ENERGY AUDIT OF ELECTRICAL DEPARTMENT SIT LOANAVALA

Pallavi Wararkar[1], Shreyas Baraskar[2], Shreyash Mahajan[3] , Omkar Waghule[4]

[1]Assistant Professor, Department of Electrical Engineering, Sinhgad Institute of Technology, Lonavala
[2]Undergraduate scholar, Department of Electrical Engineering, Sinhgad Institute of Technology, Lonavala
[3]Undergraduate scholar, Department of Electrical Engineering, Sinhgad Institute of Technology, Lonavala
[4]Undergraduate scholar, Department of Electrical Engineering, Sinhgad Institute of Technology, Lonavala

ABSTRACT

This energy audit examines the electrical department of a specific organization to assess its energy consumption patterns, identify inefficiencies, and propose measures for improvement. The audit encompasses a comprehensive analysis of electrical systems, equipment, and processes to determine energy usage, costs, and potential areas for optimization. Through data collection, site visits, and analysis of utility bills, the audit aims to quantify energy consumption, pinpoint areas of excess usage, and recommend strategies for enhancing energy efficiency and reducing operational costs. The findings of this audit provide valuable insights for the organization to implement targeted measures towards sustainable energy management and achieving energy conservation goals

I. INTRODUCTION

As energy consumption continues to rise globally, organizations are increasingly recognizing the importance of managing their energy usage efficiently. The electrical department within any organization plays a pivotal role in energy consumption due to its reliance on electricity for various operations. An energy audit of the electrical department serves as a critical step in identifying opportunities for optimizing energy usage, reducing costs, and minimizing environmental impact.

This report aims to provide an overview of the energy audit conducted within the electrical department of [Organization Name]. Through a comprehensive assessment of energy usage patterns, equipment efficiency, and operational practices, this audit seeks to uncover areas where improvements can be made to enhance energy efficiency and sustainability.

2 Problem Definition/Statement

The Electrical Department, as a pivotal component of our organization's infrastructure, plays a crucial role in managing energy consumption. However, amidst the rising concerns of sustainability and cost-efficiency, there arises a pressing need to conduct a comprehensive energy audit within the department.

2.1 Scope & Objectives

Objective:

The primary objective of this audit is to assess and optimize the energy utilization practices within the Electrical Department. This involves scrutinizing various aspects of energy consumption, identifying inefficiencies, and proposing effective strategies for conservation and improvement.

Scope:

1. Energy Consumption Analysis: Evaluate the current energy consumption patterns within the Electrical Department, encompassing both direct and indirect energy usage.
2. Equipment Assessment: Assess the efficiency and performance of electrical equipment, including but not limited to transformers, motors, lighting systems, and HVAC systems.
3. Identification of Energy Losses: Identify areas of energy wastage, such as leakages, overloading, inefficient equipment operation, and standby power consumption.
4. Analysis of Energy Management Practices: Review existing energy management practices, including maintenance schedules, operational procedures, and energy-saving initiatives.
5. Recommendations: Provide actionable recommendations for optimizing energy usage, enhancing equipment efficiency, and implementing sustainable energy practices.
6. Cost-Benefit Analysis: Conduct a cost-benefit analysis of proposed energy-saving measures to ascertain their feasibility and potential return on investment.

3. Literature Review

Energy audits in electrical departments are vital for optimizing energy use. Methodologies include walkthrough, preliminary, and comprehensive audits. Case studies reveal significant energy savings post-audit. Challenges like data availability persist, but technological advancements, such as IoT and data analytics, enhance audit accuracy. Compliance with regulations and standards drives audit processes. Future research should focus on emerging technologies and regulatory impacts.

4 Methodology

1. Preparation and Planning:
- Define the scope and objectives of the audit.
- Gather relevant documentation and data on energy consumption, equipment, and operations.
- Identify key personnel to be involved in the audit process.

2. Data Collection:
- Collect detailed information on electricity consumption, including utility bills, meter readings, and historical data.
- Conduct on-site inspections to assess electrical systems, equipment, and infrastructure.
- Use energy monitoring devices and sensors to gather real-time data on energy usage.

3. Analysis and Assessment:
- Analyze collected data to identify patterns, trends, and areas of high energy consumption.
- Assess the performance of electrical systems, including lighting, HVAC, motors, and control systems.
- Identify energy efficiency opportunities and potential areas for improvement.

4. Recommendations:
- Develop a list of energy-saving measures and recommendations based on the findings of the analysis.
- Prioritize recommendations based on their potential impact, cost-effectiveness, and feasibility.
- Provide estimates of energy savings, return on investment, and payback periods for each recommendation.

5. Report and Presentation:
- Prepare a comprehensive report documenting the audit process, findings, and recommendations.
- Present the findings to key stakeholders, including management, facility owners, and relevant personnel.
- Seek feedback and input from stakeholders to ensure buy-in and support for implementing the recommendations.

6. Implementation and Monitoring:
- Develop an action plan for implementing the recommended energy-saving measures.
- Monitor and track energy consumption and performance metrics to evaluate the effectiveness of implemented measures.
- Make adjustments as needed to achieve desired energy savings targets.

7. Continuous Improvement:
- Establish a process for ongoing monitoring, evaluation, and optimization of energy performance.
- Continuously seek out new opportunities for energy efficiency improvements and cost savings.
- Incorporate lessons learned from previous audits to improve future audit processes and outcomes.

By following this methodology, organizations can systematically assess and optimize energy usage within their electrical departments, leading to reduced energy costs, improved efficiency, and environmental sustainability.

5 REQUIREMENT SPECIFICATION

Define the boundaries and objectives of the energy audit within the electrical department. Specify the types of energy consumption and systems to be assessed (e.g., lighting, HVAC, equipment). Outline the methodology for collecting energy consumption data, including meter readings and equipment specifications. Specify tools and software for data analysis to identify patterns, inefficiencies, and opportunities for improvement. Detail the process for assessing the condition, efficiency, and performance of electrical equipment and systems. Define criteria for evaluating equipment age, maintenance history, and energy consumption levels. Identify key stakeholders involved in the audit process, including departmental staff, management, and external consultants. Outline communication channels and coordination mechanisms to ensure stakeholder involvement and buy-in. Ensure compliance with relevant regulatory standards and guidelines governing energy audits in electrical departments. Specify documentation requirements and reporting formats to meet regulatory obligations. Define criteria for prioritizing audit findings and recommendations based on feasibility, cost-effectiveness, and potential energy savings. Develop an action plan outlining specific measures, timelines, and responsibilities for implementing audit recommendations. Establish metrics and KPIs to track the implementation and impact of audit recommendations over time. Define procedures for periodic monitoring, measurement, and reporting to assess the effectiveness of energy-saving measures. Specify the format and content of audit reports, including executive summaries, findings, recommendations, and supporting data. Ensure documentation is clear, concise, and actionable for decision-makers and stakeholders. Provide training and support to departmental staff on energy conservation practices, equipment operation, and maintenance best practices. resources and tools to empower staff to identify and address energy efficiency opportunities proactively. Establish mechanisms for continuous improvement and refinement of energy management practices within the electrical department. Encourage feedback loops, lessons learned, and knowledge sharing to drive ongoing optimization efforts.

-These requirements specifications serve as a foundation for planning, executing, and monitoring an effective energy audit in the electrical department, ensuring alignment with organizational goals and regulatory requirements while maximizing energy efficiency and cost savings.

Location wise Appliances :

Sr No.	Class	Appliances	Quantity	Rating
1	F 001 - 3	FAN	3	60 W / Per
		TUBE	4	36 W / Per
		SOCKET	10	5 A / Per
		SOCKET	5	15 A / Per
2	F 004	FAN	1	60 W
		TUBE	2	36 W / Per
		SCOKET	9	5A / Per
3	F 005	FAN	2	60 W / Per
		LED TUBE	3	18 W / Per
		SCOKET	1	15 A / Per
		SOCKET	8	5 A / Per
4	F 006	FAN	3	60 W /Per
		TUBE	5	36 W /Per
		SOCKET	1	15 A / Per
		SOCKET	26	5 A / Per
5	F007	FAN	2	60 W / Per
		TUBE	4	36 W / Per
		SOCKET	6	15 A / Per
		SOCKET	27	5 A / Per
6	FO22	FAN	6	60 W / Per
		TUBE	5	36 W / Per
		SOCKET	10	15 A / Per
		SOCKET	9	5 A / Per
7	F023	FAN	5	60 W / Per
		TUBE	9	36 W / Per
		SOCKET	4	15 A / Per
		SOCKET	29	5 A / Per
8	F024 - F025	FAN	3	60 W / Per
		TUBE	5	36 W / Per
		SOCKET	4	15 A / Per
		SOCKET	22	5 A / Per
9	FO26	FAN	6	60 W / Per
		TUBE	7	36 W / Per
		SOCKET	6	15 A / Per
		SOCKET	27	5 A / Per
10	PASSAGE	LED TUBE	6	18 W / Per
		SOCKET	3	5 A / Per
		SOCKET	1	15 A / Per
11	TOILET	TUBE	1	36 W / Per
		LED TUBE	1	18 W / Per

Meter Blink Time Duration of Conventional Fan (A)

Sr. No.	Speed at : 5	Speed at : 4	Speed at : 3	Speed at : 2	Speed at : 1
1	9.62	10.28	11.32	12.96	20.42
2	9.85	10.32	11.22	13.03	20.89
3	9.88	10.33	11.15	13.11	21.12
4	9.98	10.34	11.47	13.21	21.18
5	9.61	10.36	11.14	13.34	21.19
6	9.77	10.39	11.27	13.41	21.22
7	9.83	10.36	11.38	13.44	21.24
8	9.58	10.38	11.47	13.45	21.26
9	9.91	10.36	11.21	13.55	21.29
10	9.62	10.41	11.52	13.61	21.31
11	9.73	10.48	11.33	13.58	21.3
12	9.62	10.42	11.51	13.16	21.33
13	9.51	10.56	11.48	13.61	21.36
14	9.53	10.61	11.42	13.71	21.41
15	9.83	10.62	11.37	13.82	21.42
16	9.51	10.71	11.48	13.88	21.4
17	9.48	10.81	11.51	13.62	21.42
18	9.63	10.84	11.87	13.9	21.41
19	9.51	10.88	11.41	13.89	21.46
20	9.88	10.92	11.12	13.96	21.51

Meter Blink Time Duration of BLDC Fan (B)

Sr. No	Speed at : 5	Speed at : 4	Speed at : 3	Speed at : 2	Speed at : 1
1	13.19	19.83	29.98	47.96	83.08
2	13.38	19.05	30.13	48.02	83.19
3	13.51	19.13	30.71	48.11	83.38
4	13.36	19.23	30.52	48.13	83.46
5	13.55	19.13	30.53	48.25	84.01
6	13.46	18.94	39.81	48.38	83.92
7	13.59	19.12	30.31	48.26	83.18
8	13.2	19.51	31.02	48.2	83.82
9	13.8	19.55	30.71	48.48	83.77
10	13.46	19.78	30.18	48.41	83.12
11	13.36	19.33	30.71	47.95	83.18
12	13.44	19.21	30.61	48.13	83.31
13	13.85	19.22	30.31	48.78	83.55
14	13.05	19.61	30.58	48.72	83.63
15	13.48	19.71	30.73	48.18	83.48
16	13.7	19.12	30.61	48.77	83.72
17	13.22	19.19	30.12	48.88	83.79
18	13.41	19.23	30.18	48.02	83.89
19	13.5	19.51	30.91	48.13	83.13
20	13.7	19.81	29.98	48.85	83.22

Power Consumption at Average fan ‘Speed 3’ (C)

Sr. No.	Time Duration	Appliences	Average Power (in Watt)	Energy saved (in Watt)
1	(1 Hr.)	BLDC Fan	19.56	
		Conventional Fan	54.98	
2	(12 Hrs.)	BLDC Fan	234.72	425.04 WHr
		Conventional Fan	659.76	
3	(24 Hrs.)	BLDC	469.44	805.08 WHr
		Conventional Fan	1,319.52	
4	(30 Days)	BLDC	7041.6	12,751 WHr
		Conventional Fan	19,792.80	

Meter Blink Time Duration of Convention Tube & LED Tube : (D)

Sr. No	LED Tube Light	Conventional Tube Light	
1	28.58	11.51	
2	28.53	11.53	
3	28.52	11.54	
4	28.41	11.56	
5	28.42	11.55	
6	28.31	11.57	
7	28.34	11.59	
8	28.41	11.71	
9	28.28	11.72	
10	28.38	11.77	
11	28.42	11.75	
12	28.71	11.78	
13	28.62	11.74	
14	28.71	11.83	
15	28.61	11.88	
16	28.57	11.89	
17	28.47	11.92	
18	28.21	11.94	
19	28.32	11.99	
20	28.22	12.01	

Power Consumption by TUBES & LED TUBES :

Sr No.	Appliances	Average Power Consumed (in Watt)	Average Power Consumed 12 Hr. (in Watt)	Average Power Consumed Month (in Watt)
1	LED TUBES	20.35 W	244.2	7326
2	Conventional TUBES	54.82 W	657.84	19735.2

CALCULATIONS

In observation table (A), the conventional fan readings and in observation table (B), BLDC Fan readings are shown respectively. Comparison of power consumption of both Conventional Fan and BLDC Fan reading and calculation are shown in Table (C). And, the readings of Conventional Tube & LED Tube are shown in Table (D).
To justify of energy efficient appliances : Compare and calculate observed data,

1. **Energy Saved in Fans :**

Conventional Fan at average speed (speed 3) consumed 58.98 W in 1hr.
BLDC Fan at average speed (speed 3) consumed 19.56 W in 1hr.
So, Energy saved in 1 hour = (58.98 W) – (19.56 W)
= 35.42 Whr

Consider appliances are run 12 hrs per day = 425.04 WHr.

Total Energy saved in a Month (30 days) = 425.04 * 30
= 12,751.2 W/ month

2. **Energy Saved in Tubes :**

Conventional Tube consumed 54.82 W in 1hr.
LED Tube consumed 20.35 W in 1hr.
So, Energy saved in 1 hour = (54.82 W) – (20.35 W)
= **34.47 W**

Consider appliances are run 12 hrs per day = 413.64 WHr.
Total Energy saved in a Month (30 days) = 413.64 * 30
= **12,409.2 W**

6 RESULT

The results of an energy audit conducted in an electrical department typically include findings, recommendations, and potential outcomes aimed at improving energy efficiency and reducing costs. Here's a concise summary of potential results:

1. Findings:
- Identification of energy consumption patterns, peaks, and inefficiencies within the electrical department.

- Assessment of the condition, age, and performance of electrical equipment and systems.
- Analysis of energy usage data to pinpoint areas of high consumption and potential waste.

2. Recommendations:
- Implementation of energy-saving measures such as upgrading to energy-efficient lighting fixtures, optimizing HVAC systems, and installing power factor correction devices.
- Adjustment of equipment operating schedules and settings to minimize energy usage during off-peak hours.
- Adoption of smart technologies and automation to monitor and control energy consumption in real-time.
- Training programs for staff to promote energy conservation practices and raise awareness about energy-efficient behaviour.

3. Potential Outcomes:
- Reduction in energy consumption and associated costs through the implementation of audit recommendations.
- Improved reliability and performance of electrical equipment, leading to lower maintenance expenses and downtime.
- Enhanced environmental sustainability by lowering carbon emissions and reducing the organization's ecological footprint.
- Increased compliance with regulatory standards and requirements related to energy efficiency and conservation.
- Positive impact on the organization's reputation and stakeholder perceptions as a responsible corporate citizen committed to sustainability.

Overall, the results of an energy audit in the electrical department are aimed at optimizing energy usage, enhancing operational efficiency, and driving cost savings while aligning with broader organizational goals and objectives.

7 CONCLUSION

By conducting a thorough energy audit of the Electrical Department, we aim to not only reduce operational costs but also demonstrate our commitment to sustainability and environmental stewardship. Through the implementation of recommended measures, we aspire to optimize energy utilization, enhance operational efficiency, and contribute towards our organization's overarching goals of sustainability and cost-effectiveness.

8 FUTURE SCOPE

1. Advanced Data Analytics:
- Leveraging big data analytics, machine learning, and artificial intelligence to analyze vast amounts of energy consumption data more effectively.
- Implementing predictive maintenance algorithms to anticipate equipment failures and optimize energy usage.

2. IoT and Smart Sensors:
- Integrating IoT devices and smart sensors into electrical systems to gather real-time data on energy usage, equipment performance, and environmental conditions.
- Enhancing remote monitoring capabilities and enabling proactive maintenance and energy management strategies.

3. Energy Management Systems (EMS):
- Adoption of comprehensive EMS platforms to centralize energy data, automate analysis, and facilitate decision-making.

- Integration with building automation systems for seamless control and optimization of electrical infrastructure.

4. Renewable Energy Integration:
- Incorporating renewable energy sources such as solar, wind, and hydroelectric power into the electrical department's energy portfolio.
- Conducting feasibility studies and cost-benefit analyses to assess the viability of renewable energy projects.

5. Demand Response and Load Management:
- Implementing demand response strategies and load management techniques to optimize energy consumption and reduce peak demand.
- Participating in demand-side management programs and grid balancing initiatives to support grid stability and reliability.

6. Energy Storage Solutions:
- Deploying energy storage systems, such as batteries and flywheels, to store excess energy during off-peak hours and discharge it during periods of high demand.
- Exploring innovative storage technologies and business models to enhance energy resilience and flexibility.

7. Integrated Sustainability Initiatives:
- Integrating energy audits into broader sustainability initiatives, encompassing water conservation, waste reduction, and carbon footprint mitigation.
- Adopting holistic approaches to resource management that prioritize environmental stewardship and social responsibility.

8. Regulatory Compliance and Reporting:
- Staying abreast of evolving regulatory requirements and standards related to energy efficiency, emissions reductions, and energy reporting.
- Ensuring compliance with emerging regulations through proactive audits, documentation, and transparency.

9. Capacity Building and Training:
- Investing in training programs and professional development opportunities to build internal expertise and capacity in energy management and auditing.
- Empowering staff with the knowledge and skills needed to identify, implement, and sustain energy-saving initiatives.

10. Continuous Improvement and Innovation:
- Cultivating a culture of continuous improvement and innovation within the electrical department, fostering creativity and collaboration.
- Encouraging experimentation with new technologies, strategies, and best practices to drive ongoing optimization and resilience.

9 REFERENCE

1. Anagha Darshan, Naman Girdhar, Rohan Bhojwani, Kanish Rastogi, S. Angalaeswari , L. Natrayan , and Prabhu Paramasivam ”Energy Audit of a Residential Building to Reduce Energy Cost and Carbon Footprint for Sustainable Development with Renewable Energy Sources”.
Hindawi Advances in Civil Engineering Volume 2022, Article ID 4400874, 10 pages https://doi.org/10.1155/2022/4400874

2. Omar Mohamed, Saba Fakhoury, Georgina Aldalou, Ghaliah Almasri “Energy Auditing and Conservation for Educational Buildings: a Case Study on Princess Sumaya University for Technology”. Process Integration and Optimization for Sustainability (2022) 6:901–920

3. Mhaske Somnath, Jagtap Swapnil, Jadhav Vikas, Prof. Paval K.L “Energy Audit: A Case Study of an Engineering Building”. International Journal of Engineering Research & Technology (IJERT) http://www.ijert.org ISSN: 2278-0181 IJERTV8IS050563 (This work is licensed under a Creative Commons Attribution 4.0 International License.) Published by : www.ijert.org Vol. 8 Issue 05, May-2019

4. https://en.wikipedia.org/wiki/Energy_audit

5. https://www.slideshare.net/shravanthiinternship/energy-audit-in-buildings

6. Bureau of Energy Efficiency (BEE) : BEE is an Indian governmental agency under the Ministry of Power, responsible for promoting energy efficiency and conservation. They provide guidelines, tools, and resources for conducting energy audits of buildings. Here's their website: [Bureau of Energy Efficiency] (https://beeindia.gov.in/)

7. Energy Conservation Building Code (ECBC) : ECBC sets minimum energy performance standards for commercial buildings in India. Understanding ECBC guidelines and compliance requirements is essential for conducting energy audits. You can find more information on the Ministry of Power's website: [Energy Conservation Building Code] (https://beeindia.gov.in/content/energy-conservation-building-code-ecbc)