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CARPENTRY FACTORY AND MUNICIPAL ELECTRICITY LOADS

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Abstract—Load management of electricity loads has received more interest in recent years. At least in Sweden, this is natural because of a rather cheap energy price, while at the same time, the demand charge is high. If a company could save the precise kWh that build the peak demand, then these would have a value of more than 200 times the off-peak kWh. This paper deals with monitored electricity data for two carpentry industries and one municipality, both situated in the south of Sweden. The ideal situation would be if the industry could reduce their peak demand and, at the same time, reduce the peak for the utility. Both participants would, in that case, save money, and the payback time for load management equipment would decrease substantially. If, however, a load management system at the carpentry transfers kWh to peak hours for the utility, the industry will save money, while the utility gets higher costs. The result of the study is that the Swedish electricity rates in use today are a very poor means of encouraging worthwhile load management, and often, they even aggravate the situation. © 1997 Elsevier Science Ltd.

Load management Peak saving Carpentry factories Tariffs Municipal electricity loads Economics

INTRODUCTION

Two recent studies [1, 2], showed that load management of electricity loads is a very subtle task. The number of kWh per hour that should be transferred to later hours was found to be about 2 to 3% of the total peak load if the economic benefit was to be optimized, i.e. made as high as possible. If a higher amount was transferred, the situation at later hours became worse because the peak load increased and with it, the demand charges. The number of hours that were available for postponing the electricity use were also important, but for a certain limit, no further savings occurred no matter how long the postponement. Because of this, the economic benefits were rather small compared to the total electricity bill. Load management could, however, be useful for a number of participants in the electricity market. The end user, of course, gets lower bills, but it is probable that the distributors and the producers of electric energy also do. The actions of the end user might, therefore, lead to lower costs for the utility, which must also be considered when one is to say whether load management equipment is profitable, or not.

CASE STUDY

In some earlier papers [3, 4], research was presented, on the electricity and district heating loads for the municipality of Kalmar, situated about 400 km south of Stockholm, Sweden. The data set shows one full year of hourly demands, i.e. about 8700 values for the electricity load. We have also monitored the electricity use at a carpentry factory, Rydsnäs Carpentry Ltd, sited about 300 km south of Stockholm. Because of the distance between the Kalmar utility and the end user in Rydsnäs, they do not at present have any economic relationship, but due to the now deregulated electricity market in Sweden, they might in the future. Assume now that such a relationship exists. In Table 1, 24 h for the first Monday in January are shown.

From Table 1, it is obvious that the electricity demand varies much more for the end user than it does for the utility. The top demand hours are about four times the low hours for the end user, while for the utility, the top demand is only twice the lowest hourly load. The top hour for the

Table 1. Electricity demand on a Monday in January for an end user and a utility

Time	End user (kW)	Utility (MW)	Time	End user (kW)	Utility (MW)
01.00	15.4	38.115	13.00	53.8	69.681
02.00	15.4	37.680	14.00	46.7	70.173
03.00	31.4	37.051	15.00	56.5	69.247
04.00	15.7	36.837	16.00	54.4	68.857
05.00	16.1	38.385	17.00	54.7	65.165
06.00	14.2	42.426	18.00	43.6	62.637
07.00	15.7	50.744	19.00	15.1	59.476
08.00	22.4	61.903	20.00	14.9	56.645
09.00	59.4	66.186	21.00	14.8	53.365
10.00	60.1	67.744	22.00	14.8	49.914
11.00	44.6	69.407	23.00	15.1	46.158
12.00	47.3	69.690	24.00	14.9	41.843

end user emerged at 10.00, while the maximum demand for the utility was found at 14.00. If a load management system cut the peak for the end user and transferred energy to subsequent hours, there is a substantial risk that the peak for the company would become higher than it was originally. It is also obvious that the end user company did not have any interest in reducing its demand at 14.00 hours because, at that moment, the company had a relatively low electricity load. It should be noted that there might be some error in our time registrations for the company on this specific day. The demand starts to increase between 08.00 and 09.00, i.e. one hour later than work actually began. This error, however, does not change the conclusions above. In Figs 1 and 2, the situation at the end user company is depicted for one full year. Figure 1 shows the maximum load during one day for all days within the year. It also shows that the maximum load during the year was about 160 kW. The load was in the vicinity of that value about ten times, but the major part of the registrations show much lower values, about 60 kW. There are also some very low daily peak values, about 10 kW, which occurred during Saturdays and Sundays.

It is also interesting to find how many times a peak value occurs at specific hours (see Fig. 2). The maximum daily load occurred at 08.00 more than 50 times a year, owing to registration between 07.00 and 08.00. One hour earlier, slightly less than 50 peak values occurred. The third most frequent top hour was between 10.00 to 11.00. It is interesting now to compare this with the situation for the utility In Figs 3 and 4, the corresponding graphs are shown.

In Fig. 3 it is obvious that the maximum load is slightly less than 80 MW. The highest values occur from about 09.00 to 13.00, but there are also peak daily loads at later hours. However, the utility never had peak loads earlier than 09.00 or later than 22.00. The situation is clarified in Fig. 4.

The peaks occur more than 120 times a year at 10.00 and a slightly lower frequency is found at 11.00. There is also a noteworthy peak period between 17.00 and 20.00 because of cooking etc. by the Kalmar inhabitants. The utility, therefore, must act in order to reduce the peak at these specific hours. Unfortunately, the end user will act in the opposite direction, i.e. to reduce their

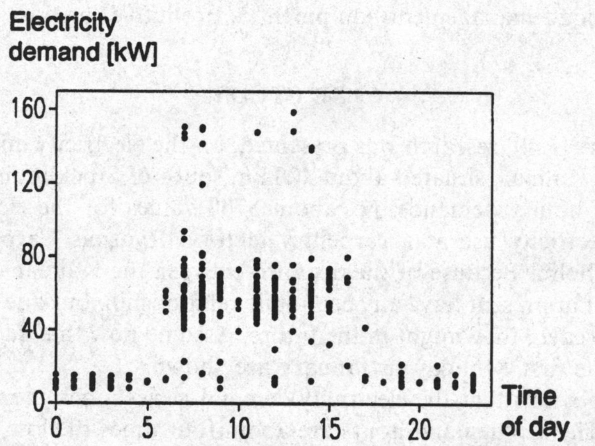

Fig. 1. End user load pattern. Electricity demand *vs*. time of day at Rydsnäs Carpentry Ltd.

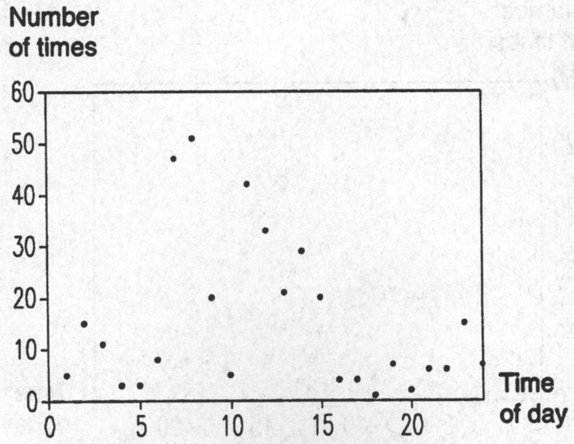

Fig. 2. End user load pattern. Frequency *vs*. time of day at Rydsnäs Carpentry Ltd.

peaks from about 07.00 to 09.00 and, therefore, add energy to the very hours when the utility definitely does not want it. The highest utility load, 75.955 MW, was found on January 17 at 11.00. The end user load that hour was only 51 kW, and therefore, the end user would not have been interested in load management. In March, however, there was a peak load at the utility, 68.988 MW, and also a significant peak at the end user of 145 kW. The end user peak emerged two hours before the utility peak, and hence, load management by the end user would make the situation at the utility worse than it was originally. The examination above showed that the design of the electricity rate might make the end user act in such a way that the utility gets higher costs. The Rydsnäs factory had significant peaks too infrequently, and therefore, this situation only occurred once during the examined year.

In Fig. 5, the load pattern for another carpentry factory, Åry Form Ltd, is shown. The factory manufactures glued veneer trays and components for the furniture market and is situated in Nybro which is very close to Kalmar where utility data were obtained. The investigation started late in November 1995, and therefore only about three months of data are available.

Once again, it is obvious that the peaks for a carpentry industry frequently emerge in the morning. The values above 160 kW are the most interesting ones for load management, and hence, 08.00, 09.00 and 11.00 are hours of major concern. There are also some peaks at later hours, e.g. at 14.00 and 15.00, which could be subject to special measures. The Åry Form factory has several processes that need heat, for instance resistance heaters for the premises, about 27 kW, veneer dryers, about 20 kW, and veneer pressing equipment of about 40 kW. They also have an old boiler fuelled by wood residues, and some of the presses use steam instead of electricity. The boiler is

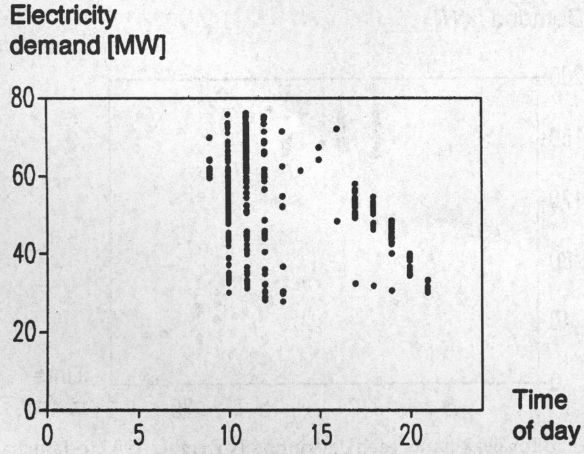

Fig. 3. Utility load pattern. Electricity demand *vs*. time of day at Kalmar utility.

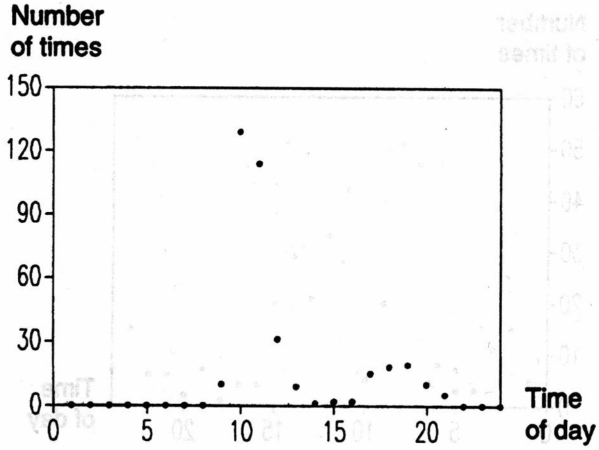

Fig. 4. Utility electricity load pattern. Frequency *vs.* time of day for Kalmar utility.

in very poor condition, and therefore, the company intends to change entirely to electrical heating. If only the electricity bill is emphasized, this will, of course, be a step in the wrong direction, but if profitability is seen in terms of the total running cost of the factory, this might be a proper course to take.

Figure 6 shows a duration graph for our monitored values at Åry Form Ltd. The values above, say 160 kW, do not contain much energy because the peak is very thin, and hence, this value could be an achievable goal.

The maximum demand for each month is monitored by the utility, and these values are the basis for the demand charges. From our monitored values for January, it is shown that the maximum load, 190.5 kW, occurred on 4 January at 09.00. Assume that the company wants a maximum demand of 160 kW, i.e. a decrease by approximately 30 kW. On 2 January, this will result in 28.9 kWh and a maximum demand of 17.5 kW that must be transferred to the hours after 17.00. On 3 January, the corresponding values are 29.0 kWh and 22.3 kW, while 4 January results in 150 kWh and 30.5 kW. Above, certain processes were mentioned which could probably be turned off for several hours without any hazardous effects. For instance, the temperature in the veneer dryers drops by a few degrees during the day, but can be recovered during the night. The temperature in the veneer dryer is only about 40°C which probably can be increased to about 70°C instead [5]. This will make it possible to use the dryer for heat storage where high temperatures occur at night, while they decline during electricity peak hours. Because of the relatively large number of electrically heated processes, substantial benefits could probably be achieved. The demand charge for the company is 395 SEK/kW, and hence, about 12,000 SEK each year could be saved.

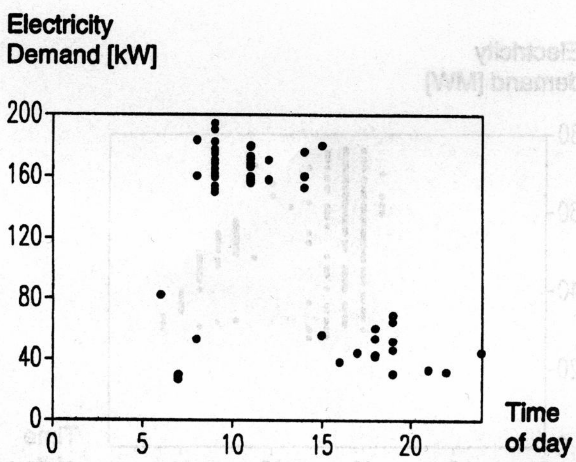

Fig. 5. Electricity demand for peak hours each day during November 1995 to January 1996 at Åry Form Carpentry in Nybro Sweden.

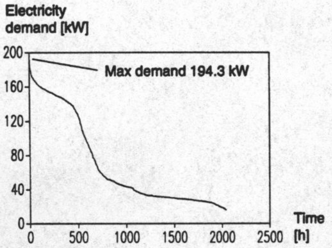

Fig. 6. Duration graph for monitored electricity load at Åry Form Ltd, Nybro, Sweden.

(1 US$ equals about 7 SEK.) If the company cuts as much as 30 kW, they cannot add all this energy to adjacent hours. This will also lead to a reduction in the costs for the utility. At this moment, we do not know, in detail, how the heating equipment and total electricity load interact, but our ongoing research will clarify the situation.

CONCLUSIONS

The case studies shown above reveal that load management, i.e. transferring electric energy from peak to later hours is of interest for end users. The electricity rates, however, are designed in such a way that they consider peak loads to be between 06.00 and 22.00 on working days. Most end user peaks emerge between 08.00 and 10.00 in the morning, and therefore, the proprietor wants to reduce these peaks and transfer energy to later hours, for instance at 11.00. The utility studied here had its peaks between 10.00 to 12.00, and subsequently, the end user will aggravate the situation for the utility. The electricity rate should, hence, be designed in order to restrict the end user to using electricity between 10.00 to 12.00 and not to punish use at earlier hours even if end user peaks occur. The now deregulated electricity market in Sweden makes it easier to construct specialized rates and tariffs in order to encourage behaviour profitable to both participants in the market.

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REFERENCES

1. Gustafsson, S. I., *Applied Thermal Engineering*, 1996, **16**(10), 829.
2. Gustafsson, S. I., "Load Management in Municipal Electricity Systems" *International Journal of Energy Research* (in press).
3. Gustafsson S. I., *Applied Energy*, 1992, **42**(4), 313.
4. Gustafsson, S. I., *Applied Energy*, 1993, **46**(2), 149.
5. Taylor, J. M., Lavery, D. J. and Cronin, K., *International Journal of Ambient Energy*, 1996, **17**(1), 41.