CARPENTRY FACTORY AND MUNICIPAL ELECTRICITY LOADS

Stig-Inge Gustafsson,
IKP/Energy systems and Wood technology
Institute of Technology, S 581 83 Linköping, Sweden

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Abstract

Load management for 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 kilowatt-hours that build the peak demand, these 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 actors would in that case save money and pay back time for load management equipment would decrease substantially. If, however, a load management system at the carpentry will transfer 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 Swedish electricity rates in use today are very blunt instruments for encouraging worthwhile load management and often they even aggravate the situation.

INTRODUCTION:

Two recent studies, see References [1] and [2], showed that load management of electricity loads is a very subtle task. The amount of kWh per hour that should be transferred to later hours was found to be about two or three per cent of the total peak load if the economic benefit was to be optimised, i.e. as high as possible. If a higher amount was transferred, the situation at later hours became worse because the peak load increased and, hence, 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 postponement were used. Because of this, the economic benefits were rather small compared to the total electricity bill. Load management, however, could be useful for a number of actors on the electricity market. The end user, of course, gets lower bills but the chance is that the distributors and the producers of electric energy do so as well. Actions by the end user might therefore lead to lower costs for the utility which also must be considered when one is to say if load management equipment is profitable, or not.

CASE STUDY:

In some earlier papers, References [3] and [4], we have presented research on the electricity and district heating loads for the municipality Kalmar, situated about 400 km south of Stockholm, Sweden. The data set shows one full year of hourly demands, i.e. about 8,700 values for the electricity load. We have also monitored the electricity use at a carpentry industry, 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 have any economic relationship today but due to the now deregulated electricity market in Sweden, they certainly could have that in the future. Assume now that such a relation existed. In Table 1, 24 hours for the first Monday in January are shown.

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

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

From Table 1 it is obvious that the electricity demand varies much more for the end user then 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 only is twice the lowest hourly load. The top hour for the end user emerged at 10.00 while maximum demand for the utility was found at 14.00. If a load management system cut the peak for the end user and transfers energy to the next 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 of 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 at this specific day. The demand starts to increase between the hours 08.00 and 09.00, i.e. one hour later than work actually begun. This error, however, does not change the conclusions above. In Figures 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 under the year. It shows also that the maximum load during the year was about 160 kW. About ten times the load was in the vicinity of that value but the major part of

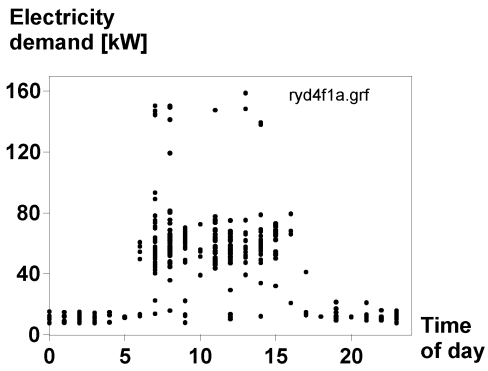

Figure 1: End user load pattern. Electricity demand versus time of day. Rydsnäs Carpentry Ltd.

the registrations show much lower values, about 60 kW. There are also very low day peak values, about 10 kW, which occurred during Saturdays and Sundays.

Interesting is also to find out how many times a peak value occurs at specific hours, see Figure 2.

More than 50 times a year the maximum day load occurred at 08.00, i.e. the registrations made between 07.00 to 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. The interesting thing is now to compare this with the situation for the utility. In Figures 3 and 4 the corresponding graphs are shown.

In Figure 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 day loads at later hours. However, the utility never had peak loads earlier than 09.00 and not later than 22.00. The situation is clarified in Figure 4.

More than 120 times a year the peaks occur 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. Appalling is that the end user will act in the opposite direction, i.e. to reduce their peaks from about 07.00 to 09.00 and therefore add energy to the very hours when the utility absolutely does not want it. The highest utility load, 75.955 MW was found 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 were 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 originally was. The examination above showed that the design of the electricity rate might make the end user act in a way such that the utility gets higher costs. The Rydsnäs factory had significant peaks too seldom and therefore this situation only occurred once during the examined year.

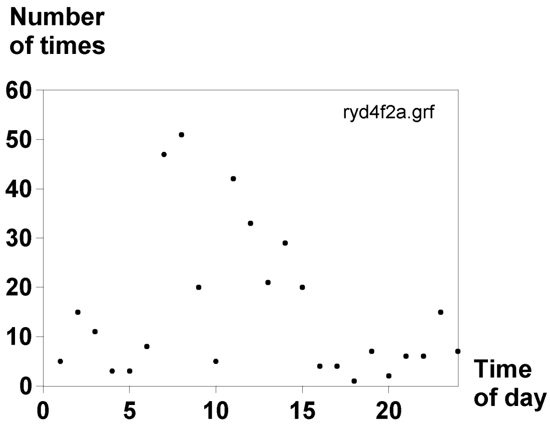

Figure 2: End user load pattern. Frequency versus time of day. Rydsnäs Carpentry Ltd.

In Figure 5 the load pattern for another carpentry factory, Åry Form, 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 fetched. 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 for 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 residuals and some of the presses use steam instead of electricity. The boiler is in a very poor condition and therefore the company considers to entirely migrate to electricity heating. If only the electricity bill is emphasised this will of course be a step in the wrong direction but if profitability seen from the total running cost of the factory this might be a proper action 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 base for the demand charges. From our monitored values for January it is shown that the maximum load, 190.5 kW, occurred at January 4, 09.00. Assume that the company wants a maximum demand of 160 kW, i.e. a decrease by approximately 30 kW. At January 2 this will result in 28.9 kWh and a maximum demand of 17.5 kW that must be transferred to the hours after

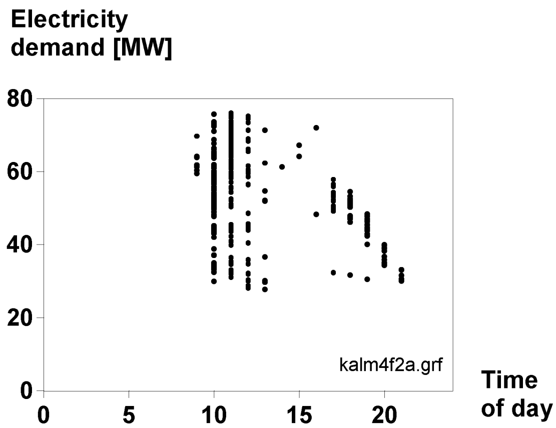

Figure 3: Utility load pattern. Electricity demand versus time of day for the Kalmar utility

17.00. January 3 the corresponding values are 29.0 kWh and 22.3 kW while January 4 results in 150 kWh and 30.5 kW. Above, certain processes where mentioned which probably could be turned off for several hours without any hazardous effects. For instance the temperature in the veneer dryers would drop some degrees during day time but it will be recovered during night time instead. The temperature in the veneer dryer is only about 40 °C which probably can be increased to about 70 °C instead, see Reference [5]. This will make it possible to use the dryer as an heat storage where high temperatures occur at night while they decline during electricity peak hours. Because of the relatively large amount 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. (1 US$ equals about 7 SEK) If the company cuts off as much as 30 kW they cannot add all this energy to adjacent hours. This will also lead to a reduction of the costs for the utility. At this moment we do not know, in detail, the interaction between all the heating equipment and the total electricity load but our ongoing research will clarify the situation.

CONCLUSIONS:

The case studies shown above show 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 a way that they consider peak loads between 06.00 to 22.00 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 we studied here had their peaks between 10.00 to 12.00 and subsequently the end user will aggravate the situation for the utility. The electricity rate should hence

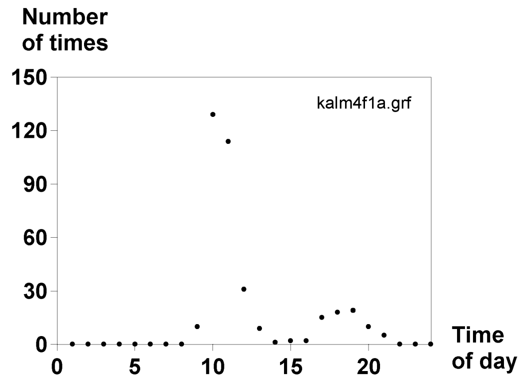

Figure 4: Utility electricity load pattern. Frequency versus time of day for the Kalmar utility.

be designed in order to restrict the end user to use electricity between 10.00 to 12.00 and not punish use at earlier hours even if end user peaks occur. The now deregulated electricity market in Sweden makes it easier to construct specialised rates and tariffs in order to encourage a behaviour profitable for both actors on the market.

ACKNOWLEDGEMENT

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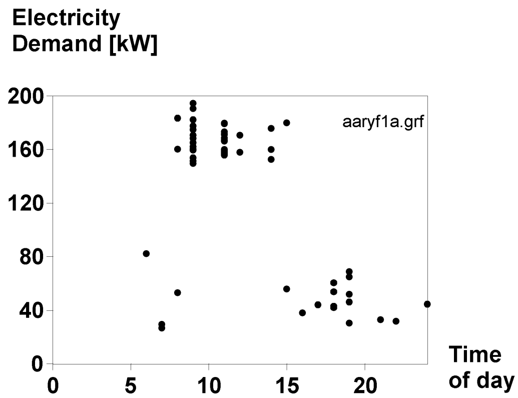

Figure 5: Electricity demand for peak hours each day during November 1995 to January 1996. Åry Form Carpentry in Nybro Sweden.

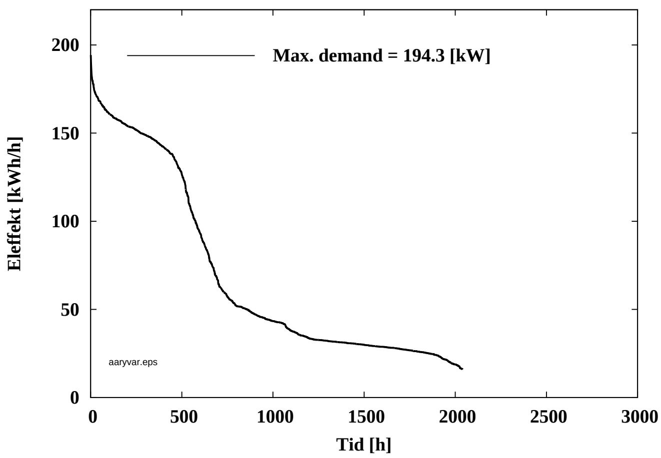

Figure 6: Duration graph for the monitored electricity load at Åry Form Ltd, Nybro, Sweden