Save Energy Program

(Financial assistance for carrying out detailed energy audit)

Maharashtra Energy Development Agency (MEDA)

(Govt of Maharashtra Institution)
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About MEDA

MEDA is a Government of Maharashtra Institution established in 1985. MEDA is working as '**State Nodal Agency'** for promotion of renewable energy sources and as **'State Designated Agency'** for implementation of Energy Conservation Act, 2001 in the State of Maharashtra.

The main objectives of MEDA are:

- To promote and develop, Non-conventional, Renewable and Alternate Energy Sources and Technologies
- To Implement Energy Conservation Act , 2001 and related schemes in the State

Need for Energy Conservation:

Power shortage hampers the economic growth of any State. Energy Conservation is the cheapest, easiest and cleanest way for bridging the gap between demand and supply. It is estimated that energy conservation projects require only one fifth of investment compared to the investment required for installation of new power projects.

Potential for Energy Conservation:

Studies have indicated the following potential for energy conservation in various sectors in the State.

Sr. No.	Sector	Conservation potential (%)
1	Industrial Sector	Up to 25
2	Agriculture Sector	Up to 30
3	Domestic Sector	Up to 20
4	Commercial Sector	Up to 30

Objective of Save Energy Program:

In order to tap the potential for energy conservation, MEDA holds that energy audit is the first step towards identification of potential areas for energy conservation. Since MEDA's inception, MEDA has been promoting this activity and nearly 527 organizations have taken part in this program till March, 2011. The main objective of this program is to provide financial assistance to eligible organizations for carrying out detailed energy audit at their facilities through empanelled consultants of MEDA. MEDA is empanelling quality energy auditors for this purpose. This is a purely promotional activity. The purpose is to create awareness about energy audit. The following sectors will be covered under this program.

1) Industries
2) Commercial Buildings
3) Government / Semi Government/Government Undertaking/ Local Self Government Buildings
4) Residential complexes
5) Municipal street lights/ Public water supply schemes

Eligibility Criteria:-

- The Unit / facility willing to do detailed energy audit should be situated in Maharashtra State.
- The Unit/ facility should be regular payer of electricity bill
- Energy Audit should be carried out only through MEDA's empanelled consultant.
- In case of Government/ Semi Government/ Government Undertaking/ Local Self Government buildings, the supporting documents to clarify the status will be necessary.
- If the unit/ facility is already availing financial assistance from any Government organization for carrying out the detailed energy audit study then the unit is not eligible for this assistance.

Financial Assistance:-

Following will be the pattern for providing the financial assistance to unit or facility.

Sr. No	Sector	Category	Annual Energy Bill	Financial Assistance if energy Audit is done by Class A Energy Auditing firm	Financial Assistance if energy Audit is done by Class B Energy Auditing firm
1)	Industrial Unit	I-1	Less than Rs.20 lakhs	Rs**. 20,000**/- or **50%** of the cost of Energy Audit study, whichever is less	Rs**. 15,000**/- or **50%** of the cost of Energy Audit study, whichever is less
		I-2	More than or equal to Rs.20 lakhs but less than or equal to 50 Lakhs	Rs**. 30,000**/- or **50%** of the cost of Energy Audit study, whichever is less	Rs**. 25,000**/- or **50%** of the cost of Energy Audit study, whichever is less
		I-3	More than Rs. 50 Lakhs	Rs. **40,000/-** or **50%** of the cost of Energy Audit study, whichever is less	Rs. **35,000/-** or **50%** of the cost of Energy Audit study, whichever is less
2)	Commercial Buildings	C-1	More than or equal to Rs.1 lakhs but less than or equal to 5 Lakhs	Rs. **25,000/-** or **50%** of the cost of Energy Audit study, whichever is less	Rs. **20,000/-** or **50%** of the cost of Energy Audit study, whichever is less
		C-2	More than Rs. 5 Lakhs	Rs. **30,000/-** or **50%** of the cost of Energy Audit study, whichever is less	Rs. **25,000/-** or **50%** of the cost of Energy Audit study, whichever is less
3)	Government / Semi-Government/ Government/ Local self Government Buildings	G-1	Less than or equal to Rs.5 Lakhs	Rs. **25,000/-** or **50%** of the cost of Energy Audit study, whichever is less.	Rs. **20,000/-** or **50%** of the cost of Energy Audit study, whichever is less.
		G-2	More than Rs. 5 Lakhs	Rs. **35,000/-** or **50%** of the cost of Energy Audit study which ever is less	Rs. **30,000/-** or **50%** of the cost of Energy Audit study whichever is less.
6)	Residential Complex	R-1	Minimum Transformer rating 200 kVA	Rs. **20,000/-** or **50%** of the cost of Energy Audit study which ever is less	Rs. **15,000/-** or **50%** of the cost of Energy Audit study whichever is less.

7)	Water Pumping stations of rural and urban local bodies	W-1	More than or equal to Rs.25.00 lakhs	Rs. **35,000/-** or **50%** of the cost of Energy Audit study which ever is less	Rs. **30,000/-** or **50%** of the cost of Energy Audit study whichever is less.
8)	Street Lighting systems of rural and urban local bodies	SL-1	More than or equal to Rs.3.00 lakhs	Rs. **20,000/-** or **50%** of the cost of Energy Audit study which ever is less	Rs. **15,000/-** or **50%** of the cost of Energy Audit study whichever is less.

Recommended frequency of Energy Audit:

The interval time for the conduct and completion of subsequent energy audit shall be t**hree years** with effect from date of the report of the first energy audit conducted and completed by Energy Auditor.

Validity of the Program:

Director General, MEDA reserves the right to issue amendments or to cancel the program without any reason.

Procedure for Registration and disbursement of financial assistance:

The following documents are necessary to be furnished to MEDA for registration:-

- The application should be in prescribed format as per the attached *Form No.-I* along with registration fee payable by demand draft only.
- Copies of energy bills for the last 12 months
- Registration fee (Non-refundable) for different criteria are as follows :-

Sr. No.	Category	Energy Bill	Registration Fee
1)	**I-1**	Less than Rs.20 Lakhs	Rs. 1000
	I-2	More than or equal to Rs.20 lakhs but less than or equal to Rs. 50 lakhs	Rs. 1000
	I-3	More than Rs. 50 lakhs	Rs. 1000
2)	**C-1**	More than or equal to Rs.1 lakhs but less than or equal to 5 Lakhs	Rs. 1000
	C-2	More than Rs. 5 Lakhs	Rs. 1000
3)	**G-1**	Less than or equal to Rs.5 Lakhs	Nil
	G-2	More than Rs. 5 Lakhs	Nil
4)	**R-1**	Minimum transformer capacity 200 kVA	Rs.1000
5)	**W-1**	More than or equal to Rs.25.00 lakhs	Nil
6)	**SL-1**	More than or equal to Rs.3.00 lakhs	Nil

- Demand Draft should be in favor of '***Maharashtra Energy Development Agency'*** only.

- MEDA will scrutinize the registration form and the list of empanelled consultant will be issued to the unit / facility for further course of action.

- The unit/facility shall finalize the auditing firm from the list of empanelled consultants. A copy of the work order should be forwarded to MEDA for information. In case unit/ facility has already finalized the consultant from

MEDA's empanelled consultant list, the unit/ facility should carry out Energy Audit and submit the energy audit report, along with the copy of work order.

- The technical guidelines for carrying out the detailed energy audit are being issued for guidance and are enlisted at Annexure A, B, C & D. These may be used, as per applicability, for carrying out the detailed energy audit.

- The unit/ facility will send to MEDA a copy of the work order issued to consultant for Energy Audit Study at the unit/ facility. MEDA will issue sanction letter to the unit/ facility.

- The unit/facility shall submit one copy of detailed energy audit report in spiral binding only, along with Undertaking which is prescribed by MEDA. The report should contain, among other things, an executive summary and specific conclusions and measures/ recommendations. MEDA will convey comments/ suggestions on energy audit report, if any and if required, to the unit/ facility.

- The unit/ facility will be expected to implement low/no cost measures of the audit and to initiate process for implementation of medium/long term measures of the audit report. The unit/ facility will submit the Undertaking as per *Form no. 2*.

- MEDA official will visit the unit/facility for verification of energy audit report measures and implementation of low cost / no cost measures and check the action plan for implementation of medium/long term measures.

- In case of residential complexes, MEDA will release/distribute the financial assistance to those residential complexes which implement the low cost /no cost measures. The eligible financial assistance will be distributed in proportion to the annual energy bill of the building/ society.

- The unit/ facility shall raise the invoice for eligible amount on MEDA.

- MEDA will release the eligible financial assistance to the unit / facility as per fund availability.

General Guidelines for carrying out Detailed Energy Audit:

The following step-wise guidelines will be used for carrying out well structured energy audit for identifying energy saving areas and potential in the unit/ facility.

Step I: Data Collection

Meeting with key facility personnel:

Establish a meeting with all key operating personnel to discuss audit objectives and scope of work; facility rules and regulations; roles and responsibilities of project team members; and a description of scheduled project activities. This first step seeks to establish; operating characteristics of the facility; energy procurement sources; operating and maintenance procedures; preliminary areas of investigation; unusual operating constraints; anticipated future business expansions or changes; and other concerns related to facility operations.

Site and unit/ facility walk- through

Conduct a walk-through of the facility to observe the various operations first hand, focusing on the major energy-consuming systems identified during the meeting with facility personnel. This includes the architectural, lighting and power mechanical and process-energy systems.

Available and existing document review

Review available facility documentation with facility engineering representatives. This documentation should include all available architectural and engineering plans; facility operation and maintenance procedures and logs; and utility bills for the previous three years. It should be noted that the available plans should represent “as-built” rather than “design” conditions. Always field verify discrepancies between the systems and structure details evaluated as part of the audit, and those actually installed at the facility.

Facility inspection

After a thorough review of the construction and operating documentation, the major energy consuming equipment/ processes in the facility should be further investigated. Take field measurements were required to substantiate operating parameters.

Walk-through/ data substantiation

Subsequent to the facility inspection, meet with the facility staff, including the major energy consuming department or service, maintenance department/ contractors and utility representatives. Review preliminary findings and the recommendations being considered. Given that the objective of the audit is to identify projects that have high value to the customer, seek management input at this point to establish the priorities that form the foundation of the energy audit.

Step II: Analysis Steps

Utility analysis

The utility analysis is a detailed review of energy bills from the previous 12 to 36 months. This should include all purchased energy, including electricity,

natural gas, fuel oil, liquefied petroleum gas and purchased steam, as well as any energy generated on site. Billing data analysis should include energy usage, energy demand and utility rate structures. Normalize utility data for changes in climate and facility operation since it is used as a baseline to computes energy conservation measures (ECMs). Evaluate local deregulation options where real-time pricing will impact the outcome of ECM analysis.

Also, utilities generally offer a comprehensive portfolio of rate tariffs and riders that can be tailored to the energy consumption and demand of the end-user. Where deregulation is active, energy can be purchased on contract from a number of third-party marketers. When it comes to using energy consumption/ demand characteristics and renewable energy resources, available grants should not be ignored. Options may include; cogeneration; power generators for emergency power and peak saving; solar panels wind turbines and propeller towers; and waste-gas cogeneration.

Calculate feasible ECMs

Energy audits should uncover both major facility modifications requiring detailed economic analysis, and minor operation modifications offering simple and / or quick paybacks. Develop a list of major ECMs for each of the major energy consuming systems, such as envelope, HVAC, lighting, power and process. Utilizing collected data, finalize a list of ECMs to be reviewed with the facility manager.

Economic analysis

Build models and simulations with software to reproduce field observations and develop a baseline to measure the energy savings potential of ECMs identified. Within the calculation, include the implementation cost, energy savings and simple payback for each of the ECMs. IRR of all EC ,measure shall be calculated

Step III: Report Preparation

Prepare audit report

Summarize the results of findings and recommendations in a final report. The report should include a description of the facilities and their operation; a discussion of all major energy consuming systems; and a description of all recommended ECMs with their specific energy impact implementation costs, benefits and payback. The report should also incorporate backup data and an executive summary with specific conclusions and recommendations.

Present and review report with facility management

Explain the process and all activities performed to substantiate the report's conclusions. Provide economic results as a format presentation of the final recommendations. Explain the data on the benefits and costs to make a decision or set priorities on implementation of ECMs.

Technical guidelines for carrying out detailed energy audit:-

- **Guidelines are as enlisted below:**

For Commercial/ Residential Buildings/ Building Complexes	:	Annexure – A
For Industries	:	Annexure – B
For Street Light	:	Annexure – C
For Water Pumping Stations	:	Annexure – D

Powers of Director General:

In case information submitted by unit/facility is found to be false, Director General, MEDA reserves the right to cancel the sanction given for the unit/facility. Also Director General of MEDA reserves all rights to accept or reject any or all applications without assigning any reason for the same.

Form No. 1

(On letter head of the unit/ facility)

Application for Registration

To
Director General,
Maharashtra Energy Development Agency
2nd Floor, MHADA Commercial Complex,
Opp. Tridal Nagar,
Yerwada
Pune 411 006

Sub:- **Application for registration under 'Save Energy Program'**

Sir,

This is in reference to above subject. M/s_____ is willing to register under your save energy program in _____ category. Our Unit's/ Facility's annual energy bill is Rs._____ and summary of last twelve months is as given in attached format. We are regular payer of the Electricity Bills. We have not taken the benefit of financial assistance under Save Energy Program for carrying out Energy Audit from MEDA in the last three years. Also we are not availing any financial assistance from any other organization for carrying out this energy audit study. We have gone through your Save Energy Program and we are agreeing to all terms and conditions applicable to this Program. We have enclosed the registration fee Rs._____ vide Demand Draft No._____ dated_____.

Hence we request you to kindly register our Unit/ Facility and to sanction our proposal.

Thanking You,

Yours faithfully,

(Signature of Unit / Facility Head/
Authorised Signatory of Unit/ Facility)

Encl:-

1.0] Demand Draft
2.0] Copies of Energy Bill of last 12 Months
3.0] Summary of Energy Bill

Summary of Energy Bill for Last twelve months:

Sr. No	Month & Year	Electricity Bill (in Rs.)	Fuel Bill (in Rs.)	Total (in Rs.)
1				
2				
3				
4				
5				
6				
7				
8				
9				
10				
11				
12				
13	**Total**			

Yours faithfully,

(Signature of Unit / Facility Head/
Authorised Signatory of Unit/ Facility)

Seal of Unit/ Facility

Form No. 2

(On letter head of the unit/ Facility)

Undertaking

(To be signed by Authorised Signatory of the unit / facility)

This is to inform you that M/s _____ has completed the Energy Audit Study of our unit/ facility as per the guidelines given in Save Energy Program of MEDA. We have accepted the recommendations given by M/s_____ in the audit report and we undertake to implement all the possible medium and long term measures recommended in the Audit Report. We have not taken the benefit of financial assistance for carrying out detailed Energy Audit under this programme for the last three years. We have implemented the no cost and low cost measures. The Action Plan for implementation of these recommendations has been prepared. We will abide by the directions issued by MEDA from time to time.

Thanking You,

Yours faithfully,

(Signature)

Place:

Date:

Annexure – A

Technical Guidelines for Commercial/ Residential Buildings/ Building Complexes

General Aspects about Building
Size, Age and Construction of the Building
Connected Load or Contract Demand
Installed DG capacity
Total electricity consumption per annum
Total electricity purchased from utilities
Total electricity generated from DG
Total Built up area (in sqm)
Total Conditioned Area
Total conditioned area as % of total built up area
Total number of employees in the office
Occupancy Information
Load distribution pattern (total lighting load, air conditioning load and other loads)
Awareness and attitude of occupants toward energy efficiency
Measures/approach to involve building owners in operation of buildings
Action plan of the building for renovation/new change in coming months/years
Administrative authority in-charge of overall functions
Authority responsible for payment of electricity bills and payment mechanism
Status of Bill Payments on time/Delay in Bill Payments, percentage paid
Controlling Authority for operation and maintenance

Electrical Distribution Pattern
Status of Operation of existing Transformers
Source of power GRID/ DG Sets
Total Connected Load and Contract Demand
Break up of all major loads in KW (Division/Section Wise
Copy of Electrical Single Line Diagram
Section wise and overall energy consumption of the building for last 3 years (If varying then hourly for one month for running operations)
Section Wise load list with application and kW rating along with usage timings
Separate feeders provided or not (for different loads like Lighting, Air Conditioning, Office Equipments etc)
Maximum Demand & Power factor Maintained for last one year (Copy of electricity bill for last one year)
Minimum payable demand or fixed charges
Energy Charges (basis of charges kVA/ kWh)
Power factor penalty/incentive (cutoff and how much)
Variation of supply voltage and frequency
Number, Type and Rating (kVA), Voltage Ratio and Test Certificates of Transformers
Usage pattern of transformers (loading/Standby pattern)
Break up of Loads connected to Each transformer
Details of various compensations provided in the building
Capacitor Bank installed – kVAR
Location - Panel or with loads
Is compensation provided through automatic P.F. controller (If yes, give details)
Any instances of over compensation
Compensation provided at Meter Terminal
Power Quality (Is Harmonics a problem ?)
Emergency Load/Power Back up

Note: Collect copies of the electricity bills for last one year as these will help us know the basis of billing like kVA / kWh basis, average monthly consumption, power factor etc.

Information about Lighting
Total Lighting Load
Lighting Load as % of total load
Lighting Load Distribution
Light load connected to DG sets/alternative power source
Indoor lighting
General Lighting Points
Task Lighting Points
Lighting in Store Rooms, corridors, staircase, Toilets
Outside Lighting (Street Lighting and Campus Lighting in Lawns with Points)
Room Properties/ Arrangement for installation
Different area types and their utility
Area of Rooms
Height of Light Points from Work areas
False Ceiling and its height, if it is there
Total Glass Area of the building and Glass thickness and properties
Status of Operation of existing installation/Measurements
Type of Light Fixtures working (e.g. 1x 40W or 2x 40W or 4x 40 W or any other with light type)
Total Number of light fixtures/points
Type of Ballasts in operation
Power Consumption per light bulb/light fixture
Number of actual light points working
Light load measurement system i.e. whether there is any separate lighting meter; Lighting transformer (if any and load connected to it)

Number of working days and operational hours per day
Comments on Lighting Design and its efficacy
Measurements
CRI Level and Lux Level required, Efficacy , Values of ILER
Lux level measurements and its distribution in various areas
All measurements details and Calculation to be provided which includes Power consumption of light point and ballasts
Status of wiring; Single switch for multiple lights
Light load measurement system i.e. whether there is any separate lighting meter and also whether lighting is on separate feeder or controls and also whether lighitng is in balance on all 3 phases if separately 3 phase supply is provided
Controls or Sensors if any
General Measurements
Comments on use of day light
Operational Aspects
Status of operation of lighting system
Preference of occupants for specific type of lighting; How to define comfort level for various options
Power failure rate (DG operation hours)
O&M measures which will effect implementation of O& M
Controlling body responsible for O & M of Lighting
Barriers to implementation
Baseline Determination
Reporting Procedures in place to assess the baseline
Standard Measurement techniques (Method of determining consumption of each fixture/Spot measurements done)
Assumptions

- hours of operation
- Working days
- energy consumption per fixture etc
Savings Calculation

Windows/Split A/C

General Information
Total HVAC load
HVAC load connected to DG
Number of Rooms having air conditioners
Area of Rooms/Cooling Space
False Ceiling/Height of roof
Exposure to sun light and Glazing, Total glass area
Presence of major heat releasing loads i.e. photocpy machines, printers etc
Working hrs per day and working days in a week
Measurements
Number of air conditioners and their rating
Air conditioner measurements i.e. EER, SEC with calculation, energy saving with star rated AC's
Sample size chosen for measurements
Orientation of Air Conditioners
Whether there is separate energy meter for HVAC
Air conditioning load connected to DG
Year of Purchase of Air Conditioners
Measurement techniques
Temperature settings

Date and time of year when sampling was done
Status of Thermostat (Working/Not working)

Central Air Conditioning

Status of Operation of existing System
Chillers
Type of Chillers (Technology)/Utility of Chillers/No. of Chillers
Make of Chillers, Model number and Year of Purchase
Chillers in Operation/Stand by
Rated TR of Chillers and Actual TR Generation of chillers
Measurements (COP and SEC)
Air Handling Units
Number of AHU and their utility
Rated Capacity of AHUs (CFM)
Measured Capacity
Comments on Working Condition of AHUs
Type of Load (Variable load/full Load)
Condenser and Chiller Pumps
Number of Condenser/Chiller Pumps
Rated Power of Pumps (KW)
Utility of Condenser/Chiller Pumps
Pump Measurements
Rated efficiency and Measured Efficiency
Power Consumption
Year of Purchase of Chillers

Cooling Tower
Rated Parameters
Number of Cooling Towers
Range/Approach
General Measurements and comments on the effectiveness of cooling towers
Whether any controls provided or not
Measurements about effectiveness of fan and CT

Operational Aspects
Existing Installations
Identify Operational and Maintenance factors responsible for energy loss in air conditioning system
Operation and Maintenance procedures adopted
Preference of occupants for specific type of lighting; How to define comfort level fo various options
Power failure rate (DG operation hours)
Controlling body responsible for O & M of air conditioning system
Barriers to implementation
Address Procurement issues
Monitoring and Verification Aspects
Baseline Determination
Reporting Procedures in place to assess the baseline
Standard Measurement techniques (Method of determining consumption)
Assumptions
- hours of operation

- Working days
Savings Calculation

DG Sets

Technical Aspects
Status of Operation of existing installation
Number of DG sets
Rating of DG sets (kVA)
Make and Year of DG
Status of Active/Standby Operations
Specification of DG Sets: Rating,Volt, Amp, RPM
Details of Load Connected on DG
Arrangement for recording performance of DG
Operational hours of DG per day
Performance Evaluation Calculation of DG
Average % Loading and Power factor
Usage Pattern (parallel etc.)

Operational Aspects
Existing Status
Records/Log Book for Specific Fuel consumption (kwh/lts)
Provision of Meter to record electricity output from DG
Provision to capture oil consumption, whether oil flow meters/measuring arrangement is there
Maintenance schedule

Monitoring and Verification Aspects

Baseline Determination

Status of Building to assess the baseline consumption

Technical Aspects of Installation & Status of Operation of existing Transformers

Electrical Systems & Harmonics

The scope covers the study of Electrical Systems comprising the Electrical Substations, Electrical Bill analysis, Electrical Demand, Transformer loading practices, Phase Balancing, Power Factor Management, Incoming Voltage Conditions and Distribution losses and Harmonics.

i) Transformer Load Management

The study will cover an in-depth analysis of the loading practices on distribution transformer to evaluate the operating efficiencies. Such an analysis would result in identification of measures for achieving optimum loading conditions and minimizing transformation losses.

ii) Power Factor Management

The study of power factor at different bus levels will help in designing and optimal placing of capacitor banks to reduce the distribution losses and at the same time to improve the power factor. Installation of capacitor banks on transformer LT bus will also be evaluated.

iii) Distribution Losses

An in-depth study of the energy losses in the cable system would indicate the measures to be taken for minimizing the energy losses in the cables and the overall distribution losses (percentage).

iv) Incoming Voltage Conditions

A detailed analysis of incoming voltage conditions would help in arriving at possible measures to improve the same.

v) Harmoincs

A detailed harmonic analysis will be carried out in the selected areas like UPS feeder, main in-comer, lighting DB etc.

Type of fans provided (Normal or exhaust) and power rating of fans; total connected load

Year of Purchase and Make

Number of fans provided
Type of regulators provided
Regulator type and Fan Blade Material
Average Working hours per day
Fan Inventory
Measurements
Power consumption per fan (W)
Air Delivery
Total Power Consumption (kW)
Star Rated fans & energy saving comparison , costing, vendors

Use of renewable Energy

- Use of SWH (Solar Water Heating Systems)
- Detailed proposal for installation of Solar Water Heating Systems in Building including detailed costing, piping layout etc.
- Description of distribution of Hot water in individual flat
- Judicious distribution of hot water in individual flat/ premises
- Cost effectiveness & life cycle costing of the use of SWH
- Possibilities of use PV in common spaces as well for individual spaces/flats etc.
- List of vendors for all systems
- For residential complexes, Awareness Program shall be conducted by consultant for residents of the building & photographs of the program shall be submitted along with report. Contents of the same shall be need of energy conservation, energy & environment, S& L Program, opportunities of energy conservation in their premises(recommendation of energy audit)

Annexure - B

Technical Guidelines for Industries

A. Furnaces
B. Cooling towers and water pumps
C. Compressed Air System
D. Electrical Systems
E. Electric Drives & motors
F. Boilers & Steam System
G. HVAC & Refrigeration system
H. DG Sets,
I. Fans & blowers
J. Lighting

A. Furnaces

The study of furnaces would cover:

- Efficiency evaluation
- Estimation of various losses
- Measurement of surface temperatures and estimation of heat losses
- Estimation of heat balance
- Monitoring of operating parameters vis-à-vis desirable parameters
- Evaluation of various energy saving opportunities

The above areas will be studied to identify opportunities for energy saving

B. Cooling Towers & Water Pumps

The cooling tower efficiency will directly affect the performance of plant equipment, which leads to higher energy consumption. In view of this a study will be under taken to analyze the present approach and range of the cooling tower against its designed values. The study of cooling towers would cover.

- Evaluation of range and approach
- Effectiveness of cooling towers
- Measurement of power parameters (kW, kVA, pf, frequency, current, voltage) of cooling tower fans
- Application potential for energy saving retrofits

Water Pumps:

Plant has different capacity of water pumps for various applications.
The study of above water pumps (15 kW and above) would cover:

- Flow and head measurement of pumps by using sophisticated energy audit equipment (ultrasonic flow meter). Where ever measurement is not possible, DCS values will be considered for evaluation.
- Measurement of power parameters (kW, kVA, pf, frequency, current, voltage)

- Evaluation of efficiency of pumps
- Application and matching of drive
- Application of flow control methods
- Application of retrofit for energy savings

C. Compressed Air System

An in-depth study of compressed air system covering compressed air generation, distribution and utilization will be made. The study should cover:

- Free air delivery assessment (output of compressors)
- Estimation of specific energy consumption (kW consumption per cfm)
- Study of distribution network for Pressure drop, leakages, etc.
- Loading and unloading pattern
- Optimization of compressed air utilization

Detailed analysis of the above should be carried out by using portable instruments to arrive at suitable recommendations.

D. Electrical Systems

The scope covers the study of Electrical Systems comprising the of loading & electrical parameters at electrical substations and transformers. The study should help in identifying:

- Electrical Bill Analysis
- Demand Analysis
- TOD tariff benefit
- Lightly loaded distribution transformers
- Minimize distribution losses
- Power factor improvement.
- Load Factor improvement

In case of similar type of transformers, snap shot study should be carried out and in case of lightly loaded transformers possibilities should be seen to shift the load after considering the reliability.

E. Electric Motor and Drives

Plant has different types of motors connected to various types of equipment such as:

- Compressors
- Pumps
- Fans
- Blowers and,
- Plant machinery

The study should cover (motors 10 kW and above) loading conditions on motors, loading analysis, drive matching by using power analyzer. Operating parameters such as kW, kVA, pf, Voltage, Current, and Frequency should be measured. Based on the above analysis the following practically implementable energy conservation measures recommendations should be made.

- % loading of the motor
- Proper sizing of motor
- Use of energy efficient motors by replacing oversized and less efficient motors
- Possibility of operating motors in star mode wherever motors are under loaded
- Reactive power compensation for motors operating at low PF
- Application speed controlling devices & smooth starting devices
- Energy efficient transmission

Detailed techno-economics of above measures should be carried out.

F. Boilers & Steam System

- ***Steam Generation***

  - Efficiency and losses evaluation of boiler and improvement aspects for fuel fired boilers.
  - Measurement and monitoring of flue gas analysis and temperatures
  - Study of auxiliary loads such as boiler feed water pumps, fans and pumps for improvements in specific auxiliary power consumption.
  - Application and matching of drives to the auxiliary equipment
  - Application potential for energy saving retrofits
  - Evaluation of Specific steam generation
  - Monitoring and instrument aspects of boiler parameters for improvement in energy efficiency

- ***Steam Distribution:***

  - Study of distribution network for pressure drop in the system
  - Study and survey of steam trapping for application, matching and performance
  - Insulation aspects including insulation surveys and improvement aspects
  - Study and survey for steam leakages

- ***Condensate recovery***

- Estimation condensate recovery
- Scope for improvement in condensate recovery and optimization
- Use of waste heat recovery options

Detailed techno economic analysis of the above should be carried out by using various portable instruments to arrive at possible energy conservation measures. The measures should be classified in low cost / no cost, medium cost and high cost measures.

G. HVAC & Refrigeration System

An in-depth study of HVAC & Refrigeration system covering compressor, evaporator, condenser and distribution & utilization will be made. The study should cover:

- Measurement of power consumption and estimation of specific power i.e, kW/TR for compressors, chilled water pumps, condenser fans , AHU fans, etc
- Operational features of compressors such as temperatures, pressure control
- Study of distribution network for leakages
- Improvement in Process Heat Exchangers
- Optimization of chilled water and air utilization
- Insulation aspects including insulation surveys and improvement aspects
- Matching Capacity to System Load
- Capacity Control and Energy Efficiency
- Possibility for Chilled Water Storage
- Application potential for various energy saving retrofits

H. DG Sets

The study should cover DG sets, steam generation, steam distribution and condensate recovery. The detailed study under each component includes:

- ***DG sets***
- Specific electricity generation ratio evaluation
- Performance evaluation i.e., Energy balance Efficiency calculations (based on the plant data).

I. Fans and Blowers

The study should cover the fans & blowers for the following.

- Flow and head measurement of major fans and blowers and evaluation of efficiency of fans and blowers by using sophisticated energy audit equipment where ever applicable
- Measurement of power parameters (kW, kVA, pf, frequency, current, voltage)
- Measurement of speed by using stroboscope
- Application and matching of drive
- Application of energy efficient flow control methods in fans and blowers
- Application of retrofit for energy savings

All the above should be studied in detail to arrive at various energy conservation opportunities

J. Lighting System

Detailed audit in lighting system normally results in considerable savings. Illumance readings with a lux meter should act as a basis for comparative purpose. The study should cover measurement of lux level at work place and at various points of light usage. Application of retrofits such as:

- Timer control
- Photocell control for street lighting
- Use of energy efficient lighting
- Harmonic Analysis

K. Others

- Carry out the detailed study for utilization of Renewable Energy Sources.
- Carry out the detailed study for rain water harvesting
- Formation of Energy Conservation Cell to implement the action plan.
- Define the methods for energy monitoring.
- Training staff for monitoring by the energy auditing consultant

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Annexure - C

Technical Guidelines for Street Lighting Facility

1) A statement of existing facilities and infrastructure, especially number and rating of electrical equipment, as provided by the ULB shall be included in the report. However, the auditor is expected to carry out extensive field level inspection to verify the same and inventories the entire street light infrastructure, including single-line diagrams, etc. so as to completely map the existing system.

2) **Baseline energy consumption:** For the entire sets of street lighting facilities, the prevailing energy consumption should be measured. Energy consumption and related parameters should be verified through on-field measurements, energy meter records and energy bills. All cyclicity in energy consumption within a day, within a week should be measured. Seasonal variations should be assessed on basis of norms and past historical trends (min 12 past month, ideally past 36 months).

3) **Baseline service levels:** Many a municipal services are provided at service levels below desired benchmarks and also vary widely within a city across different areas. It is therefore important that key parameters are recorded as part of the base line measurement.

4) **Identification of EEMs:** Identify Energy Efficiency Measures not just at the energy consuming device / equipment level, but the entire system. For e.g. for street lighting, the systems should be examined in terms of effectiveness of illumination provided, integrating switching points, etc. and not just in terms of the EEM for the lamp / luminaries.

   Extent of savings should be quantified, should the prevailing service levels be maintained or if enhanced to benchmark service levels.

5) **Investment planning under both scenarios:** Extent of investment required for implementing EEMs while maintaining current service levels should be estimated. Investment requirement should be assessed on basis of realistic price levels in the market for standard products and services. Proprietary items should be avoided. Further investment required to achieve benchmark service levels should also be estimated. A pragmatic approach should be adopted, in consultation with the ULB concerned to estimate the amount of investment required. If the entire infrastructure needs to be replaced or rehabilitated, the same may not be considered. However, if there are some improvements to be done, they should be considered.

6) **Developing optimal scenario:** In many cases the investments may far outweigh the savings to be achieved though energy efficiency measure, while the positive outcome may be improved quality of service. So an optimal scenario that considers a combination should be arrived at in consultation with the ULB. The ULB is expected to sign-off the optimal scenario it has arrived at. Projected savings, NPV and IRR should be computed for this optimal scenario.

Annexure D

Technical Guidelines for Water Pumping Facility

1) **Facility inventory baseline:** A statement of existing facilities and infrastructure, especially number and rating of electrical equipment, as provided by the ULB shall be given. However, the auditor is expected to carry out extensive field level inspection to verify the same and inventories the entire infrastructure, including single-line diagrams, flow-diagrams, etc. so as to completely map the existing system.

2) **Baseline energy consumption:** For the entire sets of facilities, the prevailing energy consumption should be measured. Energy consumption and related parameters should be verified through on-field measurements, energy meter records and energy bills. All cyclicity in energy consumption within a day, within a week should be measured. Seasonal variations should be assessed on basis of norms and past historical trends (min 12 past month, ideally past 36 months).

3) **Baseline service levels:** Many municipal services are provided at service levels below desired benchmarks and also vary widely within a city across different areas. For e.g. water is pumped for only a few hours in many cities. Improving service levels may imply increase in consumption of energy. It is therefore important that key parameters are recorded as part of the base line measurement.

4) **Identification of EEMs:** Identify Energy Efficiency Measures not just at the energy consuming device / equipment level, but the entire system. For e.g. at a pumping station, EEMs should not just be for the motor-pump set, but the entire treatment plant should be examined for effectiveness of capacity utilization, leakages and pressure loss points, balancing flow-rates through the system, etc. Similarly, in street lighting the systems should be examined in terms of effectiveness of illumination provided, integrating switching points, etc. and not just in terms of the EEM for the lamp / luminaries.

   Extent of savings should be quantified, should the prevailing service levels be maintained or if enhanced to benchmark service levels.

5) **Investment planning under both scenarios:** Extent of investment required for implementing EEMs while maintaining current service levels should be estimated. Investment requirement should be assessed on basis of realistic price levels in the market for standard products and services. Proprietary items should be avoided. Further investment

required to achieve benchmark service levels should also be estimated. A pragmatic approach should be adopted, in consultation with the ULB concerned to estimate the amount of investment required. If the entire infrastructure needs to be replaced or rehabilitated, the same may not be considered. However, if there are some improvements to be done, they should be considered. For e.g. Relocating the pump to help reduce head loss and thereby reduce energy consumption. However, if the entire piping network is corroded, replacement of the entire piping network should not be considered.

6) **Developing optimal scenario:** In many cases the investments may far outweigh the savings to be achieved though energy efficiency measure, while the positive outcome may be improved quality of service. So an optimal scenario that considers a combination should be arrived at in consultation with the ULB. The ULB is expected to sign-off the optimal scenario it has arrived at. Projected savings, NPV and IRR should be computed for this optimal scenario.

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