Energy Management Systems in India

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Abstract - *EMS is one of the emerging technology that collects real time information on energy use. This is done through monitoring, assessing and visualizing energy consumption. This enhances enterprise level operations and financial decision. The main principle is to reduce power consumption of present systems and equipment by centralized monitoring and control of energy use across such building systems. The paper discusses primarily, the scenario of the Energy Management Systems in India. The problems facing the development of such systems in our country revolve around economic considerations and lack of awareness and skill. Based on the case study of JK Lakshmi Cement LTD- Jaykaypuram, Sirohi Plant the paper tries to state the various ways in which this novel structure can be brought to the forefront in the times of fuel and economic crises.*

Key Words**: Energy Management Systems, JK Lakshmi Cement LTD, Smart Energy management Systems (SMES), Power Systems, Open Access Transmission, PAT Scheme.**

1. INTRODUCTION

Today's world has become a complete energy dependent world in which electricity is of prime importance. Electricity has made life very easy and thus its consumption is increasing day-by-day. In order to generate this electrical energy in its original form, a lot of natural resources are being used. Traditionally electricity was generated only from non-renewable energy resources but now renewables have come into picture. Although renewables are used for generation of electricity, the system and equipment needed to produce electricity from them are costly and thus can't be afforded by every common man. Hence this has led to the depletion of the natural resources. Therefore it is essential to switch to new and better options like smart grid, smart metering, and zero energy buildings that will help to reduce dependency on these reserves by reducing energy consumption and improving use of renewable energies. And in order to increase the efficiency of our power system Energy Management Systems (EMS) are essential. It is a comprehensive offering that combines energy and process optimization and, where appropriate, incorporates the solution into online advanced control and optimization strategies.

This paper focuses mainly on the present scenario of energy usage systems in India and suggests some methods and techniques adopted, that will lead to the improvement of energy usage and efficiency. Also the paper depicts the case study of JK Lakshmi Cement LTD- Jaykaypuram, Sirohi Plant in India which has shown a tremendous improvement in its operating system and energy efficiency using the Energy Management System. The advantages of EMS along with the barriers faced and the solutions to deal with these barriers so that EMS can be brought into operation in the existing industries as well as residential and commercial organizations are also discussed.

The next few paragraphs discuss the basics of Energy Management Systems.

What is an Energy Management System? An Energy Management System is a series of policies, processes and procedures to manage operational energy use. Energy, in the context of organisational use, can be defined as the direct consumption of fuel (Gas, Oil, etc.) and indirect consumption of fuel (Electricity) required to perform the organisational functions. It is a strategy of adjusting and optimising energy, using systems and procedures so as to reduce energy requirements per unit of output while holding constant or reducing the total costs of producing the output from these systems. Thus EMS leads to the judicious and effective use of energy in order to maximize the profits by reducing the operational costs and hence enhance the competitive positions.

Energy management systems are used by power system operators to monitor power grid operating conditions and control grids in a reliable, secure, and economical fashion. An energy management system interfaces with the grid through a supervisory control and data acquisition (SCADA) system. The SCADA system transmits thousands of measurements at critical points of a power system in real time to the energy management system and command signals from the energy management system to field devices to take control actions. An energy management system integrates application software such as state estimation, contingency analysis, automatic generation control, and economic dispatch. These applications typically operate the grid in a reactive (e.g., load following) or preventive (e.g., security constrained dispatch) fashion.

The increased penetration of renewable generation on the power grid imposes great challenges to the current energy management system scheme as renewable resources largely differ from conventional generation because of their uncertainty and variability. To thrive in this situation, energy management system technologies need to evolve into a proactive, look-ahead paradigm. Advanced energy management system technology is also sorely needed at the distribution system level. The traditional distribution energy management system is much less integrated than the transmission energy management system. Operational challenges arise from the significantly increased complexity of modern distribution systems, especially from distributed renewable resources, electric vehicles, and demand-side management. A fully integrated and intelligent distributed energy management system is a key to meet these challenges.

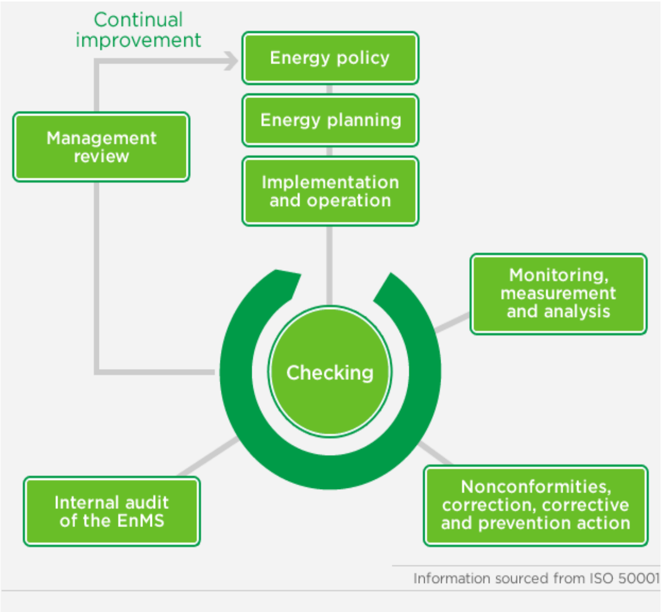


Fig 1: Basic Block Diagram of an Energy Management System

This is based on an international standard for Energy Management. The ISO 50001 Energy Management Systems Standard was released in August 2011. This International Standard establishes a framework for industrial plants; commercial; institutional and government facilities and entire organizations to manage their energy. The Standard is based on the classic business planning cycle "Plan-Do-Check-Act" and provides guidance for organizations in establishing energy policies, programs and action plans to improve their energy use.

1.1 Advantages of EMS

EMS can be used for economic dispatch of power. Power generation can be scheduled when operating costs are low so that power is delivered at minimum cost. Also scheduling generation with limited energy is also possible with the help of EMS.

EMS can play important role in power system security. Intelligent alarm processing and state estimation can also be used to detect contingencies. Dynamic security assessment can also be done with the help of EMS.

Neural networks applications form an important part of predicting and preventing contingencies. EMS can help in doing and preventing such contingencies.

Historical data can also be gathered and stored which can then be processed analytically to predict future power flow patterns.

Operator Training Simulator (OTS) is an important feature of EMS where inexperienced engineers can practice and implement various scenarios on a stress free environment without actually practicing on the grid.

EMS also strengths the competitiveness of the organization and also reduces the vulnerability of the organizations against energy price fluctuations and availability of energy thus establishing a benchmarking process.

EMS also allows organizations to gain credible external visibility of energy saving actions and also provides a better understanding between predictable energy demand and supply.

1.2 Disadvantages of EMS

The current scenario of EMS has low credibility and trust on the information collected.

Also there is lack of technical support and guidance on the implementation and maintenance side.

For successful implementation and accreditation, a proper certification of the measures implemented has to be carried out. The legalities and procedures associated with these measures are long and consume a lot of time.

Large amount of documentation is required for the proper implementation of EMS.

The following section discusses the implementation of EMS in India. The third section sheds light on the energy statistics in India up to May 2016. The fourth section give an idea about the Smart Energy Management Systems (SMES) The fifth section describes the case study of JK Lakshmi Cement Limited, Sirohi Plant. The paper concludes in the sixth section.

2. IMPLEMENTATION OF AN EMS IN PRESENT POWER SYSTEMS

Energy management system plays an indispensable role in control centers of electric power systems. All the real time characteristics of the power system and contingencies can be monitored on a real time basis with the help of an EMS. This section primarily discusses how the integration of EMS in present day power systems has improved the economic, security and user interface aspects of the present power system.

2.1 Economic Aspect

2.1.1 Economic Dispatch: Scheduling Generation to Minimize Cost

The process of scheduling generation to minimize operating cost has historically been called as the Economic Dispatch. In this calculation, the generation costs are represented in the computer system as curves, usually piecewise linear, and the overall calculation minimizes the operating cost by finding a point where the total output of the generators equals the total power that must be delivered and where the incremental cost of power generation is equal for all generators. Traditional economic dispatch calculations take account of the network losses through the use of incremental loss factors. The state of the art method of accomplishing this is to run what is called an Optimal Power Flow (OPF) which minimizes the generation cost while taking account of the entire transmission system and all its constraints.

2.1.2 Automatic Generation Control (AGC)

The basic control of generation on a power system is done through the control of the electrical frequency measured at one of the high voltage buses in the system. If the frequency drops below nominal there is a need for increase in generation and if the frequency rises above nominal there is a need for less generation. The control of generation is done as a supplementary control to the basic governor controls on the generators themselves that work to maintain system frequency by raising or lowering the energy into the prime-mover of the generator. This supplementary control known as the automatic generation control or AGC.

2.1.3 Open Access Transmission

Open transmission systems operate on the idea that all of the power plants should be managed separately, and in fact they may be owned by companies that do not own any transmission or distribution equipment. The idea is to have a transmission system provide transmission services to the generators which in turn directly sell their power to distribution companies or large loads. In such a system, the EMS does not have to have the cost data normally associated with economic dispatch. Rather, it receives bids from the generators to supply power to the loads and it selects the lost bidders as those who will supply energy.

2.2 Power System Security

2.2.1 Increased Security

The modern EMS combines Supervisory Control and Data Acquisition (SCADA) capabilities along with generation dispatch, scheduling and control capabilities. Modern EMS's now have the ingredients necessary to provide operators with advanced security analysis capabilities. This feature is considered absolutely necessary in operating a power system as it allows operations personnel to make the most efficient use of the transmission system by loading it up to its limit without placing it in an insecure state.

2.2.2 Monitoring: Alarm Processing and State Estimation

Monitoring the power system takes place in two ways. The basic process of taking measurements in the substations, transmitting the values to the central computer and comparing those values to stored limits is known as alarm processing. EMS also monitors the status of various binary devices and together these indicators make up tens of thousands of "points" that must be monitored and displayed to the operators. The main purpose of these knowledge based alarms is that they can filter out all but the most important alarms and then present summary alarms so the operator can deduce the situation quickly.
In case of transmission systems, a real time mathematical model of the power system can be built using a power flow model and a state estimation algorithm which can read many redundant measurements and calculate the statistically most probable set of states (voltage phase angles and magnitudes) existing on the network. This is known as state estimation. The state estimator has the ability, given the right set of measurements, to detect and identify measurements that are bad. The bad measurements are removed and reported to the operators so they can be recalibrated.

2.2.3 Static Security Assessment

Once a state estimate is complete the operators have a model of the power system as it presently exists. The next effort is to test that model for a large number of outages in order to determine if the system can recover from the outage without problems. The outage events or contingencies can be modelled using a power flow program by running the contingencies one at a time.

2.2.3 Security Constrained Optimal Power Flow

An OPF can accommodate a constraint that will guarantee that a contingency overload is eliminated. Thus this has led to an elaborate program that includes the contingency analysis and an OPF wherein all contingencies are tested, and all overloads are converted to constraints and are placed into the OPF. After solution it must be iterated through the contingency analysis again to ensure that it has found all bad cases. The end result is a dispatch which guarantees that all contingencies tested are not going to result in trouble.

2.2.3 Security Analysis and Open Transmission Access

When the transmission system is to be operated as an open system there is a different problem in maintaining system security. First, there is the need to allow independent generating facilities to obtain access to the transmission system in a safe manner. That is, they must contact the transmission system operator and "reserve" transmission capacity for their transaction. The reservation process will necessitate the testing of the system for system security while modelling the proposed transaction.

2.3 The Operator Interface and Intelligent Applications

2.3.1 Knowledge Based Expert Systems

Knowledge based systems involve the use of expert system software which allows the encoding of knowledge about a power system into the computer and its manipulation for solving special problems. The knowledge is encoded in the form of production rules which allow the expert system inference engine to "reason". As such, an expert system allows one to set up the solution of a problem that otherwise would be impossible to formulate as a mathematical algorithm (as are most of the applications in an EMS). Expert systems are also very powerful at solving diagnostic reasoning problems. Therefore many EMS systems include expert systems to diagnose faults on the power system using breaker status, switch status, and relay target information. This process is made even more powerful when a model of the power system is built from the SCADA system data base.

2.3.2 Neural Network Applications

Neural networks are an artificial intelligence tool that attempts to program a computer to act as it contained neurons similar to those found in the human nervous system. In an artificial neural network application, the neurons are simulated by software together with a means of presenting the network with patterns to be learned and a means of instructing the network as to the meaning of the pattern. The neural network can theoretically be taught anything, however, computers cannot store and process nearly as many neural network nodes as the human nervous system and brain, so they are far less intelligent. None of the less, the neural network research has begun to show great promises in those aspects of power system operations where patterns must be recognized.

3. ENERGY STATISTICS OF INDIA IN 2016

This section gives a brief idea about the present scenario of the energy statistics in India.

Table -1: Total Installed Capacity :(As on 31.05.2016)

Sector	MW	% of Total
State Sector	101,761	33.58%
Central Sector	76,297	25.17%
Private Sector	125,026	41.25%
Total	303,083	100%

Fuel	MW	% of Total
Total Thermal	211,670	69.84%
Coal	186,243	61.45%
Gas	24,509	8.09%
Oil	919	0.30%
Hydro (Renewable)	42,783	14.12%
Nuclear	5,780	1.91%
RES (MNRE)	42,849	14.15%
Total	303,083	100.00%

Renewable Energy Sources (RES) include SHP, BG, BP, U&I and Wind Energy.
SHP= Small Hydro Project, BG= Biomass Gasifier, BP= Biomass Power, U & I= Urban & Industrial Waste Power, RES= Renewable Energy Sources.

3.1 Policy Initiatives/Decisions Taken

Electricity Act 2003 has been enacted and came into force from 15.06.2003. The objective is to introduce competition, protect consumer's interests and provide power for all. The Act provides for National Electricity Policy, Rural Electrification, Open access in transmission, phased open access in distribution, mandatory SERCs, license free generation and distribution, power trading, mandatory metering and stringent penalties for theft of electricity.
It is a comprehensive legislation replacing Electricity Act 1910, Electricity Supply Act 1948 and Electricity Regulatory Commission Act 1998. The Electricity Act, 2003 has been amended on two occasions by the Electricity (Amendment)

Act, 2003 and the Electricity (Amendment) Act, 2007. The aim is to push the sector onto a trajectory of sound commercial growth and to enable the States and the Centre to move in harmony and coordination.

3.1 Electricity Generation Performance [4]

The electricity generation target for the year 2016-17 has been fixed as 1178 Billion Unit (BU). i.e. growth of around 6.38% over actual generation of 1107.822 BU for the previous year (2015-16). The generation during 2015-16 was 1107.822 BU as compared to 1048.673 BU generated during April- March 2015, representing a growth of about 5.64%.

Table -1: Programme, actual achievement and growth in electricity generation in the country during 2009-10 to 2016-17 (up to May 2016)

Year	Target	Achievement	% target	% growth
2009-10	789.51	771.551	97.73	6.6
2010-11	830.75	811.143	97.64	5.56
2011-12	855.00	876.887	102.56	8.11
2012-13	930.00	912.056	98.07	4.01
2013-14	975.00	967.150	99.19	6.04
2014-15	1023.00	1048.673	102.51	8.43
2015-16	1137.50	1107.822	97.39	5.64
2016-17	192.85	199.163	103.3	9.37

The electricity generation target for the year 2016-17 was fixed at 1178 BU comprising of 999.000 BU thermal; 134.000 BU hydro; 40.000 nuclear and 5.000 BU import from Bhutan.

3.2 Plant Load Factor

Table -1: The PLF in the country during 2009-10 to 2015-16 (up to May 2016)

Year	Target	Actual	Sector-wise Actual		
	%	%	Central	State	Private
2009-10	77.2	77.5	85.5	70.9	83.9
2010-11	72.1	75.1	85.1	66.7	80.7
2011-12	68.7	73.3	82.1	68.0	69.5
2012-13	70.0	69.9	79.2	65.6	64.1
2013-14	69.60	65.60	76.10	59.10	62.10
2014-15	65.52	64.46	73.96	59.83	60.58
2015-16	64.35	62.29	72.52	55.41	60.49
2016-17*	62.95	64.63	75.22	59.78	60.88

3.3 Power Supply Position

Table -1: The power supply position in the country during 2009-10 to 2016-17 (up to May 2016)

Year	Requirement	Availability	Surplus(+) / Deficits(-)	
	(MU)	(MU)	(MU)	(%)
2009-10	8,30,594	7,46,644	- 83,950	- 10.1
2010-11	8,61,591	7,88,355	- 73,236	-8.5
2011-12	9,37,199	8,57,886	- 79,313	-8.5
2012-13	9,95,557	9,08,652	- 86,905	-8.7
2013-	10,02,257	9,59,829	-	-4.2

14			42,428	
2014-15	10,68,923	10,30,785	-38,138	-3.6
2015-16	11,14,408	10,90,850	-23,558	-2.1
2016-17	1,97,919	1,95,987	-1,932	-1.0

Year	Peak Demand	Peak Met	Surplus(+) / Deficits(-)	
	(MW)	(MW)	(MW)	(%)
2009-10	1,19,166	1,04,009	-15,157	-12.7
2010-11	1,22,287	1,10,256	-12,031	-9.8
2011-12	1,30,006	1,16,191	-13,815	-10.6
2012-13	1,35,453	1,23,294	-12,159	-9.0
2013-14	1,35,918	1,29,815	-6,103	-4.5
2014-15	1,48,166	1,41,160	-7,006	-4.7
2015-16	1,53,366	1,48,463	-4,903	-3.2
2016-17	1,52,974	1,49,802	-3,172	-2.1

Chart1: Generation (Billion Units)

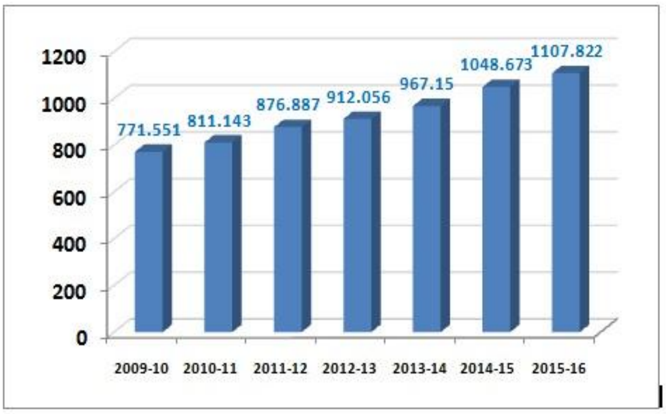
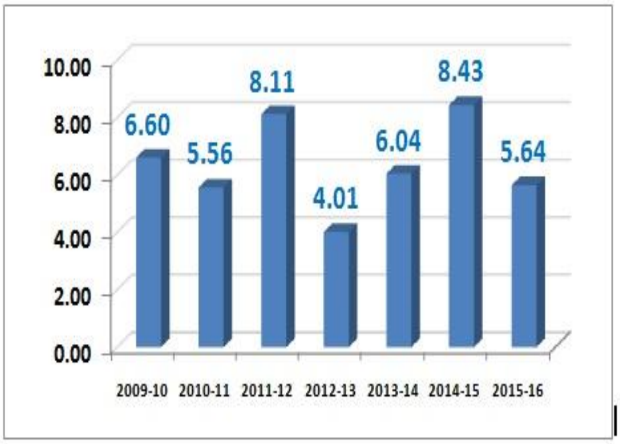


Chart -2: Generation Growth (%)



4. SMART ENERGY MANAGEMENT SYSTEMS (SMES)

Smart grid is a system to add monitoring, management, control and communication capabilities to the national electrical delivery infrastructure to move electricity around the system as efficiently and economically as possible. Integrating renewable energy sources into the smart grid system enables in the reduction of cost of sources required for building extra generators, improved power quality, reliability and achieve the customer satisfaction. Such systems are known as Smart Energy Management Systems. The various technologies used to implement SMES are as follows:

4.1 Advanced Metering Infrastructure (AMI)

Advanced Metering Infrastructure (AMI) is a vision for two-way meter or utility communication. It has two fundamental elements. First, automatic meter reading (AMR) systems provide an initial step toward lowering the costs of data gathering through use of real-time metering information. They also facilitate remote disconnection/reconnection of consumers, load control, detection of and response to outages, energy theft responsiveness, and monitoring of power quality and consumption. Second, meter data management (MDM) provides a single point of integration for the full range of meter data. It enables leveraging of that data to automate business processes in real time and sharing of the data with key business and operational applications to improve efficiency and support decision making across the enterprise.

4.2 Distribution management System (DMS)

Distribution management system (DMS) software mathematically models the electric distribution network and predicts the impact of outages, transmission, generation, voltage/frequency variation, and more. It helps reduce capital investment by showing how to better utilize existing assets, by enabling peak shaving via demand response (DR), and by improving network reliability. It also facilitates consumer choice by helping identify rate options best suited to each consumer and supports the business case for renewable generation solutions (distributed generation) and for electric vehicles and charging station management.

4.3 Geographic Information System (GIS)

Geographic information system (GIS) technology is specifically designed for the utility industry to model, design, and manage their critical infrastructure. By integrating utility data and geographical maps, GIS provides a graphical view of the infrastructure that supports cost reduction through simplified planning and analysis and reduced operational response times.

4.4 Outage Management Systems (OMS)

Outage management systems (OMSs) speed outage resolution so power is restored more rapidly and outage costs are contained. They eliminate the cost of manual reporting, analyse historical outage data to identify improvements and avoid future outages, and address regulatory and consumer demand for better responsiveness.

4. 5 Intelligent Electronic Devices (IEDs)

Intelligent electronics devices (IEDs) are advanced, application-enabled devices installed in the field that process, compute, and transmit pertinent information to a higher level. IEDs can collect data from both the network and consumers' facilities (behind the meter) and allow network reconfiguration either locally or on command from the control centre.

4. 6 Wide Area Measurement Systems (WAMS)

Wide-area measurement systems (WAMS) provide accurate, synchronized measurements from across large-scale power grids. WAMS consist of phasor measurement units (PMUs) that provide precise, time-stamped data, together with phasor data concentrators that aggregate the data and perform event recording. WAMS data plays a vital role in post disturbance analysis, validation of system dynamic models, FACTS control verification, and wide area protection schemes. Future implementation of wide-area control schemes are expected to build on WAMS.

Thus Smart Energy Management Systems can control consumption, onsite generation and storage, and potentially electric vehicle charging. Energy Management Systems are in use today in large industrial and commercial facilities and will likely be broadly adopted with the rollout of smart grids

5. BARRIERS ON EMS PATH IN INDIA

5.1 Project Funding

One of the major barriers in the implementation of EMS projects in India is the lack of capital on the part of the utilities for energy efficiency projects. Capital in terms of both money and physical resources needed for implementing EMS projects are very scarce. Utilities have to distribute the already scarce resources available to various business units within the utility according to prioritization.

5.2 Payback Period

The payback period for EMS projects stretch into years because of the large investments involved in them. This proves as a deterrent to those utilities which have end use products and require fast payback of their investment.

5.3 Tax, Split Incentives and Planning cycles

Many times there is complete mismatch between the utilities planning cycle for upgradation and the state's energy policy cycles. This proves a deterrent for the utilities to go for energy efficiency projects unless there is a need to do so.
The business units which authorize the implementation of EMS projects are not the ones that are directly involved in the energy usage. Hence decisions regarding their implementation are taken after considering the benefit of the entire organization which may sometimes sideline the energy efficiency projects.

5.4 Lack of knowledge

The method of capital recovery schemes in a utility can greatly affect the utilities interest in promoting industrial energy efficiency projects. This happens mainly in the case of smaller industrial companies.

Also companies are unable to spare time to train its employees on new EMS technology or doesn't have appropriate technical expertise to implement energy efficiency projects.

5.5 Availability of technology

Lack of energy consumption data and tools to evaluate energy data can prove deterrent to implementation of EMS projects. Also new EMS technologies are costly to implement.

5.6 Price Trends

Volatile energy prices can lead to uncertainty on return from capital invested on new energy efficiency projects and mainly a deterrent for small utilities.

6. CASE STUDY-JK LAKSHMI CEMENT LIMITED [9]

Fig 2: JK Lakshmi Cement Limited, Sirohi Plant

6.1 Company Profile

JK Lakshmi Cement LTD established in 1982 is one of the most modern dry process cement plant with modern equipment. The plant has been recommended and certified with ISO 9000, ISO 9001, ISO 14001, ISO 50001 and OHSAS 18001. Its laboratories have been accredited by NABL.

6.2 History of Energy Reduction Approach

M/s JKLC also had its approach towards energy reduction before launching of the PAT scheme. According to JKLC, 55% of the total manufacturing cost consists of energy consumption. Hence in order to achieve market advantage it took various measures to bring down this cost. The various energy consumption measures implemented by JKLC helped them to reduce the electrical energy intensity from 83 Units/Ton of cement to 79 Units/Ton. Also they reduced the thermal energy intensity from 768 kCal/Kg of clinker to 742 kCal/Kg in a period of 5 years.

6.3 The PAT Scheme of BEE, 2012

"PAT" – Perform Achieve & Trade scheme of BEE, was a scheme in which participation of notified designated consumers was mandatory from 8 highly energy intensive sectors. Each designated consumer from these 8 sectors was notified a unit specific energy reduction target on that specific sector on 31st of March, 2012. A period of 3 years was allotted to achieve the notified target from date 01st April, 2012 to 31st March, 2015. This period of 3 years was specified as "PAT"- cycle 1 and the third year of "PAT" – Cycle 1 was considered as an assessment year to achieve the target.
According to this scheme, the higher achiever shall be issued Energy Saving Certificates from the BEE, which shall be tradeable in the market. Lower achiever shall be penalised with Rs.10 Lacs and must comply his notified targets by purchasing the Energy Saving Certificates from the market. Baseline of M/s JK Lakshmi Cement Ltd. was identified as 877 kCal/kg of major product (PPC cement) through an energy audit conducted by a third party nominated by the BEE. It had given a reduction target of 4.91%, and had to achieve target of 834 kCal/kg of major product (PPC cement) in the assessment year of "PAT"- Cycle 1. At the end of PAT - Cycle 1, JK Lakshmi Cement Ltd. achieved a level of 747 kCal/Kg of major product with a reduction of 14.8%, as against notified target of 4.91%.In lieu of additional savings, M/s JK Lakshmi Cement Ltd, was recommended for 38987 Energy Saving Certificates from the BEE.

6.4 Energy Review and Planning

6.4.1 Energy Planning – General

An energy planning consistent with the energy policy had been done and documented which involved review of organization activities that can affect energy performance.

6.4.2 Energy Review

Organization had established, a procedure, to record and maintain an energy review. This was done through periodic audits. Even today the procedure is followed strictly.

6.4.3 Review, Analysis and Planning – Energy Baseline

Based on output of initial energy review, an energy baseline had been decided and recorded, considering a data period of past 2 years.

6.4.4 Energy Performance Indicators (EnPIs)

The energy performance indicators (EnPIs) appropriate for monitoring and measuring energy performance were identified and were linked with the operational performance measurable such as energy used/ton of finished product.

6.4.5 Energy Objectives, Energy Targets and Energy Management Action Plans

Documented energy objectives & targets had been established at relevant functions, levels, processes and facilities. Consideration was given to legal and other requirements, significant energy uses & opportunities to improve energy performance.

6.4.6 Financing

Further consideration was also given to financial, operational and business conditions, technological options and views of stake-holders. Documented Action Plans (EnMPs) were established, implemented and maintained for achieving objectives and targets.

6.4.7 Duration

Approx. a time period of 18 months was estimated to establish the EnMS and it was established in a period of 17 months.

6.5 Development and Use of Professional Expertise, Training and Communications

6.5.1 Competence, Training and Awareness

It is essential that every single person working related to significant energy uses are competent on the basis of appropriate education, training, skills or experience. The organization had a system to monitor the competence of its personnel and identify training needs associated with the control of its significant energy uses and the operation of the EnMS.

6.5.2 Communication

The Top management had established appropriate communication processes with regards to energy performance and EnMS. Internal communication within various levels and functions was done through formal meetings, internal circulars, letters, notice/display boards, internal mail system, training programs (including those for Energy Policy), internal magazine (Lakshmi Darpan), open forum meetings, daily, weekly meetings, safety committee meetings, cross functional teams, quality circles and similar means.

6.5.3 Professional Expertise

Energy professionals and experts are called from external agencies like, NCCBM, CII, BEE accredited energy auditors/ BEE empaneled energy audit firms and is engaged for various EnMS activities.

6.5.4 Tools and Resources

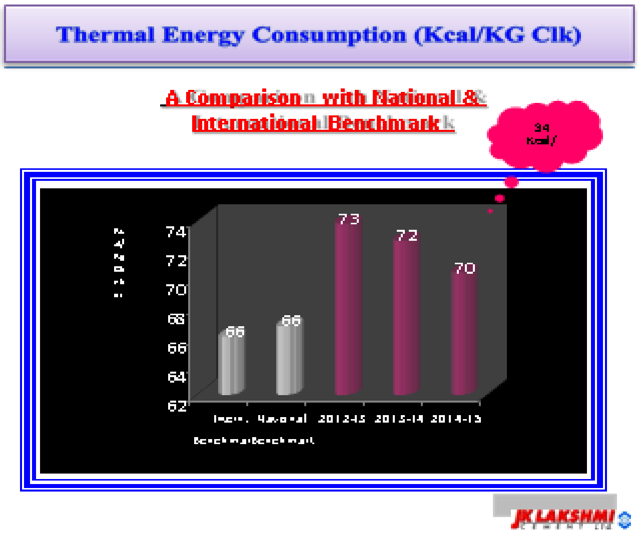
As all the employees were well versed with the existing other management systems already in place (ISO 9001, ISO 14001 and OHSAS 18001) the implementation of ISO 50001 was smooth. But involvement and to educate bottom line workmen was a challenge which was met by regular & effective training by internal & external resource persons.

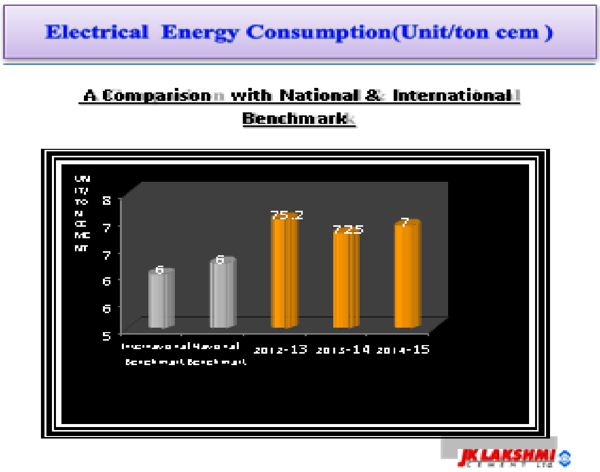
6.6 Major Energy Saving Projects

a) Installation of Waste Heat Recovery System.
b) Installation of IKN cooler in all three kilns.
c) Installation of Chinese VRM to avoid running of Ball Mill.
d) Up-gradation of major process fans with high efficiency fans
e) Capacity enhancement of Kiln-1, through installation of TA duct, enlargement of cyclone inlet area & increased calcine height.
f) Installation of twin drive control system of DC drives for Kiln-1.
g) Installation of one additional boiler to utilize increased volume of cooler exhaust hot gases for increasing power generation from WHRs.
h) Installation of hot air recirculation duct to increased power generation through WHRs.

6.7 Cost Benefit Analysis

During implementation of various energy saving measures, JKLC achieved total energy cost saving of Rs.903 million, with an investment of Rs.2832 Million and an average payback period of 38 months.





Business Benefits	Technical Benefits (After PAT cycle-1)
Structured platform for energy consumption, energy conservation and energy management	Energy performance improved from 877 kCal/Kg to 747 kCal/Kg.
Easy approach for identification and prioritization of major energy consuming activities and equipment	Thermal energy intensity reduced from 759 kCal/Kg to 704 kCal/Kg.
Close monitoring of high energy consuming process and mechanism to develop any change in energy consumption pattern.	Electrical Energy Intensity reduced from 81Units/Ton of cement to 74 Units/Ton of cement.
Improvement in operational efficiencies and different approach towards O&M procedures.	Until clinkerization process, the electrical energy intensity reduced from 55 Units/ton of clinker to 49 Units/ton of clinker
Increased awareness among employees regarding energy consumption and energy conservation	Total energy cost saving of Rs.903 million on an investment of Rs.2832 million with payback period of 38 months.
Minimise wastage of energy	CO_2 reduction from 915 Kg CO_2/ton of clinker to 891 Kg CO_2/ton of clinker.
	Increase in green energy through WHRs from 7.56 million Units/annum to 90.62 million Units/annum.

7. CONCLUSIONS

Energy Management System (EMS) is one of the upcoming technologies which has the potential of changing the energy scenario of world and India. The technology works by collection of real time information of electrical parameters and building intelligent systems which uses this data to build systems which can predict contingencies in advance. Also EMS helps in effective scheduling and generation of power at lowest operational cost and highest efficiency. Currently there are some barriers into implementing EMS in energy intensive industries. However, with improvement in technologies, these barriers can be overcome and successful implementation of EMS is possible. EMS is implemented in conjunction with Smart Grids known as Smart Energy Management Systems. This has resulted in the implementation of EMS on a nationwide basis.

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