white paper

Glass Industry

Cost of Electrical Energy

Energy cost reduction

Load shedding

Load sharing

Energy cost is one of, if not the most important issue in the glass industry at the moment and improvements in efficiency of use or reductions in energy cost would have a substantial influence on the operational result of any glass producer.

In applications where an electrical energy user has to control multiple loads the Predictive Load Management features of Eurotherm EPower controllers will give better control over Peak Power Demand. In many countries the monthly Peak Power Demand is a critical factor in the cost that industrial users have to pay for electrical energy.

The Predictive Load Management* function of EPower controllers offers two features that can lead to a reduction in Peak Power Demand and therefore a reduction in cost. The features are:

- Load sharing
- Load shedding

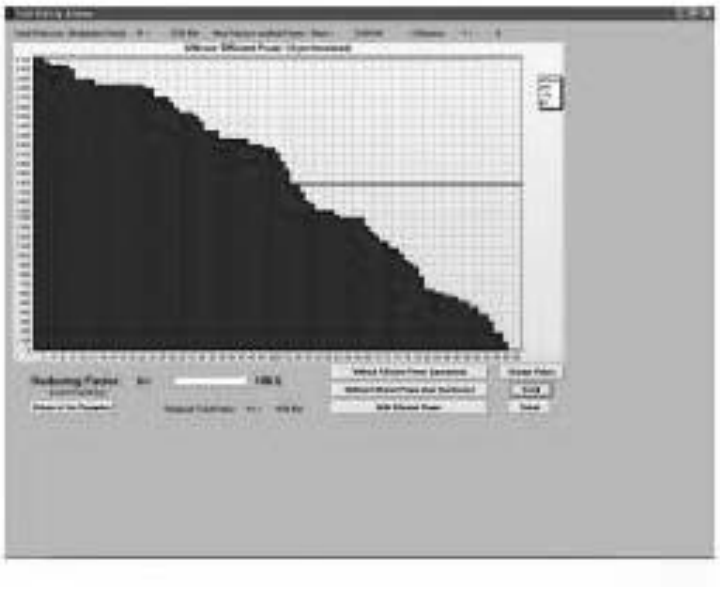
In many applications the installed power capacity exceeds the required power during normal operation. Predictive Load Management uses this overcapacity by distributing loads on/off switching over time in such a way that the power required from the network is at any moment in time lower than the installed power capacity.

*patent pending

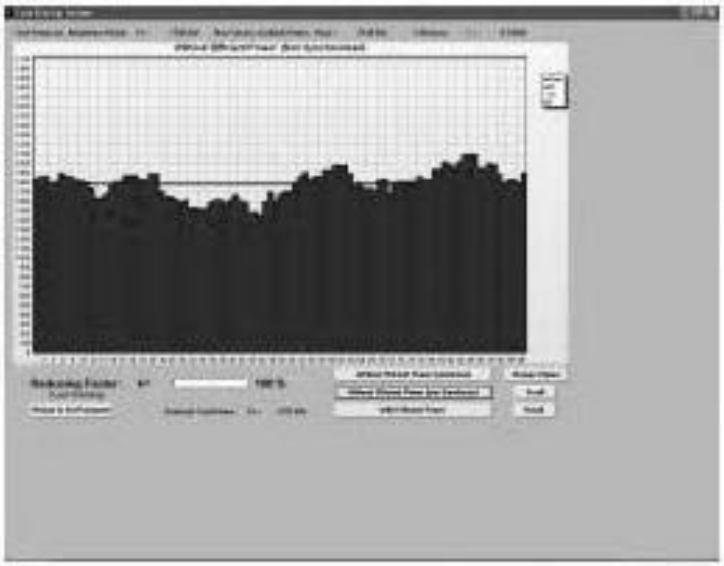
Load sharing

The load sharing feature takes care that a group of loads is switched on/off in such a way that the average power demand is flattened out as shown in the following diagrams.

In the first diagram the loads are switched on in a synchronised fashion. The moment the furnace is switched on all loads will be switched on at the same time causing a peak demand equal to the installed power.



The second diagram shows the effect of desynchronising the switching of the loads and the effect on the peak demand.



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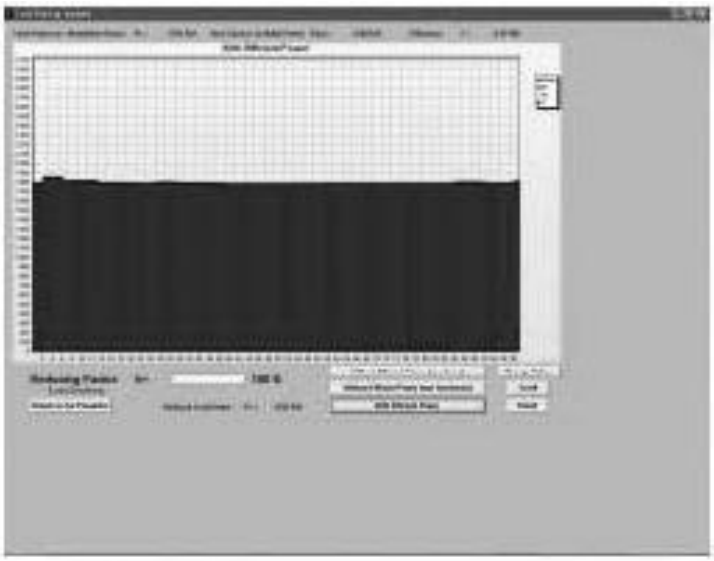
The result is a decreased Peak Demand and flattened average power use. By switching on EPower controllers "Efficient Power" features the result becomes even better.



The average power demand shows an almost flat line, which results in less flickering and a reduced peak.

The efficiency of the use of power can be characterised by the Power Efficiency Factor K, a value between 0 and 1. The closer to one the more efficient the use of power is. K is calculated with the following equation:

$$K = \frac{\text{Installed Power} - (\text{max power} - \text{min power})}{\text{Installed Power}}$$

In this example the installed power is 3138kW with a total power per modulation period of 1792kW.

The Power Efficiency Factor goes from 0 in the synchronised case to 0.84 in the desynchronised case and 0.97 by the use of "Efficient Power"

However, although Peak Demand is reduced significantly, it is not limited to a certain level. To limit the peak demand we can use the load shedding feature of EPower controllers.

Load shedding

With load shedding a user can define a maximum allowable peak demand. Because this feature will actively reduce the power applied to certain loads it cannot be used under all circumstances. The possible effects of load shedding on the behaviour, the dynamic stability of control and accuracy of control should be taken into consideration before load shedding is applied.

It is particularly useful when large thermal masses such as a lehr are controlled.

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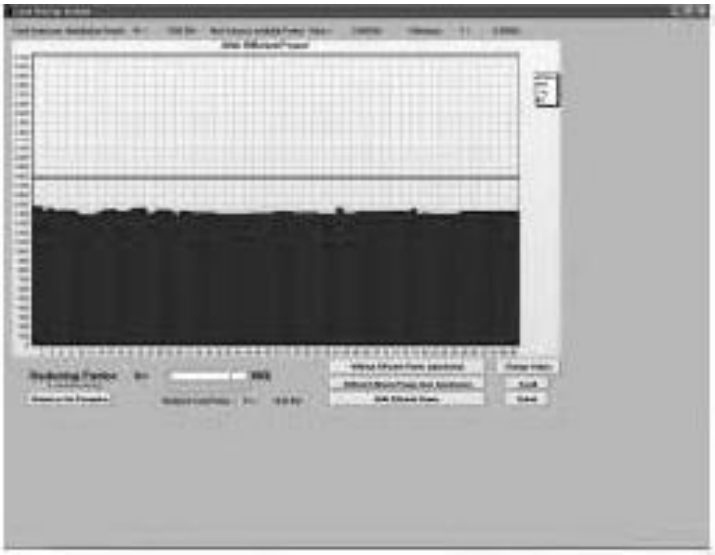
When all the signs are at green a user gets real dynamic control over its peak power demand.



In this case for instance the power demand during normal operation could be reduced by 20% to 1433kW without harming process dynamics. The limit of 1433kW is set in the Eurotherm EPower master controller and Eurotherm patented load shedding feature takes care that the limit is never exceeded.

So rather than a peak demand that is unpredictable and could be as high as the installed power of 3138kW load shedding in this case takes care of a controlled maximum peak demand of 1433kW.

To be able to predict the cost benefit for the user we would have to know how electrical energy costs are calculated and invoiced by the power company.

The tangle of rules, regulations, rates and conditions

Before the liberalisation of the power market life was easy. As a power user one had the choice out of a list of one power supplier, the power supplier active in the region and that was it. In each country all power suppliers applied comparable conditions and

prices. That one company was responsible for generating and delivering the power at the user's doorstep.

So how have things changed? The energy market in many areas is completely liberalised and a user can buy power from any supplier all over Europe, with power suppliers being totally free in setting their conditions and prices.

Rather than dealing with one supplier responsible for the complete supply chain, a user now has to deal with three companies and a tangle of rules, regulations, rates and conditions.

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These three companies are:

- The energy supplier. The company from which a user buys the actual kWh's - a highly competitive market.
- The network operator. The company that transports the actual energy from the generator to the customer. This company owns the grid in a region and often has a monopoly in that region.
- The metering company. An independent company that meters the actual energy use, the monthly peak demand and the power factor.

Energy supplier

The four main variables used to fix the price of a kWh for an energy contact are:

- Contract power in kW: the maximum power expected to be used at any moment i.e. equal to the total installed power
- Annual use during off-peak hours: i.e. between 23.00 and 07.00 and weekends
- Annual use during peak hours
- Duration of a supply contract: in most cases a minimum period of ½ a year is applicable

The higher the contract power or the longer the contract duration, the higher the price per kWh will be.

Eurotherm EPower controllers may reduce the peak demand and therefore a lower contract power could be agreed reducing the cost per kWh

Example by supplier Oxxio:

Contract Power	**3200kW**	**1800kW**
Peak hour use kWh	7,072,000 kWh	7,072,000 kWh
Off-peak hour use	6,944,000 kWh	6,944,000 kWh
Contract duration	12 months	12 months
Average price/kWh	7,86 ct/kWh	7.56 ct/kWh
Total annual cost	€1,101,573.60	€1,071,896.80

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Annual savings by reducing the contract power on the basis of a lower peak demand are €29,676.80.

Network operator

An energy transporter charges for:

- Connection costs: a one-off cost for connecting a customer tothe grid, this includes transformers, cables and junction boxes.

  The charge is depending on the maximum capacity of the connection. This is about big money! i.e. typically, Eneco

  Netbeheer charges 40k€ for a connection in the range of1MVA to 2.4MVA and 220k€ for a connection in the 2.4MVAto 10MVA range. A difference of 180k€.

  These costs only have to be taken into consideration when a new factory is to be erected or when connection capacity hasto be increased because of an extension of existing facilities.

- Annual connection maintenance cost: an annual fee depending on the range of the connection. i.e. typically, Eneco Netbeheer charges €1,272 for a connection in the range of 400KVA to 2.4MVA and €6,804 for a connection in the 2.4MVA to 10MVA range. A difference of €5,532/year.

- A fixed annual transport charge: i.e. typically, Eneco Netbeheer charges €0 for a connection in the range of 400KVA to 2.4MVA and €2,760 for a connection in the 2.4MVA to 10MVA range. A difference of €2,760/year.

- A fixed cost for transport of the "Contact Power" (see energy supplier). The charge per kW per annum also varies with the power range. i.e. typically, Eneco Netbeheer charges €14.16 per kW of contract power per annum for a connection in the range of 400KVA to 2.4MVA and €20.16 per kW for a connection in the 2.4MVA to 10MVA range. This again could be big money. i.e. If it would be possible to go down from 3200kW contract power to 1800kW it would also be able to reduce the connection range. A cost saving of €39,024 would be possible.

- A variable monthly charge for transport based on the actual monthly peak demand. i.e. typically, Eneco Netbeheer charges €1.96 per kW of peak power per month for a connection in the range of 400KVA to 2.4MVA and €2.03 per kW for a connection in the 2.4MVA to 10MVA range. A reduction in average peak demand of 700kW in the >2.4MVA range saves 700*12*€2.03 or €17,052.

- A variable charge for the actual kWh transported could be applicable but in the case of Eneco this only applies for the lower ranges of the connections.

- A variable charge for reactive power when the power factor of the connection is lower than a certain value. For Eneco this value is 0.85 and the charge is €0.00102 per kVARh for additional reactive power.

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Metering company

It is assumed that the metering costs are marginal compared to the cost of energy and have therefore, not been taken into consideration.

Conclusion

Load sharing and load shedding could allow substantial cost savings for industrial electricity users. A proper calculation of the savings however can only be made when details of the rates and conditions of the different parties in the supply chain are known.

Note: All figures are based on rates applicable in December 2006.

Invensys Eurotherm

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