ENERGY AUDIT REPORT

KAMKUS COLLEGE OF LAW

16 YEARS OF EXCELLENCE

KAMKUS COLLEGE OF LAW

JULY 2022

Audit Conducted by:

Professional Quality PQMS Management Services

PROFESSIONAL QUALITY MANAGEMENT SERVICES

SCO-21, 4th Floor, Feroze Gandhi Market Rd, Ludhiana, Punjab-141001

ACKNOWLEDGEMENT

We take the opportunity to express our deep sense of gratitude towards management and staff of Kamkus College of Law, the support and disposition of the Teaching & Supporting Staff of College for awarding the work of executing Energy Audit in Kamkus College of Law. In particular we wish to thank them for their timely initiative, advice and valuable support extended to the project.

We are also grateful for extending all sorts of help while carrying out energy audit and also for their valuable help regarding the data collection and details at various stages of the project. We are also thankful to them for providing support while conducting survey in Kamkus College of Law.

We would be failing in our duty if we do not thank our respondents, who gave their valuable time and answered the survey questions with tremendous patience and understanding.

(Mr. DEEPAK BAJPAI)
CERTIFIED ENERGY AUDITOR & CHARTERED ENGINEER

DISCLAIMER

This Energy audit report of Kamkus College of Law is prepared by Professional Quality Management Services on interest of the organization.

This report need not necessarily represent the views of building management and its employees. The building management, any employee of Kamkus College of Law or any person acting on behalf of any of them makes no warranty or representation whatsoever express or implied with respect to use of any information, process, method or similar item disclosed in this report and assumes no legal liability for the information in this report, nor does any party represent that the use of this information will not infringe upon privately owned rights.

All calculations in this report are done based on the data provided by university administration, the necessary measurements taken during the study, and the operating conditions prevailing during the study period. The accuracy of the report is subject to these limitations.

Using/Reproducing Information:

All requests to use or reproduce any part of this report should be directed to :

THE ENGINEERING & MAINTENANCE -INCHARGE
KAMKUS COLLEGE OF LAW, GHAZIABAD

TEAM MEMBER

PROJECT TEAM	NAME
Kamkus College of Law	Dr. Seema Singh
	Mr. Rajesh Srivastava
Professional Quality Management Services	Mr. Deepak Bajpai (BEE Certified -Energy Auditor)
	Mr. Vikrant Pal (Engineer-Energy Audit)
	Mr. Rajat Katiyar (Engineer-Energy Audit)

CONTENTS

ABOUT

ABOUT

1.1 PROFILE OF THE COMPANY

"Professional Quality Management Services" is an energy centric organization involved in Generation (Renewable), Measurement & Efficiency enhancement of energy. Our focus is towards greener & cleaner economy with three-dimensional approach viz. Generation of power from renewable sources, manufacturing of world class energy monitoring devices and Energy Audit Services. Our Manufacturing facilities are located in North India.

1.2 VISION & MISSION

We shall **"GENERATE", "MEASURE" & "MANAGE" the "ENERGY."**

It is evident that organization has been launched with a very thoughtfully nurture division of being the leader in a basket of High Technology Business fields with far-reaching & all-encompassing implication on the Industry, Society & Ecology. We

Shall "Generate" only "Renewable" or "Green" Energy;

Shall Design & Manufacture the most advanced, accurate & reliable "Measurement" Products & Systems for Energy & Power Sector;

Shall "Manage" the "Energy Consumption" by helping Monitor the "wastage" and/or "consumption" terms of commercial, industrial, municipal organizations; hence improve their "Energy Efficiency".

Our Vision to dedicate all our resources in 'Generation', 'Measurement' and 'Management' of 'Power & Energy' is very unique in a way that shows our deep compassion for the Society & Ecology.

The promoters have committed their organization to the business, which shall practice & advocate the tenet of "Sustainable Development" which makes us responsible & account to "Meeting the needs of the present generation without compromising the ability of future generations to meet their needs".

1.3 APPROVALS/CREDENTIALS

BEE Accredited Energy Auditors & Certified Energy Auditors/Managers (Under Ministry of Power, Govt. of India).

1.4 PRODUCTS & SERVICES

In Brief, our company operates in several business Segments: -

- Power Generation- Green Energy
-

- Consultancies & Services
- Energy Audit
- PAT Assistance
- Green Buildings
- Green audit
- Environment Audit
- Renewable energy project implementation
- Training to improve Energy Efficiency

1.5 ENERGY AUDIT & MANAGEMENT

The Objective of this division is to provide solutions for the efficient management of every form of energy. The management service begins with the energy audit process comprising of an inspection and survey of the total energy consumption in a building, process system with the end objective to reduce the amount of energy used without any negative effect. The available consumer base of this division covers a single residential consumer to the largest industrial establishment or commercial complex however the focus for now is 4 main areas.

- Commercial - Malls, Commercial Buildings etc.
- Power Plant – Energy audit of thermal power plant and captive power plant.
- Industrial – Energy intensive industrial establishments.
- Hospitality – Building and Resort complex

2 INTRODUCTION TO ENERGY AUDIT & METHODOLOGY

INTRODUCTION

2.1 OBJECTIVE OF ENERGY AUDIT IN KAMKUS COLLEGE OF LAW

- The objective of this study is to carry out investment grade audit of building followed by submission of Detailed Energy Audit Report to the building management & maintenance department. The implementation support provided is for the benefit of the building management so as to make sure that the recommended savings potential is met and monetary savings achieved to the fullest.

2.2 SCOPE OF WORK

Broadly, the following scopes are limited to the building: -

- Review of present electricity, fuel oil, fuel gas, lighting, HVAC and Water consumption.
- Review and Study of existing Electrical Distribution System, Lighting System, HVAC System, and Diesel Generator sets etc. along with respective energy conservation options.
- Review and Study of Energy Monitoring & Accounting System.
- Review of present maintenance practices.
- Cost benefits analysis of each energy conservation options.
- Preparation and submission of Detailed Energy Audit Report.

2.3 METHODOLOGY

- The study has been conducted by the Energy consultants, Auditors of Professional Quality Management Services and consists of the following components.
- Preliminary visits to each of the sub-systems to obtain an overview.
- Brief discussions with concerned executives, preparation of data collection forms/checklists instrumentation requirements, etc.
- We have used diagnostic portable instruments for power measurement, Water Flow measurement, Thermograph study, Lux meter, Infra-red and conventional temperature measurement instruments, and would also draw upon the inferences from onsite instrumentation data, etc.
- Carried at field studies in each of the sub-systems, involving performance assessment trials of Refrigeration & Air Conditioning System, vis-à-vis existing conditions. To the extent possible, trials have been conducted without disturbing normal operation of working equipment.
- Detailed analysis of field data outputs and evaluation of energy performance of equipment studied, with respect to operation efficiencies, comparison of these values with Performance Guarantee figures, or typical industry norms and establishing margins for improvements.
- Identification of Energy Conservation opportunities (ENCON).

2.4 APPROACH

The Energy Audit & Investment Grade Audit is planned in five parts:

- **Part-I: Energy Audit**
  This part involves performance assessment of the key energy consuming equipment such as A/C Machines, Fans, Deep freezers, Lighting, and all major electrical motors to establish margins for improvement.

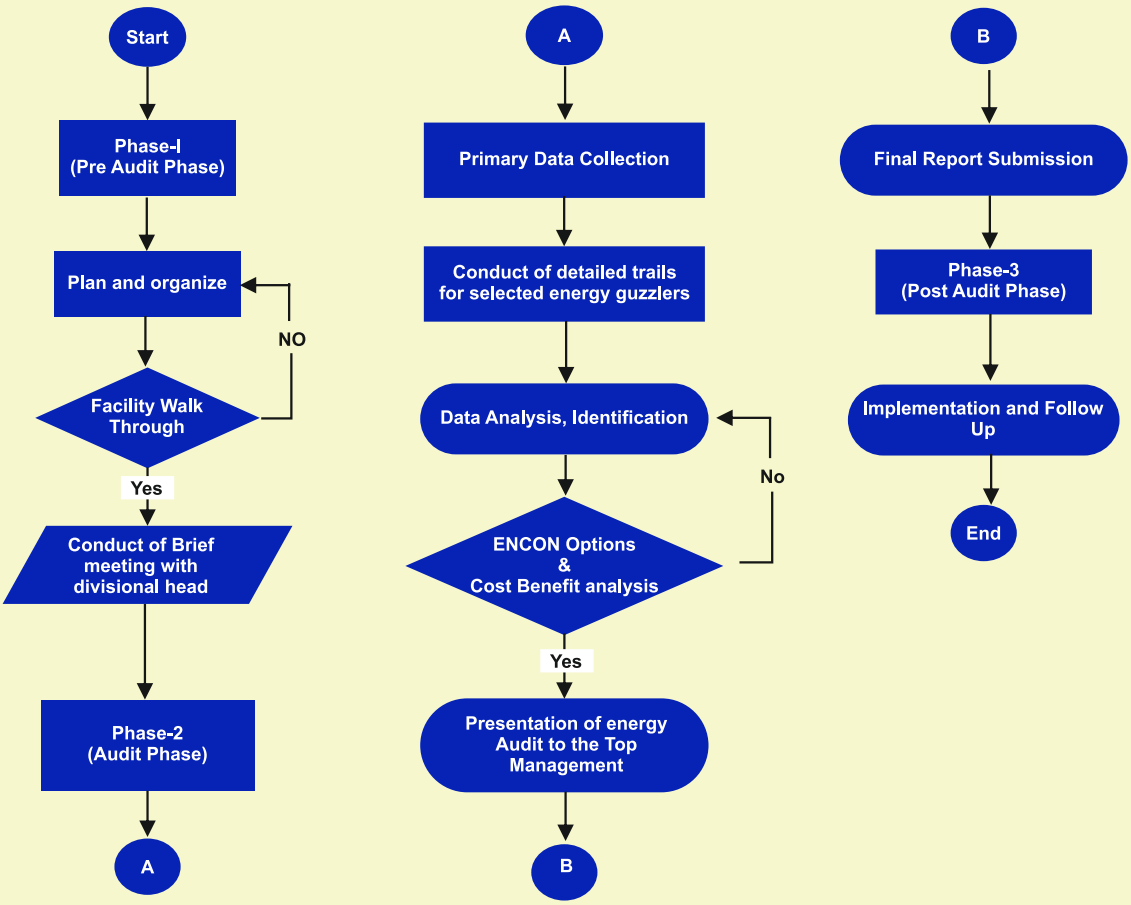
- **Part-II: Energy Conservation**
  This part as a fall out of the Energy Audit Study would involve identification of Energy Saving Measures, detailing of measure to achieve improvements in efficiency and reduction in energy Consumption, backed by operational trial data wherever possible, in-depth analysis and techno economic Feasibility reports along with relevant vendor information.

- **Part-III: Preparation of Investment Grade Proposals**
  This part involves preparation of Investment Grade proposal, based the identified Energy Conservation Options with cost benefits and vendor details.

- **Part – IV: Preparation of Draft Report**
  In this phase, the draft report would be prepared and submitted to Building Management.

- **Part – V: Final Report Submission**
  After presentation of their support and getting comments from Building Management the final report would be submitted after incorporating all the comments and suggestions.

Energy Audit Approach



Energy Audit Approach

2.5 INSTRUMENTS USED IN ENERGY AUDIT

Master List Of EA Instruments					
SR. No.	INSTRUMENTS	MODEL	INSTRUMENT NUMBER	OEM	IMAGE OF INSTRUMENTS
1.	POWER ANALYZER	ALM 30 ALM 35	00302929	KRYKARD INDIA	
2.	FLOW METER	Pt878	Pt76186 E	GE USA	
3.	THERMAL IMAGER	881-2	02214667	TESTO GERMAYNY	
4.	INFRARED THERMOMETER	62 MINI	14841880	FLUKE USA	
5.	DIGITAL THERO HYGROMETER	288 ATH	2027386	HTC CHINA	
6.	DIGITAL ANEMOMETER	AM 4201	AE.09961	LUTRON CHINA	
7.	DIGITAL LUX METER	LX 101	AE. 09143	LUTRON CHINA	
8.	DIGITAL MULTIMETER	801 AUTO	201061078	MECO INDIA	
9.	DIGITAL CLAMPMETER	DT 3150	YC-209634	Meco India	
10.	DIGITAL TDS METER	CD 610	S358236	HANNA ITALY	

Energy Audit Instruments

3 ELECTRICAL LOAD MEASUREMENT

ELECTRICAL LOAD MEASUREMENT

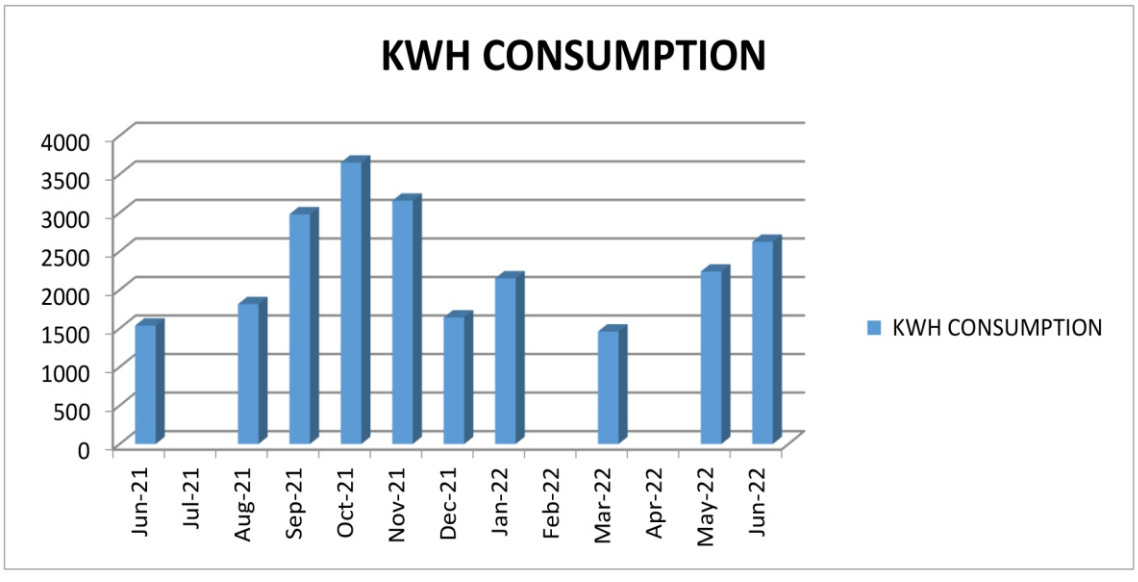
3. Electrical Load Measurement

3.1 Electricity consumption (in Units) and management of Kamkus College of Law

The energy demand of the building is fulfilled by the electricity from Grid. The annual energy consumption from electricity grid from sources no one is as follows:

MONTH	KWH CONSUMPTION	KVAH CONSUMPTION	FIXED CHARGE	ENERGY CHARGES (INR)	PF	CONTRACT DEMAND (KW)	MAX DEMAND (KVA)	BILLING DEMAND (KVA)	NET AMOUNT PAYABLE (INR)
Jun-21	1537	1566	11813.85	11714.83	0.981	35	5.96	29.17	25052
Aug-21	1815	1850	11813.85	16952.75	0.981	35	16.58	29.17	27700
Sep-21	2981	3017	11813.85	23148.71	0.988	35	18.24	29.17	37587
Oct-21	3651	3673	11813.85	28318.0	0.994	35	22.24	29.17	43143
Nov-21	3156	3227	11813.85	24803.51	0.978	35	24.44	29.17	39364
Dec-21	1641	1674	11813.85	12565.87	0.980	35	10	29.17	26210
Jan-22	2149	2213	11813.85	16813.19	0.971	35	6.86	29.17	30790
Mar-22	1459	1502	11813.85	11210.51	0.971	35	6.1	29.17	24753
May-22	2238	2279	11813.85	17333.27	0.982	35	15.96	29.17	31500
Jun-22	2623	2684	11813.85	20524.67	0.977	35	18.34	29.17	34779
Total	**23250**	**23685**		**183385.3**					**320878**
Max	**3651**	**3673**	**11813.85**	**28317.99**	**0.994**	**35**	**24.44**	**29.17**	**43143**
Min	**1459**	**1502**	**11813.85**	**11210.51**	**0.971**	**35**	**5.96**	**29.17**	**24753**

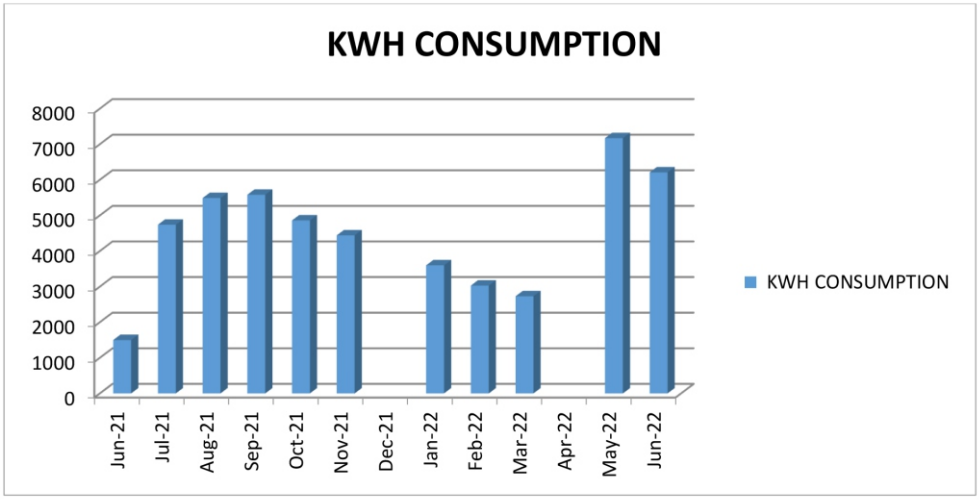
Graphical representation of KWH consumption is given below:



Energy consumption from electricity grid from sources no two is as follows:

MONTH	KWH CONSUMPTION	KVAH CONSUMPTION	FIXED CHARGE	ENERGY CHARGES (INR)	PF	CONTRACT DEMAND (KVA)	MAX DEMAND (KVA)	BILLING DEMAND (KVA)	NET AMOUNT PAYABLE (INR)
Jun-21	1500	1560	7290	11667.55	0.962	24	8.4	18	20647
Jul-21	4740	4860	8628.5	37871.88	0.975	24	21.3	18	48853
Aug-21	5490	5700	12757.5	44290.75	0.963	24	31.5	31.5	67857
Sep-21	5580	5700	11907	44290.75	0.979	24	29.4	29.4	65115
Oct-21	4860	4890	11178	37907.95	0.994	24	27.6	27.6	55904
Nov-21	4440	4560	11178	36307.55	0.974	24	27.6	27.6	52645
Jan-22	3600	3750	7290	28924.75	0.960	24	14.4	18	39254
Feb-22	3030	3180	7290	24433.15	0.953	24	11.7	18	33786
Mar-22	2730	2850	7290	21832.75	0.958	24	11.7	18	30989
May-22	7170	7350	12636	57292.75	0.976	24	31.2	31.2	81696
Jun-22	6210	6330	15673.5	49255.15	0.981	24	38.7	38.7	82598
Total	**49350**	**50730**		**394075**					**579344**
Max	**7170**	**7350**	**15673.5**	**57292.75**	**0.994**	**24**	**38.7**	**38.7**	**82598**
Min	**1500**	**1560**	**7290**	**11667.55**	**0.953**	**24**	**8.4**	**18**	**20647**

Graphical representation of KWH consumption is given below:



Lighting, pump/ motor load and HVAC are the major energy consuming components in the building, followed by diesel (very less consumption) used in DG sets.

The building utilizes various energy resources to provide best of the amenities in the management, break up of different resources is given below and this consumption of resources forms the baseline/ benchmarking of the energy use.

4 SOUND DECIBEL MONITORING

Sound db Monitoring

Sound db monitored at Kamkus College of Law site and details as under.

Sr.No	Location	Sound DB	
		Min	Max
Reception Area			
1	Waiting Area	51	56
2	Meeting Room	44	48
3	Director's Office	45	48
Basement Area			
4	Library	48	51
5	GD Room	49	53
Ground Floor			
6	Classrooms	47	55
7	Corridor Area	50	57
First Floor			
8	Classrooms	48	55
9	Staff Room	49	52
10	Library	47	53
11	Corridor Area	51	57
Second Floor			
12	Library	48	53
13	Classrooms	48	55
14	Staff Room	47	52
15	Corridor Area	51	55
16	Moot Court	50	54
Terrace Area			
17	Guest Room	48	52
18	Garden Area	48	53
19	Kitchen Area	50	55
20	Canteen	51	53
21	DG Set Area	48	52

Recommended sound level as set in CPCB- Environmental Standards - Noise (ambient standards) dB (A)

SCHEDULE

[see rule 3(1) and 4 91)]

Ambient Air Quality Standards in respect of Noise

Area Code	Category of Area / Zone	Limits in dB(A) Leq*	
		Day Time	Night Time
(A)	Industrial area	75	70
(B)	Commercial area	65	55
(C)	Residential area	55	45
(D)	Silence Zone	50	40

Note: 1. Day time shall mean from 6.00a.m. to 10.00p.m.

2. Night time shall mean from 10.00 p.m. to 6.00 a.m.

3. Silence zone is an area comprising not less than 100 metres around hospitals, educational institutions, courts religious places or any other area which is declared as such by the competent authority

4. Mixed categories of areas may be declared as one of the four above mentioned categories by the competent authority.

*dB(A) Leq denotes the time weighted average of the level of sound in decibels on scale A which is relatable to human hearing.

5 LIGHTING/ILLUMINATION SYSTEM

5.1. LUMINARY DETAILS

The building maintenance cell had already changed all the old high energy consuming light with the energy efficient LED lights.

We have measured lux area wise for the sample basis.

5.2. AREA WISE LUX LEVEL

Sr.No	Location	Lux Levels	
		Min	Max
Reception Area			
1	Waiting Area	165	180
2	Meeting Room	198	205
3	Director's Office	198	210
Basement Area			
4	Library	240	265
5	GD Room	180	205
Ground Floor			
6	Classrooms	198	210
7	Corridor Area	200	248
First Floor			
8	Classrooms	198	210
9	Staff Room	200	225
10	Library	248	280
11	Corridor Area	200	248
Second Floor			
12	Library	248	275
13	Classrooms	198	210
14	Staff Room	195	220
15	Corridor Area	200	225
16	Moot Court	180	210
Terrace Area			
17	Guest Room	160	180
18	Kitchen Area	120	150
19	Canteen	138	150
20	DG Set Area	120	148

OBSERVATIONS

- It was observed that the building has opted for the Energy-efficient lighting system i.e. LED which is good option to save energy and we personally felt good to observe it and checked whether the lux level we are getting is sufficient or not and was observed that the lux level was good.

- It was observed that the lux level in some of the areas is within limits and in some areas, it is a bit more.

RECOMMENDATION

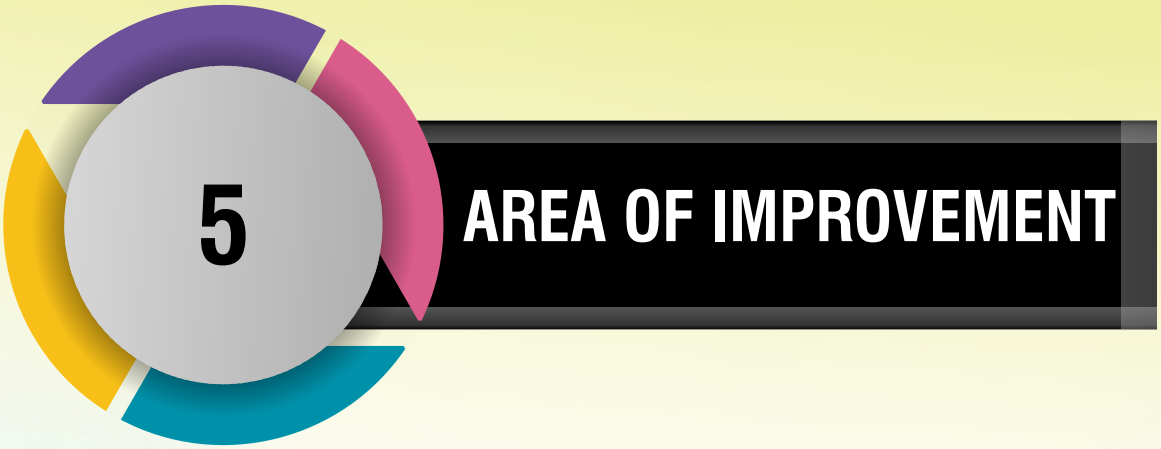
- LED lights are highly recommended as they are the best in technology available in the illumination market and will provide a good amount of energy and monetary savings since major lighting includes halogens which are the most inefficient light in the market. So please go for the led lights for the areas where it is still remaining to go for 100% LED lightings.

- LED also helps in heat load reduction since the heat dissipated by the halogens is much higher than the heat dissipated by LED lights thus intangible savings by reduction in cooling can be easily be achieved. Also, we recommend not using GLS Bulbs as they are inefficient lights and also dissipate heat increase HVAC load.

- It is recommended to install a photo sensor for all the outdoor light and also in the working floor near to the glasses envelope in the building.

- It is recommended to install occupancy sensors in Stores/office cabins and toilets to save energy.

- It is recommended to install the daylight sensor on the outdoor lights for automation and control of the lights and this will also help us reduce the unwanted running hours of the lights.


5
AREA OF IMPROVEMENT

AREA OF IMPROVEMENT

- Energy Management has become crucial to the competitors of the facility. Rising fuel costs coupled with increased global competition is forcing industries/buildings and other facilities to slash energy costs. It was aimed at obtaining a detailed idea about the various end use energy consumption activities and identifying, enumerating and evaluating the possible energy savings opportunities. However, Energy conservation is a continuous process and there is always scope for further improvements. With this objective the Energy Audit team with the active involvement of office we have identified the following Energy Conservation Opportunities (ECO's). Implementation of the ECO's can further help improve the energy consumption.

- The following energy saving/conservation measures were identified for the plant.

Table: List of Energy saving / conservation recommendations

S. No.	Recommended Measure
1.	Replace the ceiling fan with BLDC fan
2.	Replace the AC with VRV technology
3.	It is recommended to install occupancy sensor in office cabins and toilets to save energy
4.	It is recommended to install the day light sensor on the outdoor lights for automation and control of the lights and this will also help us reduce the unwanted running hours

Some Energy Saving measure already taken by Institute as listed below:

- The institute has a very clear environmental vision and trying to reduce the energy
- The institute has planted a lot of trees and has maintained very good greenery.
- The institute generates more than 50 percent of energy through solar power plant for its domestic needs.
- It was observed that the building has opted the Energy efficient lighting system that is LED which was good option to save energy and we personally felt good to observe it.
- Most of the building have sufficient day light which saves the energy in the institutes.

Ceiling Fan

- We can replace the existing ceiling fans with the energy efficient BLDC fans: Savings should be taken as when the fan is needed to be changed as when they get faulty. Saving calculation given below.

Parameters	Unit	Value
Average power consumption of the ceiling fan at present	Watt	60
Average power consumption of energy efficient star rated (BLDC) fans	Watt	28
Equivalent Power saving per fan	Watt	32
Numbers of fans to be replaced	Nos.	200
Working Hours Per annum	Hr	3500
Overall electric Power Cost	Rs/KWH	8.00
Annual Energy Saving	KWH	22400
Monetary saving	Rs/Year	179200
Investment	Rs	520000
Payback	Month	34.82

- It is recommended to replace the Institute ceiling fan with BLDC fan immediately and plan to replace the 200 fans with BLDC fan in first phase.

Variable refrigerant flow (VRF)

We can use VRF's in place of different Split and window A.C's doing so will help us to save energy up to 50% of total consumption with AC.

- Variable refrigerant flow (VRF), also known as variable refrigerant volume (VRV), is an HVAC technology invented by Daikin Industries, Ltd. in 1982. Like ductless minisplits, VRFs use refrigerant as the cooling and heating medium. This refrigerant is conditioned by one or more condensing units (which may be outdoors or indoors, water or air cooled), and is circulated within the building to multiple indoor units. VRF systems, unlike conventional chiller-based systems, allow for varying degrees of cooling in more specific areas (because there are no large air handlers, only smaller indoor units), may supply hot water in a heat recovery configuration without affecting efficiency, and switch to

heating mode (heat pump) during winter without additional equipment, all of which may allow for reduced energy consumption. Also, air handlers and large ducts are not used which can reduce the height above a dropped ceiling as well as structural impact as VRF uses smaller penetrations for refrigerant pipes instead of ducts.

- VRFs are typically installed with an air conditioner inverter which adds a DC inverter to the compressor in order to support variable motor speed and thus variable refrigerant flow rather than simply perform on/off operation. By operating at varying speeds, VRF units work only at the needed rate allowing for substantial energy savings at load conditions. Heat recovery VRF technology allows individual indoor units to heat or cool as required, while the compressor load benefits from the internal heat recovery. Energy savings of up to 55% are predicted over comparable unitary equipment. This also results in greater control of the building's interior temperature by the building's occupants.

- VRFs come in two system formats, two pipe and three pipe systems. In a heat pump two pipe system all of the zones must either be all in cooling or all in heating. Heat Recovery (HR) systems have the ability to simultaneously heat certain zones while cooling others; this is usually done through a three pipe design, with the exception of Mitsubishi, Carrier and LG whose systems are able to do this with a two pipe system using a branch circuit (BC) controller to the individual indoor evaporator zones. In this case the heat extracted from zones requiring cooling is put to use in the zones requiring heating. This is made possible because the heating unit is functioning as a condenser, providing sub-cooled liquid back into the line that is being used for cooling. While the heat recovery system has a greater initial cost, it allows for better zoned thermal control of building and overall greater efficiencies. In heat recovery VRF systems, some of the indoor units may be in cooling mode while others are in heating mode, reducing energy consumption. If the coefficient of performance in cooling mode of a system is 3, and the coefficient of performance in heating mode is 4, then heat recovery performance can reach more than 7. While it is unlikely that this balance of cooling and heating demand will happen often throughout the year, energy efficiency can be greatly improved when the scenario occurs.

- VRF systems may be air or water cooled. If air cooled, VRF condensing units are exposed to outside air and may be outdoors, and condensing units are the size of large refrigerators, since they need to contain a large condenser (heat exchanger) which has a

large surface area to transfer heat to the surrounding air, because air doesn't have a high heat capacityand has a low density, volumetric thermal capacity and thermal conductivity thus needing to transfer heat into a large amount of air volume at once. If water cooled, the condensing units are placed indoors and are much smaller and cooled with water by a closed type or circuit cooling tower or dry cooler.

7. CHECKLIST & TIPS FOR ENERGY EFFICIENCY IN ELECTRICAL UTILITIES

Electricity

- Optimise the tariff structure with utility supplier
- Schedule your operations to maintain a high load factor
- Shift loads to off-peak times if possible.
- Minimise maximum demand by tripping loads through a demand controller
- Stagger start-up times for equipment with large starting currents to minimize load peaking.
- Use standby electric generation equipment for on-peak high load periods.
- Correct power factor to at least 0.90 under rated load conditions.
- Relocate transformers close to main loads.
- Set transformer taps to optimum settings.
- Disconnect primary power to transformers that do not serve any active loads
- Consider on-site electric generation or cogeneration.
- Export power to grid if you have any surplus in your captive generation
- Check utility electric meter with your own meter.
- 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)
- Use energy-efficient motors where economical.
- Use synchronous motors to improve power factor.
- Check alignment.
- Provide proper ventilation (For every 10oC 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. (If rewinding is not done properly, the efficiency can be reduced by 5 - 8%)

Drives

- Use variable-speed drives for large variable loads.

- Use high-efficiency gear sets.
- Use precision alignment.
- Check belt tension regularly.
- Eliminate variable-pitch pulleys.
- Use flat belts as alternatives to v-belts.
- Use synthetic lubricants for large gearboxes.
- Eliminate eddy current couplings.
- Shut them off when not needed

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.
- Minimise 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 units.
- Stop running both pumps -- add an auto-start for an on-line spare or add a booster pump in the problem area.
- 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) returnmall loads requiring higher pressures.
- Increase fluid temperature differentials to reduce pumping rates.
- Repair seals and packing to minimize water waste.

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 morning pre-cooling in summer and pre-heating in winter (i.e. -- before electrical peak hours).
- 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.
- Reduce humidification or dehumidification during unoccupied periods.
- Use atomization rather than steam for humidification where possible.
- Clean HVAC unit 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 window units.
- Put HVAC window units on timer control.
- Don't oversize cooling units. (Oversized units 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.
- Consider ground source heat pumps.
- Seal leaky HVAC ductwork.

- Seal all leaks around coils.
- Repair loose or damaged flexible connections (including those under air handling units).
- 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.

Compressors

- Consider variable speed drive for variable load on positive displacement compressors.
- Use a synthetic lubricant if the compressor manufacturer permits it.
- Be sure lubricating oil temperature is not too high (oil degradation and lowered viscosity) and not too low (condensation contamination).
- Change the oil filter regularly. Periodically inspect compressor intercoolers for proper functioning.
- Use waste heat from a very large compressor to power an absorption chiller or preheat process or utility feeds.
- Establish a compressor efficiency-maintenance program. Start with an energy audit and follow-up, then make a compressor efficiency-maintenance program a part of your continuous energy management program.

Compressed Air

- Install a control system to coordinate multiple air compressors.
- Study part-load characteristics and cycling costs to determine the most-efficient mode for operating multiple air compressors.
- Avoid over sizing -- match the connected load.
- Load up modulation-controlled air compressors. (They use almost as much power at partial load as at full load.)
- Turn off the back-up air compressor until it is needed.
- Reduce air compressor discharge pressure to the lowest acceptable setting. (Reduction of 1 kg/cm2 air pressure (8 kg/cm2 to 7 kg/cm2) would result in 9% input power savings. This will also reduce compressed air leakage rates by 10%)
- Use the highest reasonable dryer dew point settings.
- Turn off refrigerated and heated air dryers when the air compressors are off.

- Use a control system to minimize heatless desiccant dryer purging.
- Minimize purges, leaks, excessive pressure drops, and condensation accumulation. (Compressed air leak from 1 mm hole size at 7 kg/cm2 pressure would mean power loss equivalent to 0.5 kW)
- Use drain controls instead of continuous air bleeds through the drains.
- Consider engine-driven or steam-driven air compression to reduce electrical demand charges.
- Replace standard v-belts with high-efficiency flat belts as the old v-belts wear out.
- Use a small air compressor when major production load is off.
- Take air compressor intake air from the coolest (but not air conditioned) location. (Every 50C reduction in intake air temperature would result in 1% reduction in compressor power consumption) Use an air-cooled aftercooler to heat building makeup air in winter.
- Be sure that heat exchangers are not fouled (e.g. -- with oil).
- Be sure that air/oil separators are not fouled.
- Monitor pressure drops across suction and discharge filters and clean or replace filters promptly upon alarm.
- Use a properly sized compressed air storage receiver. Minimize disposal costs by using lubricant that is fully demulsible and an effective oil-water separator.
- Consider alternatives to compressed air such as blowers for cooling, hydraulic rather than air cylinders, electric rather than air actuators, and electronic rather than pneumatic controls.
- Use nozzles or venturi-type devices rather than blowing with open compressed air lines.
- Check for leaking drain valves on compressed air filter/regulator sets. Certain rubber-type valves may leak continuously after they age and crack.
- In dusty environments, control packaging lines with high-intensity photocell units instead of standard units with continuous air purging of lenses and reflectors.
- Establish a compressed air efficiency-maintenance program. Start with an energy audit and followup, then make a compressed air efficiency-maintenance program a part of your continuous energy management program.

ENERGY AUDITOR CERFITIFATE

Regn No. EA-19771

Certificate No. 8890

National Productivity Council

National Productivity Council

(National Certifying Agency)

PROVISIONAL CERTIFICATE

This is to certify that Mr. / Mrs. / Ms. .....Deepak.....

son / daughter of Mr.....Vineet Kumar.....

has passed the National certification Examination for Energy Auditors held in September - 2016, conducted on behalf of the Bureau of Energy Efficiency, Ministry of Power, Government of India.

He / She is qualified as Certified Energy Manager as well as Certified Energy Auditor.

He / She shall be entitled to practice as Energy Auditor under the Energy Conservation Act 2001, subject to the fulfillment of qualifications for the Accredited Energy Auditor and issue of certificate of Accreditation by the Bureau of Energy Efficiency under the said Act.

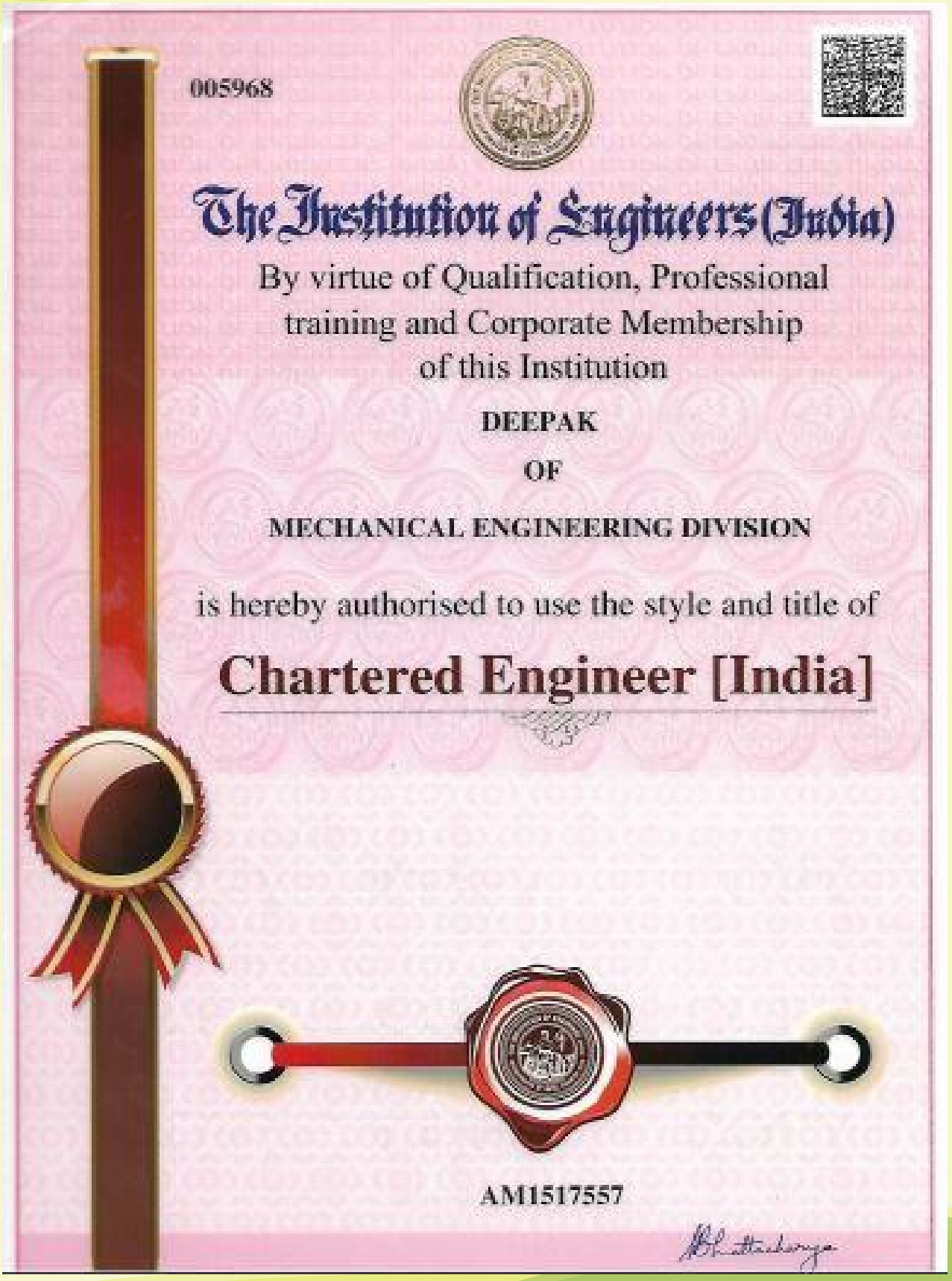
This certificate is valid till the issuance of an official certificate by the Bureau of Energy Efficiency.

Place : Chennai, India

Date : *10th March, 2017*

Controller of Examination

ENERGY AUDITOR CERFITIFATE



005968

The Institution of Engineers (India)

By virtue of Qualification, Professional training and Corporate Membership of this Institution

DEEPAK

OF

MECHANICAL ENGINEERING DIVISION

is hereby authorised to use the style and title of

Chartered Engineer [India]

AM1517557


We Encourage Students to Develop
THEIR UNIQUE QUALITIES
AND TALENTS
KAMKUS
COLLEGE
OF LAW
25 YEARS OF EXCELLENCE
www.kamkus.org