ENERGY AUDIT REPORT

January, 2020

Jesus & Mary College

(University of Delhi)

Chankya Puri, New Delhi – 110 021

CONDUCTED BY:

Petroleum Conservation Research Association

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A. INTRODUCTION

PCRA has been entrusted with the task of conducting Energy Audit & Energy Management study for the Jesus & Mary College, New Delhi. The field work and data collections were carried out in January, 2020.

The study encompassed the examination of the existing pattern of energy use in the college and identification of areas where energy & monetary savings could be achieved by employing suitable techno-economic measures.

This report gives the details of observations of the team along with appropriate recommendations and supporting calculations. We hope that the findings of the team will supplement the efforts of the management in bringing the energy consumption of the office to the lowest possible level.

Note:

This report is based on the present operating status of the office. The recommendations are based on various operational parameters examined by the team and the information supplied to the team by the management of Jesus & Mary College, New Delhi.

B. EXECUTIVE SUMMARY

Assignment was conducted and the following areas have been covered in the study.

1. Electricity Bill
2. Distribution Network
3. DG Sets
4. Lights
5. Air Conditioning Load
6. Solar Power etc.

The summary of the observations and recommendations evolved out of the energy management study of the college building is given below:-

1. The Running maximum Demand (kVA) of the college varies from 9 kVA to 79 kVA. The running maximum Demand depends on power factor which also varies from 0.57 to 0.92 and average monthly P.F. is 0.757 which consider as very poor. Details of Power Factor is given in the report.

   It is advisable to reduce the sanctioned load of 198.6 kW to 90 kW with the NDMC. This will be helpful in reducing the fixed cost in electricity bill by Rs. 4.39 lacs per year as shown under para 1.2 'Sanctioned Demand'. For precaution, a Demand controller can be installed which will help in keeping the maximum running demand within the limit. The payback period will be around 1 month.

2. The average monthly power factor is 0.757 which is not good. If the power factor improves to 0.99 or unity then it will further reduce the fixed cost by Rs. 92000/- per year as shown under para 1.3 'Power Factor'. The payback period will be around 4 months.
3. Lux level in the class room at the entrance wall was found less. It is advisable to put some more tubes there for better light intensity.

The summary at a glance of the observations and the return on investment is tabulated below:-

SUMMARY OF ANTICIPATED ANNUAL RECURRING SAVINGS

S. N.	OBSERVATIONS	SAVINGS		SAVINGS	Investment	REMARKS
		kWh	Lit.	(Rs. In lacs)	(Rs. In lacs)	
1	By reducing the sanction load from 198.6 kW to 90 kW	-	-	4.39	0.4	Payback period of 1 month.
2	By improving Power factor near to 0.99 or unity	-	-	0.92	0.3	Payback Period of 4 months
Total		-	-	5.31	0.7	

C. STATUS OF THE COLLEGE BUILDING

C.1 General

Jesus & Mary College comes under the University of Delhi and it is established in the year 1968, imparting higher education in the field of Arts & Commerce. It is located in the heart of the capital of India and in prime location i.e. Chankyapuri, New Delhi.

The College admits students from all social milieus and empowers them through intensive mentoring and counselling to face the challenges of life and become responsible and sensitized citizens of the country. JMC provides a caring and nurturing environment where students come into their own, blossoming into confident young women ready to face the world.

C.2 Energy Sources

Electricity is the major energy sources of the college. Electricity is supplied by NDMC, New Delhi. Diesel oil is being used in the DG sets for in-house generation of electricity during power cut.

C.3 Energy Consumption

For the Unit / college, the applicable BSES electrical tariff is in two part i.e. a fixed cost (Demand Charges) and unit (kWh) rate. The average monthly unit consumption of the college is 16018 kVAh and the average monthly electricity bill amount is around Rs. 229064/- (Nov., 18 to Nov., 19 except Sept.,2019). The average monthly unit cost would be around Rs. 14.30/ kVAh.

C.5 DG Sets

There is one DG set of capacity 82.5 kVA installed in the college. There is hardly any power cut so the running hour of DG set is very less.

C.6 Air Conditioning

In the Unit/ college, there are package unit of 6 x 10TR, 4 x 8.5 TR, 8 nos of cassette unit (5 x 2TR, 3 x 3TR) and 15 nos of 2 TR split units Air-conditioners to maintain comfort temperature in the office/ class rooms etc.

SECTION 1

Electrical Supply & Billings

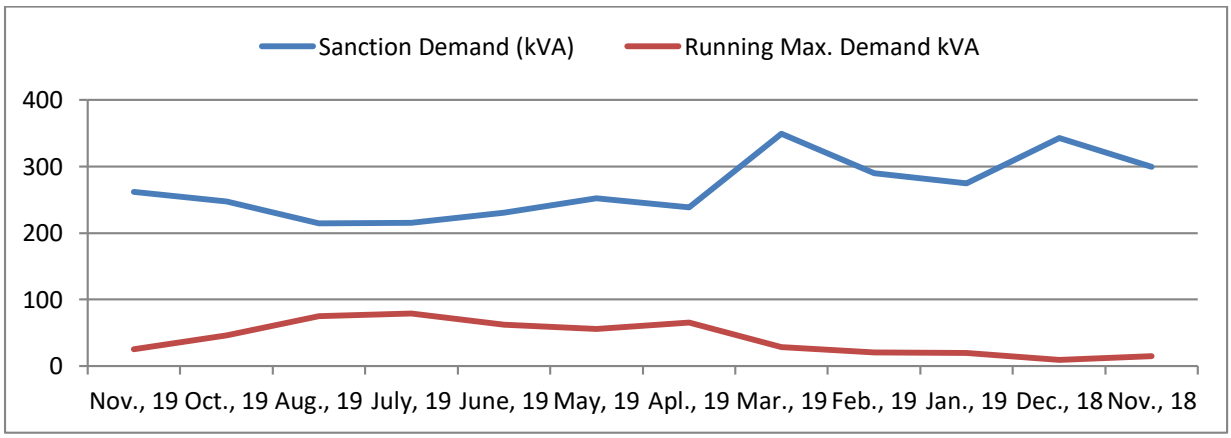
1.1 ELECTRICAL SUPPLY

The college is getting electrical supply by the NDMC, New Delhi. There is one energy meter installed in the premises. There is a transformer 11 kV/ 433 V of capacity 990 kVA.

1.2 SANCTIONED DEMAND

The sanctioned demand for the unit is 198.6 kW from NDMC, New Delhi. Its sanctioned demand kVA varies every month because of change of power factor every month. The recorded running maximum demand of the college from the electricity bill is given below:

Months	Sanction Demand (kVA)	Running Max. Demand kVA	Fixed Cost (Rs.)	Difference (S.D. - R.M.D.)
Nov., 19	261.92	25.0	65500	236.9
Oct., 19	247.84	46.0	62000	201.8
Aug., 19	214.58	75.0	53750	139.6
July, 19	215.75	78.9	54000	136.9
June, 19	230.28	62.1	57750	168.2
May, 19	251.93	55.8	63000	196.1
Apl., 19	238.31	65.6	59750	172.7
Mar., 19	349.07	28.1	87500	321.0
Feb., 19	289.87	20.2	72500	269.7
Jan., 19	274.61	19.9	68750	254.7
Dec., 18	343.03	9.3	86000	333.7
Nov., 18	299.5	14.8	75000	284.7



The difference between Sanctioned Demand and running maximum Demand (R.D.) varies between 136.9 kVA to 333.7 kVA. It is advisable to reduce the sanctioned Load from 198.6 kW to 100 kW. This will yield an annual saving in the electricity bill under fixed cost of around Rs. 4.39 lacs as shown below:

Months	Present Sanction Load (S.L.) kW	Monthly Power Factor (P.F.)	Sanction Demand (S.D.) (kVA)	Running Max. Demand kVA	Fixed Cost (Rs.)	Recommended Sanction Load (kW)	Recommended S.D. (kVA)	Difference (S.D. - Recommended S.D.)	Saving in Fixed cost / month
Nov., 19	198.6	0.757	261.92	25.0	65500	90	118.8904	143.030	35757
Oct., 19	198.6	0.8	247.84	46.0	62000	90	112.5	135.340	33835
Aug., 19	198.6	0.924	214.58	75.0	53750	90	97.4026	117.177	29294
July, 19	198.6	0.919	215.75	78.9	54000	90	97.93254	117.817	29454
June, 19	198.6	0.861	230.28	62.1	57750	90	104.5296	125.750	31438
May, 19	198.6	0.787	251.93	55.8	63000	90	114.3583	137.572	34393
Apl., 19	198.6	0.832	238.31	65.6	59750	90	108.1731	130.137	32534
Mar., 19	198.6	0.568	349.07	28.1	87500	90	158.4507	190.619	47655
Feb., 19	198.6	0.684	289.87	20.2	72500	90	131.5789	158.291	39573
Jan., 19	198.6	0.722	274.61	19.9	68750	90	124.6537	149.956	37489
Dec., 18	198.6	0.578	343.03	9.3	86000	90	155.7093	187.321	46830
Nov., 18	198.6	0.662	299.5	14.8	75000	90	135.9517	163.548	40887
Saving in fixed cost due to change in fixed load from 198.6 kW to 90 kW in a year (Rs.)									439140

Since the supply is in LT connection. The transformer belongs to the college as told by the concerned officer. Then it is advisable to change the electrical supply from LT to HT supply i.e. 11 kV. This will reduce the energy charge by 3% per month which will be a good amount i.e. Rs. 46500 per year. (As per electrical tariff, Rebate of 3% on the Energy Charges for supply at 11kV).

For the purpose of precaution, A maximum Demand Controller (DC) can be installed at the main LT panel to avoid the maximum demand penalty. In case the running maximum demand increases, the demand controller will switch off some non-essential load like Air-conditioning load etc.and simultaneously it will also give alarm for further action.

Saving by reducing the sanctioned demand	=	439140	Rs.
Cost of Demand controller	=	40000	Rs.
No of Demand controller	=	1	No.
Total Cost of Demand controller	=	40000	Rs.
Simple Payback period	=	1.09	Month

USE OF ELECTRICITY DURING PEAK HOUR AND OFF PEAK HOUR

The applicable electricity tariff is not also based on timing of the day but it may not be applicable in case of domestic LT/ HT type connection. This will also helpful in maintaining the demand graph. It is recommended to avoid use of electrical gadget for cleaning, watering etc. during the peak hours. This type of work should be operational during the off peak hour.

1.3 POWER FACTOR

The college has installed one Automatic Power Factor controller (APFC) with capacity 125 kVAr capacitor bank i.e. 25 kVAr x 5. All the capacitors were tried to examine during the study. Details of test report are given below.

Capacitor Bank						
S. No.	Place of Installation	Capacity (kVAr)	R	Y	B	Remarks
1	Capacitor	25	29.2	29.3	29.7	OK
2	Capacitor	25	0	29.4	29.3	Recheck, tight the loose wire
3	Capacitor	25	34.3	34.4	34.1	OK
4	Capacitor	25	34.3	34.1	33.9	OK
5	Capacitor	25	34.7	34.2	34.1	OK

It is clear from the above table that all the capacitors are all right except one capacitor. It is advisable to recheck the capacitor, its contactor and connected wire. Since the load of the college is very low so it is advisable to put small capacity capacitors like 1x25 kVAr, 1 x 10 kVAr, 2 x 5kVAr, 2 x 2kVAr and 1x1kVAr in the panel. This will be helpful in fine tuning of the power factor of the system to maintain unity power factor. If the unit even maintains unity or 0.99 power factor, it will yield saving in the bill (in fixed cost) by around Rs. 92000/ year as shown below:

Months	Recommended Sanction Load (S.L.) kW	Monthly Power Factor (P.F.)	Recommended S.D. (kVA) at 90 kW on existing P.F.	Recommended to maintain unity P.F. then chargeable F.C.	Recommended to maintain 0.99 P.F. then chargeable F.C.	Difference in F.C. beetween existing P.F. - F.C. at unity P.F.)	Difference in F.C. beetween existing P.F. - F.C. at 0.99 P.F.)
Nov., 19	90	0.757	118.89	90	90.91	7223	6995
Oct., 19	90	0.8	112.50	90	90.91	5625	5398
Aug., 19	90	0.924	97.40	90	90.91	1851	1623
July, 19	90	0.919	97.93	90	90.91	1983	1756
June, 19	90	0.861	104.53	90	90.91	3632	3405
May, 19	90	0.787	114.36	90	90.91	6090	5862
Apl., 19	90	0.832	108.17	90	90.91	4543	4316
Mar., 19	90	0.568	158.45	90	90.91	17113	16885
Feb., 19	90	0.684	131.58	90	90.91	10395	10167
Jan., 19	90	0.722	124.65	90	90.91	8663	8436
Dec., 18	90	0.578	155.71	90	90.91	16427	16200
Nov., 18	90	0.662	135.95	90	90.91	11488	11261
Extra Annual saving in Fixed cost by maintaining recommended P.F. unity/ 0.99 (Rs.)						95033	92305

If the unit is providing some small capacitor (as said above) and maintaining Power Factor near to unity or 0.99 with the help of Automatic (Intelligent) Power Factor Controller (all ready installed) then its payback period would be around 7 months as given below:

Annual (Approximate) saving in Fixed cost for maintaining unity/ 0.99 P.F.	=	92305	Rs.
Cost of capacitors (Small capacity capacitor)	=	30000	Rs.
Payback Period	=	4	Months

Testing procedure of the capacitor is given below:

Good healthy capacitors should deliver 1.3 times amperage in all the three phases compared to its rating in kVAr. Thus, a 10 kVAr capacitor should deliver about 13 amps in each of the three phases. Due to development of internal faults, the capacitors get derated/ damaged in the course of time. A capacitor derated to less than 75% of its rating should be replaced. On the other hand, if there is considerable unbalance between the phases, that can be indication of possible damage of the capacitor and may be removed immediately.

1.4 DISTRIBUTION NETWORK

There is a main electrical panel installed near the DG Set. All the distribution cables are going from the main panel to all the buildings, submersible pump, street light etc. Sub panels are installed in the buildings. There is a taping on each floor from the raising mains.

During the study, it was observed that the conductor size is good according to ampere load. No any conductor was found over heated or its insulation burnt. Adequate size of conductor is going to feed the utility area. So, distribution losses are within the limit.

1.5 D G SETS

There is a DG set available in the college of capacity 82.5 kVA for in house generation of electricity. As the power supply is very good in the area so the running hour of DG set is very less.

It is advisable to put an energy meter on each DG set then it would be easy to conduct the efficiency of DG set. This way, the operator could also note down the unit generation and oil consumed. The operator may record the operating parameters of the sets in the following manner in future.

Start Time	Off Time	Diesel consumption	Unit Generated	Loading	KW Loading	Voltage	KVAh/ lit.
				R Y B	R Y B		

The mechanical details like temperature, lube oil etc. should be in addition to the above. From the above data, the management may calculate the offices generated by the DG set in an hour and total diesel consumption. The offices generated per litre of diesel consumed can hence be calculated on an hourly basis. Thereafter, the monthly figures can be calculated in the similar fashion.

It may be noted that the efficiency of the DG set depends largely on the operating load factor. The maximum efficiency of the DG set is available at about 80-85% load factor.

SECTION 2

Lights, Air-condition & Solar PV

2.1 LIGHTING

The total lighting (luminary) load of the college is about 8 kW which includes Fluorescent tubes 36w/ 40w, LED lights 12w/ 36w etc. LED lights is good from energy efficiency point of view.

LED tube lights are also available in the market, which is also good from energy efficiency point of view. Whenever 36/40w tube gets fuse (not in warranty period) then it could be replaced by 18w/ 9w LED tube. There are 20 nos of street lights which are working on solar power with battery. These lights are switched ON in the night with the help of timer.

During study, tube lights were ON in the class room and it was observed that lux level was good (240 – 320) in the class room near to window. But Lux level was down (120 – 200) near the entrance door and its wall side. It is advisable to increase some tube lights in the class room for better lux value.

2.2 Air Conditioning Load

In the Unit/ college, there are package unit of 6 x 10TR, 4 x 8.5 TR, 8 nos of cassette unit (5 x 2TR, 3 x 3TR) and 15 nos of 2 TR split units Air-conditioners to maintain comfort temperature in the Auditorium/ office etc. Package units are installed mainly for the Auditorium.

Due to the study being done in winters, the Energy efficiency assessment could not be done for the ACs. However, it was observed that some split ACs fitted in the office carries 5 star, which is good from energy efficiency point of view. It is recommended that whenever new split/ window ACs are being installed, it should be 5 star rated. Filters of package units were also checked during study which was found very clean.

Energy Consumption in star rated split office is given above for information.

S.No.	Type of Ac	Rated TR	Star	KW
1	Split	1.5	*	1.91 - 2.1
2	Split	1.5	**	1.75 - 1.9
3	Split	1.5	***	1.65 - 1.74
4	Split	1.5	****	1.55 - 1.64
5	Split	1.5	*****	1.45 - 1.54

Star rated window ACs are also available in the market. It also consumes similar power as there in split office. Proper cleaning of ACs are very important for its output performance. At least, once in two months cleaning of ACs filter is recommended during the season.

2.3 SOLAR POWER GENERATION

There is a Solar Photovoltaic (SPV) unit for Power Generation with capacity 48 kW. The SPV is connected with the LT supply with some relay/sensor which keeps senses of electrical supply. When there is electrical supply, the SPV will generate electricity. As the electrical supply goes off, the SPV will not generate any electricity. SPV will also not generate electricity when there is electrical supply of DG set.

The best use of SPV is to put all lighting, exhaust fan load, fan load etc. on it. Some intelligent relay/ sensor need to install for better management. The energy meter should also be calibrated by third party once in a year or two years. This way, the SPV will continue supply even there is utility supply available or not and it will also help in saving a substantial amount in the electricity bill. It was also observed that electrical data like daily/ weekly/ monthly units generated by SPV are not recorded in the register or in soft copy.

The SPV system should be installed along with Net metering system. For this, there is a proper format in the concerned NDMC office to install Net metering. Benefits of net metering is given below:

Advantage of Net Metering

1. Financial benefit for the system owner

Since the system owner is charged for the net energy consumed from the utility grid, the owner gets financial benefits. Eg. If energy generation < energy consumed: owner pays just for the net amount. If energy generation > energy consumed: the owner gets credit for excess generation.

2. Avoid the use of batteries

In a grid connected solar pv system, any excess energy generated can be fed back to local utility grid and can be taken back at later stage when required. Thus, there is no need to store the surplus energy in batteries for later use, thus, avoiding the heavy costs of batteries. Also, since batteries are eliminated, the maintenance costs of the system also reduce to a great extent. Batteries may be required only when there are frequent power fluctuations/outages.

3. Produce more today, use that tomorrow

If there is a surplus of power generation than the consumption, the surplus can be fed into grid system and if consumption increases, it can be taken from the grid.

Appendix - 1

General Energy Conservation Tips

Electricity

- Schedule your operations to maintain a high load factor
- Minimize maximum demand by tripping loads through a demand controller
- Use standby electric generation equipment for on-peak high load periods.
- Correct power factor to at least 0.99 under rated load conditions.
- Set transformer taps to optimum settings.
- Shut off unnecessary computers, printers, and copiers at night.

Motors

- Properly size to the load for optimum efficiency.
- (High efficiency motors offer of 4 - 5% higher efficiency than standard motors)
- Check alignment.
- Provide proper ventilation
- (For every 10°C increase in motor operating temperature over recommended peak, the motor life is estimated to be halved)
- Check for under-voltage and over-voltage conditions.
- Balance the three-phase power supply.
- (An Imbalanced voltage can reduce 3 - 5% in motor input power)
- Demand efficiency restoration after motor rewinding.

Fans

- Use smooth, well-rounded air inlet cones for fan air intakes.
- Avoid poor flow distribution at the fan inlet.
- Minimize fan inlet and outlet obstructions.
- Clean screens, filters, and fan blades regularly.
- Use aerofoil-shaped fan blades.
- Minimize fan speed.
- Use low-slip or flat belts.

- Check belt tension regularly.
- Eliminate variable pitch pulleys.
- Use variable speed drives for large variable fan loads.
- Use energy-efficient motors for continuous or near-continuous operation
- Eliminate leaks in ductwork.
- Minimize bends in ductwork
- Turn fans off when not needed.

Blowers

- Use smooth, well-rounded air inlet ducts or cones for air intakes.
- Minimize blower inlet and outlet obstructions.
- Clean screens and filters regularly.
- Minimize blower speed.
- Use low-slip or no-slip belts.
- Check belt tension regularly.
- Eliminate variable pitch pulleys.
- Use variable speed drives for large variable blower loads.
- Use energy-efficient motors for continuous or near-continuous operation.
- Eliminate ductwork leaks.
- Turn blowers off when they are not needed.

Pumps

- Operate pumping near best efficiency point.
- Modify pumping to minimize throttling.
- Adapt to wide load variation with variable speed drives or sequenced control of smaller offices.
- Stop running both pumps -- add an auto-start for an on-line spare or add a booster pump in the problem area.
- Use booster pumps for small loads requiring higher pressures.
- Increase fluid temperature differentials to reduce pumping rates.
- Repair seals and packing to minimize water waste.

- Balance the system to minimize flows and reduce pump power requirements.
- Use siphon effect to advantage: don't waste pumping head with a free-fall (gravity) return.

Chillers

- Increase the chilled water temperature set point if possible.
- Use the lowest temperature condenser water available that the chiller can handle.
- (Reducing condensing temperature by 5.5°C, results in a 20 - 25% decrease in compressor power consumption)
- Increase the evaporator temperature
- (5.5°C increase in evaporator temperature reduces compressor power consumption by 20 - 25%)
- Clean heat exchangers when fouled.
- (1 mm scale build-up on condenser tubes can increase energy consumption by 40%)
- Optimize condenser water flow rate and refrigerated water flow rate.
- Use water-cooled rather than air-cooled chiller condensers.
- Use energy-efficient motors for continuous or near-continuous operation.
- Specify appropriate fouling factors for condensers.
- Do not overcharge oil.
- Install a control system to coordinate multiple chillers.
- Study part-load characteristics and cycling costs to determine the most-efficient mode for operating multiple chillers.
- Run the chillers with the lowest operating costs to serve base load.
- Avoid over sizing - match the connected load.
- Isolate off-line chillers and cooling towers.
- Establish a chillers efficiency-maintenance program. Start with an energy audit and follow-up, then make a chillers efficiency-maintenance program a part of your continuous energy management program.

HVAC (Heating / Ventilation / Air Conditioning)

- Tune up the HVAC control system.
- Consider installing a building automation system (BAS) or energy management system (EMS) or restoring an out-of-service one.
- Balance the system to minimize flows and reduce blower/fan/pump power requirements.
- Eliminate or reduce reheat whenever possible.
- Use appropriate HVAC thermostat setback.
- Use building thermal lag to minimize HVAC equipment operating time.
- In winter during unoccupied periods, allow temperatures to fall as low as possible without freezing water lines or damaging stored materials.
- In summer during unoccupied periods, allow temperatures to rise as high as possible without damaging stored materials.
- Improve control and utilization of outside air.
- Use air-to-air heat exchangers to reduce energy requirements for heating and cooling of outside air.
- Reduce HVAC system operating hours (e.g. -- night, weekend).
- Optimize ventilation.
- Ventilate only when necessary. To allow some areas to be shut down when unoccupied, install dedicated HVAC systems on continuous loads (e.g. -- computer rooms).
- Provide dedicated outside air supply to kitchens, cleaning rooms, combustion equipment, etc. to avoid excessive exhausting of conditioned air.
- Use evaporative cooling in dry climates.
- Clean HVAC office coils periodically and comb mashed fins.
- Upgrade filter banks to reduce pressure drop and thus lower fan power requirements.
- Check HVAC filters on a schedule (at least monthly) and clean/change if appropriate.

- Check pneumatic controls air compressors for proper operation, cycling, and maintenance.
- Isolate air-conditioned loading dock areas and cool storage areas using high-speed doors or clear PVC strip curtains.
- Install ceiling fans to minimize thermal stratification in high-bay areas.
- Relocate air diffusers to optimum heights in areas with high ceilings.
- Consider reducing ceiling heights.
- Eliminate obstructions in front of radiators, baseboard heaters, etc.
- Check reflectors on infrared heaters for cleanliness and proper beam direction.
- Use professionally-designed industrial ventilation hoods for dust and vapor control.
- Use local infrared heat for personnel rather than heating the entire area.
- Use spot cooling and heating (e.g. -- use ceiling fans for personnel rather than cooling the entire area).
- Purchase only high-efficiency models for HVAC offices.
- Put HVAC window offices on timer control.
- Don't oversize cooling offices. (Oversized offices will "short cycle" which results in poor humidity control.)
- Install multi-fueling capability and run with the cheapest fuel available at the time.
- Consider dedicated make-up air for exhaust hoods. (Why exhaust the air conditioning or heat if you don't need to?)
- Minimize HVAC fan speeds.
- Consider desiccant drying of outside air to reduce cooling requirements in humid climates.
- Seal leaky HVAC ductwork.
- Seal all leaks around coils.
- Repair loose or damaged flexible connections (including those under air handling offices).
- Eliminate simultaneous heating and cooling during seasonal transition periods.

- Zone HVAC air and water systems to minimize energy use.
- Inspect, clean, lubricate, and adjust damper blades and linkages.
- Establish an HVAC efficiency-maintenance program. Start with an energy audit and follow-up, then make an HVAC efficiency-maintenance program a part of your continuous energy management program.

Lighting

- Reduce excessive illumination levels to standard levels using switching; de-lamping, etc. (Know the electrical effects before doing de-lamping.)
- Aggressively control lighting with clock timers, delay timers, photocells, and/or occupancy sensors.
- Install efficient alternatives to incandescent lighting, mercury vapour lighting, etc. Efficiency (lumens/watt) of various technologies range from best to worst approximately as follows: low pressure sodium, high-pressure sodium, metal halide, fluorescent, mercury vapour, incandescent.
- Select ballasts and lamps carefully with high power factor and long-term efficiency in mind.
- Upgrade obsolete fluorescent systems to Compact fluorescents and electronic ballasts
- Consider lowering the fixtures to enable using less of them.
- Consider day lighting, sky lights, etc.
- Consider painting the walls a lighter colour and using less lighting fixtures or lower wattages.
- Use task lighting and reduce background illumination.
- Re-evaluate exterior lighting strategy, type, and control. Control it aggressively.
- Change exit signs from incandescent to LED.

DG sets

- Optimize loading
- Use waste heat to generate steam/hot water /power an absorption chiller or preheat process or utility feeds.
- Use jacket and head cooling water for process needs

- Clean air filters regularly
- Insulate exhaust pipes to reduce DG set room temperatures
- Use cheaper heavy fuel oil for capacities more than 1MW

Buildings

- Seal exterior cracks / openings / gaps with caulk, gasketing, weather stripping, etc.
- Consider new thermal doors, thermal windows, roofing insulation, etc.
- Install windbreaks near exterior doors.
- Replace single-pane glass with insulating glass.
- Consider covering some window and skylight areas with insulated wall panels inside the building.
- If visibility is not required but light is required, consider replacing exterior windows with insulated glass block.
- Consider tinted glass, reflective glass, coatings, awnings, overhangs, draperies, blinds, and shades for sunlit exterior windows.
- Use landscaping to advantage.
- Add vestibules or revolving doors to primary exterior personnel doors.
- Consider automatic doors, air curtains, strip doors, etc. at high-traffic passages between conditioned and non-conditioned spaces. Use self-closing doors if possible.
- Use intermediate doors in stairways and vertical passages to minimize building stack effect.
- Use dock seals at shipping and receiving doors.
- Bring cleaning personnel in during the working day or as soon after as possible to minimize lighting and HVAC costs.

Water & Wastewater

- Recycle water, particularly for uses with less-critical quality requirements.
- Recycle water, especially if sewer costs are based on water consumption.
- Balance closed systems to minimize flows and reduce pump power requirements.

- Eliminate once-through cooling with water.
- Use the least expensive type of water that will satisfy the requirement.
- Fix water leaks.
- Test for underground water leaks. (It's easy to do over a holiday shutdown.)
- Check water overflow pipes for proper operating level.
- Automate blow down to minimize it.
- Provide proper tools for wash down -- especially self-closing nozzles.
- Install efficient irrigation.
- Reduce flows at water sampling stations.
- Eliminate continuous overflow at water tanks.
- Promptly repair leaking toilets and faucets.
- Use water restrictors on faucets, showers, etc.
- Use self-closing type faucets in restrooms.
- Use the lowest possible hot water temperature.
- Do not use a heating system hot water boiler to provide service hot water during the cooling season -- install a smaller, more-efficient system for the cooling season service hot water.
- If water must be heated electrically, consider accumulation in a large insulated storage tank to minimize heating at on-peak electric rates.
- Use multiple, distributed, small water heaters to minimize thermal losses in large piping systems.
- Use freeze protection valves rather than manual bleeding of lines.
- Consider leased and mobile water treatment systems, especially for deionized water.
- Seal sumps to prevent seepage inward from necessitating extra sump pump operation.
- Install pre-treatment to reduce TOC and BOD surcharges.
- Verify the water meter readings. (You'd be amazed how long a meter reading can be estimated after the meter breaks or the meter pit fills with water!)
- Verify the sewer flows if the sewer bills are based on them

Miscellaneous

- Meter any unmetered utilities to know what normal efficient use is. Track down causes of deviations.
- Shut down spare, idling, or unneeded equipment.
- Make sure that all of the utilities to redundant areas are turned off -- including utilities like compressed air and cooling water.
- Install automatic control to efficiently coordinate multiple air compressors, chillers, cooling tower cells, boilers, etc.
- Renegotiate utilities contracts to reflect current loads and variations.
- Consider buying utilities from neighbours, particularly to handle peaks.
- Leased space often has low-bid inefficient equipment. Consider upgrades if your lease will continue for several more years.
- Adjust fluid temperatures within acceptable limits to minimize undesirable heat transfer in long pipelines.
- Minimize use of flow bypasses and minimize bypass flow rates.
- Provide restriction orifices in purges (nitrogen, steam, etc.).
- Eliminate unnecessary flow measurement orifices.
- Consider alternatives to high-pressure drops across valves.
- Turn off winter heat tracing that is on in summer.

Annexure – I

List of Energy Efficient Equipments Suppliers

Product/ Equipment	Contact Details
Building Automation, sensors, twilight switches	Electro Art, Plot No K-11, MIDC Area, Ambad, Nashik –422010, Ph: 0253-5603954, 2380918 www.electronicswitchesindia.com
Capacitors and APFC Panels	Matrix Controls & Engineers Pvt Ltd., Rajeev Batra 9811624440, Rajeev@matrixcapacior.com E- 725 DSIDC, Industrial Complex, Narela, GT Road, Delhi – 110040 Ph: 01127786945 / 46 / 47 www.matrixcapacitor.com
Capacitors and APFC Panels	Standard Capacitors, B-70/43, DSIDC Complex, Lawrence road Industrial Area, Delhi –110035 Ph: 011 –27181490, 27151027 www.standardcapacitors.com
DG Synchronization, Automation and Capacitors	SGS Industrial Controls & Solutions Pvt Ltd Floor-II, Madanpur Khadar, Sarita Vihar, New Delhi. Ph 011 – 29942516, 41402992
Energy Management & Control Systems	Manaco Energy Solutions (P) Ltd., A-6, Shanti Apts.,21 & 22, 1st Cross St, TTK Road, Alwarpet, Chennai-18 , 044-42316164, www.mesco.co.in
Energy Saving products	Techmark Engineers & Consultants, K-1/28 Ground Floor, Chittaranjan Park New Delhi-110019 Telephone: 91-011-26238349, Fax : 91-011-51603925
For Air quality measurement, Flue Gas Analyzers / Oxygen Analyzer, Energy Consultacy, Power Factor controller, Demand controller, etc.	Shahi Instruments & Consultants, 1C, 20/1 krishna nagar; Opp. B4/ 211 Safdarjung Enclave New Delhi – 110 029 Telephone No 26162800, 9818397301
HVAC related instruments Thermocouples, pipe fittings, pressure gauges	Waaree , 36 Damji shamji Industrial Complex Off Mahakali caves road, Andheri East Mumbai 400093

Product/ Equipment	Contact Details
	022 –66963030 26874778 www.waaree.com
Insulations	Lloyd Insulation (India) Ltd. P.B. No. 4321, Kalkaji Industrial Area, Punj Sons Premises, New Delhi – 110 019 Ph: 26430746-7 Fax: 26478601/26467259
LED lighting	Synergy Solar (P) ltd SCO 133, sector 28D, Chandigarh Ph 0172-6451133 www.synergysolars.com
Lighting Systems	OSRAM India Ltd. Signature Towers, 11th Floor, Tower B, South City-I, Gurgaon 122001, Haryana Tel: 0124- 6526175, 6526178, 6526185 Fax: 0124- 6526184
Lighting Systems	Asian Electronics Surya Place, First Floor, K-185/1, Sarai Julena, New Friends Colony, New Delhi – 110 025
Lighting Systems	Philips India Limited , Technopolis Knowledge Park, Nelco Complex, Mahakali Caves Road, Chakala, Andheri (East), Mumbai 400 093. Tel : 022 56912000
Lighting Systems	Wipro Limited Sco 196-197, Sector 34-A, Chandigarh - 160 022
Lighting Voltage Control Systems	Jindal Electric & Machinery Corporation C-57, Focal Point, Ludhiana – 141010 Ph : 2670250 , 2676890 , www.jindalelectric.com
Soft starters	Amtech Electronics (India) Ltd E-6, GIDC Electronics Zone, Ghandinagar – 382028 , Gujarat Ph : 079 –23289101-3, www.amtechelectronics.com