CENTRAL ENERGY MANAGEMENT CONTROL SYSTEMS

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Abstract. Electrical Energy is an asset and Engineering is about risk mitigation. This article highlights the need to implement a centralised energy management control system that adopts and modifies existing systems and concepts to meet the overall requirement. i.e. to de-risk a business.

Although energy might be a small percentage of running costs in a business, it affects 100% of profitability. Energy risk mitigation must therefore incorporate all aspects of business operation. Establishing baselines by Monitoring and Measuring current processes are the initial steps necessary to risk assess energy however actions need to be taken to mitigate the risk. An action that should never be taken is the stopping of core business activities to mitigate energy risk and increase energy savings.

RISK ASSESSMENT PROCESS

Every business/plant has one objective and that is to minimize risk to business. Risks can be broken down into different levels since the risk from a CEO's perspective is different from an engineer's perspective. Examples of risks to both levels of management are provided below in Tables 1 and 2.

	What if?	Risks / Threats
POLITICAL	Power shortage	Production loss. Safety of personal. Income Loss.
	Loss of jobs	South African economy shrinks. Trade union action.
	Increasing costs	Loss of jobs. Loss of income.
ECONOMICAL	Loss of profits	Insolvency. Cash flow constraints. Limited business growth.
	Reduction in capital	Limited business growth. Energy efficiency projects stop.
	Loss of earnings	Loss of jobs. Loss of income.
TECHNICAL	Energy efficiency not optimized	Increasing charges. PCP penalties, MD penalties.
	Costs are not reduced	Compounded energy costs increasing
	Relevant information not available	Inability to manage energy costs and usage.
	Blackouts	Failure of equipment and safety.
LEGISLATURE	Government energy efficiency targets not met	Non Compliance to government energy targets and CO_2 reductions.
	New legislature	Power Conservation Program implemented. New energy standards.
ENVIRON	Energy efficiency not implemented	Reputational attack due to public image arising from emissions and exasperating energy shortage.
	No energy efficiency controls	Unable to manage energy consumption
SOCIAL	Blackouts occur	Prolonged blackouts leading to loss of production, loss of jobs
	Lack of energy efficiency competency	Lack of capacity & availability of skills to implement energy efficiency

Table 1: Risks for a CEO

The various risks for a CEO (Table 1) have been weighed and are shown in the form of a spider graph in Fig. 1. The red area depicts the present intensity of the various risks while the green area depicts were a CEO would like to be in terms of risk evaluation.

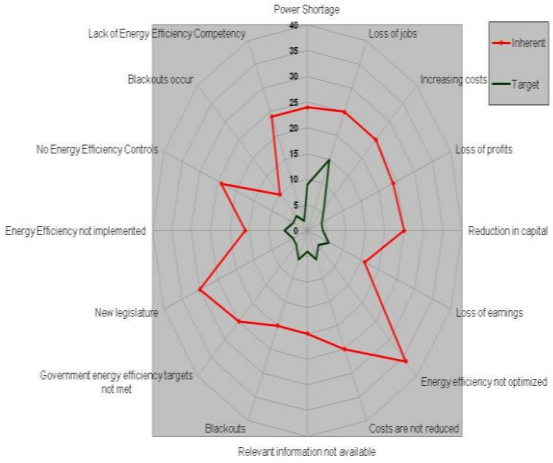

Fig 1. Spider grapgh depicting risk intensity

The risks for an engineer are shown in Table 2.

	What if?	Risks / Threats
MD CONTROL	What if Power Factor Correction (PFC) does not exist or not compliant	Non Compliance. PF must be 0.85 and above
	PFC fails.	Annual Utilized Capacity (AUC) increases. Maximum Demand (MD) charges increase.
	New MD rules	Overshoot Notified Maximum Demand (NMD)
	MD overshoots above NMD	Penalties
	No MD control	Increased costs and possible penalties.
	MD control works effectively	Unnecessary Network Access Charges (NAC)
	No loads to shed	MD control not possible
LOAD SHIFT	Operations remain the same	Increased energy charges
	TOU is optimized	Higher MD
ENERGY SAVINGS	Energy efficiency not optimized	Increasing charges and non compliance to government energy targets and CO_2 reductions.
	Costs are not reduced	Compounded energy costs increasing
	Relevant information not available	Inability to manage energy costs and usage.
	Loads 'ON' unnecessarily	Reduced life of equipment, Unnecessary higher energy consumption.
PCP	PCP implemented	Penalties, Loss of production
	New legislature	PCP implemented. New energy standards.
ENERGY MANAGEMENT SYSTEMS	No systems	All of the above
	Systems in place	Unable to manage energy consumption

Table 2: Risks for an engineer

The intensity of the various risks for an engineer (Table 2) is depicted by the red area in Fig. 2 while the green area is where an engineer would like to be in terms of risk evaluation.

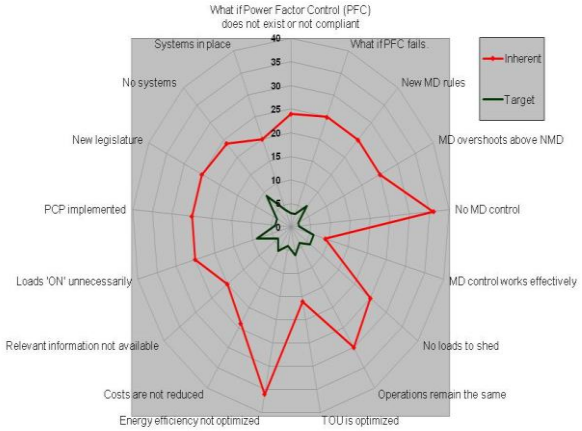

Fig. 2 Spider grapgh depicting risk intensity

RISK MITIGATION STRATEGY

To mitigate the various risks associated with energy, a 'Centralized' energy control system is required – 'Centralized' in a sense that the control system should not only comprise hardware and software algorithms, strategies and behavior have to also be incorporated. National Power Contractors (NPC) has developed a PLC based Central Energy Management Control System (CEMCS) that enables the various levels of management to mitigate the energy risk. This CEMCS incorporates all existing systems and controls making energy easily controllable. The hardware involved is based on reputable off the shelf hardware making the system easily adaptable - 'plug and play'. The main aspects of control that the system performs are MD control; Load shifting, Process optimization and Real Time trading of energy. The tools necessary to mitigate against the PCP "if/when it is implemented" are also incorporated in the system.

CONTROL IDENTIFICATION

1. Maximum Demand (MD) Control

MD control is a fairly old concept which has been practiced for many years but before trying to implement MD control one needs to establish whether there is an opportunity for MD control. Monthly data from an energy meter has to be analyzed for this purpose. Fig. 3 and Fig. 4 both show typical kVA data and its load duration curve for a month.

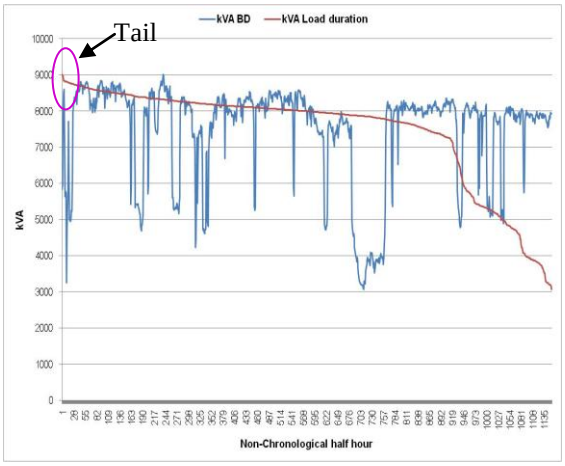

Fig. 3 kVA data with load duration curve-small tail

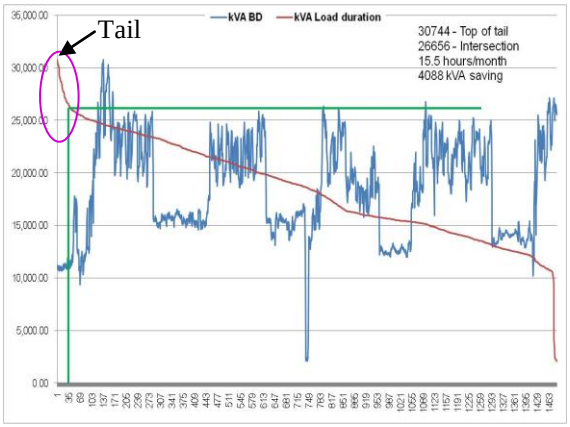

Fig. 4 kVA data with load duration curve-large tail

The data in Fig. 3 depicts the load duration curve having a small tail whilst the data in Fig. 4 shows the load duration curve has a large tail. Immediately from Fig. 3 one can identify that there is no or very little opportunity to save on MD. Referring to Fig. 4 the data shows that only 15.5 hours of MD control per month is required to achieve a monthly saving of 4088 kVA. Note kVA savings also results in energy savings as well. Based on the new Demand rules from Eskom, a 4088 kVA saving will result in significant monetary savings and a guarantee of MD savings will result in a possible reduction of a client's NMD as well, resulting in further savings. Another important factor to consider is, should there be no energy control systems in place and should the MD exceed the NMD for a month, the client will pay penalties and a higher AUC for the next 12 months. This could be financially crippling.

2. Power Conservation Program (PCP)

The PCP has been introduced by Eskom but has not been implemented 'yet'. Eskom's largest clients will first be affected should this program be implemented. Should a client exceed the baselines allocated by Eskom, punitive tariffs will be introduced. Presently Eskom has been sending out 'dummy' monthly bills to these clients showing what penalties will be charged should baselines exceed allocated baselines. From these bills one can identify if action/load control is required.

3. Load Shift

Load shifting can only be done on loads that don't need to be "On' all the time. Examples of loads that can be load shifted are pumps, conveyors etc. By optimizing the process these loads can be switched 'Off' in peak periods resulting in energy savings. Note as long as a load is 'OFF' energy and cost savings are achieved.

CONTROL IMPLEMENTATION

Load control has been difficult to implement in the past due to the high costs involved. To therefore help reduce costs fewer large loads instead of many smaller loads were identified to be controlled in a business/plant. The problem with controlling large loads is that these are generally critical production loads. Due to the advances in technology Load control has now become easier at a reduced cost. NPC together with a Danish company Develco developed a wireless solution. This solution comprised of wireless Relays, Plugs, Energy meters and Occupancy sensors. These wireless devices communicate using ZigBee protocol based on the EEE 802.15.4-2003 standard for Wireless Personal Area Networks (WPAN). The low cost, low power devices operate in a license free 2.4 GHZ radio band and is based on the ZigBee 2007 stack. A great advantage that ZigBee provides is its mesh network capability enabling ZigBee devices to operate as masters and slaves to each other. Distances of up to 30m indoors between devices have been achieved. Up to a 6 tier network from a central coordinator is possible making distances of up to 180m achievable. Each coordinator can handle a maximum of 500 devices. The coordinators have been designed with an Ethernet interface making installation simple since plants and businesses have existing Ethernet networks. A picture depicting a mesh network with ZigBee devices is shown in Fig. 5.

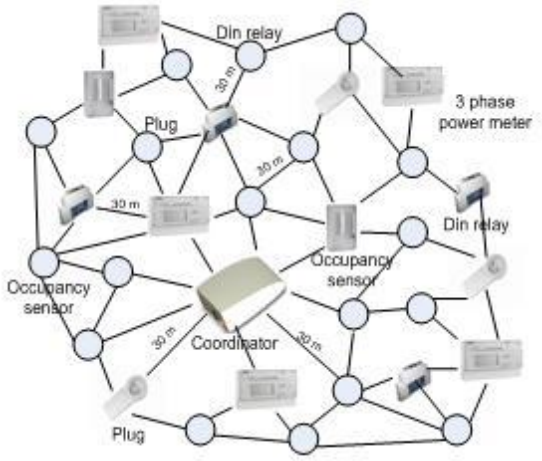

Fig. 5 ZigBee mesh network with ZigBee devices

CONCLUSION

This article presents the importance of energy risk mitigation in any business. The various risks associated with energy from a CEO's and an engineer's perspective have been identified and discussed. Without any form of Monitoring and Control the various identified risk levels are high, clearly showing the need for action to be taken. Action can be taken by implementing different types of load control. The identification of some forms of load control were discussed. The implementation of a CEMCS will perform the necessary load control and process optimization required to mitigate energy risk and reduce energy usage.

Abbreviations

AUC – Annual Utilized Capacity
CEMCS - Central Energy Management Control System
MD – Maximum Demand
NAC – Network Access Charge
NMD – Notified Maximum Demand
NPC – National Power Contractors
PCP – Power Conservation Program
PFC – Power Factor Correction
PLC – Programmable Logic Controller
WPAN – Wireless Personal Area Networks

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