Energy Management - A Case Study of Companies in Singrauli Area in India

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Energy should be regarded as a business cost similar to other business costs including raw material and labor. The effort required to manage energy effectively will vary between companies and depends on the company size, and energy intensity (energy costs expressed as a percentage of total company costs) and the current level of efficiency. Energy management requires a logical and comprehensive management approach and it needs managerial decision making based on energy data analysis. This paper presents comparative analysis of energy management in industries in Singrauli area of India. On the basis of this analysis, calculation of energy saving will be made. The research methodology used is collection of primary data through energy meters and questionnaire and interviews from opinion leaders and general workers and secondary data from energy bills of selected industries. The companies were measured on 1000 point energy efficient scale based on the data analysis and the energy smartness of companies has been compared.

Keywords- Strategic Energy Management, Energy Audit, Specific Energy Consumption

1. Introduction

Energy Management is the science involving planning, directing and controlling the supply and consumption of energy to maximize productivity and comforts and minimize the energy cost and pollution with conscious, judicious and efficient use of energy. According to Piper [17], the basic objective of energy management function is to see that energy needs of the companies are satisfactorily met at minimum cost at present and in future to extend possible. Strong commitment from top management is essential for a successful energy management program which includes managerial decision making. However, managing energy does not necessarily require a formal system; any firm can improve their energy performance by following a few simple techniques. As with any business strategy, strategic energy management incorporates a few fundamentals:

1. Get senior management commitment
2. Assess current situation
3. Set goals and targets
4. Establish an action plan

5. Allocate resources
6. Implement plan
7. Review and evaluate

Energy strategy spans a number of the key functions within a firm and therefore requires cooperation and commitment from all. *Senior management* provide the leadership and set direction; *finance* are involved to ensure that most appropriate purchasing decisions are made; *production*, as the key user, ensures that energy is used appropriately; *engineering* ensure that plant is operated and maintained efficiently and *HR* are involved to facilitate training and help generate a culture of energy awareness.

The most successful energy management strategies suggested by Rajan [18] typically involve the setting up of an energy management team with participants from each of the functions mentioned above. This team would support a dedicated energy manager with responsibility for the coordination of energy management activities. Depending on the size of the business, this may or may not be a full-time, dedicated post. The team in association with senior management would establish an energy management policy, which should include general aims and specific energy cost reduction targets, timetables and budgetary limits, the methods to be employed and the organization of management resources. The energy manager should set up a system to collect, analyze and report on energy consumption and costs.

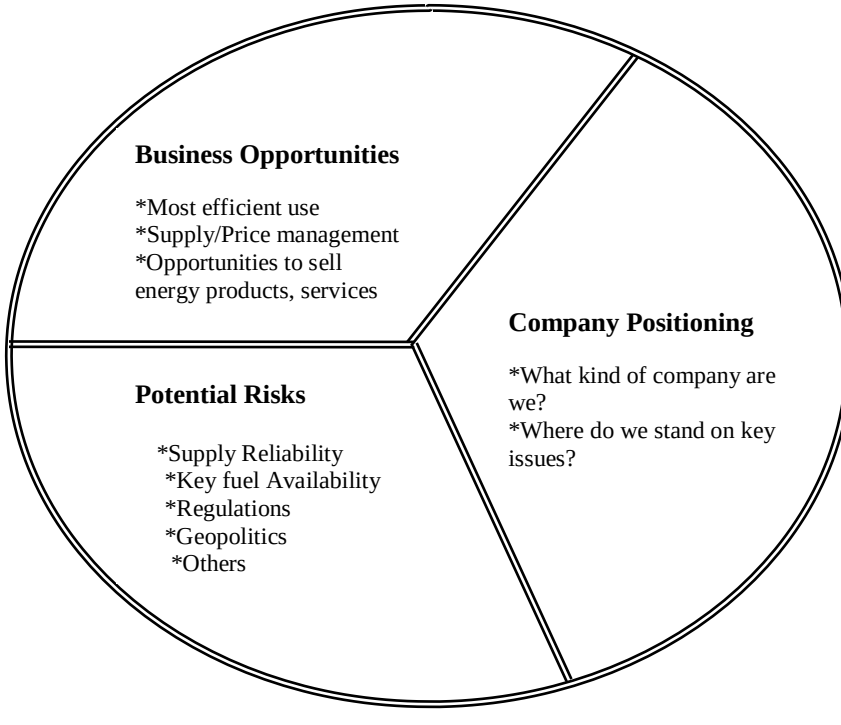


Figure 1 *Drivers for Company Energy Management, Impact of Energy Management on Corporate Planning*

This can consist of reading meters on a regular basis and the analysis of utility bills i.e. gas, fuel oil and electricity. Business opportunity, potential risks and company positioning are key drivers for company's energy management. Figure 1 shows how energy management can impact corporate planning**.**

Strategic Energy Management Process

There are four steps in the overall process, as shown in Fig.2:

• Step 1: Initial Assessment
• Step 2: Design the Process
• Step 3: Evaluate Opportunities
• Step 4: Implementation

Step 1: Initial Assessment

This first step involves a thorough, organization-wide assessment of the importance of energy to the company in relation to its overall needs, risks, goals, image and reputation, and of potential business opportunities through energy-related products or services. Properly implemented, the assessment can provide clear direction as to the potential inherent in a strategic approach to energy planning and management. The key question posed by the assessment process is "what are the business opportunities related to energy?" This framework provides the context for evaluating energy as more than simply a cost of operation.

Companies that have embarked on such an evaluation have asked themselves very fundamental questions about how energy relates to:

• Potential business opportunities;

• Potential business risks; and

• The overall "positioning" of the company

The bottom line is that while cost is an increasingly important factor, companies evaluate the importance of energy from multiple perspectives. Other factors such as risk management, reputation, and even product-line issues may carry weight as well. As Howard Stanley of Corning, Inc. observes: *"Cost and consumption are key elements of managing energy. You have to gather your data and implement strategies to affect the factors you can control. Even if your energy dependence is low, if energy is important to your company, then a review is justified."* The outcome of this step is a decision: to go forward with a more strategic approach to energy management, or not.

Step 2: Design the Process

The design and planning process begins with an assessment of a company's actual energy needs versus "business as usual" practices and an investigation into the most promising solutions for meeting those needs. Taking this approach—asking the fundamental question of "how much energy do we need?"—encourages thinking beyond the familiar and the comfortable and exploring possibilities for innovation. It is important that process design and planning consider all factors that could inhibit success, from corporate culture to appropriate scale to resources, funding and organization.

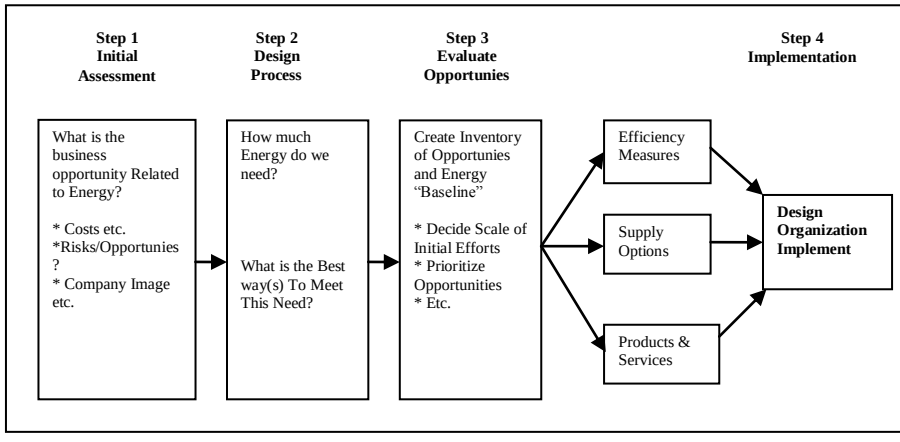


Figure 2 *Energy Planning & Management Strategy*

Key questions to consider:

• At what scale should we initially approach energy management: a single facility or division, or enterprise wide? This decision is driven by the potential for success in the early stages and consequent sustainability of the overall management process.

• What technical and financial resources are available (this is closely related to the scale question): are they internal, external, or both? What are the competing priorities for these resources?

• Are there programs or processes already in place (e.g. Six Sigma) with which energy management could be integrated?

These and other questions frame the overall approach that a company will choose and can greatly influence the chances for early success, which is critical to establishing a sustainable management process that will maximize potential benefits.

Step 3: Evaluate Opportunities

This step is the "nuts and bolts" of the energy strategy and management planning process because it is where real opportunities can be realized. It is where the "real work gets done," but because of its potential size and complexity, especially in larger, diversified and energy intensive businesses, if not well mapped out and systematically approached, significant opportunities may be missed, or momentum may be lost that will be difficult to regain. Essential to this third and crucial step in the process is a baseline that reflects the types, quantities, and costs of energy used in each significant component of the business. Ideally this will include facilities, operations, transportation, distribution, and in some cases even the energy required by the product itself, especially if that issue is increasing in importance in a business sector. Also, for certain companies, this will include an assessment of new or expanded energy-related products and services that may benefit the company.

Opportunities fall into three categories, although not all will be relevant for all companies:

• Energy efficiency reduces the amount of energy used, reducing both cost and environmental impact.
• Energy supply management can help to control costs and assure reliability.
• Energy related products and services can help existing products to be more competitive in the marketplace or create new markets. Factors influencing Energy opportunities at a given point in time are shown in Fig. 3.
At any point in time, in addition to the cost of energy, a range of factors influence the opportunities that are available. Because these influencing factors, including energy cost, are dynamic, a strategic approach to energy planning and management must be dynamic and iterative rather than static. Only in this way will opportunities be continuously identified and realized.

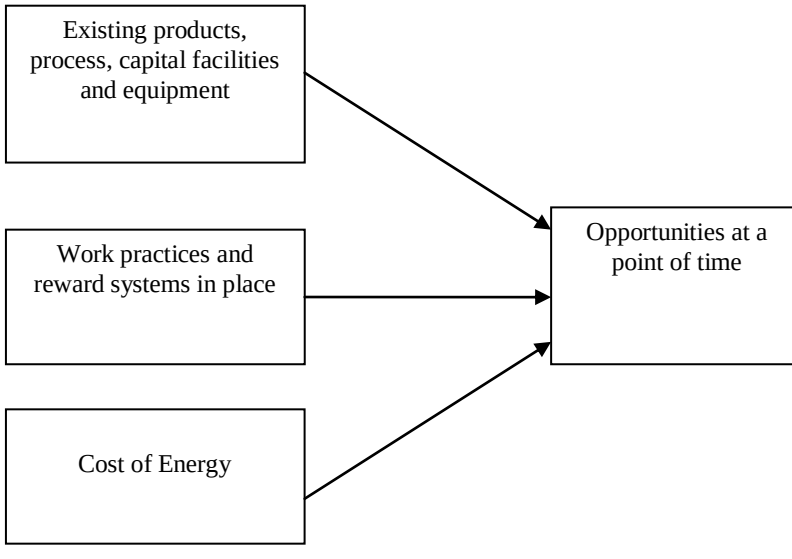


Figure 3 *Factors influencing Energy Opportunities at a Given Point in Time*

Step 4: Implementation

This fourth and final process step follows a classic management system model and involves determining and setting in place an organizational structure that will ensure that the program is integrated into the overall company management culture and that the new energy management goals are achieved. Regardless of the framework decided upon, certain management principles and tools must be in place to achieve significant results.

These include:

• Leadership at the very top of the company with a clear commitment to results;
• Clearly stated goals and measurable objectives at appropriate levels;
• Clear accountability for results, whether in a single or multiple executives;
• Sufficient resources to enable achievement of the objectives and goals;
• Periodic review and updating of goals, objectives and resource commitments; and
• Recognition of progress and reward for achievements.

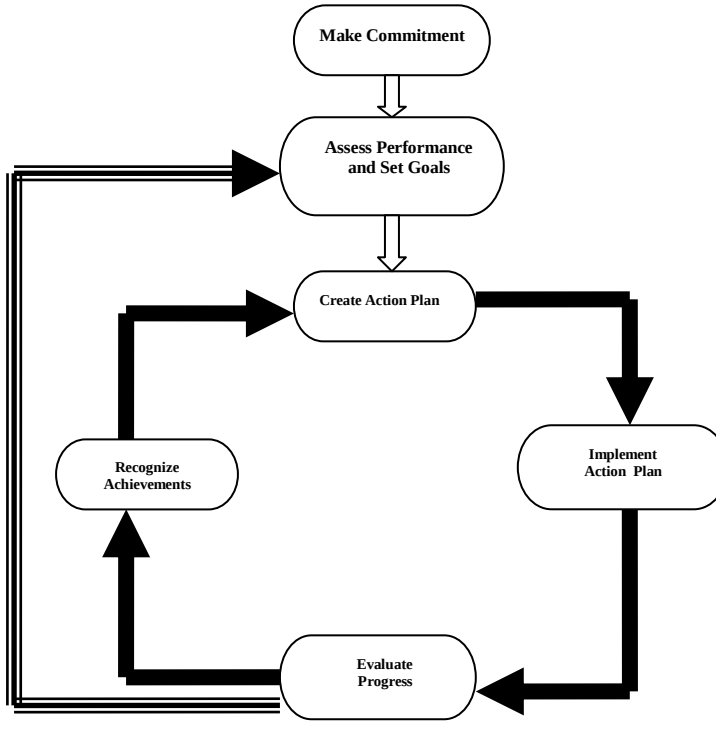


Figure 4 *Guidelines for Energy Management*

Strategic Management model for Energy Cost Reduction in Industry-

One simple and widely adopted management system model and guidelines has been developed by Tripathi and Pandey [25] as shown in Figure 5. The various implementable guidelines recommended for energy conservation measures in industries are:

- Reducing energy consumption through operational improvements resulting in little or no investment with immediate pay back/within one year (Short-Term Measures)
- Making low-cost modifications and improvement to existing equipment having the pay-back period less than two years(Medium-Term Measures/Low Cost Alternative)
- Making equipment changes or implementing new techniques and new technologies involving large investments leading to capacity utilization and major energy savings having payback more than 2 years (Long-Term Measures, High Cost Alternative)

2. Review of Literature

The important of energy management as a tool of reducing the cost of production in industries is being recognized since last two decades. Anandalingam G. [1] explained

policy incentives for industrial energy conservation in a discussion paper presented to Tata Energy Research Institute. He further worked on energy conservation in the industrial section of developing countries [2].

Schurr, S.H. [3] raised the important question and tried to answer – Energy conservation and productivity group: can we have both? The report of TERI presented by Kothari, V.S. [4] gives a critical analysis of industrial energy policies in India. In Jordan Aburas R. [5] worked on evaluation of energy conservation policies in Jordan. An important work was done by Pasha H.A., Ghaos A. and Malik S. [6] on economic cost of power outages in the industrial sector of Pakistan.

The report on state of industrial sickness in India [7] emphasis on high cost of energy and the less understanding of energy management in Indian industries. The Australian government report on "Future energy management" [11] also raises the similar issues in their country.

Hansen U. [8] worked on delinking of energy consumption and economic growth and presented German experiences on effectiveness of energy management.

The National Productivity Council India worked on energy indicators for Indian Refinery Sector [9] and Food Processing Industries[10] and clearly shown how energy management affects productivity in these industrial sector.

The significant work of Nilsson K. [12] in this field is highly appreciated. He presented the industrial production planning with optimal electricity cost. In China, Huang's [13] work on industry energy use and structural changes a case study of the people's republic of China is noteworthy.

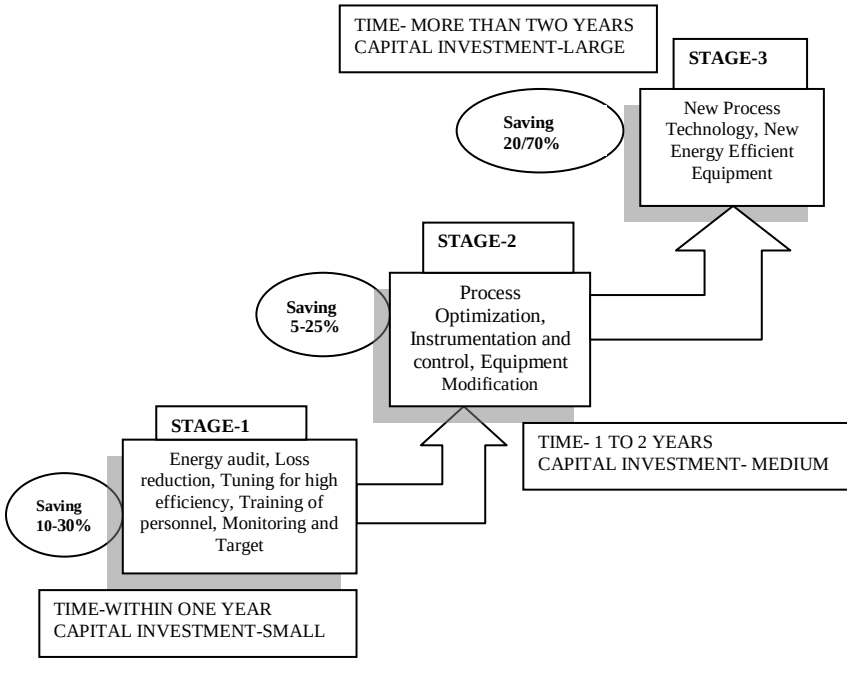


Figure 5 *Strategic Model for Energy Management*

The role of energy economics in business management was being understood since last decade only. Ang B.W. [14] presented his work on decomposition of industrial energy consumption and energy intensity approach. Chupyatov V., Makarov A. and Medvedeva E. [15] worked on energy efficiency and savings in Russia.

In India, Central India Institute of Management, Nagpur, organized First National Seminar on energy management in October 2002, and the need of energy audit, efficient use of energy conservation, demand side management of energy etc. were discussed in details. Institution of Engineers (India) organized a national seminar on *Energy Security* at Hyderabad in Nov. 2006 [21] [25]. The expert committee in this seminar framed a 1000 point scale for assessing the energy smartness of companies.

3. Objectives of Research

The objectives of the research work is-

1. To conduct assessment of industries on energy efficiency.
2. To classify industries in Singrauli area on energy efficient grading.
3. To find out if there is significant difference in companies on energy management criteria.
4. To know the awareness level of energy management policy among different companies.
5. To find the profitability due to energy management methodology adopted among different companies
6. To find the difference in imparting Training in energy conservation to staff among different companies.
7. To investigate promotion /reward criteria in energy management among different companies.
8. To observe the effect of difference in Energy saving methodology adopted by workers among different companies.
9. To find the use of non conventional energy sources in different companies
10. To conduct energy audit in selected industries and to find out-
    a) Major energy consuming area of industry
    b) Quantum of Energy consumption of industry
    c) Energy Expenses of industry
    d) Energy cost as percentage of Production cost
    e) Energy saving potential
    f) Increase in Profitability due to energy saving

4. Hypotheses

After defining objectives the next step is to formulate the hypothesis. On the basis of the above defined objectives following hypothesis are framed:

(1) H_0: There is no significant difference in the awareness of energy management policy among different companies.
(2) H_0: There is no significant difference in the opinion of profitability due to energy management methodology adopted among different companies
(3) H_0: There is no significant difference in imparting Training in energy conservation to staff among different companies.

(4) H_0: There is no significant difference in promotion /reward criteria in energy management among different companies.
(5) H_0: There is no significant difference in Energy saving methodology adopted by workers among different companies.
(6) H_0: There is no significant difference in use of non conventional energy sources among different companies

5. Research Approach

This study aims to analyze managerial decision making in energy management in industries of Singrauli area of Madhya Pradesh in India. Six industries in Singrauli area were selected:

1. Northern Coal-fields Ltd. (NCL – A subsidiary of Coal India ltd.)
2. National Thermal Power Corporation (NTPC)
3. Renusagar Power Company (RPC-Aditya Birla Group)
4. IDL Industries Ltd. (IDL-Hinduja Group)
5. Rewa Gases Pvt. Ltd., Waidhan [RGPL]
6. Vindhyachal Air products Pvt. Ltd. [VAPL]

5.1 Source of Data - Data needed for this exploratory research were collected from *primary* as well as *secondary sources*. Study would comprise the impartial and analytical review of books from libraries and educational institutions, Reference books by Indian / Foreign authors, Research Journals and Articles. Along with these, subject matter from industries in Singrauli area has been collected for in depth study. References from similar development at international level are studied to compare the cases. To derive opinion of other components like BEE, TERI etc., primary and secondary data were collected and analyzed in the light of present requirement of Indian industry. Views, opinion & experience of Managers, Executives and other employees of selected industries are incorporated to get the bigger picture of the impact of energy management strategy. Also annual reports of selected industries that have gone for these strategic options were studied and evaluated. The primary data has been collected with the help of structured questionnaire and structured interview. The response of employees and executives has been elicited through a questionnaire while structured interview of the Managers has been conducted. Monthly Energy consumption data such as Maximum demand, Unit consumed, power factor, load factor, auxiliary consumptions, net energy expenditure, production and energy cost as percentage of production cost has been collected and analyzed.

5.2 Period of study - Data over a period of four years has been collected. Year 2003 is taken as base year/ reference year. Monthly Energy consumption data such as Maximum demand, Unit consumed, power factor, load factor, auxiliary consumptions, Diesel consumption, net energy expenditure, production and energy cost as percentage of production cost for the year 2003 to 2007 has been studied.



5.3 Methods of Data Collection

A. Primary Sources -

- Measurements of Energy inputs and outputs at various units of industry in KWH, KVARh and Maximum demand in KVA
- Measurements of illumination level at various units of industry in lumens
- Questionnaire for workers
- Questionnaire for opinion leaders
  a. The questionnaire for workers -

     It contains twelve question in Hindi [local language] to asses workers awareness on energy saving and energy management.

  b. The Questionnaire for opinion leaders -

     It contains about 100 questions in the form of yes/no. These questions were asked about many aspects of energy management in company such as – Management commitment, Strategic planning, Monitoring, measurement and continual improvement ,Resource management, Process management, Reduction in specific energy consumption, Resource optimization, Waste minimization, Reduction in pollution, Greening supply chain, Use of non-conventional source of energy etc. Sample questionnaire for opinion leaders is given in APPENDIX

B. Secondary Sources -

- Energy bills of the company for past 4 years [electricity department]

- Diesel and other fuel bills of company for past 4 years

5.4 Sampling - Two stage sampling has used in the sample design. In the first stage, out of 20 industries in Singrauli area, 6 industries have been chosen giving representation to each kind of industry by application of Quota sampling. NCL, the only player in the coal industry in this area has been selected. There are six power generation industries in the area; hence one from government sector (NTPC) and one from private sector (RPC) have been selected. Out of three gases industries, two have been selected one from AKVN area (RGPL) and one outside the AKVN area (VAPL). One explosive industry (IDL) has been chosen from six similar kind of industries. In the six selected industries, three are major industries (NTPC, NCL, RPC) and other three are minor industries (IDL, RGPL, VAPL). Hence representation was given to all types of industries in Singrauli area.

Table 1 *Distribution of Questionnaire*

Sr. No	Name Of Industry	Quest. For opinion leader			Quest. For workers		
		Circulated	Population	%	Circulated	Population	%
1	Northern Coalfields Ltd.	40	150	25	320	16000	2
2	National Thermal Power Corporation	50	200	25	50	1800	2.8
3	Renusagar Power Company	15	50	25	20	650	3
4	IDL Industries Ltd.	6	6	100	20	20	100
5	Rewa Gases Pvt. Ltd.,	3	3	100	30	30	100
6	Vindhyachal Air Products Pvt. Ltd	3	3	100	20	30	100
	Total	150	412	36.4	460	18530	2.5

In the second stage, the numbers of respondents to questionnaire have been chosen among the senior managers and workers of these six selected industries. Two separate questionnaires have been employed for opinion leaders (senior managers) and workers of these industries. The sample size is selected as to cover 25% managers from major industries and 100% mangers from minor industries looking at the total population of each type. Hence overall sample size is about one-third for opinion leaders. The sample size 2% to 3% for workers in major industries and 100% to workers in minor industries, the overall sampling is 2.5% in case of workers.

5.5 Tools for Data Analysis - On the basis of various parameters and attributes the ENERGY EFFICIENT SCALE (Energy Smart Standard) for industry has been framed. It is a 1000 point scales and industries under study were given marks on that scale to determine their energy smartness. The results have been tested using statistical tools like ANNOVA, regression analysis, chi-square test etc by VISUALSTAT software to analyze the impact of energy management and managerial decision making in performance of industries.

6. Energy Smart Standard

This Energy Smart Standard - Specifications and Guidelines for Assessment, has been developed in response to the urgent national requirement for conservation of energy and its effective management by Energy Conservation Mission (ECM) Constituted by The Institution of Engineers (India), at AP State Centre, Hyderabad INDIA on 16th December 2003.This is modified and used for present research work

The standard specifies a model for evaluating Energy Smartness of organization as per Energy Smart criteria. The model derives inspiration from various organizational effectiveness evaluation models and approaches used throughout world e.g. EFQM (European Foundation for Quality Management) Model, Malcolm Baldridge Award (USA)) criteria for organizational excellence, Tata Business Excellence Model (in India)

The energy Smart Model and evaluation is based on 12 criteria. Six of these are enablers and six results. The model also recognizes Energy Smart Results- reduction in specific energy consumption, resource optimization, waste minimization, reduction in pollution, green supply chain, use of non conventional sources of energy based on Management Commitment delivered through strategic planning, monitoring, process management, monitoring, measurement and continual improvement.

The model prescribed in this standard is generic and can be used for all types of organizations. The total points are divided into 50% - 50% (50% for Enablers and 50% for Results)

Part I of this standard gives the model and criteria while part II gives the detailed criteria for awarding of points (out of 1000 points)

The Model & Assessment criteria can be used for

1. Self assessment
2. Bench marking with other organizations
3. To identify areas for improvement
4. For recognition and awards
5. Certification

Guidelines for Assessment and Awarding points out of 1000 points

ENABLERS (500 Points)

1. MANAGEMENT COMMITMENT- 100 Points

a) Energy Management Policy **(20 Points)**
- Organizations top management has declared Energy Management Policy

b) Energy Management Policy includes commitment to **(30 Points)**
- Promote energy savings and conservation of resources reduction in specific energy consumption
- Minimization of waste generation and promote reuse recycling and disposal in eco-friendly manner in all segments of operation
- Comply with energy legislation/ regulation/ guidelines

- Continual improvement in cost reduction by adopting effective Energy Management System
- Use of renewable energy sources

c) Management communicates to the organizations**.**
Energy Management Policy and Energy Smart Criteria **(30 Points)**

- Effective System of communicating Energy Policy and Energy Smart System criteria. To different levels in the organization.
- Appropriate knowledge and visible commitment at different management levels on complying with energy policy and Energy Smart System

d) Management determines Energy Smart requirements applicable to the organization ensure incorporation in objectives and targets. **(20 Points)**

2. STRATEGIC PLANNING -50 Points

a) Energy Smart Objectives & Targets

- Energy Smart Objectives & Targets are determined & established at relevant functions and levels of the organization
- The objectives are consistent with Energy Policy & Energy Smart criteria
- Objectives are specific, measurable , achievable and time bound (S.M.A.R.T.)
- Energy objectives are derived based on bench marks with organizations of similar nature.
- Objectives and targets pursue improvement goals
- Objectives and targets are reviewed by Top Management

b) Energy Smart System Planning

- Effective Planning of the Energy Smart System is carried our in order to meet the requirement of objectives.

c) Internal Communication

- Communication processes are established to communicate Energy Smart effectiveness
- Communication process is effective

3. MONITORING, MEASUREMENT & CONTINUAL IMPROVEMENT 100 Points

Evaluation will be based on

- Collection of data & information as per Energy Smart Criteria
- Collection of competitive benchmarks on other energy smart criteria to set targets
- Analysis of information and data on Energy Management from all parts of organization, customers and suppliers
- Using information and data for setting priorities
- Monitoring and measuring critical operating parameter’s and activities that can have significant impact on energy management
- Evaluating compliance with relevant legal requirements related to energy management/conservation

- Taking corrective and preventive action to eliminate the cause of actual and potential non-compliance
- Energy management system audit.
- Continually improving energy performance through the use of energy policy, energy objectives, audit results, analysis of data, corrective and preventive actions and management review

4. RESOURCE MANAGEMENT – 50 Points

Evaluation will be based on

a) Organization setup for Energy Conservation **(10 Points)**
   - Separate Energy Cell created in Organization
   - Energy cell lead by trained senior executive reporting to top management

b) Provision of Resources **(40 Points)**
   - Organizations Management provides resources to facilitate planned improvement and to achieve objectives and targets (Resources may include human, financial and material resources as needed)

Management provides

- Resources for implementing Energy Management System and continually improve its effectiveness
- Organizations Management determines and provides infrastructure needed to implement Energy Smart Systems including.
- Energy efficient buildings, work plan and associated utilities.
- Process equipment (both hardware and software) and plants & machinery.
- Supporting services(such as transport or communications)
- Calibrated measuring instruments.

5. PROCESS MANAGEMENT - 150 Points

Evaluation will be based on

a) HR Process (25 Points)

- Reward Recognition.
  How people are rewarded/recognized in order to sustain their involvement in Energy Smart Criteria in organization
- How career advancement of people are integrated with involvement in Energy Smart Criteria.
- People Competency development/training (% of employees trained/no. of training hours).
- Motivation-motivation method employed in organization to drive people towards Energy Smartness.

b) Engineering Process (25 Points)

Evaluation will be based on

Proposition of products with specific environmental features to total production output in percent. For example, the following product aspect may be considered.

- Recycling.

- Environmentally safer disposal.
- Use of renewable raw materials.
- Efficient manufacturing.
- Low emission production and utilization.
- Longevity.
- Usable packing.
- Good proportion of products from ecological raw material.
- Good proportion of environmentally approved products.

c) Purchasing Process (25 Points)

Evaluation is based on the priority given to supplier following Energy Smart Criteria.

- Training to suppliers on Energy Smart Criteria & System.
- Conducting Assessment of suppliers as per Energy Smart criteria.
- Greening Supply Chain, Life Cycle Cost, Value Analysis as part of Purchase Policy.
- All the above included in measurable objective.

d) Production Process (50 Points)

Evaluation based on Production System includes.

- Reduction of specific Energy Conservation.
- Reduction Water Consumption.
- Waste reduction.
- Cycle time reduction.
- Reduction in non value added processes.
- Reduction of occupational accidents.
- Increase in Waste Recycling Rates.
- Reduction in cases of occupational illness.
- Capacity utilization.
- Application of modern techniques like lean production, etc.
- Including above in goals & targets.

Other Organization Processes (25 Points)

- All processes in organization (Admn/Personnel inclusive) consider capacity utilization, energy conservation, waste reduction, continuous improvement of (e.g. Reduction of travel time, reduction in paper consumption).

RESULTS (500 Points)

1. REDUCTION IN SPECIFIC ENERGY CONSUMPTION-(150 Points)

Evaluation is based on

- Specific energy consumption vs. bench mark in similar organization.
- Reduction in total electricity consumption/unit of production in one year.
- Reduction in electricity consumption/employee (e.g. in offices).
- Reduction in coal/oil/gas consumption/unit.

- Reduction in special energy consumption as per objectives and targets set.
- Reduction in proportion of energy costs to manufacturing costs.

2. RESOURCE OPTIMIZATION (100 Points)

Evaluation will be based on:

- Efficient use of raw materials, water, energy, etc.
- Reduction in production costs by reducing material consumption.
- Reduction of environmental hazardous input material consumption.
- Reduction of environmentally harm input material (solvents, dyes, etc.)
- Replacements with environmentally safer alternatives (e.g. renewable raw materials, reusable packing, recyclable raw materials, solvent free paints and vanishes).
- Incorporating eco-friendly, degradability, health & safety aspects in consideration in input material.

Examples of indicators for resource optimization can be.

- Total material consumption.
- Proportion of reusable packaging.
- Hazardous material input - in Kg (absolute)
- Proportion of renewable raw material- amount of renewable raw material in Tones Material Consumption in Tones
- Environmentally problematic matters absolute in Kg.
- Environmentally safer alternative material – absolute in Kg.

3. WASTE MINIMIZATION (100 Points)

Evaluation will be based on

- Reduction in total amount of waste from production processes.
- Reduction of waste from other processes (other than production).
- Reduction in proportion of waste for disposal to waste for recovery (recyclable waste)
- Reduction in specific waste (in Kg/Tone) or waste/Unit of product.
- Paper waste/employee.
- Reduction of waste transportation cost.
- Reduction of hazardous waste in proportion to total waste.
-

4. REDUCTION IN POLLUTION (50 Points)

Evaluation will be based on

- Reduction in air pollution due to toxic air emission.
- Reduction in process emissions with odor causing gases like Ammonia.
- Reduction in hazardous waste.
- Reduction in emission of green house gases.
- Reduction in polluted water (in production process, sanitation waste)
- Degree of pollutant concentration in waste water.
- Improvement in environmentally safer disposal.
- Reduction of pollution in transportation.

5. GREENING SUPPLY CHAIN (50 Points)

- No of suppliers that have Energy Smart System criteria or part of it.
- Energy Smart Assessment of supplier conducted (%)
- Proportion of purchased goods from suppliers implementing Energy System Criteria.

6. USE OF NON CONVENTIONAL SOURCE OF ENERGY (50 Points)

Evaluation will be based on

- Promotion of clean & green energy' in the organization in all areas.
- Making energy efficient buildings will conserve energy
- Making investment in harnessing various renewable energy sources
- Undertaking awareness campaign to all employees on NCSE/RE

7. Analysis and Results

7.1 Tables of Results

Table 2 Assessments of Industries and Awarding Points on Energy Efficient Scale has been given in Appendix.

Table 3 *Summary of Results*

Energy Efficient Grading Of Industries In Singrauli Area			
Rank	Company	% Points Obtained	Grade
1	Renusagar	80.5	A
2	NTPC	76.7	A
3	NCL	45.2	B
4	RGPL	34.2	C
5	VAPL	33.8	C
6	IDL	24.6	D

Table 4 *Respondents Details*

Sr. No	Name Of Industry	Quest. For Opinion Leader		Quest. For Workers	
		Circulated	Responded	Circulated	Responded
1	Northern Coalfields Ltd.	40	28	320	87
2	National Thermal Power Corporation	50	31	50	21
3	Renusagar Power Company	15	16	20	16
4	IDL Industries Ltd.	6	5	20	19
5	Rewa Gases Pvt. Ltd.,	3	2	30	18
6	Vindhyachal Air products Pvt. Ltd	3	3	20	19
	Total	150	85	460	180

7.2 $\chi 2$ - Testing

The chi-square test is one of the most popular statistical inference procedures as a non-parametric test of goodness of fit for the reason that is enables us to ascertain how approximately the theoretical distribution fit empirical distributions i.e. those obtained from sample data. When an ideal frequency curve whether normal or some other type is fitted into data, we are interested in finding out how this curve fits with the observed facts. Null and alternative hypotheses are established and a significant level is selected for rejection of the null hypothesis. A random sample of observations is drawn from a relevant statistical population. A set of expected and theoretical frequencies is derived under the assumption that the null hypothesis is true. This generally takes the form of assuming that a particular probability distribution is applicable to the statistical population under consideration. The observed frequencies are compared with expected or theoretical frequencies. If the calculated value of $\chi 2$ is less than the table value at a certain level of significance (here 5% level is taken) and for certain degree of freedom the fit is considered to be good i.e. the divergence between the actual and expected frequencies is attributed to fluctuation of simple sampling. On the other hand if the calculated value of $\chi 2$ is greater than the table value, the fit is considered to be poor i.e. it can not be attributed to fluctuations of simple sampling rather it is due to the inadequacy of the theory to fit the observed facts.

We test six hypotheses on energy management in industries of Singrauli area framed in 4 from the observations taken from questionnaire.

7.2.1 Awareness of Energy Management Policy

Hypothesis H_0- There is no significant differences in the awareness of energy management policy among different companies.

Contingency Table

Company	Yes	No	Total
NCL	11	76	87
NTPC	16	5	21
RPC	10	6	16
IDL	7	12	19
RGPL	12	6	18
VAPL	9	10	19
Total	65	115	180

$\chi 2 = 48.55$, Coefficient of Association = 0.52

For $\alpha = 0.05$ and $\upsilon = 5$, $\chi 2 = 11.1$

At 5% significant level, the calculated value of $\chi 2$ is greater than the table value. Hence the hypothesis is rejected.

We conclude that there is significant difference in the awareness of energy management policy among different companies. It is because in NTPC, RPC and RGPL the top management declared energy management policy for the company. While in NCL, IDL and VAPL no such action taken at company level. It is also

observed that there is a good association between the row variable and the column variable at the 5% level.

Profitability due to Energy Management Methodology Adopted-

Hypothesis $H_{0:}$ There is no significant difference in the opinion of profitability due to energy management methodology adopted among different companies.

Contingency Table

Company	Yes	No	Total
NCL	63	24	87
NTPC	15	6	21
RPC	9	7	16
IDL	13	6	19
RGPL	11	7	18
VAPL	11	8	19
Total	112	58	180

$\chi 2$= 3.18, Coefficient of Association = 0.13, For $\alpha = 0.05$ and $\upsilon = 5$, $\chi 2 = 11.1$.

At 5% significant level, the calculated value of $\chi 2$ is less than the table value. Hence the hypothesis is accepted.

We conclude that there is no significant difference in the opinion of profitability due to energy management methodology adopted among different companies. It is because in all companies maximum numbers of managers and workers have the opinion that by adopting energy management policy the profitability of company will increase. It is also observed that there is a fair association between the row variable and the column variable at the 5% level.

7.2.2 Training in Energy Conservation

Hypothesis H_0- There is no significant difference in imparting Training in energy conservation to staff among different companies.

Contingency Table

Company	Yes	No	Total
NCL	13	74	87
NTPC	15	6	21
RPC	11	5	16
IDL	6	13	19
RGPL	6	12	18
VAPL	5	14	19
Total	56	124	180

$\chi 2$= 37.36, Coefficient of association = 0.46, For $\alpha = 0.05$ and $\upsilon = 5$, $\chi 2 = 11.1$

At 5% significant level, the calculated value of $\chi 2$ is greater than the table value. Hence the hypothesis is rejected.

Conclusion-Reject the Null Hypothesis, There is significant difference in imparting Training in energy conservation to staff among different companies. It is because two companies (NTPC and RPC) conduct energy conservation training programs for their employees while other four companies (NCL, IDL, VAPL, RGPL) do not.

It is also observed that there is a fair association between the row variable and the column variable at the 5% level.

7.2.3 Promotion/Reward Criteria in Energy Management

Hypothesis H_0- There is no significant difference in promotion /reward criteria in energy management among different companies.

Contingency Table

Company	Yes	No	Total
NCL	6	81	87
NTPC	16	5	21
RPC	11	5	16
IDL	7	12	19
RGPL	12	6	18
VAPL	10	9	19
Total	62	118	180

$\chi 2 = 64.89$, Coefficient of Association = 0.60, For $\alpha = 0.05$ and $\upsilon = 5$, $\chi 2 = 11.1$

At 5% significant level, the calculated value of $\chi 2$ is greater than the table value. Hence the hypothesis is rejected.

Conclusion-Reject the Null Hypothesis, There is significant difference in promotion /reward criteria in energy management among different companies. It is because in NTPC, RPC and RGPL there is appreciation to employees who adopt the methods of consuming less energy in their works. Other companies (NCL, IDL and VAPL) don't have such criteria. It is also observed that there is a good association between the row variable and the column variable at the 5% level.

7.2.4 Energy Saving Methodology Adopted in Works

Hypothesis H_0- There is no significant difference in Energy saving methodology adopted by workers among different companies.

Contingency Table

Company	Yes	No	Total
NCL	41	46	87
NTPC	11	10	21
RPC	10	6	16
IDL	9	10	19
RGPL	9	9	18
VAPL	11	8	19
Total	91	89	180

$\chi 2$= 3.18, Coefficient of Association = 0.10, For α = 0.05 and υ= 5, $\chi 2$ = 11.1.

At 5% significant level, the calculated value of $\chi 2$ is less than the table value. Hence the hypothesis is accepted.

We conclude that there is no significant difference in Energy saving methodology adopted by workers among different companies. It is because there is about 50% employees in all companies are unaware of such energy saving methodology. It also indicates that although NTPC and RPC conducts energy conservation training programs for their employees, it reaches up to 50% of workers. It is also observed that there is a fair association between the row variable and the column variable at the 5% level.

7.2.5 Use of Non Conventional Energy Sources -

Hypothesis H_0- There is no significant difference in Use of non conventional energy sources among different companies.

Contingency Table

Company	Yes	No	Total
NCL	5	82	87
NTPC	11	10	21
RPC	10	6	16
IDL	5	14	19
RGPL	5	13	18
VAPL	5	14	19
Total	41	139	180

$\chi 2$= 52.86, Coefficient of Association = 0.47, For α = 0.05 and υ= 5, $\chi 2$ = 11.1

At 5% significant level, the calculated value of $\chi 2$ is greater than the table value. Hence the hypothesis is rejected.

Thus there is no significant difference in use of non conventional energy sources among different companies. It is because about 50% employees in NTPC and RPC know or observed a little use of non conventional energy sources in the company. The employees of other companies (NCL, RGPL, IDL and VAPL) are totally unaware of such non conventional energy sources. It is also observed that there is a fair association between the row variable and the column variable at the 5% level.

8. Conclusion

Energy is the motive power and it is the basis of modern civilization. The greatest possible care needs to be taken for proper and efficient utilization of our energy resources. Rising prices of energy are partly responsible to the problems of inflation and economic stagnation. Cost of all products has been rising, but energy prices have been rising faster than the cost of materials and labor. In this context cost effective energy conservation and improvement in energy productivity by applying energy management procedures through equipment modifications /rearrangements can help in saving both fuel and money. The results indicate that except for NTPC and Renusagar other companies don't have energy management cell headed by qualified

energy manager. Smaller companies like IDL, VAPL, RGPL don't conduct energy audits of their company which is mandatory under energy conservation act 2001. There is no energy management policy in highly energy intensive industries such as NCL, IDL and VAPL. Other companies as NTPC, Renusagar, RGPL have energy management policy. No industry is following greening supply chain criteria. Companies don't know whether the suppliers have energy smart criteria or not. No company conducted or demanded energy smart assessment of suppliers. Only NTPC and Renusagar having all processes in organization (administrative/personal inclusive) consider capacity utilization, energy conservation, waste reduction and continuous improvement of efficiency. There is no energy smart system planning found in NCL and RGPL while other companies having it. Maximum numbers of laborers and workers are unaware of any energy policy of company. They don't know about energy conservation in there work. In NCL and IDL there is no reward recognition, career advancement and motivation method employed to derive employees toward energy smartness. Except for NTPC and Renusagar other companies don't provide competency development/training of employees in energy management/conservation. In IDL much wastage of energy is observed at all levels. All motors are running at under loading and over heating conditions. No fine tuning and capacity utilization was found. Free Electricity to all employees in NCL is main reason of wastage and heavy consumption in NCL Townships. Some townships are having electricity consumption at par with mining projects. Also there is no metering /monitoring of electricity in individuals residential units. This leads high percentage of energy cost in companies overall expenditure.

It is concluded that there is a significant difference in the awareness of energy management policy among different companies. It is because in NTPC, RPC and RGPL the top management declared energy management policy for the company. While in NCL, IDL and VAPL no such has been action taken at company level.

There is no significant difference in the opinion of profitability due to energy management methodology adopted among different companies. It is because in all companies maximum numbers of managers and workers have the opinion that by adopting energy management policy the profitability of company will increase.

There is significant difference in imparting training in energy conservation to staff among different companies. It is because two companies (NTPC and RPC) conduct energy conservation training programs for their employees while other four companies (NCL, IDL, VAPL, RGPL) don't.

There is significant difference in promotion /reward criteria in energy management among different companies. It is because in NTPC, RPC and RGPL there is appreciation to employees who adopt the methods of consuming less energy in their works. Other companies (NCL, IDL and VAPL) don't have such criteria.

There is no significant difference in Energy saving methodology adopted by workers among different companies. It is because there is about 50% employees in all companies are unaware of such energy saving methodology. It also indicates that although NTPC and RPC conducts energy conservation training programs for their employees, it reaches up to 50% of workers.

There is no significant difference in Use of non conventional energy sources among different companies. It is because about 50% employees in NTPC and RPC

know or observed a little use of non conventional energy sources in the company. The employees of other companies (NCL, RGPL, IDL and VAPL) are totally unaware of such non conventional energy sources.

Industries and Establishments are of different types and kinds. Hence criteria for energy smart classification may differ from industry to industry, and one commercial establishment to another establishment. There is no single "strategy" for energy. Each company will develop a unique approach based on its perception of risks and opportunities, specific targets, available resources, schedule, etc. Each company has a unique culture and must develop its own management approach to realize energy opportunities.

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APPENDIX

Table 2 *Assessment of Industries and Awarding Points on Energy Efficient Scale*

Quest No	Criteria	Sub-Criteria	Total Points	NCL	NTPC	Renu Sagar	IDL	RGPL	VAPL
1	**Management Commitment**	Energy Management Policy	20	0	20	20	0	20	0
		E M P includes commitment	30	0	30	30	0	12	0
		Management communicates to the organizations	30	0	30	30	0	0	0
		Management determines Energy Smart requirements	20	0	20	20	0	0	0
		Total	100	0	100	100	0	32	0
2	**Strategic Planning**	Energy Smart Objectives & Targets	30	15	30	30	10	15	15
		Energy Smart System Planning	10	0	10	10	10	0	10
		Internal Communication	10	10	10	10	0	5	10
		Total	50	25	50	50	20	20	35
3	**Monitoring, Measurement & Continual Improvement**		100	90	100	100	30	10	20
4	**Resource Management**	Organization setup for Energy Conservation	10	0	10	10	0	0	0
		Provision of Resources	40	40	40	40	20	25	25
		Total	50	40	50	50	20	25	45
5	**Process Management**	HR Process	25	0	20	25	0	15	15
		Engineering Process	25	11	21	25	23	9	11
		Purchasing Process	25	0	5	0	0	0	0
		Production Process	50	34	50	50	26	14	34
		Other Organization Processes	25	0	25	25	0	0	0
		Total	150	45	121	125	49	38	60

R1	**Reduction In Specific Energy Consumption**		150	125	150	150	25	150	100
R2	**Resource Optimization**		100	64	68	84	48	36	68
R3	**Waste Minimization**		100	14	58	70	58	16	30
R4	**Reduction In Pollution**		50	24	20	26	26	0	0
R5	**Greening Supply Chain**		50	0	0	0	0	0	0
R6	**Use Of Non Conventional Source Of Energy**		50	25	50	50	0	0	0
	Grand Total		1000	452	767	805	246	342	338

Questionnaire

NAME……COMPANY……DESIG……

1. **MANAGEMENT COMMITMENT- 100 Points** a) Energy Management Policy (20) • Has Organizations top management declared Energy Management Policy?	○ YES ○ NO
b) Does Energy Management Policy include commitment to (30) • Promote energy savings and conservation of resources reduction in specific energy consumption?	○ YES ○ NO
• Minimization of waste generation and promote reuse recycling and disposal in eco-friendly manner in all segments of operation?	○ YES ○ NO
• Comply with energy legislation/ regulation/ guidelines?	○ YES ○ NO
• Continual improvement in cost reduction	○ YES ○ NO

by adopting effective Energy Management System?	
• Use of renewable energy sources?	YES NO
c) Management communicates to the organizations**.** Energy Management Policy and Energy Smart Criteria (30) • Is Effective System of communicating Energy Policy and Energy Smart System criteria applied to different levels in the organization?	YES NO
• Is there appropriate knowledge and visible commitment at different management levels on complying with energy policy and Energy Smart System?	YES NO
d) Does Management determine Energy Smart requirements applicable to the organization ensure incorporation in objectives and targets? (20)	YES NO
2. **STRATEGIC PLANNING -50 Points** a) Energy Smart Objectives & Targets • Are Energy Smart Objectives & Targets determined & established at relevant functions and levels of the organization?	YES NO
Are The objectives consistent with Energy Policy & Energy Smart criteria?	YES NO

For the complete questionnaire, please write to the authors.