

International Journal of Innovative Research in Science, Engineering and Technology

(A High Impact Factor, Monthly, Peer Reviewed Journal)

Visit: www.ijirset.com

Vol. 8, Issue 6, June 2019

Energy Audit, Management and Conservation A Case Study of GCET Boys Hostel

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ABSTRACT: India is the third largest producer of Electrical energy in the world with nearly installed capacity of 350 GW. In spite of such achievements the demand and supply deficit of electrical energy is increasing each and every year. Energy is very crucial constraint in all economic sectors for any country. Any country's economic development is closely linked with energy consumption. Thus it is very necessary to optimize use of natural resources to avoid energy crisis. As demand for Energy has increased, its consumption is increased so proper and sustainable energy conservation methodology is to be adopted. Energy Audit is the key to a logical and coherent approach for decision-making in management of energy. It aims to stable and balance energy inputs with its use, and helps to find all the energy streams in a facility. It helps to quantify energy usage according to its discrete functions. Energy audit is an important and feasible tool in defining and pursuing inclusive and complete energy management programme. Energy audit reports are intended to encourage implementation of proper, sustainable and efficient application of energy. The main motive of an energy report is to achieve increased energy efficiency and energy cost measures and savings for the customer. This paper mainly construe and infer about Energy Audit, Management and their correlated terms. It discusses and explores the common features of electrical energy management and various phases and stages of Energy Audit to lessen energy requirements and hence, the total cost spent towards the consumption.

KEYWORDS: Energy Audit, Energy Management, Data collection, Data Analysis, Energy Conservation.

I. INTRODUCTION

At the present time, most of our activities are mainly reliant on the use of electricity. It plays an important part, assists as an essential aspect for the commercial, industrial and development of any country in all respects. It is desirable for developing countries to have a boosting and profitable economic growth, and energy is essential for economic growth. However, the association between economic growth and increased energy demand is not always a linear one. For example, according to various reports, under present conditions if there will be 6% increase in India's Gross Domestic Product (GDP), it would impose 9 % of increased demand on its energy sector. In this context, the ratio of energy demand to GDP is an important convenient factor. A high ratio depicts dependence of energy and a substantial impact of energy on GDP growth. This ratios for developing countries like India are much higher. In India, per capita energy consumption is too low as compared to developed countries. It is about 4% of United States and 20% of the world average. The per capita consumption is likely to grow in India in coming years with growth in economy thereby increasing the total energy demand.

Energy conservation and Energy efficiency are distinct, but though a related concepts. Conservation of Energy is attained when growth of energy consumption is lessened, measured in physical terms. Thus, Energy conservation is the outcome and consequence of several processes or developments, such as productivity increase or technological advancement. Energy efficiency is also achieved when energy intensity in an area of production or consumption is reduced without influencing or affecting the output and comfort levels. So Encouragement of energy efficiency will

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contribute towards energy conservation and in any means is constitutive, structural and intrinsic part of energy conservation promotional policies.

Some appropriate steps and measures are required to conserve the energy using coherent and systematic approach. However a most comprehensive tool in inspecting and examining energy usage, consumption and wastage is the "Energy Audit".

As per the Energy Conservation Act, 2001, Energy Audit is defined as "the verification, monitoring and analysis of use of energy including submission of technical report containing recommendations for improving energy efficiency with cost benefit analysis and an action plan to reduce energy consumption".

Energy audits doesn't furnish or deliver the final answer to the problem but it surely identifies the potential and scope for improvement, therefore identifies the places where energy management efforts must be directed. It is first and foremost step towards understanding the pattern of energy usage in any facility.

Energy Audit is considered as one of the extensive methods in inspecting the energy consumption and wastage in facilities. The procedure of energy audit includes data collection, data analysis and formulation of energy audit programme to the actual implementation. Energy audit is widely used to a large degree. There is now a worldwide recognition of the fact that new technologies provide the most hopeful prospects in energy conservation for the future.

II. AIM OF ENERGY AUDIT

Energy audit refers to the inspection, surveying, examination, scrutinizing, investigating and analyzing on the high energy-using unit enterprises according to pertinent state guidelines and standards of energy-saving. It is conducted by utilization units or its proficient and experienced authority officials or consigned specialist agencies. Energy audit is a form of scientific method of management of energy. Its main and important content is impartially inspecting on the energy efficiency, its consumption level and the financial benefit of the energy unit and recommending the cost effective energy-saving measures for energy-using units by means of statistical analysis, inspective testing, and comprehensive evaluation.

The motives of energy audit are probing and investigating problem and weaknesses in energy usage, identifying the energy-saving potential, giving recommendatory rectification means, devising energy saving goals and plan through evaluation, comprehensive energy utilization. The ultimate and sole aim of energy audit is to encourage enterprises to save and conserve energy, reduce the costs of production without affecting output and increasing economic benefit. Energy Audit furnish a "bench-mark" for energy management in the organization or enterprises and also provides the foundation for planning a more cost effective use of energy in the organization.

III. ENERGY CONSERVATION ACT 2001

Energy Conservation Act 2001 has been passed by the Parliament of India in October 2001 under ACT NO. 52 OF 2001.

- This Act provides a legal structure for an efficient use of energy and its conservation.
- The Act encompasses whole of India except the state of Jammu and Kashmir.
- As per provisions of the Act, (BEE) The Bureau of Energy Efficiency came into effect from March 2002 onwards.
- Act proscribe manufacture, sale, purchase and import of notified equipment and appliances not conforming to energy consumption standards.

It provides power to Central Government to:

- Direct designated consumer to get energy audit conducted and supervised by a certified energy auditor.
- Direct designated consumer to appoint a Manager to be in charge of activities for energy conservation.
- Stipulate minimal qualifications for the nomination and appointment of the energy managers

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IV. ENERGY AUDIT METHODOLOGY

In any commercial or industrial enterprise, the three top prioritized operating expenditures are often found to be energy, labor and materials. Energy without exception will emerge as a top ranker, if considering the manageability and flexibility of the cost or potential cost savings in each of the above, and thus the energy management constitutes a strategic and crucial area for reduction of cost.

Energy audit will help to understand more about the consumption of energy and fuel used in commercial enterprises, and help in recognizing the areas where there is possible scope for improvement. In general, it is the translation of conservation ideas into realities, by formulating technically feasible, reliable and practical solutions with economic, financial and other organizational factors within a limited time-frame.

Energy auditing can be possible by assembling energy consuming data and analyze, scrutinize that data to find out unnecessary utilization of energy. It can be broadly categorized in three processes

Data Collection

1. It is first and important step in energy audit, data collection includes data like electricity bills for the year
2. List of load details of each equipment present in building or industry like lighting load, fan, computer and air conditioner for each department.
3. Voltage, Current and Power are to be measured at each feeder.

The data received during data collection and acquisition is compared and interpreted.

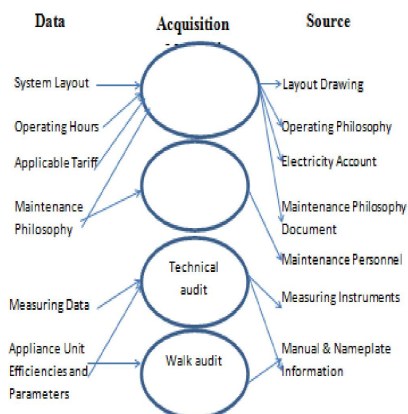


Fig 4.1 (a): The illustration of data collection and

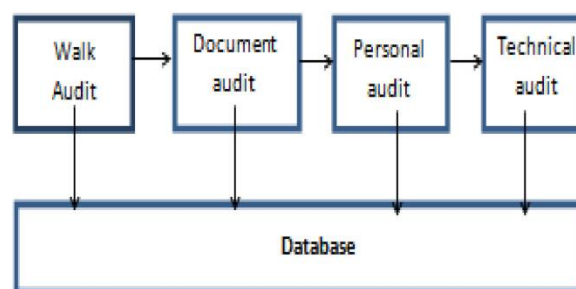


Fig 4.1 (b): The details involved in each process acquisition process

Data Analysis

Data analysis is next important step after collection of data and load details, the areas where unnecessary power wastage occurs are identified.

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Recommendation for Energy Conservation

In this process, recommendation and action is taken on different areas where the scope for energy consumption is identified.

Types of energy audit to be performed mainly depends on:

- Purpose and type of industry.
- Need of final audit.
- Potential of cost reduction desired

Thus based upon that energy audit can be classified into the following two types:

Preliminary audit

Preliminary energy audit is a fast exercise to do and it uses already available or existing, or easily obtained data.

1. Establish energy consumption in the organization,
2. Estimate the scope of improvement for energy savings,
3. Identify the most feasible and reliable areas.
4. Identify immediate and necessary improvements.
5. Identify particular areas for more detailed measurement

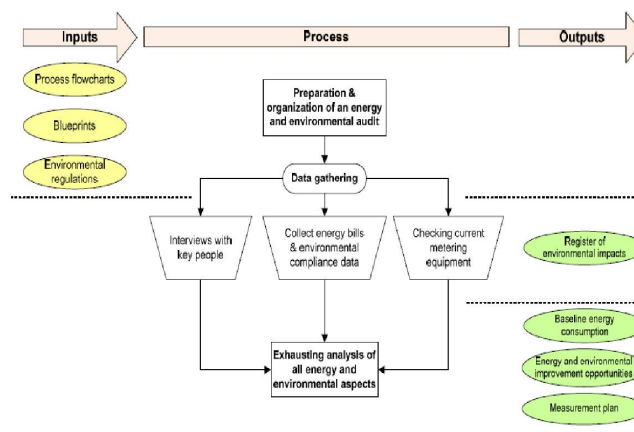


Fig 4.2 Preliminary Auditing Process

Detailed audit

A comprehensive and overall audit delivers a detailed energy project implementation for a facility, since it evaluates and assess all the significant energy using systems.

This audit provides the most precise estimate of energy savings and cost. It examines the collective effects of all projects, accounts for the energy use of all significant equipment, and includes detailed cost saving computations and project cost.

An overall ten-step methodology for supervising an Energy Audit at field level is presented below. Energy Manager and Energy Auditor must follow these steps as per their needs. By using and implementing these steps, the scopes of works and the attainable resources for conducting the audit should be determined specifying the scope and potential of energy saving.

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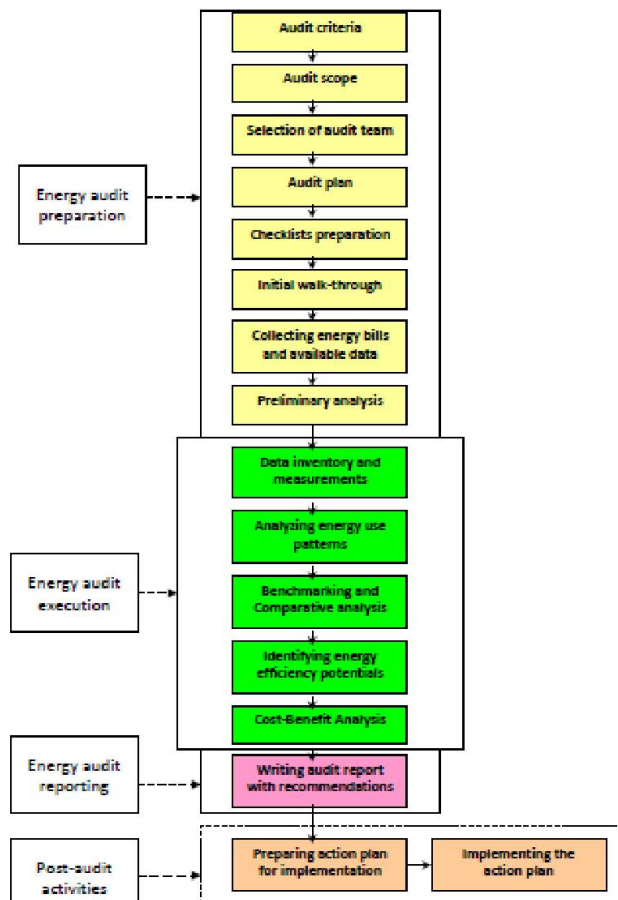


Fig 4.2 Step methodology of auditing process.

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V. CASE STUDY OF GCET BOYS HOSTEL

The location, application and equipment wise classification of load in the hostel has been shown in the following pie charts

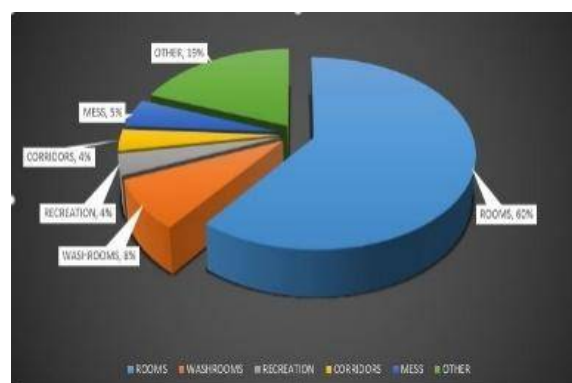


Fig 5.1 Location wise chart

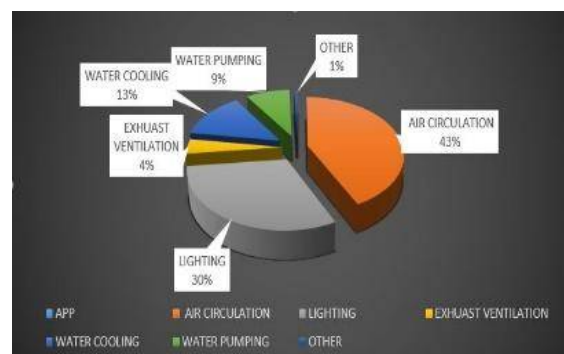


Fig 5.2 Application wise chart

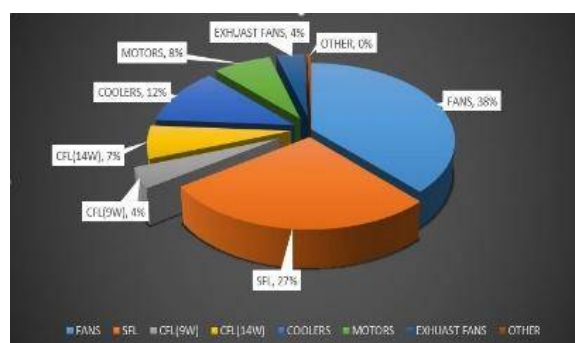


Fig 5.3 Equipment wise chart

As the chart suggests, major load areas are rooms (60%) After that there are washroom (8%), recreation hall (4%), corridors (4%), Mess (5%) and other (19%). Rooms with 60% load share are very important area to focus for improving energy efficiency of the hostel. Corridors and washrooms are the areas where automation can be used to reduce the

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consumption largely. It's quite clear from the chart that maximum load is of comfort applications (43%) such as room coolers, fans etc. To reduce the consumption in these applications, awareness about the energy conservation is very important and effective step. Lighting with 41% of total load is an application where energy efficiency can be achieved very easily by replacing old appliances by new efficient ones.

VI. ANNUAL ENERGY CONSUMPTION

The location wise , equipment wise and application wise estimated annual energy consumption in boys hostel is shown in following graphs

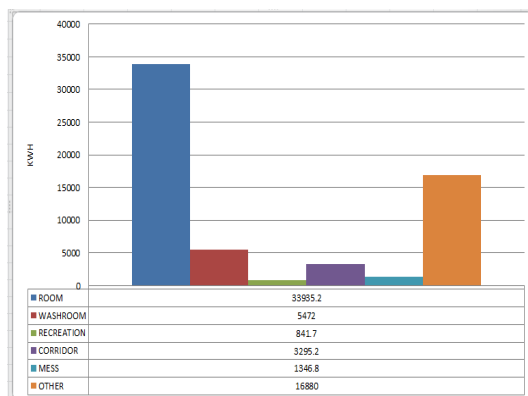


Fig 6.1 Location wise annual energy consumption

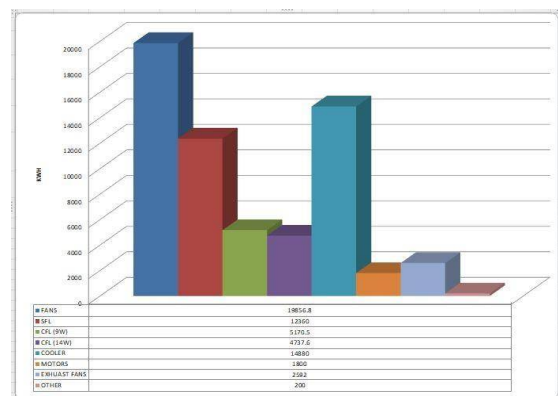


Fig 6.2 Equipment wise annual energy consumption

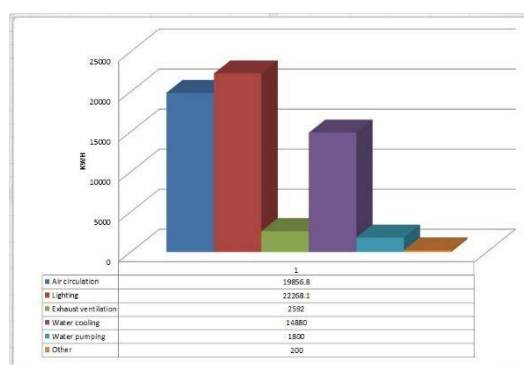


Fig 6.3 Application wise annual energy consumption

VII. RECOMMENDATIONS FOR BETTER ENERGY EFFICIENCY

Based on the analysis of the power consumption data, certain steps have been recommended for improving energy efficiency of the hostel. Complete cost analysis of implementation of recommended measures has been performed wherever necessary. Also, a number of general measures for energy efficiency have been listed. Described below are some important recommendations for better energy efficiency:

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Replacing 40W SFLs with 18 W SFLs:

Dominant light source at most places in the hostel rooms is traditional 40 W SFLs. As per our data collection, the hostel has in total 264 40W SFLs. If these SFLs are replaced by 18 W SFLs, (20-22 W) can be saved per SFL.

Cost Analysis of Replacing 40 W SFL with 18 W SFL

- Total No. of conventional 40 W SFLs in Hostel = 264
- Average Power of SFL = 40W
- Average Power of replaced SFL = 18W
- Power saved per SFL = (40-18) W = 22W
- Total Power saving = $264 \times 22\text{W} = 5808\text{W} = 5.8 \text{ kW}$
- Average Use of SFL per year = $300 \times 4\text{h} = 1200\text{h}$
- Total Energy saved per year = $5.8 \times 1200\text{kWh} = 6960 \text{ kWh}$
- Saving in Rs. Per year = $6960 \times 2.50 = \text{Rs.} 17400$
- Average Cost of Replacing each SFL = Rs. 150
- Total Cost of Replacing all SFLs = $264 \times 150 = \text{Rs.} 39600$
- Capital Cost Recovery time = $(39600) / (17400) = 2.27 \text{ yrs.}$

Hence, the capital cost recovery time for replacing all 40 W SFLs of the hostel is around 2.27 years.

Use of Motion Sensors in Corridors and Washrooms:

Corridors and toilets have large potential of saving energy by use of automation tools. Motion sensors can be used there to automatically switch on the light when there is any movement and switch off the light when there is no movement. This can greatly reduce the total load in corridors and toilets.

Cost analysis of Installing Motion Sensors in a Typical Corridor:

- Average number of CFLs in a corridor = 16
- Average power of the CFLs = 9W
- Average number of motion sensors required = 4
- Average reduction in usage per day by motion sensor = 4h
- Total energy saved in corridor per year = $(4 \times 9 \times 16 \times 365) / 1000 = 210.24 \text{ kWh}$
- Saving in Rs. Per year = $210.24 \times 2.50 = \text{Rs.} 525.6$
- Cost of installation per motion sensor = Rs. 200
- Total cost of installing motion sensors in a corridor = $4 \times 200 = \text{Rs.} 800$
- Capital Cost Recovery Time = $(800 / 525.6) = 1.52 \text{ yrs.}$

Hence, the capital cost recovery time for installing motion sensors in corridors is 1.52 years. Toilets are also having comparable capital cost recovery time. Hence, this is a highly recommended step to largely reduce the consumption in corridors and toilets.

Minimizing Repair Works in Fans:

The repaired fans have been found to be consuming very high power as compared to the rated power. Fans repaired once and twice are calculated to be consuming more than the average consumption of new fans respectively. Thus, effort should be made to minimize the repairing of fans and also repair work should be supervised properly.

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Energy Management Structure

In order to streamline the use of energy in the GCET Hostel and to ensure its efficient utilization, we propose three possible energy management structures. A final decision on the type of energy management structure suitable for the institute should be taken by the Institute management.

Appointment of an Energy Manager - with suitable experience and a proven track record. The person shall be responsible for the day to day energy conservation activities. New staff should be allotted to the Energy Manager or some staff members from Electrical Maintenance Section be made responsible to him/her. An annual review of the energy performance of the institute is to be performed and a certain percentage of the quantified savings be shared with the Energy Manager.

- I. The Staff should himself take over the responsibility of ensuring efficient energy use in the hostel. This will ensure prompt implementation of measures. This system may also require additional staff. A performance related incentive in the form of a bonus can be provided to the Electrical Maintenance staff based on savings achieved.
- II. Formation of an Institute level committee headed by the principal to review the implementation of energy conservation measures.

VIII. CONCLUSION

We have identified the areas where energy utilization is not efficient and remedy for that wastage has been provided in recommendation. If we have opportunity to save energy we should not miss that opportunity concerning today's energy crisis that world is facing. Identified areas where wastage is at its peak are also provided with recommendations that suits best. Also, their payback period is taken into consideration in this paper.

REFERENCES

1. W.C.Turner, Energy Management Handbook, Wiley, New York, 1982. W.-K. Chen, Linear Networks and Systems (Book style).Belmont, CA: Wadsworth, 1993, pp. 123–135.
2. "General Aspects of Energy Management and Energy Audit" "Bureau of energy efficiency, NewDelhi.
3. Jian Zhang, Yuchen Zhang, Song Chen, Sizhuo Gong How to Reduce Energy Consumption by Energy Audits and Energy Management, The Case of Province Jilin in China, IEEE 2011.
4. Chikku Abraham, George Mel & Jose Victor "ENERGY AUDIT OF IIT-BOMBAY CAMPUS" IIT-BOMBAY, 2008.
5. Energy Audit Team "ENERGY AUDIT OF IIT-ROORKEE CAMPUS" IIT-ROORKEE, January 2010.
6. Jankes Goran, Stamenic Mirjana, Simonovic Tomislav, Trninic Marta, Tanasic Nikola, "Energy Audit as a Tool for Improving Overall Energy Efficiency in Serbian Industrial Sector", IEEE 2nd International Symposium on Environment-Friendly Energies and Applications (EFEA), 2012, PP 118-122.
7. T.E.R.I., "Energy Audit at Unit -I of G.H.T.P.", the energy and Resources institute, 78PP, New Delhi, 2011, Project report no. 2011 IE 10. PP 1- 210.
8. Chai Yuman, Zhao Hongbin, "Energy analysis of a power cycle system with 300 MW capacity", IEEE International Conference on Advances in Energy Engineering, 2010, PP 247250.
9. Ding Jinliang, Liu Changliang, Wang Hong, Zhen Chenggang , "An Overview of Modelling and Simulation of Thermal Power Plant", Proceedings of the 2011 International Conference on Advanced Mechatronic Systems, Zhengzhou, China, August 11-13, 2011, PP 8691.
10. Gupta, J.B., "A Course in Power System", S.K. Kataria & Sons, 4424/6 Guru Nanak Market Nai Sarak Dehli-110006, 2006-07, PP 46-93.
11. Guo Ying, Lu Jianhong, Wu Ke, Zhang Tiejun, "A Multi-Objective Optimizing Control Method for Boiler-Turbine Coordinated Control", IEEE International Conference on Mechatronics and Automation, China, August 5 - 8, 2007, PP 37003705.
12. Guo Tiegao, Zheng Haiming, "Relative Accuracy Test Audit Evaluation for Flue Gas Continuous Emission Monitoring Systems in power plant", IEEE Pacific-Asia Workshop on Computational Intelligence and Industrial Application, 2008, PP 239243.