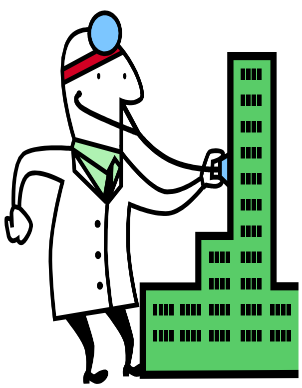
Checklist for Self-Audit

Of

Energy Utilisation

Ideal for manufacturing companies having electricity bill less than Rs. 1,00,000/- p.m.



Name of the Co. /Unit: .

Address:

Areas covered:

Areas excluded;

Sanctioned Load: kVA

Peak Load: kVA

Gross consumption of last 12 months: kWh

Audit performed by:

Confederation of Indian Industry
CII – Sohrabji Godrej Green Business Centre
Survey No. 64, Kothaguda Post, Near HITEC City,
Ranga Reddy Dist., Hyderabad - 500 084, INDIA
Tel: +91-40-44185111 Fax: 91-40-44185189
Email: envirogbc@cii.in
Website: www.greenbusinesscentre.com

L S Ganapati
Chairman, CII-National Award for Excellence in Energy Management

05th August 2014

MESSAGE

The need of the hour is to cover entire spectrum of industries in Energy conservation efforts. "Check-Lists" are fundamental to any audit/assessment initiative; yet very easily taken for granted resulting in vital slips!

The effort of Sri SP Damle - Executive Director & Principal Tutor, Gunavardhan Training Institute, is a welcome step in providing a very important input to all practicing professionals and user interactions.

I am sure with further enhancements of awareness levels on Energy conservation front and Improvement suggestions from user industries/practicing professionals this Important documentation will further undergo higher levels of revisions and result in targeted "SME" sector achieve significant energy conservation.

Here are my Best Wishes.

L S Ganapati

Headquarters: The Mantosh Sondhi Centre, 23, Institutional Area, Lodi Road, New Delhi 110 003

Instructions

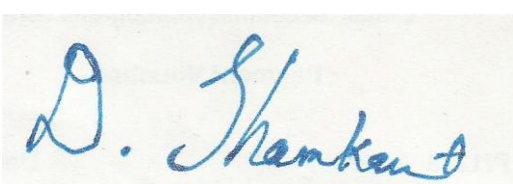
This checklist consists of different types of questions and hints that you can ask yourself. Some of them are 'walk-through' i.e you can ask and answer them just by taking a walk across the shop floor in one round. Others require an ongoing or periodic scrutiny. Some of the questions can be answered only after collecting data, which may take you one full year. The checklist does not have questions that involve large capital investment. Nor does it question the plant design. Selection & purchase of capital equipment, say a boiler or transformer, involves different dynamics, which is not covered here. You have been given a plant. The checklist only provides hints as to what best can you do within the given plant. It gives little bit of engineering inputs so as to kindle your mind. It does not aim to be a handbook.

We do not seek to create a complete Energy Audit Report in one go. An external Energy Auditor is bound by a contract and is paid for his efforts. Therefore, it is expected out of her/him to deliver an actionable report in a short span of time. That is not the case with in-house auditor. An in-house auditor is there in the midst of machines all the time. He is committed to the job. However, (s)he may not have the data, may not have a frame of mind to look at things differently. This checklist will provide her/him with an opportunity to look at the machines and processes from a different angle.

We suggest that you carry out first a 'walk-through', to generate ideas for energy reduction as well as to identify areas, which require data collection. After collecting the necessary data in two-weeks time, you can conduct another round of walk-through, generating even more ideas.

During this stage, **DO NOT PRE-JUDGE OR EVALUATE THE IDEAS**. Just note them down. Section 3 will tell you how to evaluate and approach those ideas.

Wish you all the success!



Section 1 : Energy Overview

Energy In

Source	Average Monthly consumption	Unit	Average Consumption in MJ
Hydro-carbons	For heating . For Elec (DG Set) .		
Solar	For heating . For Elec (DG Set) .		
Wind			
Other			
	Total	PS (MJ)	MJ

Primary sources

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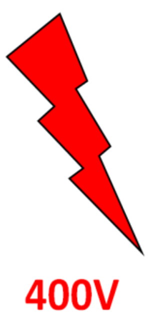
Secondary source



	Average Monthly consumption	Unit	Average Consumption in MJ
Electricity generated within	W=	kWh	
Electricity from Discom	D=	kWh	D(MJ)=
Gross electricity consumed	W+D=	kWh	
	Total EnIn		PS(MJ)+D(MJ) =

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Other Intermediate Transmission sources, such as:-

1. **Compressed Air**:- (Description)
2. **Thermic fluid** :- (Description)
3. **Steam**:- (Description)

Processes

Mechanical/chemical exothermic/endothermic

Description and/or Schematic of the process(es) and/or typical product:-
(Consider drawing a Pareto diagram of consumption by different processes/equipment).

Benchmarking: industry benchmarking feasible for key processes?

Yes		No	
Yes		No	

Is data available?

Obvious wastages thro hot air/steam/ hydrocarbons in effluent etc.

List of major equipment on facility (Energy supply) side

1. **Transformers**
2. **DG Sets**
3. **Compressors**
4. **.**

List of major Energy Consumers

1. **Air-condn.**
2. **Lighting**
3. **.**
4. **.**
5. **.**
6. **.**

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Section 2 Checklist

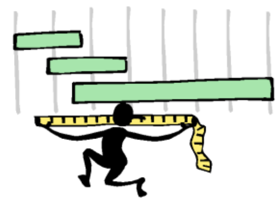
Section 2.1 Lighting System

Light output from a light source is measured in lumens.
Lumens/Watt is the ratio of the amount of light produced per the input energy. The larger this ratio, the more efficient the fixture is.
The amount of light "available" at a particular location is measured in foot-candles or lux (1 foot-candle=10.76 lux) by a hand held light meter.
Typical recommended levels of maintained luminance for different locations or visual tasks

Location/Task	Typical recommended level of maintained luminance (lux)
General offices	500
Computer workstations	500
Factory assembly areas	
Rough work	300
Medium work	500
Fine work	750
Very fine work	
Instrument assembly	1,000
Jewellery assembly/repairs	1,500
Hospital operating theatres	50,000

Source:- http://www.ilo.org/safework_bookshelf/english?content&nd=857170550

Are any Work-stations over-illuminated?


Measurement required!

Can we reduce the overall lighting and introduce "task-lighting"?

Yes		No	

If yes, in which areas ?-

Look for--

Where "task-lighting" exists, are switches easily accessible?

Yes		No	

Are lights ON in unoccupied areas? Where occupancy is intermittent or rare, are switches easily accessible? E.g. Warehouse, store-rooms, passages

Yes		No	

Are the outdoor lights switched off during daytime?

Yes		No	

Will manual switching off work or we need to install photo-sensor/occupancy sensor?

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Can we switch over from
Incandescent lamps --> Fluorescent lamps --> CFL --> LED
If yes, in which areas ?-

Do we use electronic ballast for Fluorescent lamps? Why not?

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Section 2.2 Motors, Belts and Drives

Motors have relatively constant power factor and efficiency down to approximately 50 % of full load (within +/- 5 percent), then power factor and efficiency degrade rapidly. Larger motors are typically more efficient than smaller motors.

VFDs or Variable Frequency Drives can help save motor energy by allowing for variable flow of air, water, etc., based on the demands. This is accomplished by converting the fixed frequency of incoming alternating current (AC) voltage to direct current (DC) — and then reconverting it back to AC voltage by varying the frequency at which the insulated gate bipolar transistors (IGBTs) are gated on and off.

The installation of Variable Speed Drives (VSDs) or Variable Frequency Drives (VFD) may induce harmonics into the electrical distribution system. A system with many capacitors installed can be particularly vulnerable unless "tuned" by a professional. Some installations are relatively insensitive; others are VERY sensitive to this problem. Be particularly careful if a facility already has experienced power quality problems. Also be careful in facilities with heavy rectifier loads - charging equipment or induction furnaces, or significant computer and other electronic loads.

Caution:  Existing motors can be overheated by VFDs. They can also affect the life of bearing. Ensure carrier frequency is less than 6 kHz with adjustable frequency. Ensure the VFD is as close as possible to the motor.

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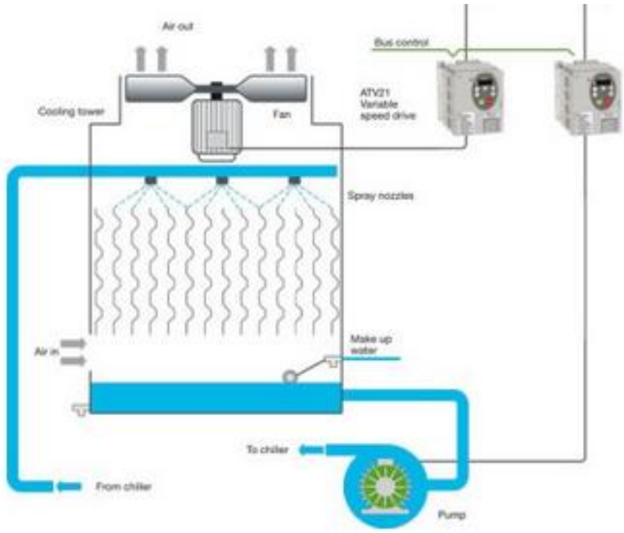
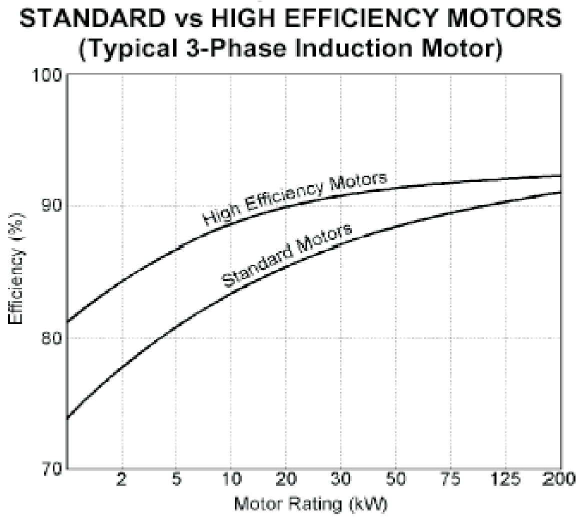
A typical application of Variable Speed Drive



Courtesy: http://www2.schneider-electric.com/

Energy Efficient motors can give an advantage of 3-5% efficiency, but they come at a premium price.



Energy savings by motor replacement:

kW savings
= kW output × [1/ηold – 1/ηnew]

where ηold and ηnew are the efficiency values of existing and proposed motor.

Find out time(hours) for which the motor runs in a month.

Compare this with the cost of high **η** motor.

Look for--

Is any motor operating regularly below 60% of full load?

Yes		No	

Details of such motor(s)

Can we downsize the motor(s)? i.e. replace it with lower rating motor? Can the bigger motor be deployed for some other application within company?

Are motors running in idle condition during lunch break or when the process does not require them to run?

Yes		No	

If Yes, try interlocking equipment with process.

What types of belts are used?

Switch over to HTD(High Torque Drive) Belts.

T H I N K		Make a list of motors, which are due for replacement, & motors, which were rewound. Can we afford to replace them with High Efficiency Motors? Make a list of motors, which are required to run at varying speed/output. Can we install VFD?

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2.3 Pumps, Fans & Blowers

Fan output power (P_{out}) or airpower using Metric units is:-
P_{out} (Watts) = Air pressure <Pascal's> x Air flow <m3/sec>

Fan efficiency = P_{out}/P_{in}

According to the Fan affinity laws, fan power is proportional to third power of ratio of fan speed. i.e. If fan speed is reduced by 10%, power consumption will reduce by 27%.

?	Has the system requirement (demand) changed since the time of selection of the fan or blower? Yes [ ] No [ ] Replace the fan with lower capacity, energy efficient fan.

Is a throttle or mechanical damper being used continuously?

Yes		No	

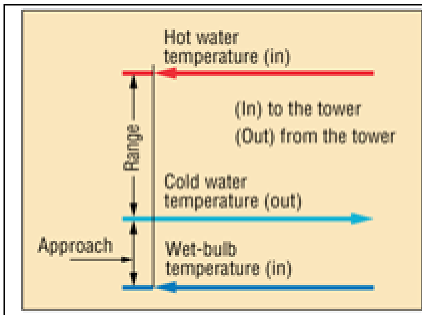
If yes, replace it.

Options are Variable Speed Drive, Two speed drives and low rpm motor.

Are we pumping fluids over long distances? How can we avoid/reduce it?

If multiple pumps are used in parallel, how are they operated? Can we afford a software solution to select & cut-off pumps?

Are we using cooling towers?



"Range" is the difference between the cooling tower s' inlet and outlet temperature.

"Approach" is the difference betn The outlet cold water temperature & ambient wet bulb temperature.

Cooling tower effectiveness = Range / (Range + Approach).

Maintaining dry and cool weather near cooling tower helps reduce the pumping requirement.

Plant trees (not creepers) around the tower.

Other **Opportunities of Energy Saving**:

- Change of metallic / Glass reinforced Plastic (GRP) impeller by hollow FRP impeller with aero-foil design.
- Change of impeller by an impeller along with cone
- Minimizing excess air level in combustion systems to reduce FD and ID fan load.
- Fan speed reduction by pulley Φ modifications for de-rating.
- Use booster pumps for small loads requiring higher pressures.
- Repair seals and packing to minimize water loss by dripping.
- Maintain and replace nozzles in cooling tower periodically.

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2.4 Compressed Air

- Take a large print of the factory layout plan.
- Classify the Compressed air requirement in three categories—
  - less than 2kg/mm^2,= **O**
  - between 2 & 6 kg/mm^2 = **O** and
  - above 6 kg/mm^2 = **O**
- Using colour code, plot all the demand points on the plan.

T H I N K		Can we provide separate supply lines for low and high pressure applications of compressed air? Are there any isolated demand points, which can be catered by a dedicated compressor?

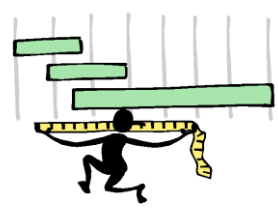
Carry out a leak test. On a shutdown day, close all applications and charge the pipeline. Note down the time when the compressor is fired

% leakage = ON time/(ON time + OFF Time)*100.

. Establish a baseline and monitor.

Note down the consumption over 24 hours. Also note down flow meter readings at the peak demand & lean demands of the process in different seasons.

Are we using a big compressor to cater to lean period requirements?



Measurement required!

Is the pressure drop across auxiliary equipment such as dryers, oil separators, or filters excessive?

Pressure drop should not exceed 8 to 10 psi; for oil separators, 5 psi for a dryer, 0.5 to 1 psi for a filter.

Replace filters, overhaul equipment to reduce pressure drop.

Cross-check whether

- Preventive maintenance of compressor and filters is carried out as per plan.
- Inlet air is cool—no hot air blast or exhaust near air inlet
- Properly designed nozzles are used for spray; not steel tubes inserted in hose.

2.5 Heating Applications

2.5.1 Specifications

When sophisticated temperature controllers were not available, it was a practice to specify wider range of temperature e.g. if the metallurgist needed minimum 830 ^{O}C, he would specify 840$\pm$10 ^{O}C. Explore the possibility of specifying and achieving 832$\pm$2 ^{O}C.

This would require better controls by way of furnace mapping & frequent and reliable calibration of thermocouples and gauges, etc. We were doing it for the ISO 9001 auditor; now let us do it for our own benefit.

2.5.2 Sources of heat

If something is not ecologically sound, it is not economically viable – Capt. Gopinath

T H I N K

Think of alternate source of heat. If we are using furnace oil, can we replace it with naptha or CNG?

If we have low temperature applications (<250^{O}C), can we use biomass? Check what are the common agriculture wastages in the locality around the factory. Biomass compactors can be donated to the local community and they can in turn supply you with fuel.

For lower temp application (<100^{O}C), can we use solar heating?

Electrical sources of heating

Check for

- Preventive maintenance of furnace, including the sealing of doors and replacing the damaged resistance heaters.
- Balanced 3 phase load
- Optimization of frequency for induction heating
- Check for proper coil design/selection for induction heating

2.5.3 Load and patterns

Collect the data on last 20 batches of furnace loading. Is it being operated at less than 85% of furnace capacity?

Often delivery deadlines & crisis management force shop-floor operators to operate furnace at less load. If that is happening frequently, highlight it to management. The crisis is generally man-made.

Are we using a continuous or belt type furnace when the load can no more justify it?

Try converting it to batch type by running the furnace in alternate shift.

2.5.3 Recovery of heat

Can we use a Vapour Absorption Machine for refrigeration needs?

Can we use flue gases to pre-heat boiler water or fuel?

Check for

- Leakages and wastage

Caution: .

Home-made heat exchangers can be a fire-hazard. Any modification needs to be approved by technical expert and where applicable, by Competent statutory authority

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2.6 Air Conditioning & refrigeration

Note down all the heat loads (other than human beings) in an air-conditioned enclosure.

Can we move some of them outside the enclosure?

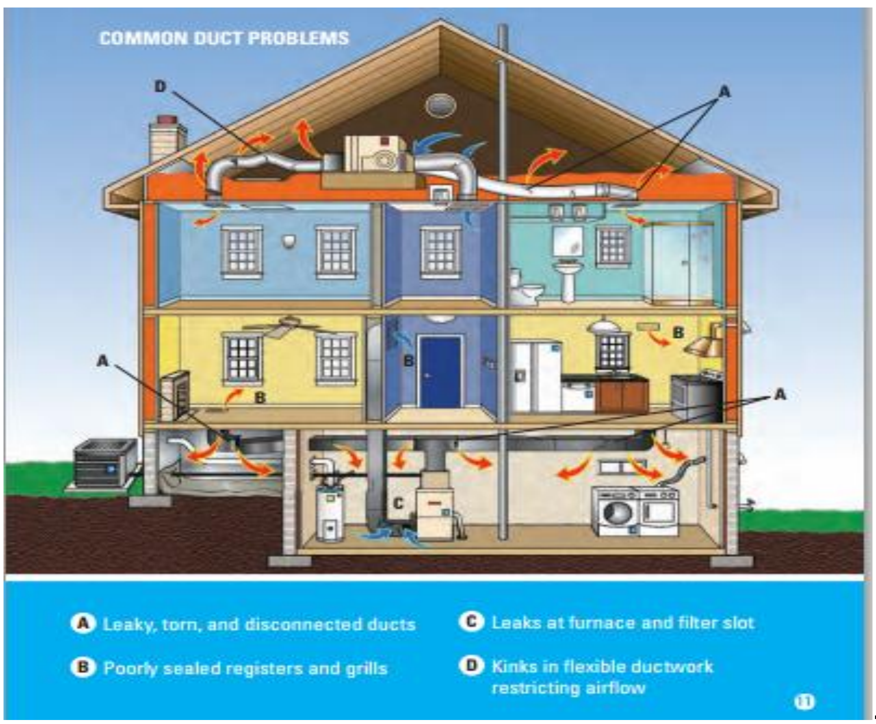
E.g. A deep-freezer inside an air-conditioned restaurant.

Can we replace them with more efficient substitutes. Such as LED lights?

Advantage of efficiency is doubled when in an AC enclosure.

If you have very low temperature storages (-20 ^{O}C), surround the stores with other offices/structure such that stores is not exposed to sunlight.

Common duct problems:-



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Switch of the office AC 15-30 minutes before closing the office.

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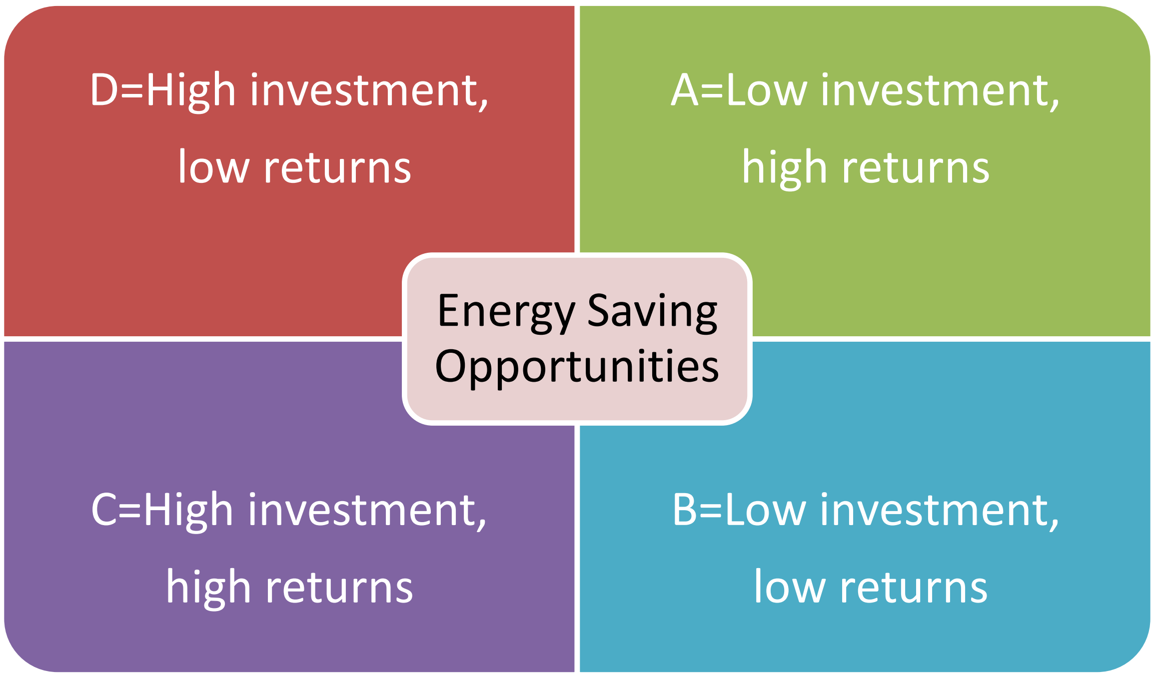
Section 3: Evaluating the ideas and preparing Action Plan

During the application of checklist (Section 2), we had recommended that you should not to evaluate or pre-judge any suggestion or idea. Keep noting down all the ideas, which come to your mind. Encourage workers to give suggestions.

Now classify the ideas in four quadrants as below



The ideas in quadrant A should be implemented without a second thought.

The ideas in quadrant D should be discarded.
However, keep record. They may shift to quadrant B or C in future.

For quadrant B, you need to discuss the matter with your finance man. If your energy bill constitutes major part of your expenditure, then quadrant B may still be attractive.

For Quadrant C, involve an external expert —a qualified Energy Auditor or equipment supplier. Ask the expert to perform ROI calculations.

Bon Voyage!