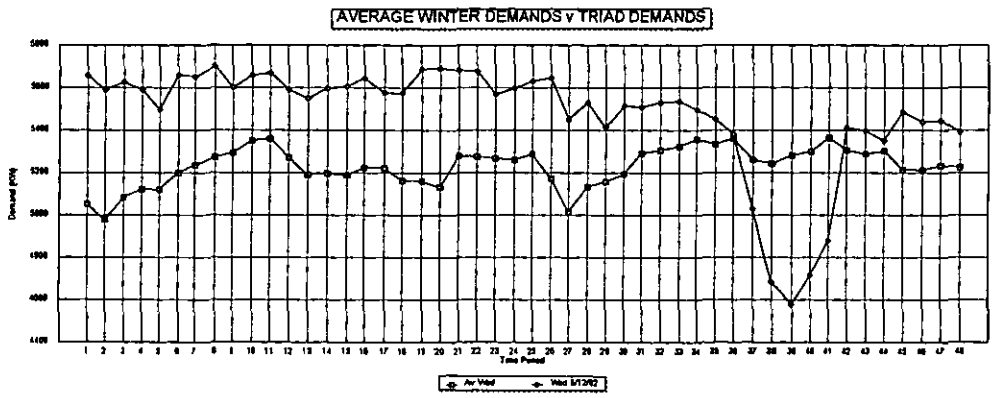
UNITS : KW

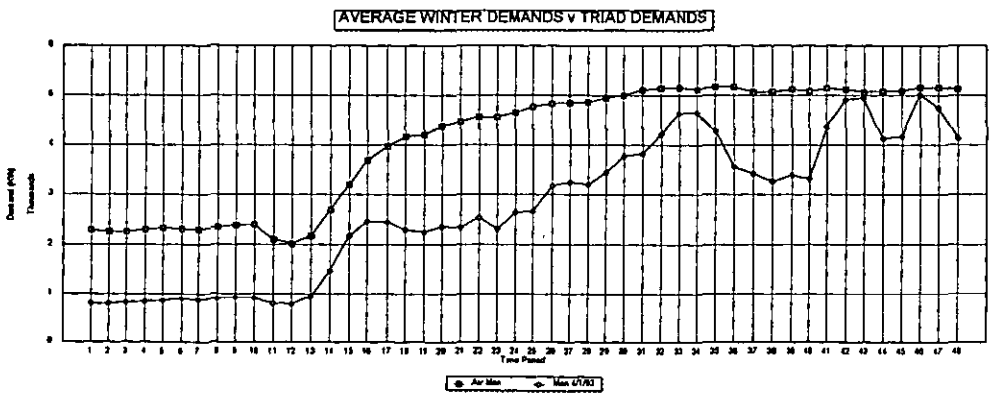
DAY	DATE	TP	ACTUAL DEMAND	TYPICAL DEMAND	DIFF	% DIFF
TUE	11/17/92	35	5,636	5,192	(444)	-8.55%
WED	12/09/92	35	5,450	5,332	(118)	-2.22%
MON	01/04/93	35	4,286	5,192	906	17.45%

Typical daily demands are calculated for each day type for the period November to February, excluding the full Christmas period.

The typical demands also exclude the period between time periods 34 and 36 for the Triad warning days.







TRIAD DEMAND ANALYSIS : WINTER 1991/92 & 1992/93

CUSTOMER NO : 21

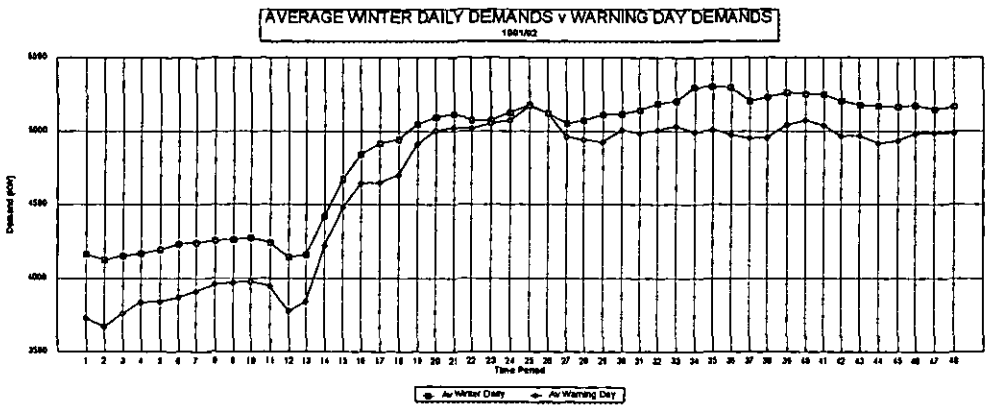
NAME : PAPER MANUFACTURING / PROCESSING 2

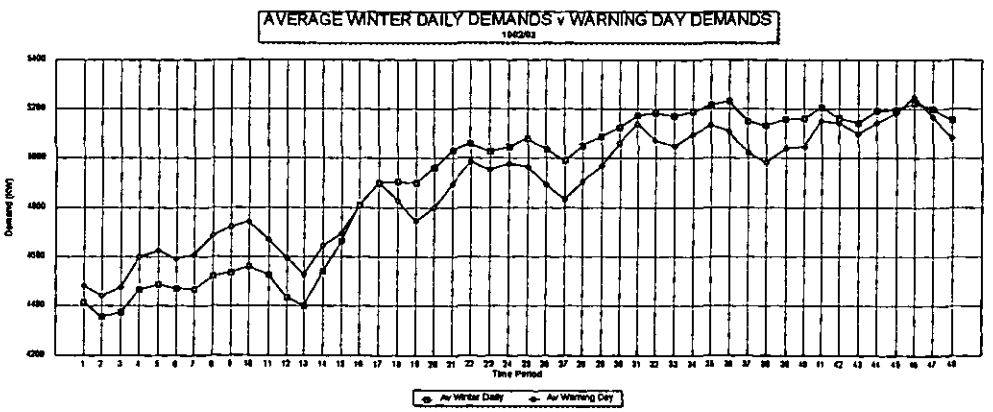
SIC CODE : 471

UNITS : KW

WINTER 91/92	32	33	34	35	36	37	38
AV DAILY	5,184	5,204	5,296	5,300	5,296	5,202	5,228
AV WARNING DA	5,005	5,032	4,996	5,005	4,973	4,951	4,953
Unit Reduction	179	172	300	295	323	251	274
%age Reduction	3%	3%	6%	6%	6%	5%	5%

WINTER 92/93	32	33	34	35	36	37	38
AV DAILY	5,184	5,171	5,190	5,216	5,230	5,150	5,131
AV WARNING DA	5,075	5,049	5,095	5,136	5,107	5,023	4,982
Unit Reduction	108	123	94	80	123	127	149
%age Reduction	2%	2%	2%	2%	2%	2%	3%





TRIAD DEMAND ANALYSIS : WINTER 1991/92

CUSTOMER NO : 22

NAME : PAPER MANUFACTURING / PROCESSING 3

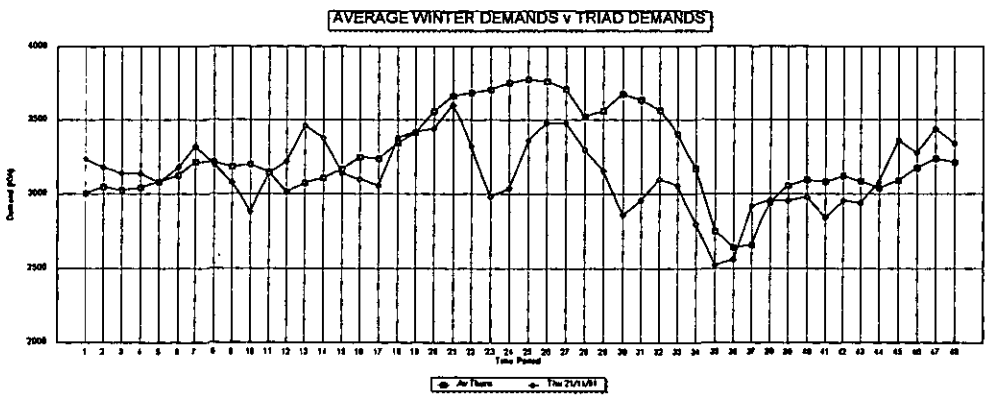
SIC CODE : 471

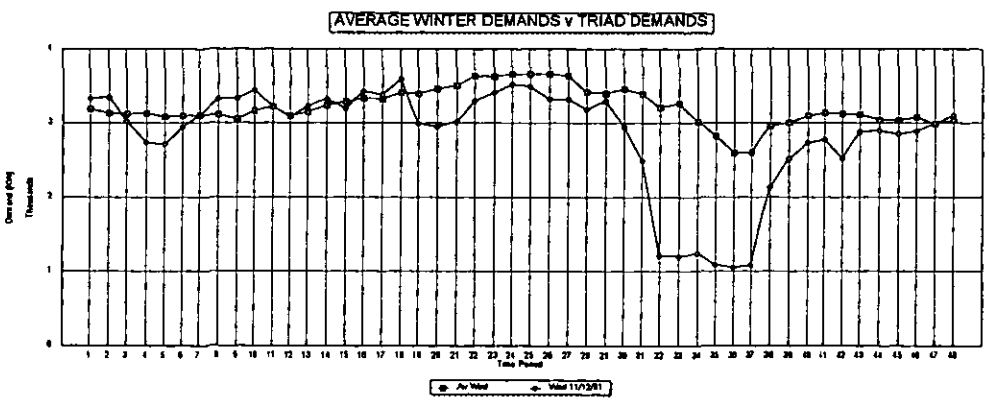
UNITS : KW

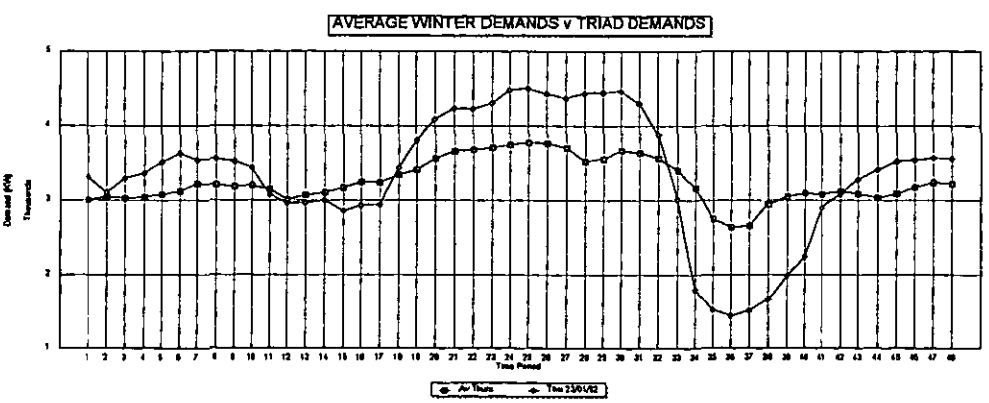
DAY	DATE	TP	ACTUAL DEMAND	TYPICAL DEMAND	DIFF	% DIFF
THU	11/21/91	35	2,520	2,751	231	8.39%
WED	12/11/91	35	1,090	2,822	1,732	61.37%
THU	01/23/92	35	1,520	2,751	1,231	44.74%

Typical daily demands are calculated for each day type for the period November to February, excluding the full Christmas period.

The typical demands also exclude the period between time periods 34 and 36 for the Triad warning days







TRIAD DEMAND ANALYSIS : WINTER 1992/93

CUSTOMER REF : 22

NAME : PAPER MANUFACTURING / PROCESSING 3

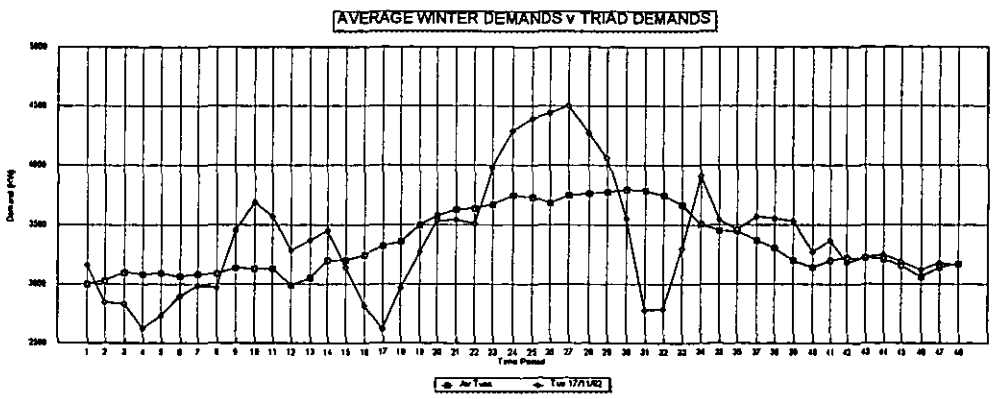
SIC CODE : 471

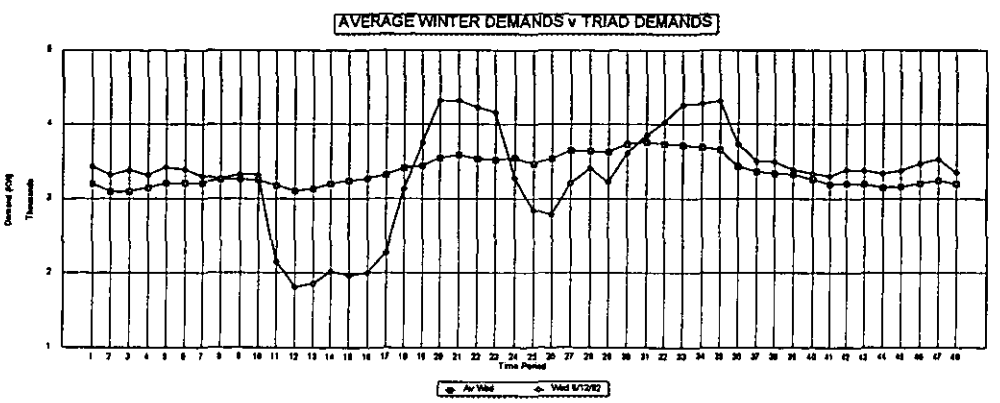
UNITS : KW

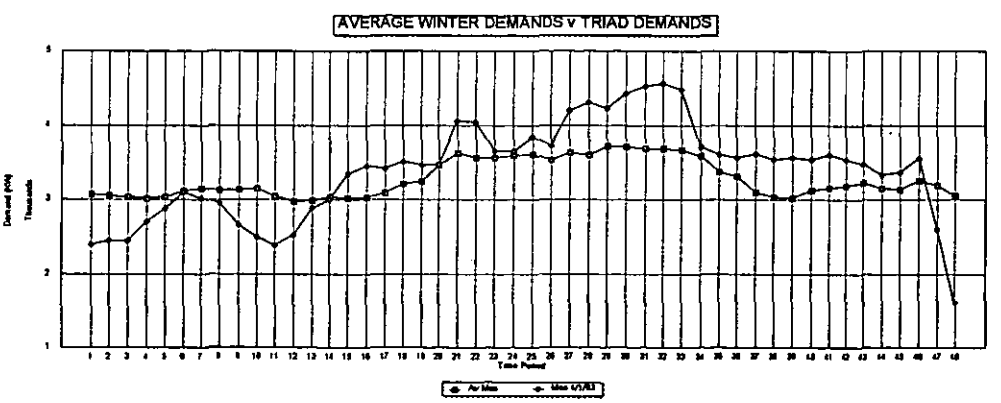
DAY	DATE	TP	ACTUAL DEMAND	TYPICAL DEMAND	DIFF	% DIFF
TUE	11/17/92	35	3,540	3,491	(49)	-1.41%
WED	12/09/92	35	4,310	3,657	(653)	-17.87%
MON	01/04/93	35	3,610	3,491	(119)	-3.42%

Typical daily demands are calculated for each day type for the period November to February, excluding the full Christmas period.

The typical demands also exclude the period between time periods 34 and 36 for the Triad warning days.







TRIAD DEMAND ANALYSIS : WINTER 1991/92 & 1992/93

CUSTOMER NO : 22

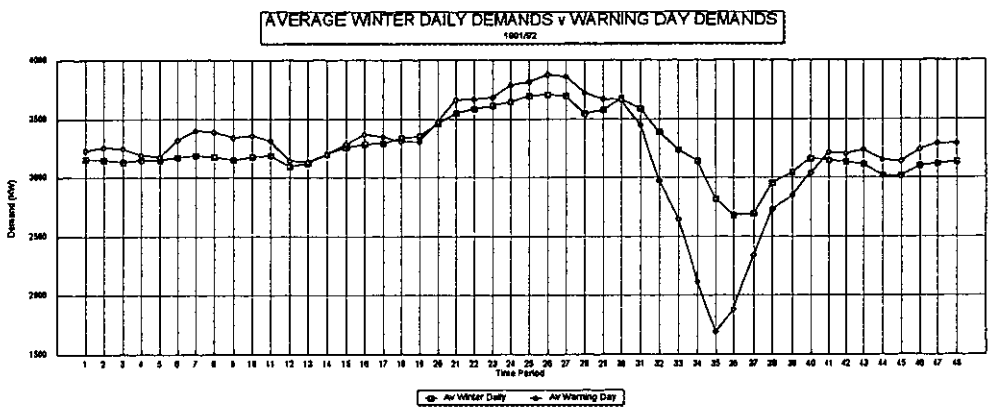
NAME : PAPER MANUFACTURING / PROCESSING 3

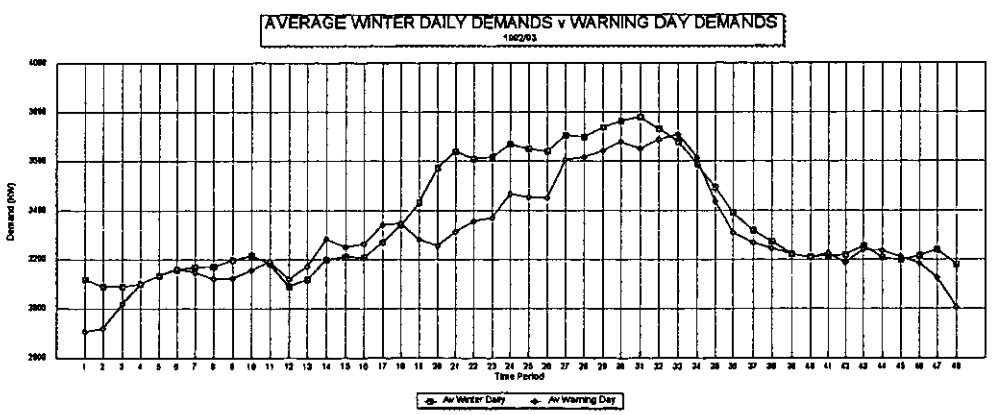
SIC CODE : 471

UNITS : KW

WINTER 91/92	32	33	34	35	36	37	38
AV DAILY	3,389	3,237	3,137	2,818	2,679	2,691	2,954
AV WARNING DA	2,973	2,645	2,115	1,694	1,882	2,343	2,727
Unit Reduction	416	592	1,022	1,124	798	348	227
%age Reduction	12%	18%	33%	40%	30%	13%	8%

WINTER 92/93	32	33	34	35	36	37	38
AV DAILY	3,731	3,680	3,589	3,493	3,392	3,317	3,273
AV WARNING DA	3,687	3,708	3,613	3,435	3,309	3,268	3,243
Unit Reduction	43	(28)	(23)	58	83	49	29
%age Reduction	1%	-1%	-1%	2%	2%	1%	1%





TRIAD DEMAND ANALYSIS : WINTER 1991/92

CUSTOMER NO : 23

NAME : PAPER MANUFACTURING / PROCESSING 4

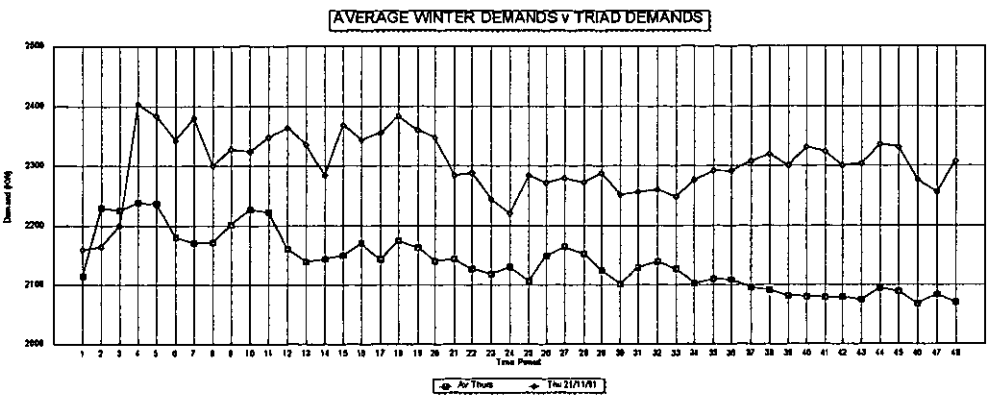
SIC CODE : 471

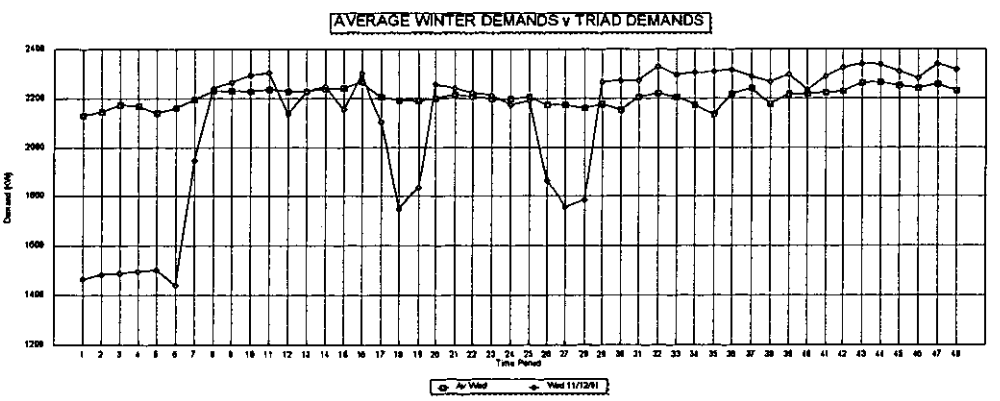
UNITS : KW

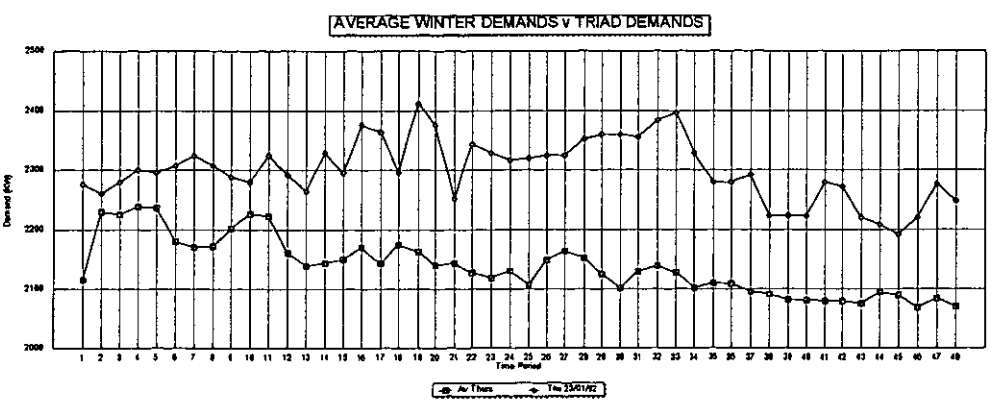
DAY	DATE	TP	ACTUAL DEMAND	TYPICAL DEMAND	DIFF	% DIFF
THU	11/21/91	35	2,292	2,110	(182)	-8.63%
WED	12/11/91	35	2,308	2,133	(175)	-8.19%
THU	01/23/92	35	2,280	2,110	(170)	-8.06%

Typical daily demands are calculated for each day type for the period November to February, excluding the full Christmas period.

The typical demands also exclude the period between time periods 34 and 36 for the Triad warning days







TRIAD DEMAND ANALYSIS : WINTER 1992/93

CUSTOMER REF : 23

NAME : PAPER MANUFACTURING / PROCESSING 4

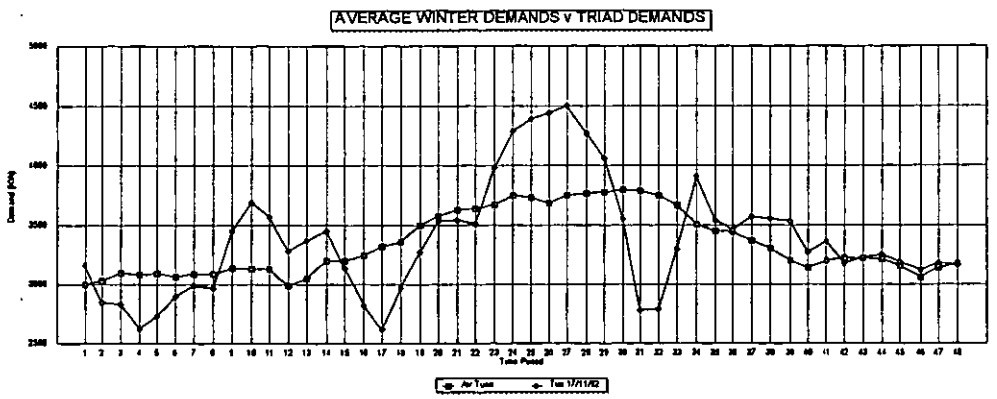
SIC CODE : 471

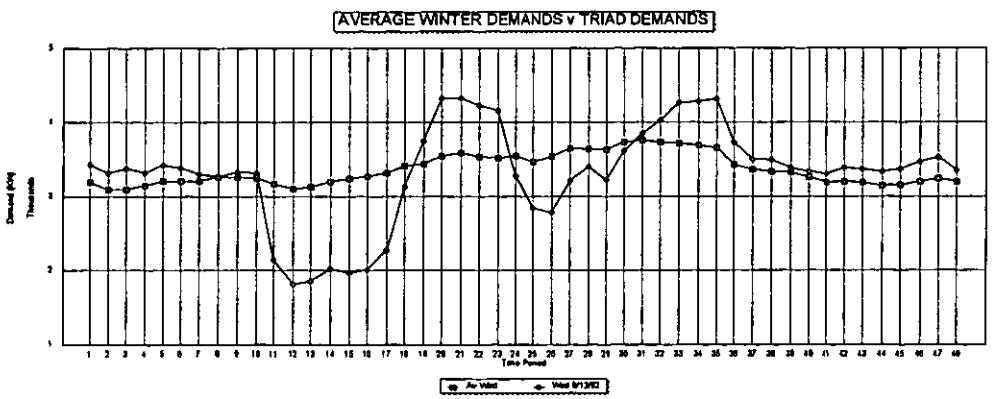
UNITS : KW

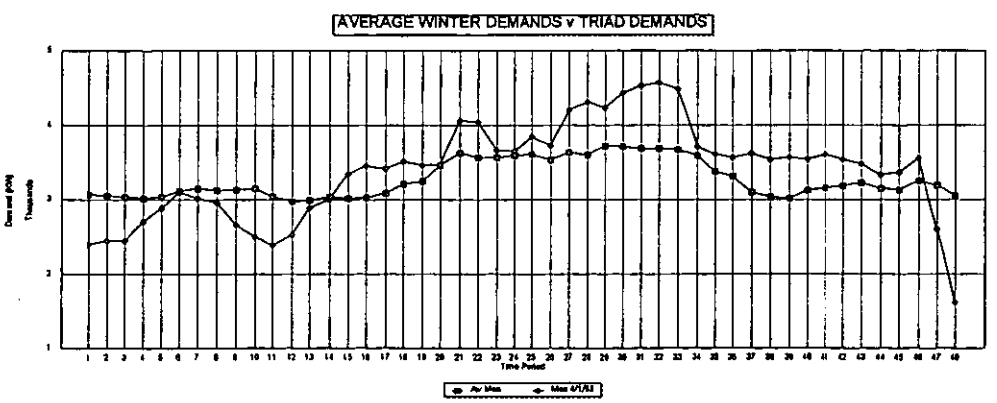
DAY	DATE	TP	ACTUAL DEMAND	TYPICAL DEMAND	DIFF	% DIFF
TUE	11/17/92	35	3,540	3,491	(49)	-1.41%
WED	12/09/92	35	4,310	3,657	(653)	-17.87%
MON	01/04/93	35	3,610	3,491	(119)	-3.42%

Typical daily demands are calculated for each day type for the period November to February, excluding the full Christmas period.

The typical demands also exclude the period between time periods 34 and 36 for the Triad warning days.







TRIAD DEMAND ANALYSIS : WINTER 1991/92 & 1992/93

CUSTOMER NO : 23

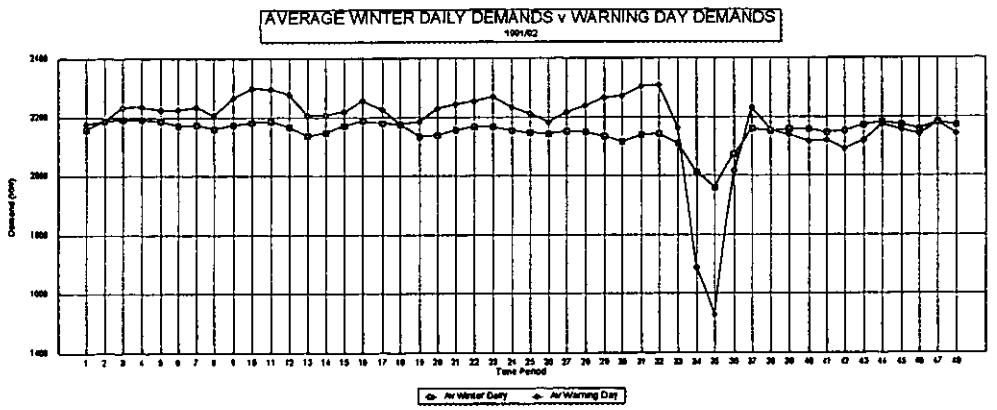
NAME : PAPER MANUFACTURING / PROCESSING 4

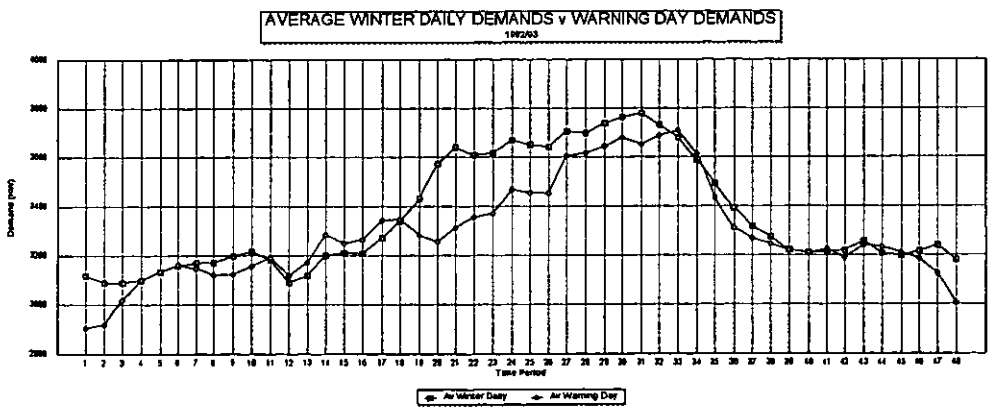
SIC CODE : 471

UNITS : KW

WINTER 91/92	32	33	34	35	36	37	38
AV DAILY	2,141	2,110	2,012	1,960	2,073	2,159	2,151
AV WARNING DA	2,309	2,162	1,688	1,530	2,016	2,232	2,157
Unit Reduction	(168)	(53)	324	430	57	(72)	(5)
%age Reduction	-8%	-2%	16%	22%	3%	-3%	-0%

WINTER 92/93	32	33	34	35	36	37	38
AV DAILY	3,731	3,680	3,589	3,493	3,392	3,317	3,273
AV WARNING DA	3,687	3,708	3,613	3,435	3,309	3,268	3,243
Unit Reduction	43	(28)	(23)	58	83	49	29
%age Reduction	1%	-1%	-1%	2%	2%	1%	1%





TRIAD DEMAND ANALYSIS : WINTER 1991/92

CUSTOMER NO : 24

NAME : RUBBER INDUSTRY 1

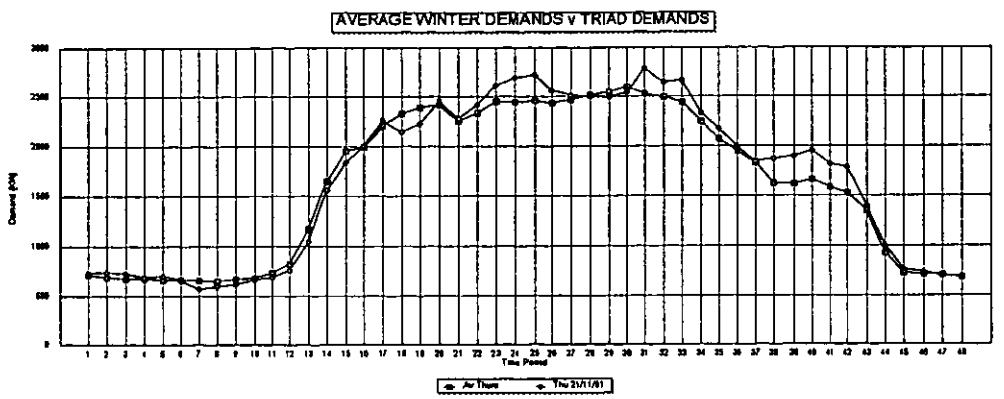
SIC CODE : 481

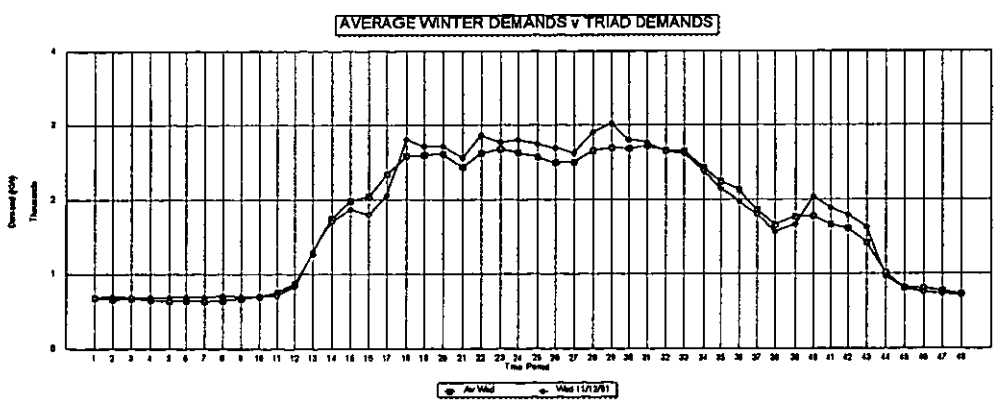
UNITS : KW

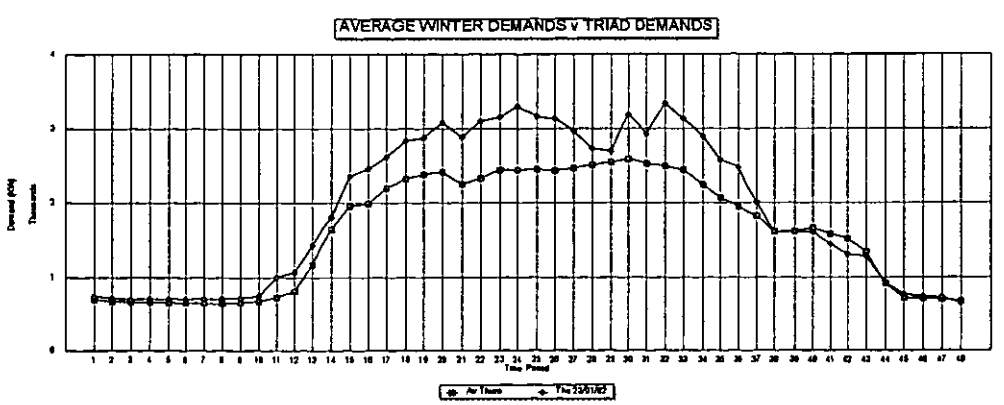
DAY	DATE	TP	ACTUAL DEMAND	TYPICAL DEMAND	DIFF	% DIFF
THU	11/21/91	35	2,176	2,075	(101)	-4.86%
WED	12/11/91	35	2,148	2,242	94	4.21%
THU	01/23/92	35	2,584	2,075	(509)	-24.53%

Typical daily demands are calculated for each day type for the period November to February, excluding the full Christmas period.

The typical demands also exclude the period between time periods 34 and 36 for the Triad warning days







TRIAD DEMAND ANALYSIS : WINTER 1992/93

CUSTOMER REF : 24

NAME : RUBBER INDUSTRY 1

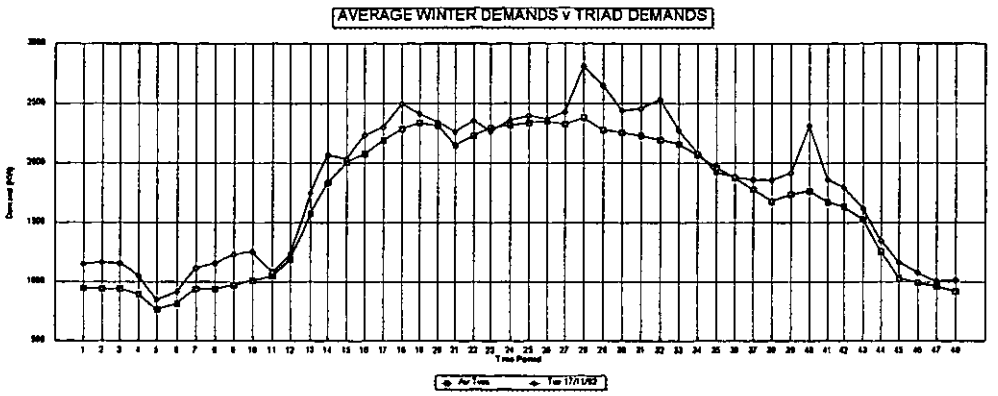
SIC CODE : 481

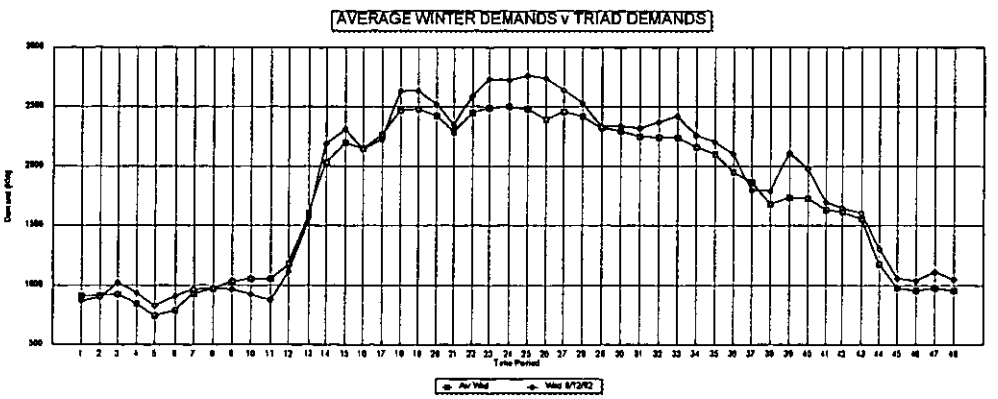
UNITS : KW

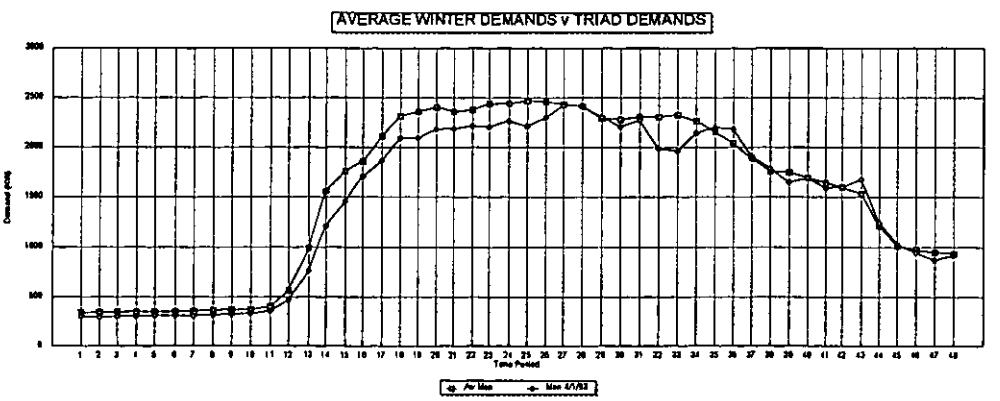
DAY	DATE	TP	ACTUAL DEMAND	TYPICAL DEMAND	DIFF	% DIFF
TUE	11/17/92	35	1,920	1,987	67	3.38%
WED	12/09/92	35	2,204	2,101	(103)	-4.91%
MON	01/04/93	35	2,204	1,987	(217)	-10.92%

Typical daily demands are calculated for each day type for the period November to February, excluding the full Christmas period.

The typical demands also exclude the period between time periods 34 and 36 for the Triad warning days.







TRIAD DEMAND ANALYSIS : WINTER 1991/92 & 1992/93

CUSTOMER NO : 24

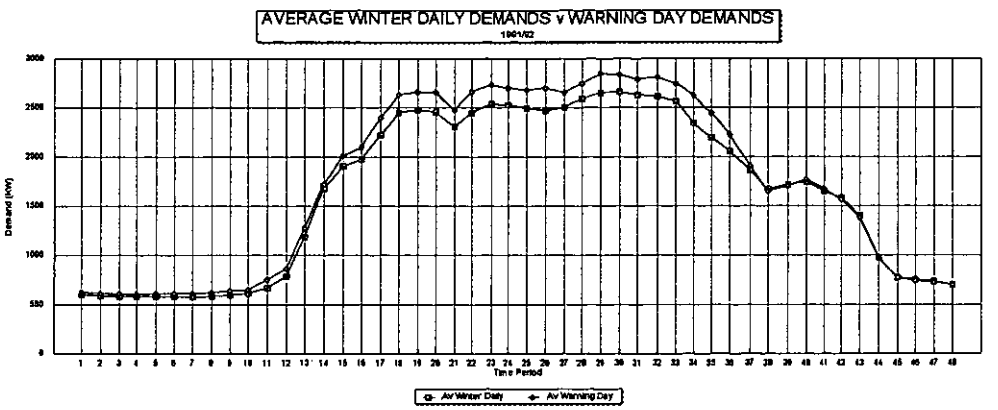
NAME : RUBBER INDUSTRY 1

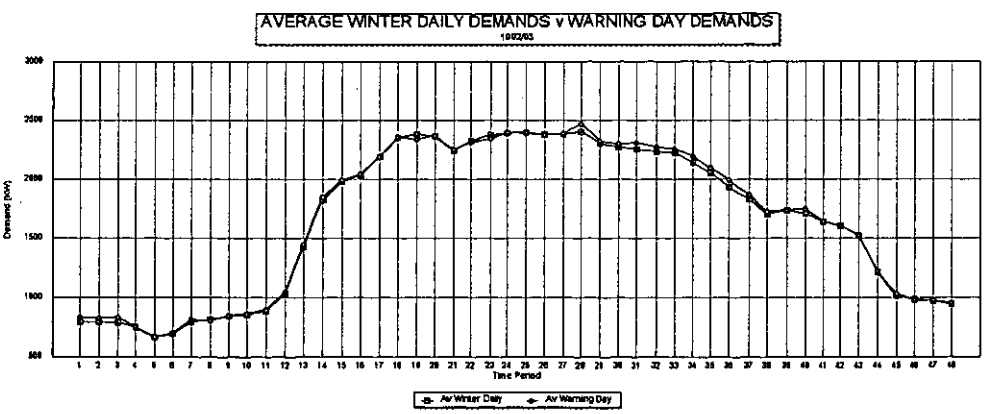
SIC CODE : 481

UNITS : KW

WINTER 91/92	32	33	34	35	36	37	38
AV DAILY	2,615	2,567	2,344	2,195	2,059	1,861	1,673
AV WARNING DA	2,811	2,747	2,627	2,443	2,228	1,908	1,650
Unit Reduction	(196)	(181)	(283)	(247)	(169)	(47)	23
%age Reduction	-8%	-7%	-12%	-11%	-8%	-3%	1%

WINTER 92/93	32	33	34	35	36	37	38
AV DAILY	2,232	2,223	2,140	2,053	1,933	1,830	1,704
AV WARNING DA	2,272	2,258	2,197	2,096	1,994	1,868	1,724
Unit Reduction	(41)	(35)	(57)	(43)	(61)	(38)	(20)
%age Reduction	-2%	-2%	-3%	-2%	-3%	-2%	-1%





TRIAD DEMAND ANALYSIS : WINTER 1991/92

CUSTOMER NO : 25

NAME : RUBBER INDUSTRY 2

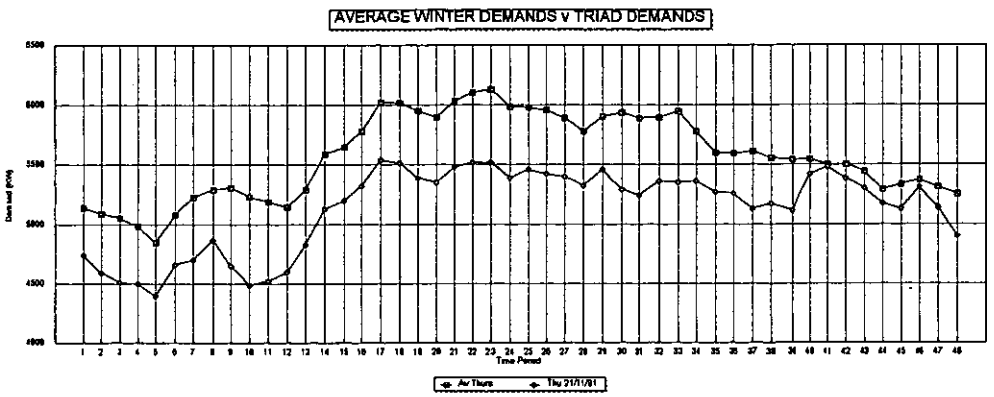
SIC CODE : 481

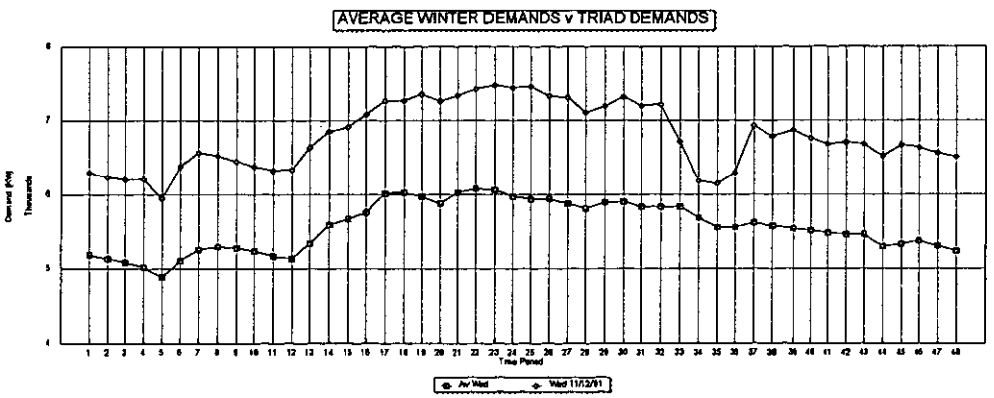
UNITS : KW

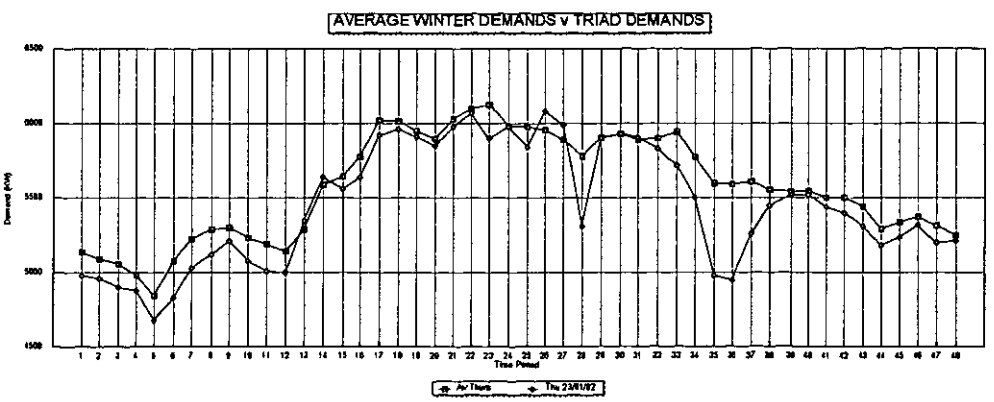
DAY	DATE	TP	ACTUAL DEMAND	TYPICAL DEMAND	DIFF	% DIFF
THU	11/21/91	35	5,270	5,597	327	5.84%
WED	12/11/91	35	6,150	5,557	(593)	-10.67%
THU	01/23/92	35	4,980	5,597	617	11.02%

Typical daily demands are calculated for each day type for the period November to February, excluding the full Christmas period.

The typical demands also exclude the period between time periods 34 and 36 for the Triad warning days







TRIAD DEMAND ANALYSIS : WINTER 1992/93

CUSTOMER REF : 25

NAME : RUBBER INDUSTRY 2

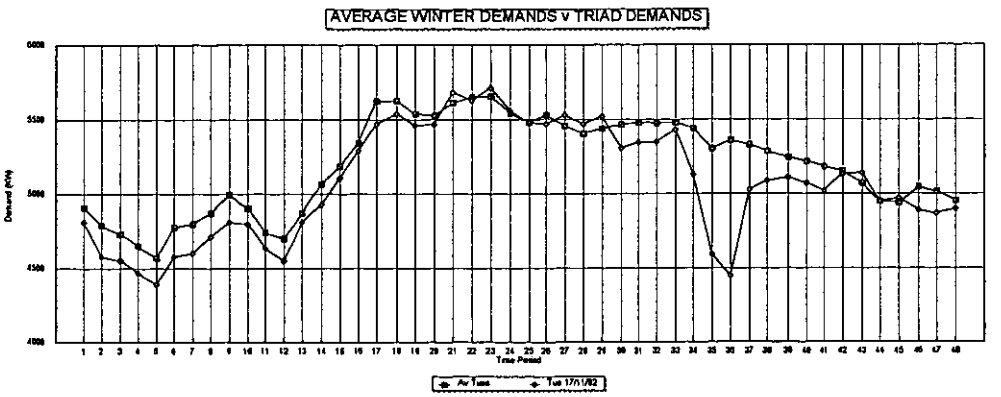
SIC CODE : 481

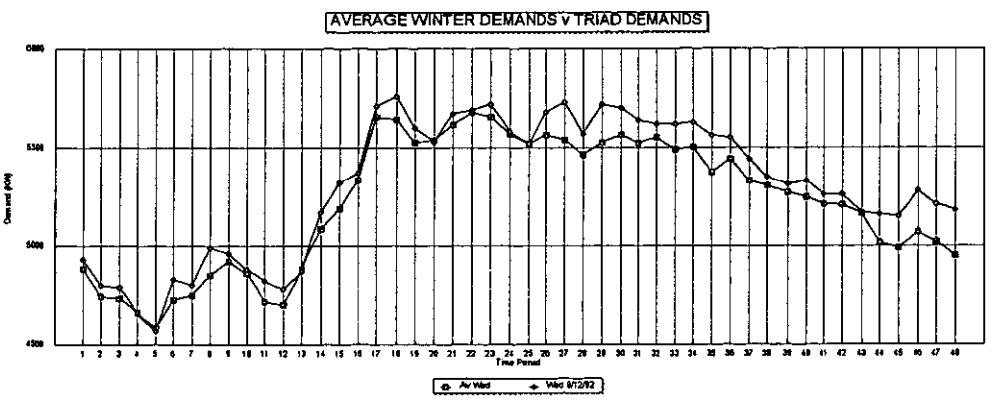
UNITS : KW

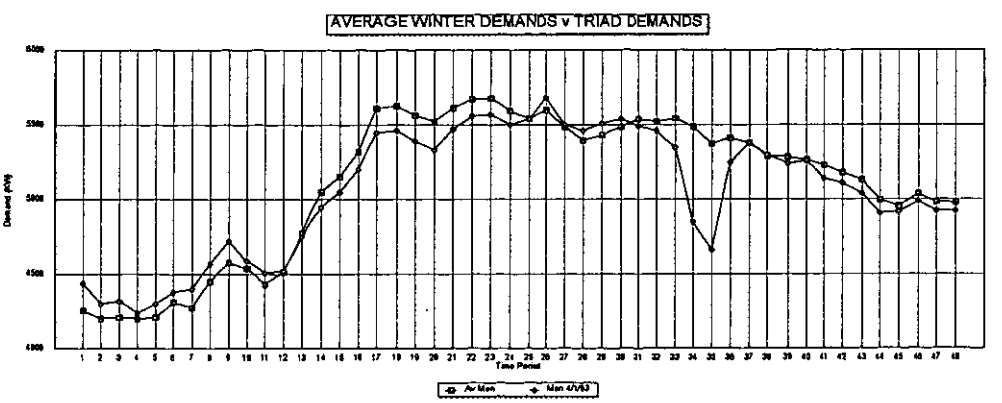
DAY	DATE	TP	ACTUAL DEMAND	TYPICAL DEMAND	DIFF	% DIFF
TUE	11/17/92	35	4,590	5,378	788	14.66%
WED	12/09/92	35	5,560	5,374	(186)	-3.45%
MON	01/04/93	35	4,660	5,378	718	13.36%

Typical daily demands are calculated for each day type for the period November to February, excluding the full Christmas period.

The typical demands also exclude the period between time periods 34 and 36 for the Triad warning days.







TRIAD DEMAND ANALYSIS : WINTER 1991/92 & 1992/93

CUSTOMER NO : 25

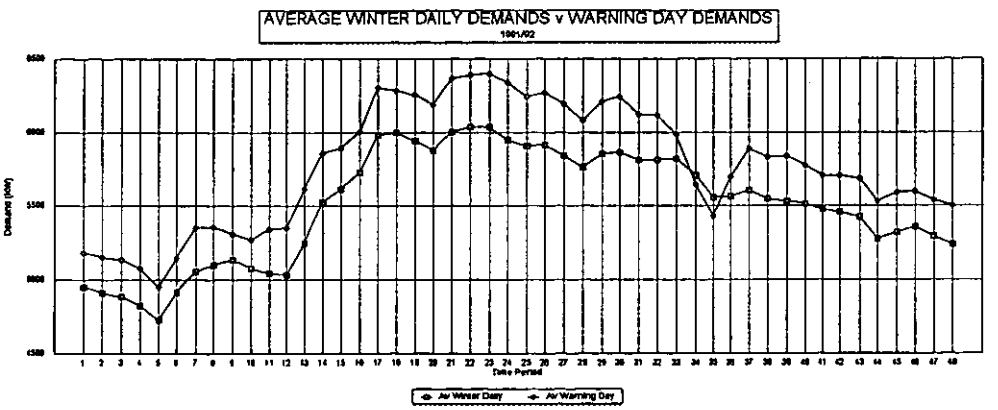
NAME : RUBBER INDUSTRY 2

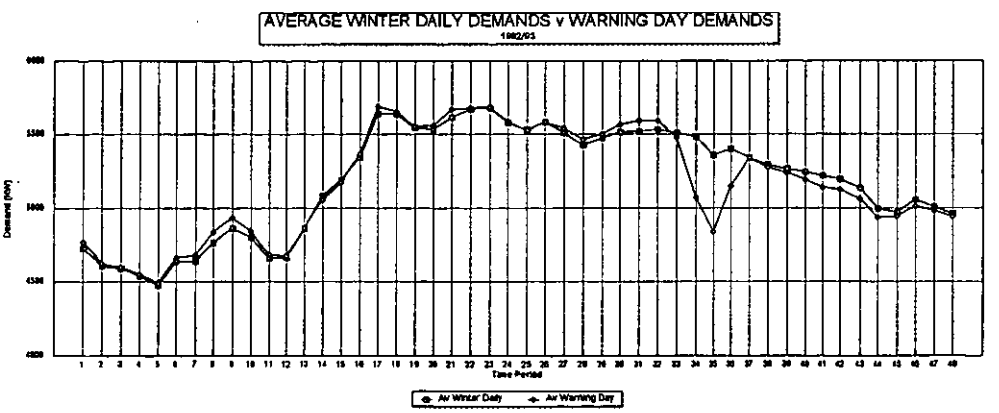
SIC CODE : 481

UNITS : KW

WINTER 91/92	32	33	34	35	36	37	38
AV DAILY	5,811	5,818	5,708	5,557	5,566	5,605	5,547
AV WARNING DA	6,117	5,984	5,647	5,433	5,696	5,888	5,834
Unit Reduction	(306)	(166)	62	124	(130)	(283)	(287)
%age Reduction	-5%	-3%	1%	2%	-2%	-5%	-5%

WINTER 92/93	32	33	34	35	36	37	38
AV DAILY	5,531	5,508	5,485	5,358	5,402	5,338	5,291
AV WARNING DA	5,593	5,477	5,070	4,835	5,146	5,341	5,275
Unit Reduction	(63)	31	415	523	255	(3)	15
%age Reduction	-1%	1%	8%	10%	5%	-0%	0%





TRIAD DEMAND ANALYSIS : WINTER 1991/92

CUSTOMER NO : 26

NAME : PLASTICS PROCESSING 1

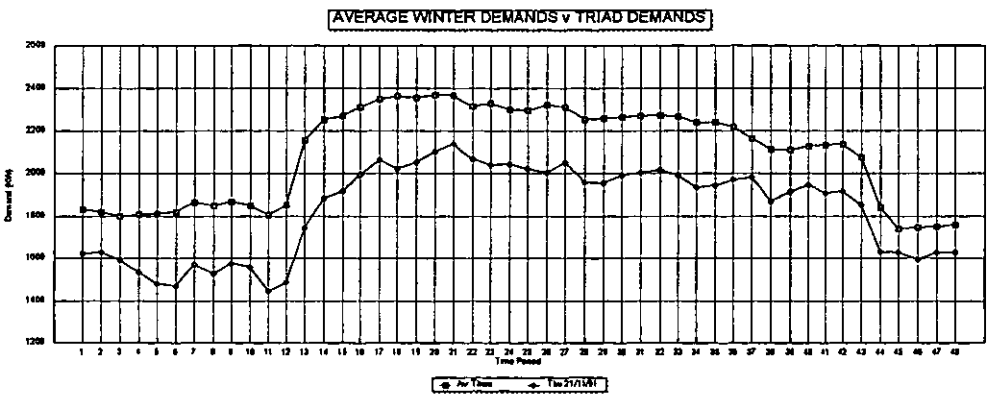
SIC CODE : 483

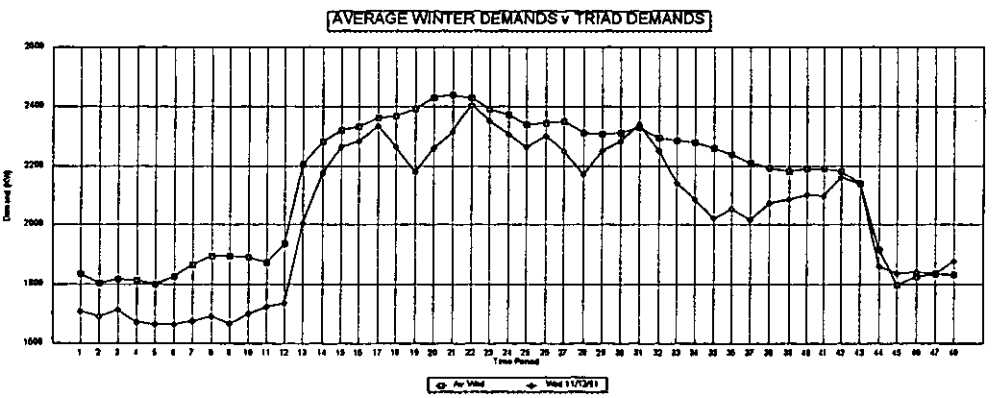
UNITS : KW

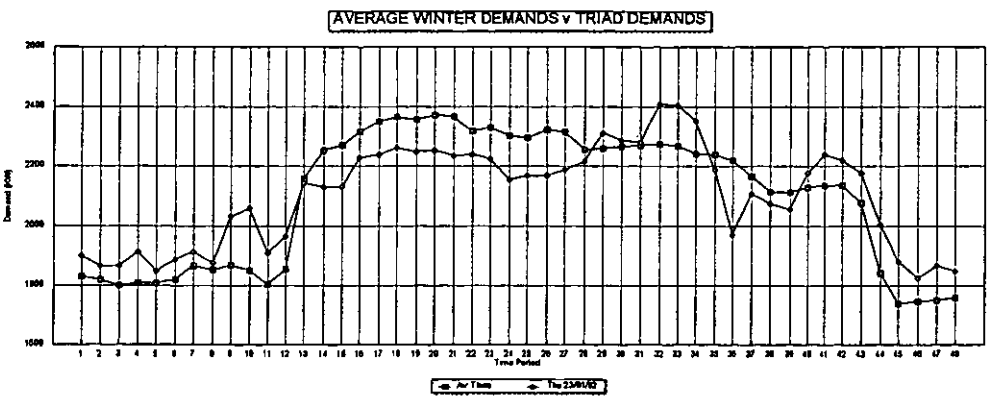
DAY	DATE	TP	ACTUAL DEMAND	TYPICAL DEMAND	DIFF	% DIFF
THU	11/21/91	35	1,944	2,240	296	13.20%
WED	12/11/91	35	2,020	2,260	240	10.62%
THU	01/23/92	35	2,188	2,240	52	2.31%

Typical daily demands are calculated for each day type for the period November to February, excluding the full Christmas period.

The typical demands also exclude the period between time periods 34 and 36 for the Triad warning days







TRIAD DEMAND ANALYSIS : WINTER 1992/93

CUSTOMER REF : 26

NAME : PLASTICS PROCESSING I

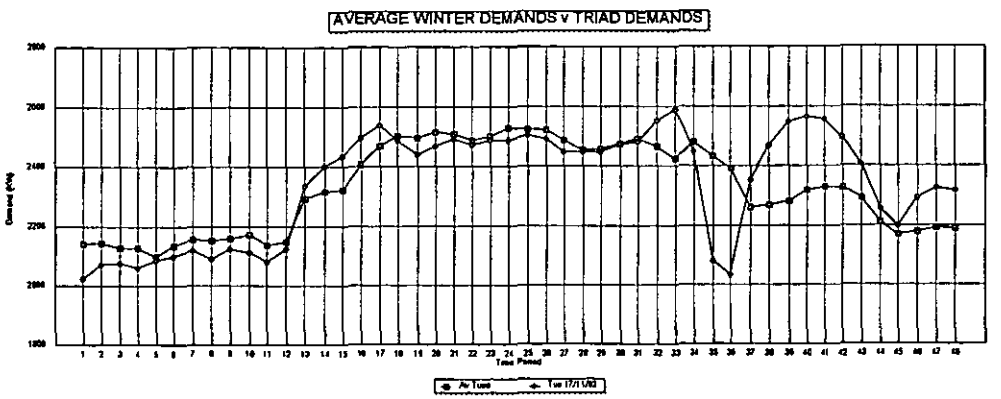
SIC CODE : 483

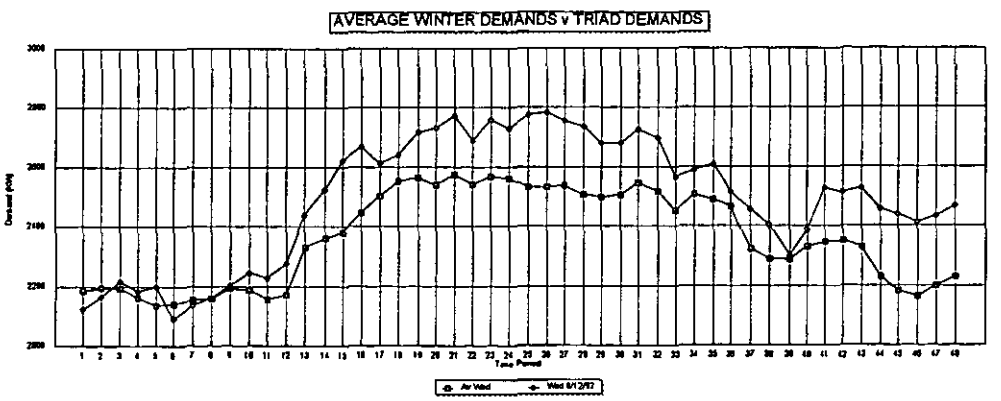
UNITS : KW

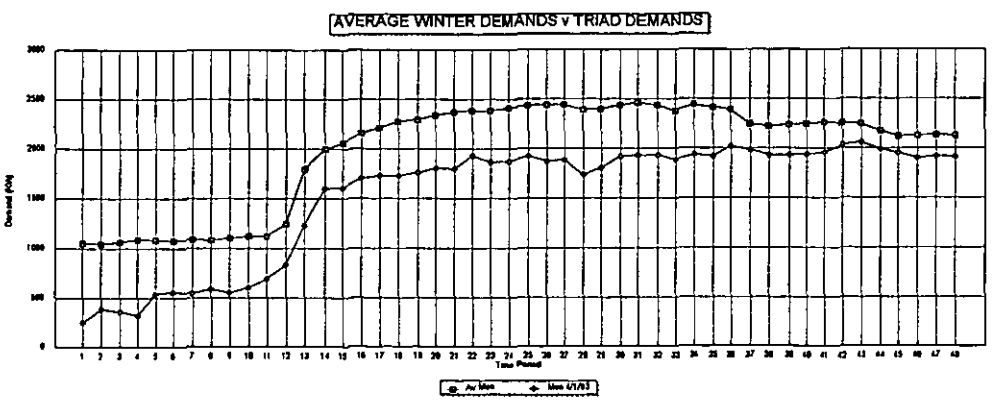
DAY	DATE	TP	ACTUAL DEMAND	TYPICAL DEMAND	DIFF	% DIFF
TUE	11/17/92	35	2,080	2,407	327	13.60%
WED	12/09/92	35	2,608	2,490	(118)	-4.75%
MON	01/04/93	35	1,920	2,407	487	20.25%

Typical daily demands are calculated for each day type for the period November to February, excluding the full Christmas period.

The typical demands also exclude the period between time periods 34 and 36 for the Triad warning days.







TRIAD DEMAND ANALYSIS : WINTER 1991/92 & 1992/93

CUSTOMER NO : 26

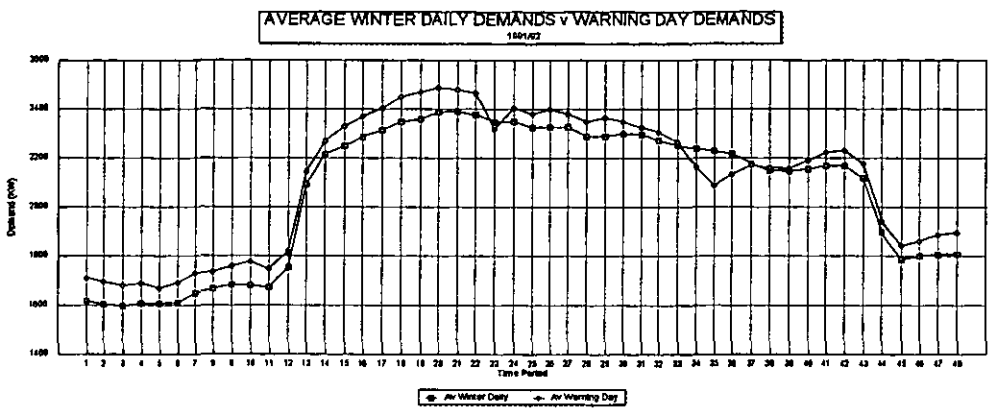
NAME : PLASTICS PROCESSING 1

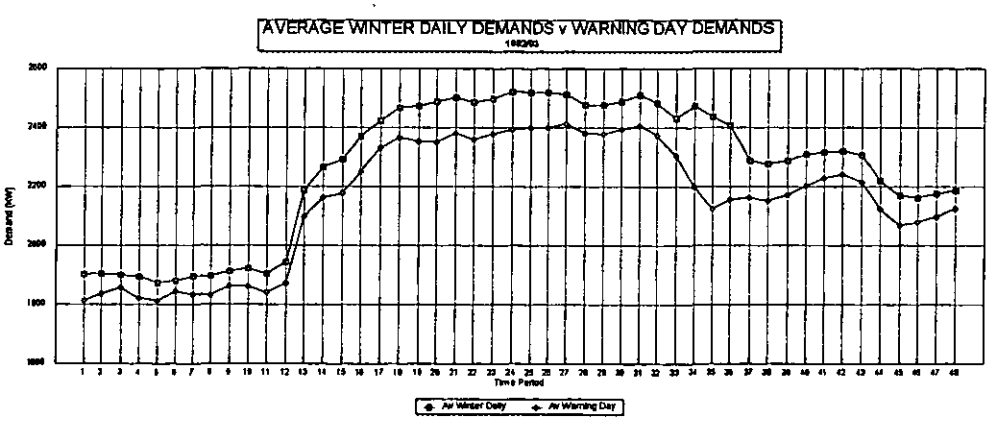
SIC CODE : 483

UNITS : KW

WINTER 91/92	32	33	34	35	36	37	38
AV DAILY	2,274	2,253	2,238	2,229	2,219	2,176	2,150
AV WARNING DA	2,308	2,265	2,162	2,085	2,134	2,171	2,160
Unit Reduction	(34)	(13)	75	143	85	4	(9)
%age Reduction	-2%	-1%	3%	6%	4%	0%	-0%

WINTER 92/93	32	33	34	35	36	37	38
AV DAILY	2,483	2,430	2,472	2,436	2,406	2,287	2,276
AV WARNING DA	2,374	2,305	2,200	2,123	2,157	2,163	2,152
Unit Reduction	109	125	272	314	250	124	125
%age Reduction	4%	5%	11%	13%	10%	5%	5%





TRIAD DEMAND ANALYSIS : WINTER 1991/92

CUSTOMER NO : 27

NAME : PLASTICS PROCESSING 2

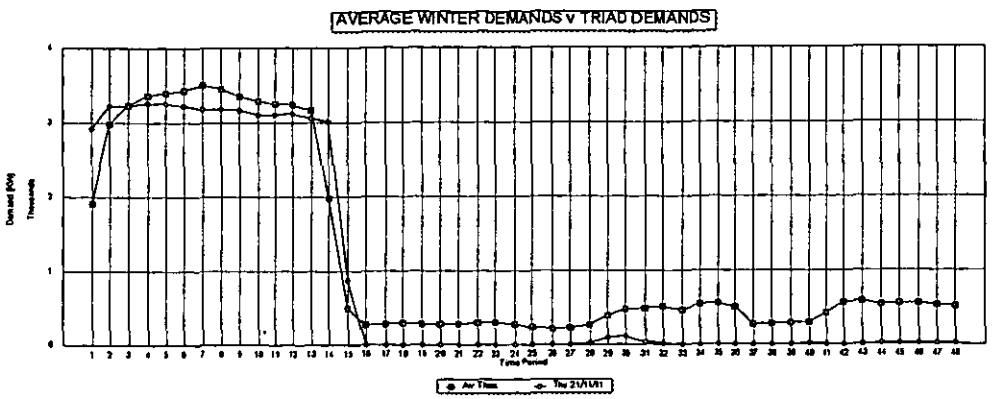
SIC CODE : 483

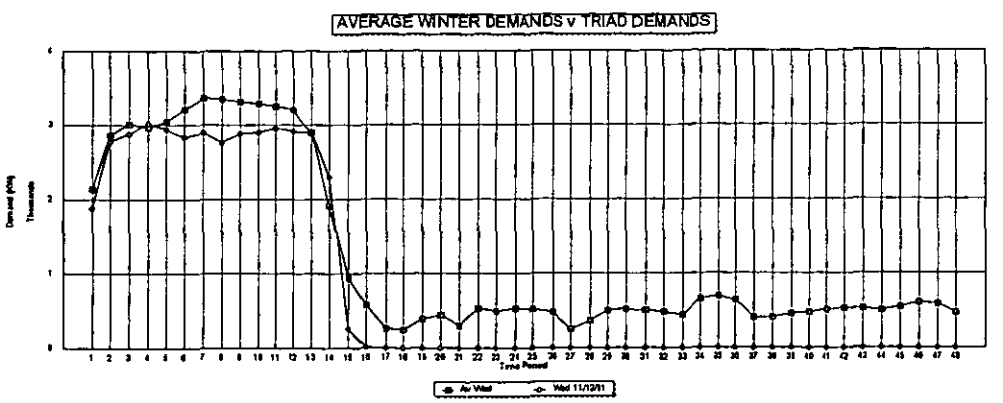
UNITS : KW

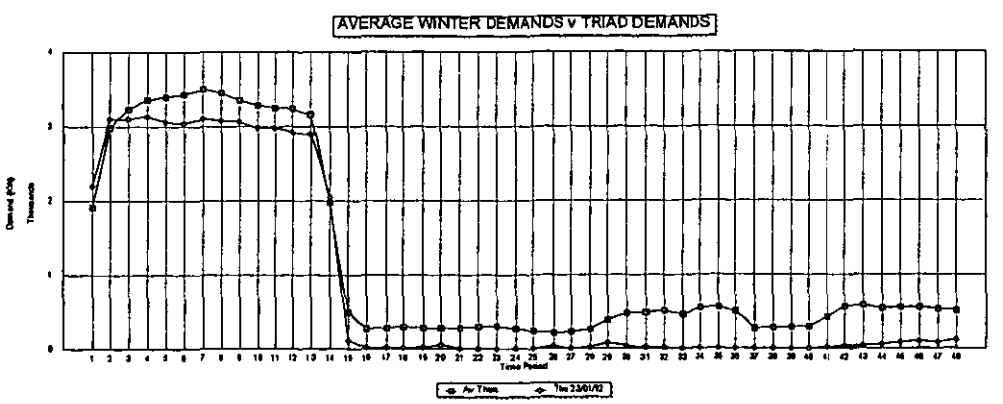
DAY	DATE	TP	ACTUAL DEMAND	TYPICAL DEMAND	DIFF	% DIFF
THU	11/21/91	35	0	558	558	100.00%
WED	12/11/91	35	0	692	692	100.00%
THU	01/23/92	35	0	558	558	100.00%

Typical daily demands are calculated for each day type for the period November to February, excluding the full Christmas period.

The typical demands also exclude the period between time periods 34 and 36 for the Triad warning days







TRIAD DEMAND ANALYSIS : WINTER 1992/93

CUSTOMER REF : 27

NAME : PLASTICS PROCESSING 2

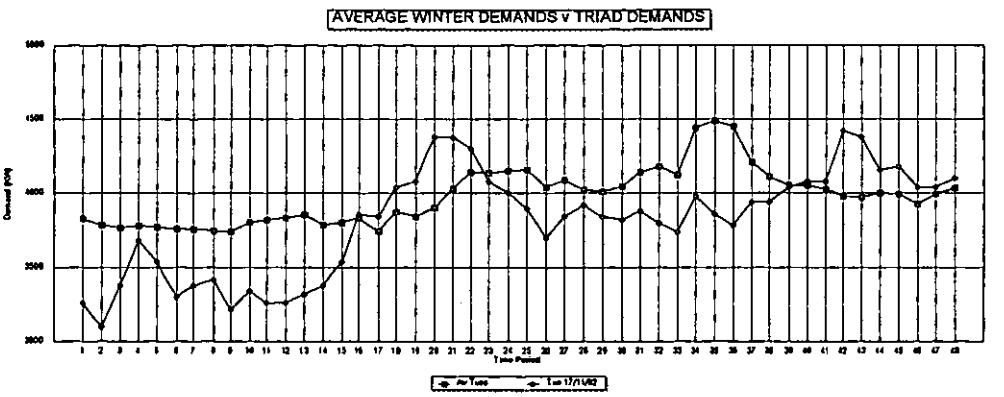
SIC CODE : 483

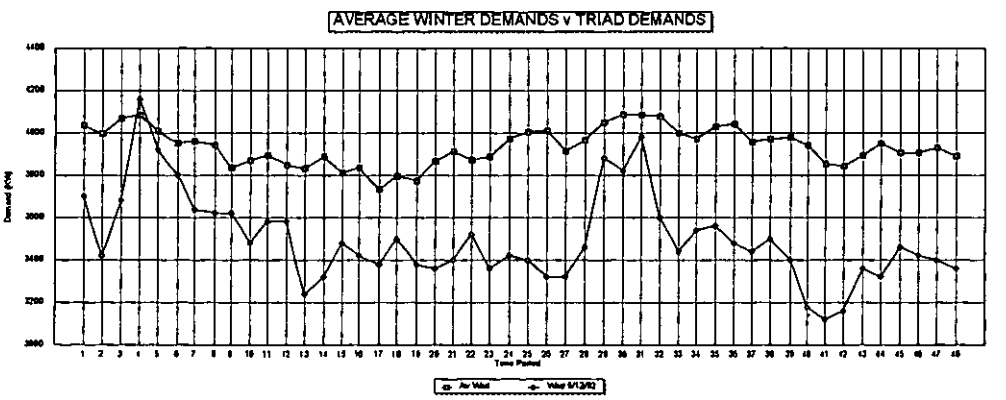
UNITS : KW

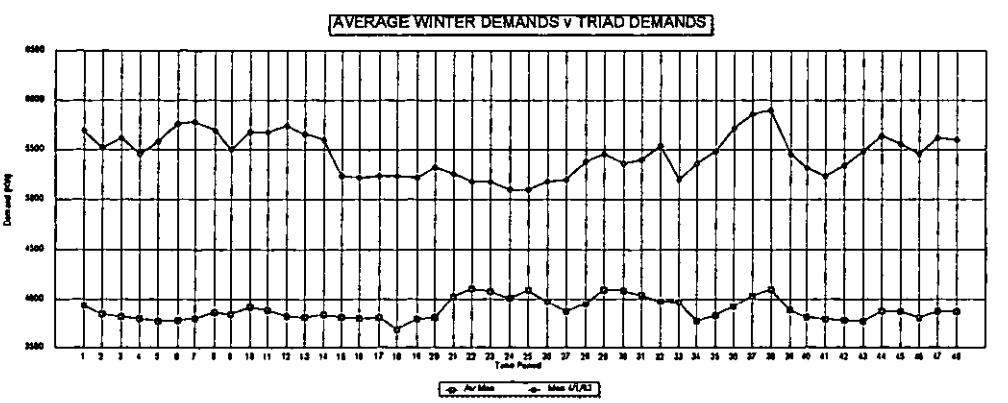
DAY	DATE	TP	ACTUAL DEMAND	TYPICAL DEMAND	DIFF	% DIFF
TUE	11/17/92	35	3,860	3,985	125	3.13%
WED	12/09/92	35	3,560	4,029	469	11.64%
MON	01/04/93	35	5,480	3,985	(1,495)	-37.53%

Typical daily demands are calculated for each day type for the period November to February, excluding the full Christmas period.

The typical demands also exclude the period between time periods 34 and 36 for the Triad warning days.







TRIAD DEMAND ANALYSIS : WINTER 1991/92 & 1992/93

CUSTOMER NO : 27

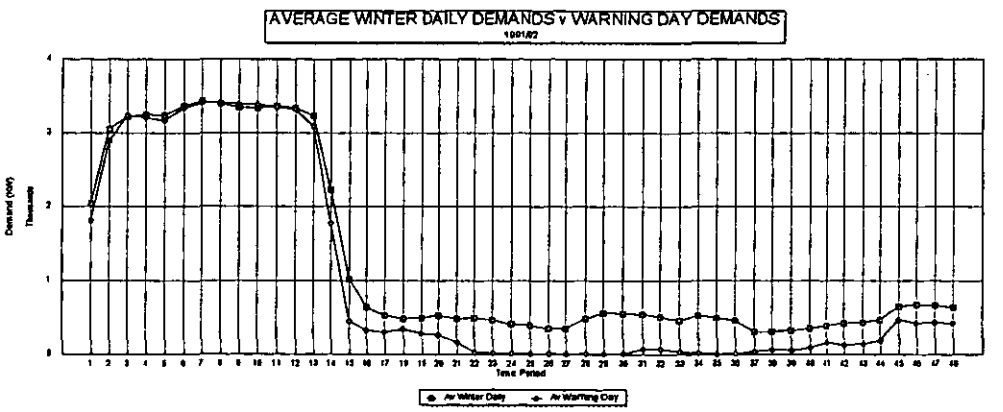
NAME : PLASTICS PROCESSING 2

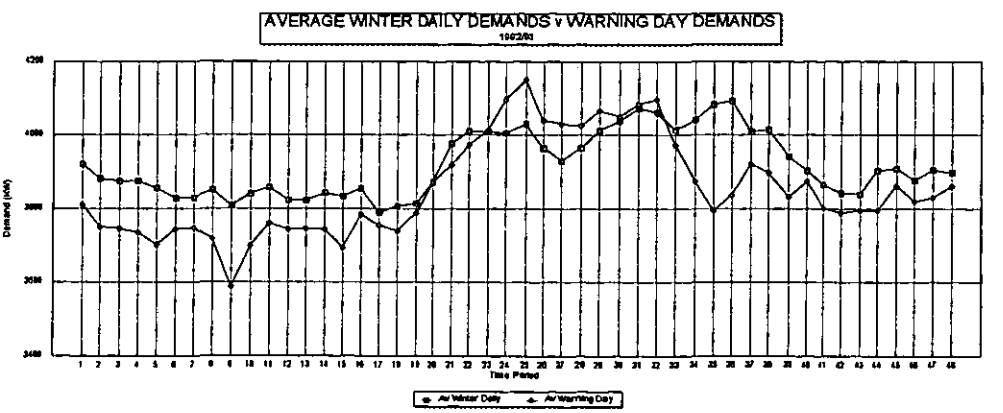
SIC CODE : 483

UNITS : KW

WINTER 91/92	32	33	34	35	36	37	38
AV DAILY	504	455	523	490	457	304	310
AV WARNING DA	68	40	20	0	8	35	65
Unit Reduction	436	415	503	490	449	269	245
%age Reduction	86%	91%	96%	100%	98%	88%	79%

WINTER 92/93	32	33	34	35	36	37	38
AV DAILY	4,062	4,015	4,041	4,082	4,092	4,008	4,014
AV WARNING DA	4,097	3,972	3,874	3,795	3,837	3,920	3,897
Unit Reduction	(35)	43	167	288	256	88	117
%age Reduction	-1%	1%	4%	7%	6%	2%	3%





TRIAD DEMAND ANALYSIS : WINTER 1991/92

CUSTOMER NO : 28

NAME : WHOLESALE PREMISES 1

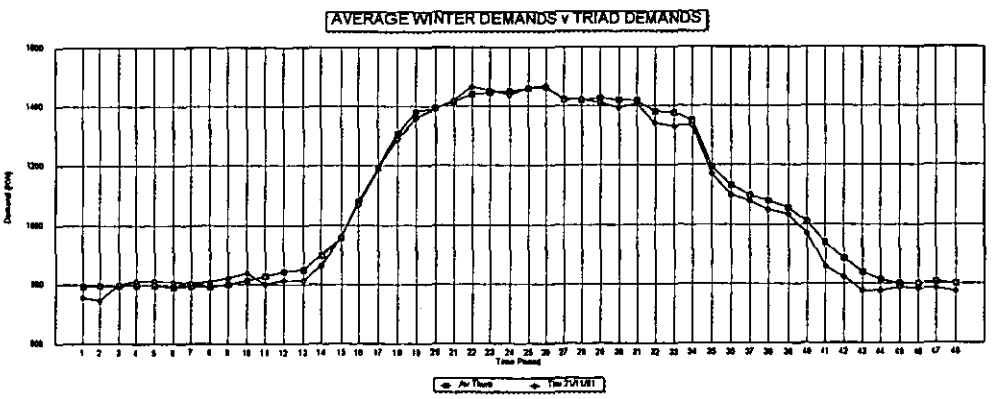
SIC CODE : 617

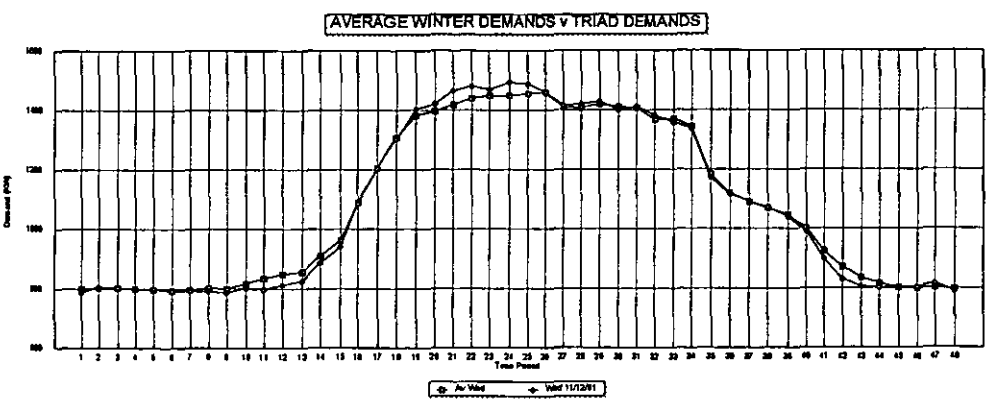
UNITS : KW

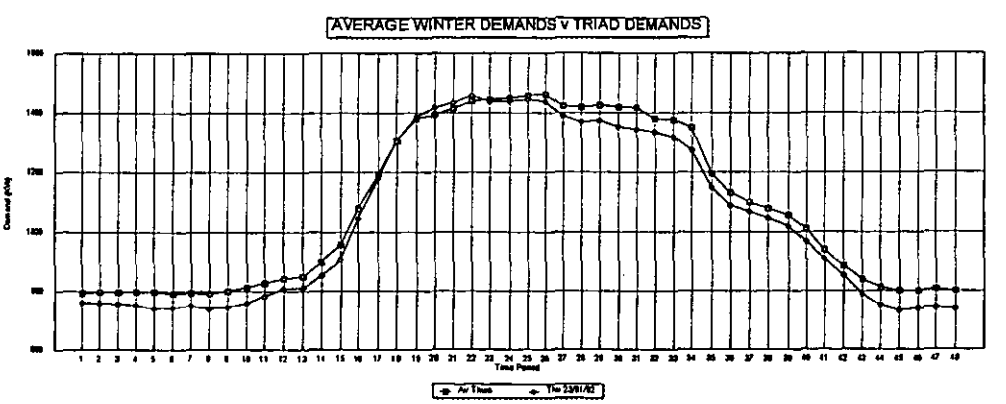
DAY	DATE	TP	ACTUAL DEMAND	TYPICAL DEMAND	DIFF	% DIFF
THU	11/21/91	35	1,170	1,194	24	2.05%
WED	12/11/91	35	1,174	1,183	9	0.73%
THU	01/23/92	35	1,148	1,194	46	3.89%

Typical daily demands are calculated for each day type for the period November to February, excluding the full Christmas period.

The typical demands also exclude the period between time periods 34 and 36 for the Triad warning days







TRIAD DEMAND ANALYSIS : WINTER 1992/93

CUSTOMER REF : 28

NAME : WHOLESALE PREMISES 1

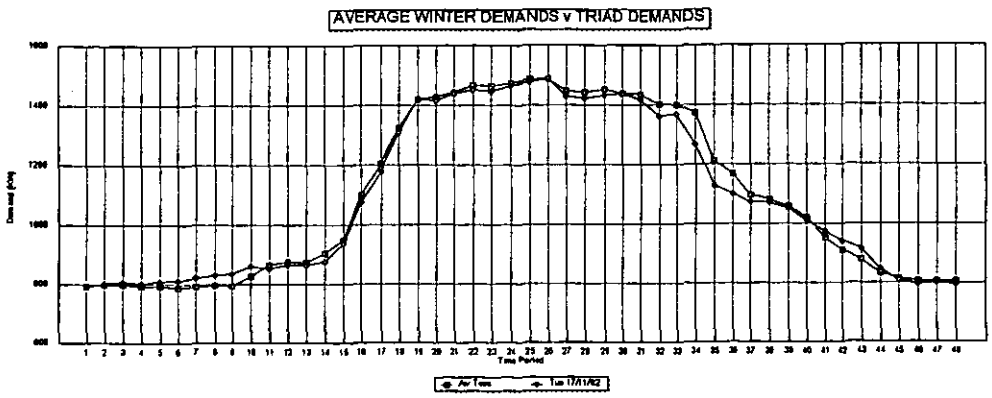
SIC CODE : 617

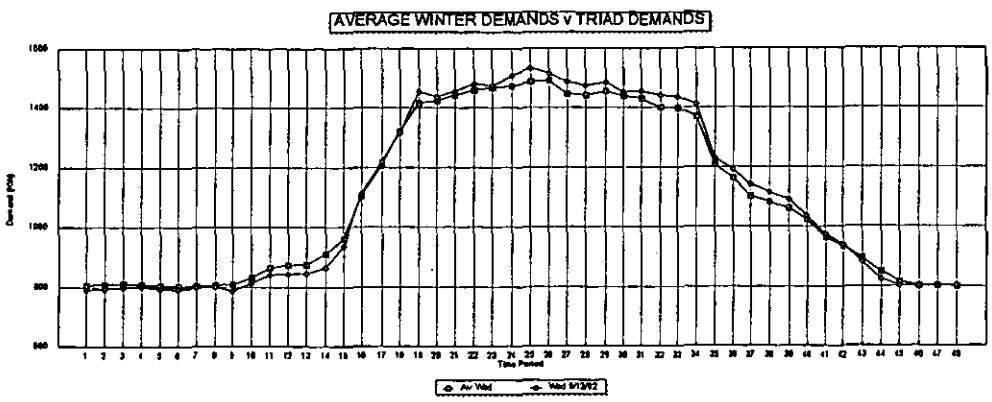
UNITS : KW

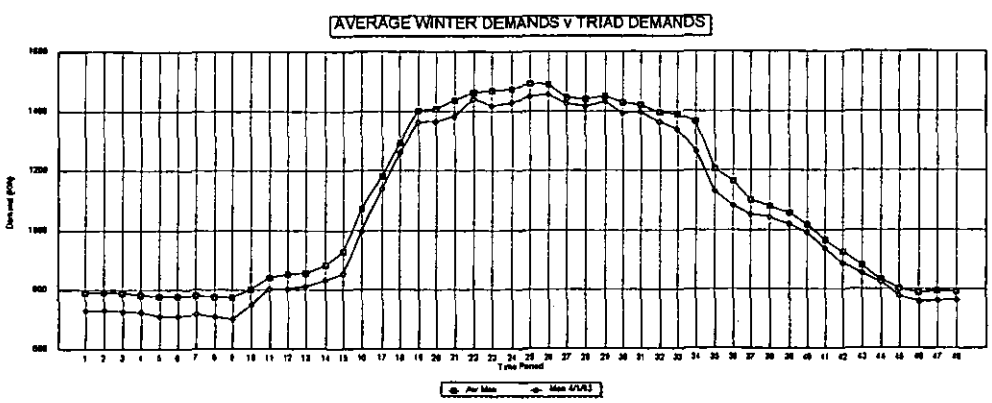
DAY	DATE	TP	ACTUAL DEMAND	TYPICAL DEMAND	DIFF	% DIFF
TUE	11/17/92	35	1,128	1,204	76	6.30%
WED	12/09/92	35	1,230	1,207	(23)	-1.90%
MON	01/04/93	35	1,130	1,204	74	6.13%

Typical daily demands are calculated for each day type for the period November to February, excluding the full Christmas period.

The typical demands also exclude the period between time periods 34 and 36 for the Triad warning days.







TRIAD DEMAND ANALYSIS : WINTER 1991/92 & 1992/93

CUSTOMER NO : 28

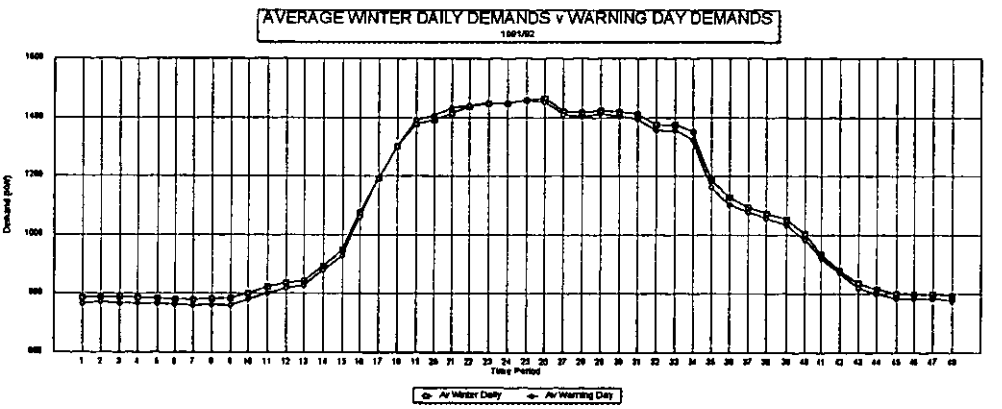
NAME : WHOLESALE PREMISES 1

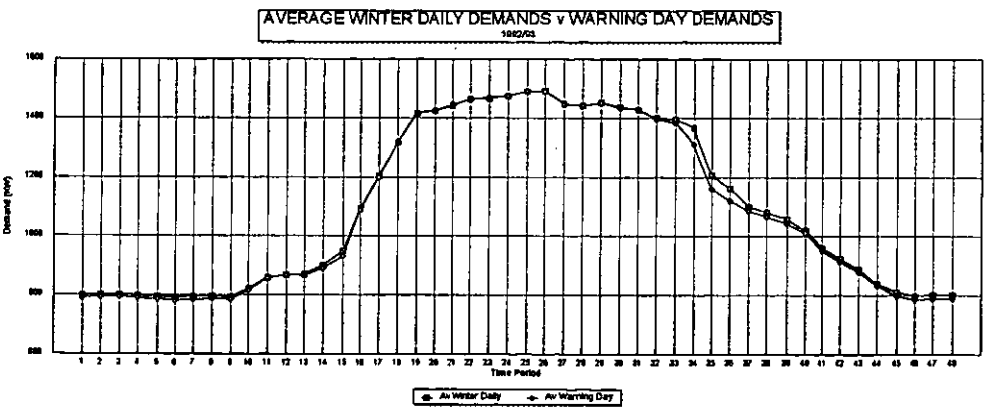
SIC CODE : 617

UNITS : KW

WINTER 91/92	32	33	34	35	36	37	38
AV DAILY	1,375	1,375	1,352	1,188	1,128	1,094	1,075
AV WARNING DA	1,356	1,356	1,323	1,164	1,103	1,079	1,057
Unit Reduction	19	20	29	25	25	16	18
%age Reduction	1%	1%	2%	2%	2%	1%	2%

WINTER 92/93	32	33	34	35	36	37	38
AV DAILY	1,402	1,396	1,368	1,207	1,163	1,101	1,081
AV WARNING DA	1,397	1,386	1,311	1,160	1,120	1,085	1,067
Unit Reduction	5	10	58	47	43	16	13
%age Reduction	0%	1%	4%	4%	4%	1%	1%





TRIAD DEMAND ANALYSIS : WINTER 1991/92

CUSTOMER NO : 29

NAME : COMMUNICATIONS 1

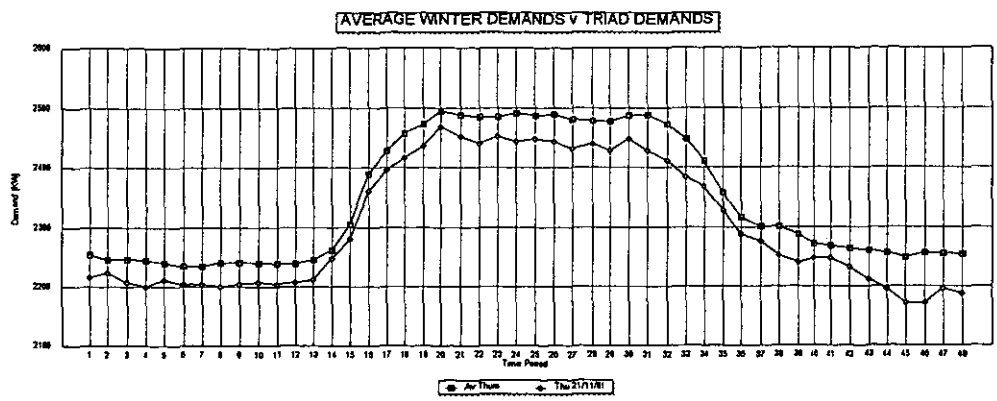
SIC CODE : 644

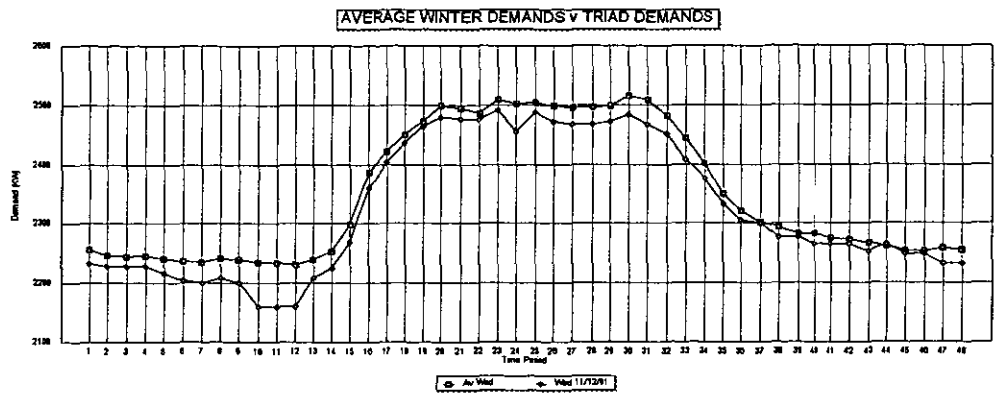
UNITS : KW

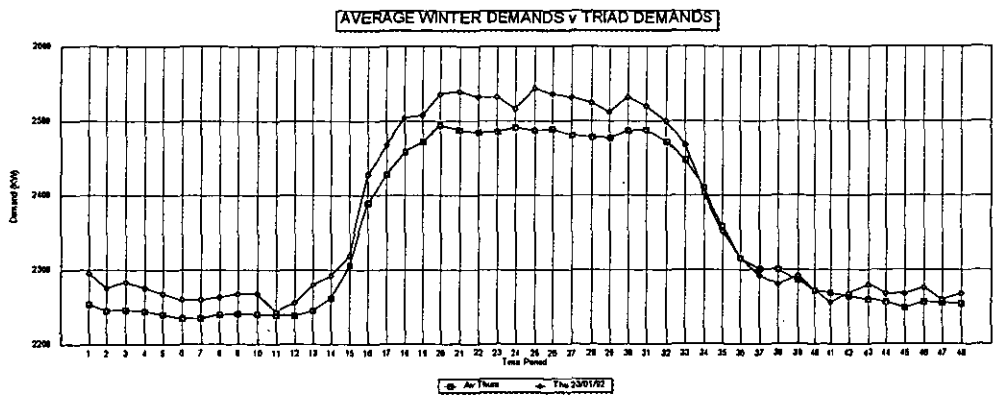
DAY	DATE	TP	ACTUAL DEMAND	TYPICAL DEMAND	DIFF	% DIFF
THU	11/21/91	35	2,328	2,358	30	1.29%
WED	12/11/91	35	2,332	2,348	16	0.70%
THU	01/23/92	35	2,352	2,358	6	0.27%

Typical daily demands are calculated for each day type for the period November to February, excluding the full Christmas period.

The typical demands also exclude the period between time periods 34 and 36 for the Triad warning days







TRIAD DEMAND ANALYSIS : WINTER 1992/93

CUSTOMER REF : 29

NAME : COMMUNICATIONS 1

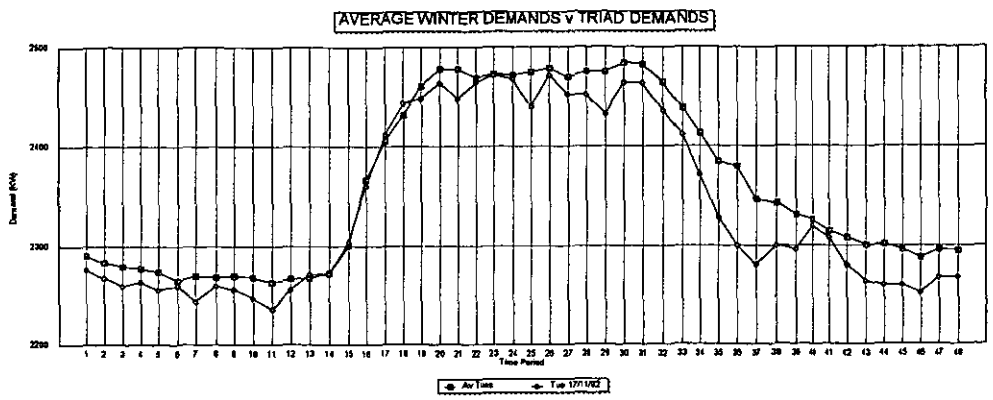
SIC CODE : 644

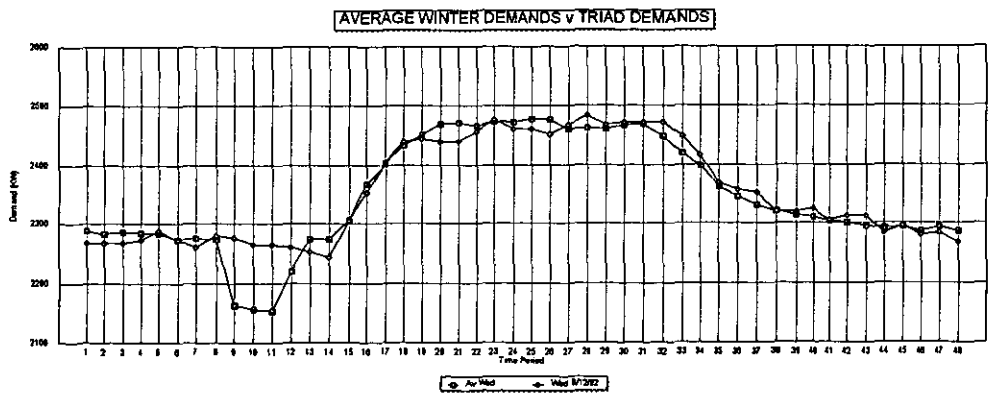
UNITS : KW

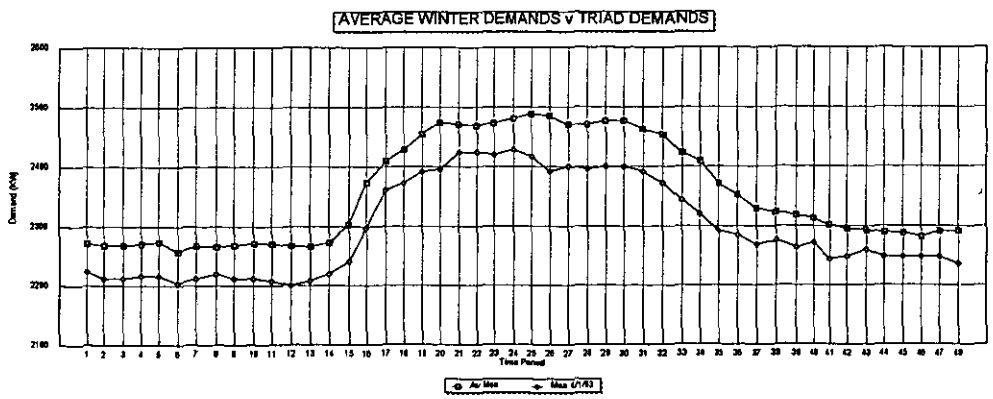
DAY	DATE	TP	ACTUAL DEMAND	TYPICAL DEMAND	DIFF	% DIFF
TUE	11/17/92	35	2,328	2,353	25	1.06%
WED	12/09/92	35	2,368	2,362	(6)	-0.24%
MON	01/04/93	35	2,292	2,353	61	2.59%

Typical daily demands are calculated for each day type for the period November to February, excluding the full Christmas period.

The typical demands also exclude the period between time periods 34 and 36 for the Triad warning days.







TRIAD DEMAND ANALYSIS : WINTER 1991/92 & 1992/93

CUSTOMER NO : 29

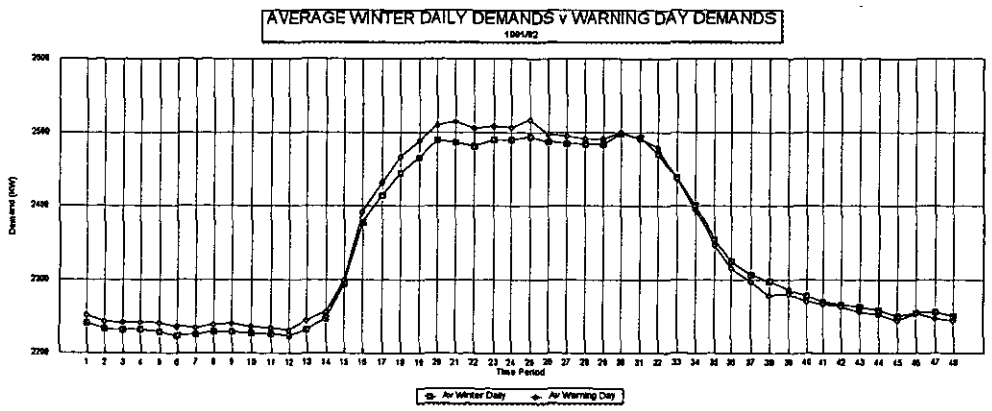
NAME : COMMUNICATIONS 1

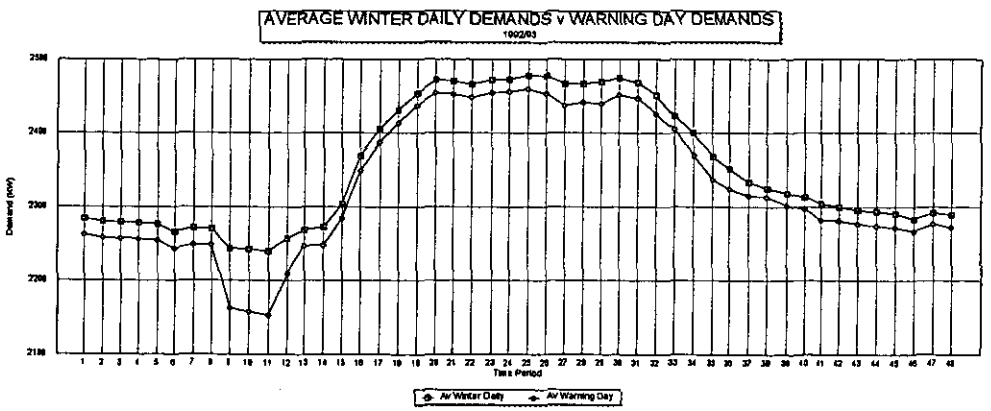
SIC CODE : 644

UNITS : KW

WINTER 91/92	32	33	34	35	36	37	38
AV DAILY	2,470	2,438	2,401	2,355	2,325	2,307	2,298
AV WARNING DA	2,479	2,437	2,394	2,347	2,316	2,297	2,279
Unit Reduction	(9)	2	6	8	10	10	19
%age Reduction	-0%	0%	0%	0%	0%	0%	1%

WINTER 92/93	32	33	34	35	36	37	38
AV DAILY	2,452	2,423	2,400	2,368	2,351	2,333	2,325
AV WARNING DA	2,427	2,405	2,369	2,336	2,324	2,315	2,313
Unit Reduction	25	18	31	31	27	18	13
%age Reduction	1%	1%	1%	1%	1%	1%	1%





TRIAD DEMAND ANALYSIS : WINTER 1991/92

CUSTOMER NO : 30

NAME : OFFICES 1

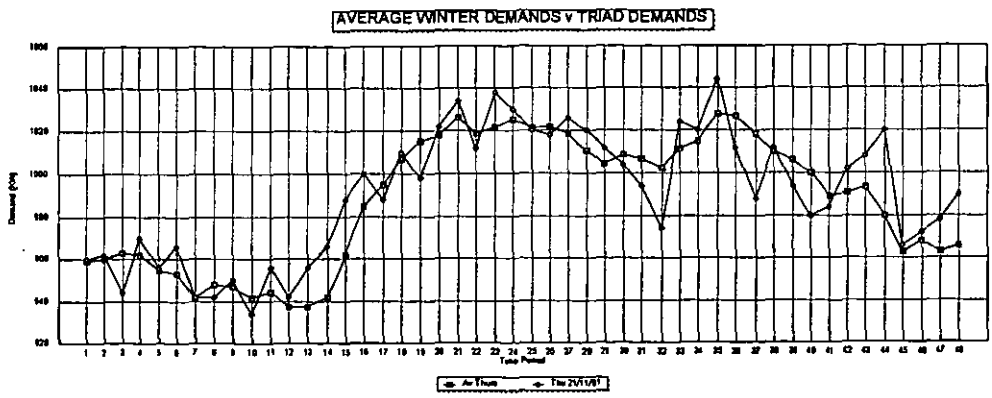
SIC CODE : 652

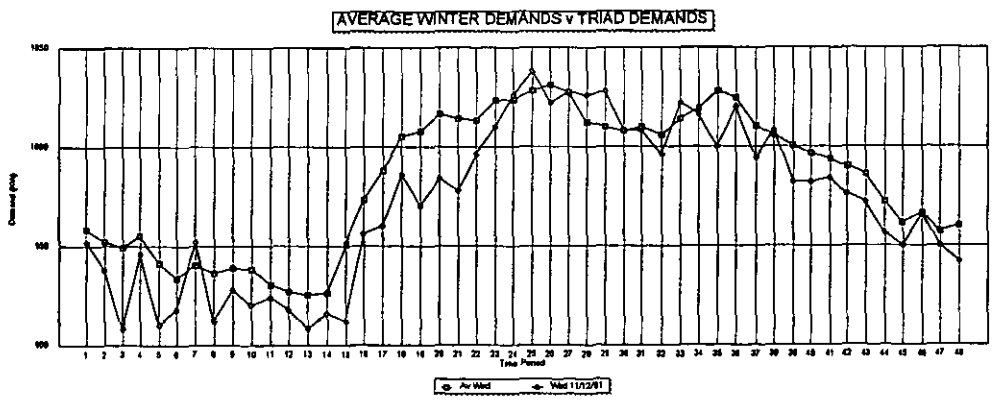
UNITS : KW

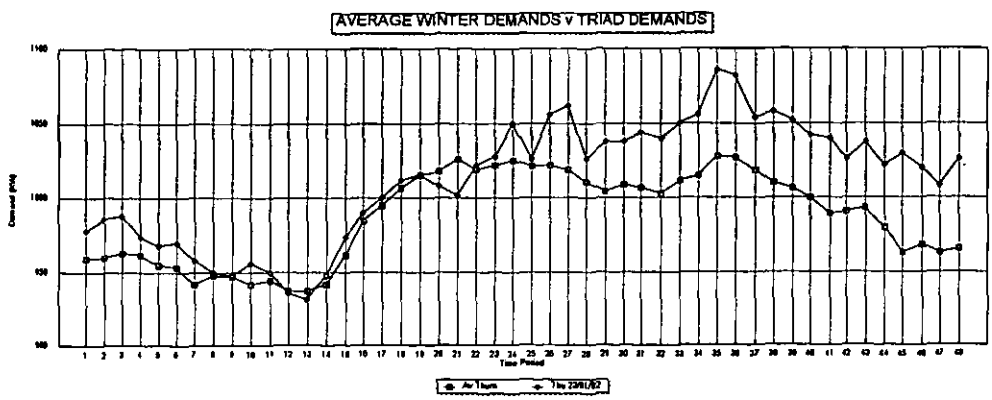
DAY	DATE	TP	ACTUAL DEMAND	TYPICAL DEMAND	DIFF	% DIFF
THU	11/21/91	35	1,044	1,028	(16)	-1.57%
WED	12/11/91	35	1,000	1,028	28	2.72%
THU	01/23/92	35	1,086	1,028	(58)	-5.66%

Typical daily demands are calculated for each day type for the period November to February, excluding the full Christmas period.

The typical demands also exclude the period between time periods 34 and 36 for the Triad warning days







TRIAD DEMAND ANALYSIS : WINTER 1992/93

CUSTOMER NUMBER : 30

NAME : OFFICES 1

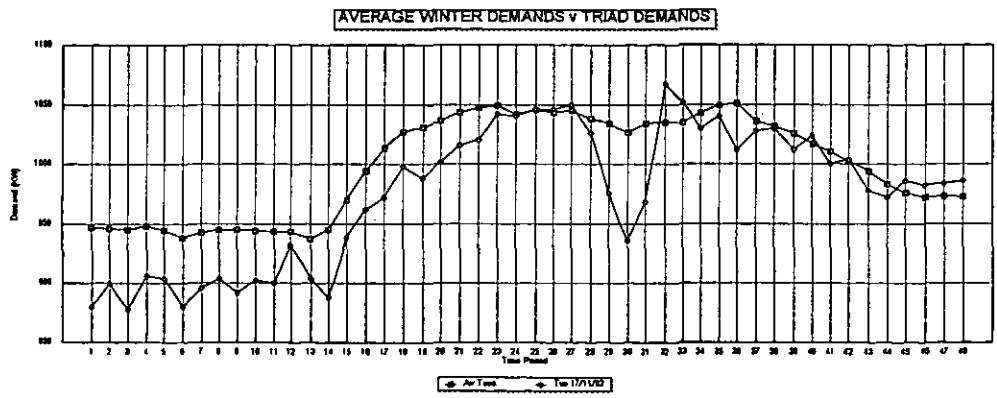
SIC CODE : 652

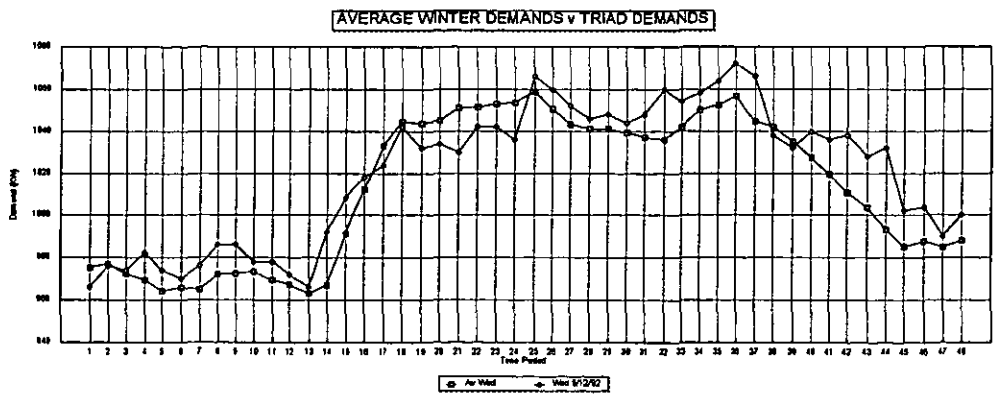
UNITS : KW

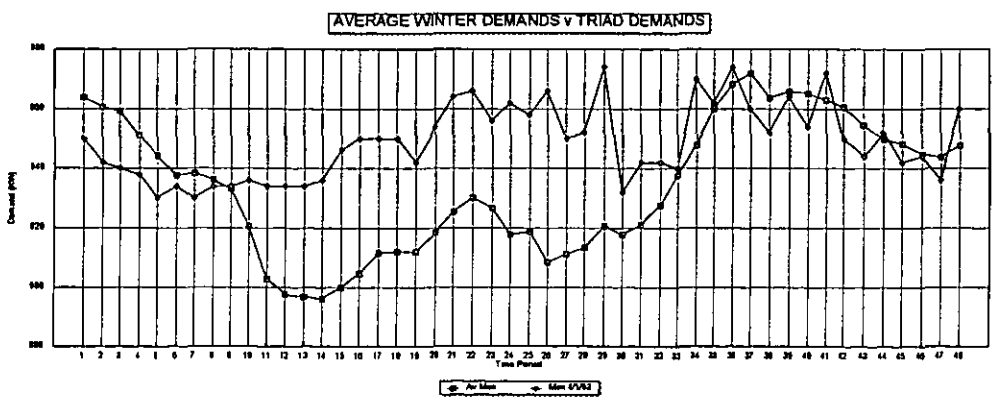
DAY	DATE	TP	ACTUAL DEMAND	TYPICAL DEMAND	DIFF	% DIFF
TUE	11/17/92	35	1,040	1,048	8	0.79%
WED	12/09/92	35	1,064	1,052	(12)	-1.12%
MON	01/04/93	35	962	1,048	86	8.23%

Typical daily demands are calculated for each day type for the period November to February, excluding the full Christmas period.

The typical demands also exclude the period between time periods 34 and 36 for the Triad warning days.







TRIAD DEMAND ANALYSIS : WINTER 1991/92 & 1992/93

CUSTOMER NUMBER : 30

NAME : OFFICES I

SIC CODE : 652

UNITS : KW

WINTER 91/92	32	33	34	35	36	37	38
AV DAILY	1,004	1,013	1,017	1,025	1,024	1,014	1,006
AV WARNING DA	1,019	1,031	1,035	1,045	1,042	1,020	1,021
Unit Reduction	(15)	(18)	(18)	(20)	(18)	(6)	(15)
%age Reduction	-1%	-2%	-2%	-2%	-2%	-1%	-1%

WINTER 92/93	32	33	34	35	36	37	38
AV DAILY	1,008	1,012	1,022	1,028	1,030	1,023	1,017
AV WARNING DA	1,013	1,020	1,030	1,031	1,029	1,025	1,019
Unit Reduction	(5)	(9)	(8)	(4)	1	(2)	(1)
%age Reduction	-1%	-1%	-1%	-0%	0%	-0%	-0%