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Comprehensive Energy Audit And Conservation Opportunities In A Medium-Scale Machining & Heat Treatment Industry

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Abstract

Energy audits are a vital tool for identifying energy conservation measures, reducing operating costs, and minimizing carbon emissions in industrial facilities. This paper presents the findings of an authorized energy audit located in Gundasara near Gondal, Gujarat. The study analyzed energy consumption trends, capacitor bank conditions, feeder loads, and performance of major equipment. Conservation opportunities were identified in the areas of motor efficiency, compressor maintenance, ventilation systems, and solar photovoltaic installation. The findings highlight the role of systematic energy management in achieving industrial sustainability.

- KKeywords: Energy, Energy Efficiency, Industrial Energy Audit

- **1. Introduction**

Industrial energy consumption contributes significantly to global greenhouse gas emissions and operational costs. In India, the manufacturing sector, particularly medium-scale enterprises, consumes large quantities of electrical energy, primarily in operations involving motors, furnaces, compressors, and auxiliary systems. An engineering and manufacturing company specializing in precision machining, heat treatment, assembly, and quality inspection. The company provides an ideal case for assessing industrial energy efficiency practices. This paper documents the findings of a detailed energy audit conducted in March 2025 to identify energy-saving opportunities, optimize processes, and enhance sustainability.

2. Methodology

The audit followed the procedures recommended by the **Bureau of Energy Efficiency (BEE), Government of India**. The methodology included:

1. **Electricity Bill Analysis (2024–25):** Study of kWh consumption, Maximum Demand (MD), and Power Factor.

2. **Capacitor Bank Evaluation:** Condition monitoring to identify malfunctioning units affecting reactive power.

3. **Feeder Load Analysis:** Measurement of voltage, current, and kW loads of major equipment.

4. **Equipment-Specific Studies:**
   - Motors and compressors assessed for efficiency.
   - Ventilation systems compared (electrical exhaust fans vs. eco ventilators).
   - Cooling tower and recooling system performance reviewed.

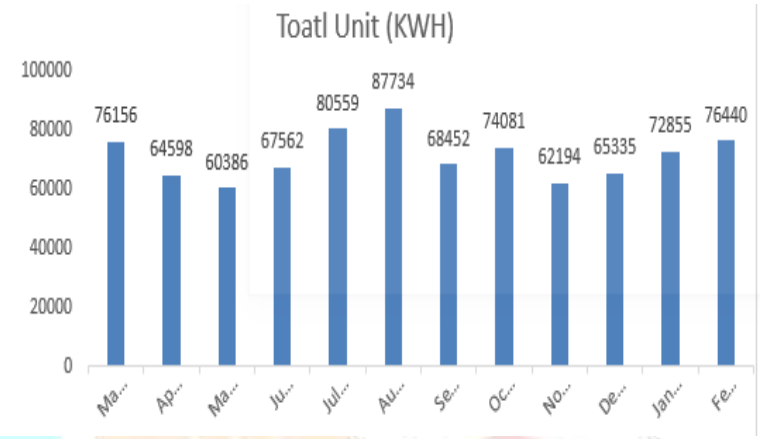
5. **Thermography & Lux Measurements:** Infrared imaging for hotspot detection and lux assessment for workplace lighting compliance.

6. **Financial Analysis:** Estimation of savings, investment, and payback period.

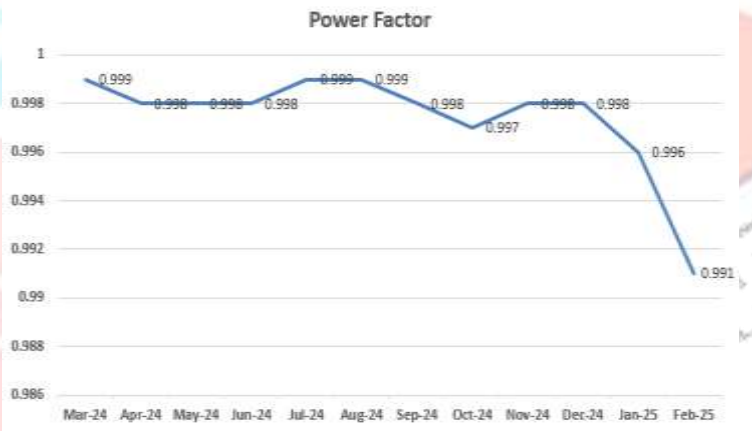
3. Results and Discussion

3.1 Electricity Consumption

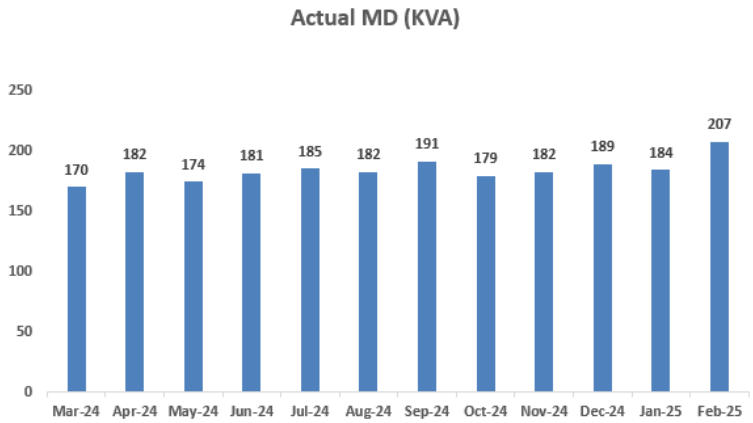
- Annual kWh usage ranged from **60,386 (May 2024)** to **87,734 (Aug 2024)**.



- Power factor remained excellent (>0.99) but dropped slightly in Feb 2025 (0.991).



- MD varied from **170 kVA to 207 kVA**, below the contract demand of 260 kVA.



3.2 Capacitor Bank Performance

- Several units were in "BAD" condition, requiring replacement.
- Poor reactive power management may lead to penalties if not addressed.

Sr. No	Capacitor bank	Current			Condition
		R	Y	B	
1	Unit-1	2.8	0	2.8	BAD
2		2.1	0	2.1	BAD
3		0	0	0	BAD
4		8.8	9.1	9.4	GOOD
5	Unit-2	13.5	12.86	12.66	GOOD
6		7.8	0	0	BAD
7		3.33	7.4	8.49	BAD
8		0.19	0.30	0.16	BAD
9	Unit-3	16.53	15.90	13.40	GOOD
10		19.65	18.82	19.35	GOOD
11		14	14.11	12.75	GOOD
12		0.17	0.17	0.15	BAD

3.3 Feeder Load Analysis

- Major consumers: Furnace (53.81 kW), UPS (36.41 kW), Compressor (31.04 kW).
- Lighting contributed minimal loads.

Feeder Name	Voltage (Volts)	Current (Amp.)	Power Factor	Power (kW)
Main Incoming	407	52	0.991	36.30
Main Plant	408	34	0.991	23.81
Cutting Main	409	17	0.991	11.93
UPS	408	52	0.991	36.41
Compressor	411	44	0.991	31.04
Furnace	418	75	0.991	53.81
Lighting Main (Single Phase)	230	8	0.991	1.82
Shop -2	230	3	0.991	0.68
CNC Shop	229	2.5	0.991	0.56
AC Office	230	9.2	0.991	2.09

3.4 Energy Conservation Opportunities (ECOs)

1. **Energy-Efficient Motors** – Savings: 27,304 kWh/year (₹ 2.15 lakhs); Investment: ₹ 4.6 lakhs; Payback: 2.13 years.

2. **Compressor Maintenance** – Preventive measures yield 98 kWh/year savings; indirect benefits include longer lifespan.

3. **Eco Ventilators** – Replacement of 8 exhaust fans with 10 eco ventilators saves 18,000 kWh/year (₹ 1.42 lakhs); Payback: 0.62 years.

4. **Solar PV Installation (100 kW)** – Generates 1,44,000 units/year; savings of ₹ 10 lakhs; Investment: ₹ 40 lakhs; Payback: 4 years.

Total Savings Potential: 171,984 kWh/year = ₹ 13.58 lakhs.
Annual Carbon Reduction: 140 tons CO_2.
Overall Payback: 3.3 years.

3.5 Additional Observations

- **Cooling Towers:** Opportunity to improve efficiency via nozzle replacement, fan blade angle optimization, and variable-speed drives.
- **Lighting (Lux Analysis):** Adequate levels recorded (310–440 lux), but office lighting could be upgraded for better ergonomics.
- **Thermography:** Identified hotspots – transformer (45.4 °C), battery (46.1 °C), heat treatment (64.3 °C), cooling unit (41.6 °C). These indicate preventive maintenance needs.

4. Conclusion

The audit demonstrated that energy efficiency improvements in medium-scale industries are both technically and financially viable. With targeted investments in solar PV, eco ventilators, and high-efficiency motors, It can reduce its annual electricity consumption by 22%, cut operational costs significantly, and lower its carbon footprint.

This case study validates that structured energy audits not only improve sustainability but also enhance competitiveness in the manufacturing sector. Future research can explore integrating **AI-driven predictive maintenance** and **IoT-based monitoring systems** for real-time energy management.

References

1. Bureau of Energy Efficiency (BEE), Government of India
2. General Aspects of Energy Management and Energy Audit Guide Book 1 of 4th Edition 2015.
3. Handbook of Energy audits by Albert Thumman, Terry Niehus and William J.Younger.
4. Energy Efficiency in Thermal Utilities Guide Book 2 of 4th Edition 2015
5. Energy Efficiency in Electrical Utilities Guide Book 3 of 4th Edition 2015
6. Energy Performance Assessment for Equipment and Utility Systems of 4th Edition 2015.
7. Kenbrook Solar – Technical Specifications of 100 kW On-Grid Systems.