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Energy Audit: A Case Study

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ABSTRACT
Hotels are the industries that consumes large amount of energy. Now days, these industries are facing the challenges of moving towards a cleaner and most sustainable path of production to become globally competitive. There is lot to learn from the approaches adopted in advanced countries to transform industrial energy efficiency so as to meet international standards. By way of energy conservation one contributes towards greener and cleaner environment towards next generation and protection of Earth. It is essential to demonstrate the positive impacts of lower energy use in terms of increased productivity and higher profitability. Through energy audit one can easily conserve energy without affecting the production.
Keywords: Energy Audit, Energy Conservation, Load Detail, LUX Level.

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I. INTRODUCTION

Energy audit plays a vital role in understanding the energy dynamics of the building. The electrical energy is used in various forms like heating, cooling, mechanical etc. So, it is very much important to know the losses in a building. By reducing the losses we can improve our efficiency which in result affects our budget in a positive way. Therefore we can conclude that input power is the sum of losses and the output power. The losses can be minimized but cannot be excluded from the system. Energy audit is used to reduce the energy input to meet the desired output by reducing the losses.

The energy audit is conducted to find various ways through which we can reduce the losses in any system. It is very important whether it is small building or large building. The building which is under the energy audit has prime concern of human comfort and safety.

Shangri-La's - Eros Hotel, New Delhi is a parliament facing hotel within 3 km from the popular attractions like the bustling markets of Connaught Place and the Central Government Ministries including Rashtrapati Bhawan, North Block and South Block. Hotel Rooms: 320, Hotel Chain: Shangri-La Hotels & Resorts. [1]

Shangri-La's Eros consists of fourteen floor including ground floor and basements (B1, B2). All the rooms are centrally air conditioned having a main entrance lobby. The building has many facilities like central air conditioning system (can provide heating during winters for guest comfort), complex lighting, water pumping systems, water softening plant. The Shangri-La's Eros is situated under composite climatic belt as per the distribution of climatic zones decided by the code given by Bureau of Indian Standards. New Delhi experience extreme temperatures in summers and winters and moderate temperatures in other seasons.

MONTHS	MAX. TEMP. (^{0}C)	MIN. TEMP. (^{0}C)
JANUARY	21	6
FEBRUARY	22	11
MARCH	28	16
APRIL	35	23
MAY	44	25
JUNE	46	28
JULY	42	25
AUGUST	34	22
SEPTEMBER	32	20
OCTOBER	30	15
NOVEMBER	27	12
DECEMBER	23	7

II. ENERGY DATA COLLECTION

The Hotel is consuming different source of energy- Grid Electricity, Electricity from Diesel generating sets and PNG. Electricity is generally used for all electrical equipment while diesel is used to operate the diesel generator, hot water generator, PNG is used to operate the Steam Boilers and in kitchen for cooking purposes.

The Hotel is getting the power supply from NDMC power limited through 11KV line from HANUMAN LANE and NDMC LINE which directly

feeds into three 1250 KVA transformer further step down voltage from 11KV to 415V.

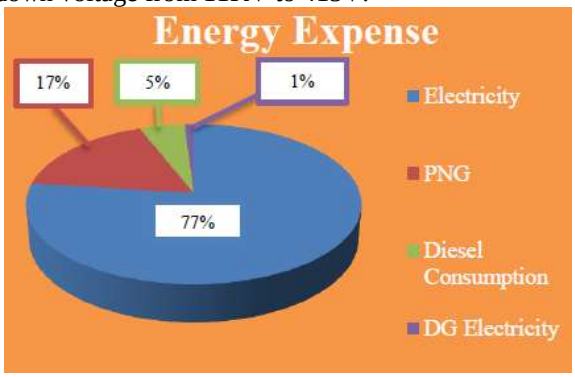

Fig 2. Energy Expense in Hotel

Lighting, pump, motor load and HVAC are the major energy consuming components in hotel, followed by PNG and diesel used in boilers. The Hotel utilizes various energy resources to provide best of its amenities in the hospitality industry. The figure below shows the breakup percentage load of the hotel and gives us idea of major energy consuming areas.

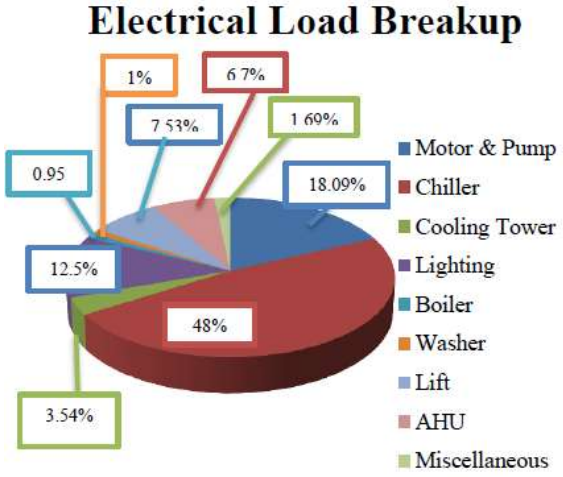

Fig 3. Electrical Load Break-up

Hotel falls under the Non-Domestic [HT] Tariff category. The contract maximum demand is 2500 KVA; hotel is getting a bill for Energy consumption at RS7.15/KVAH. The fixed charges are applicable on their contract demand. The below table shows electric consumption trend:

For the year 2015-2016			
Month	Total unit (KWH)	Amount	Avg. price (Rs./ KWH)
Jul-2015	848288.5	7592182	8.95
Aug-2015	847244	7294771	8.61
Sept-2015	772677	6699110	8.67
Oct-2015	780986	6599332	8.45
Nov-2015	665064	5666345	8.52
Dec-2015	599282	5123861	8.55
Jan-2016	601800	5169462	8.59
Feb-2016	620756	5518521	8.89
Mar-2016	727137	6340635	8.72
Apr-2016	745924	6668561	8.94
May-2016	800716	7214451	9.01
Jun-2016	781450.5	7017425	8.98
Total	8791343	76904656	8.74

The month wise consumption of Electricity units and DG units are shown above. The trend shows the energy consumption based on seasonal variation and hotel occupancy.

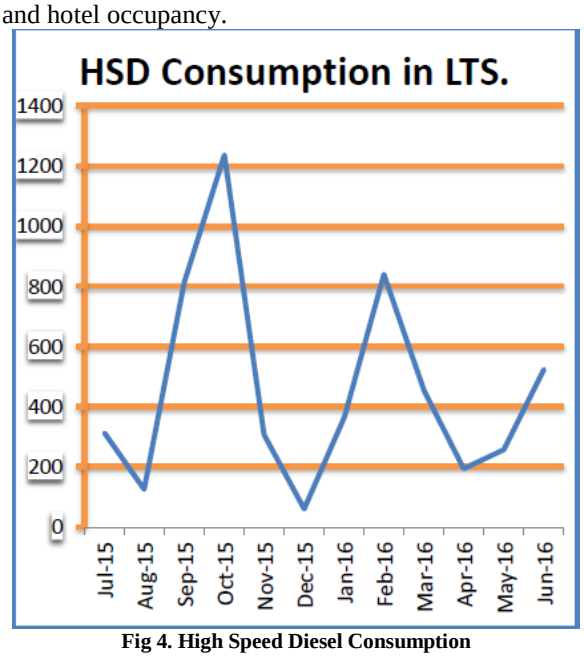

Fig 4. High Speed Diesel Consumption

There are three hot water generators Make Thermax 600,000 kcal each and three steam generators Make Thermax 850 Kg/Hr., 672 Kg/Hr. X 2Nos. The hot water generator and steam generator were PNG and diesel fired also the switching of fuels in both the HWG and SB was as per requirement. At present scenario, HWG and SB are using PNG as primary fuel. It was observed that the facility has the solar water heater of 10 KL capacity on their roof to cater hot water requirement along with the hot water generator. The table shows PNG consumption trend for the year 2015-2016:

For the year 2015-2016	
Month	Total unit (SCM)
Jul-2015	41153
Aug-2015	39759
Sept-2015	37887
Oct-2015	45244

Nov-2015	45993
Dec-2015	52003
Jan-2016	49791
Feb-2016	47166
Mar-2016	45456
Apr-2016	41570
May-2016	40561
Jun-2016	34226
Total	520809

It is suggested to have all the measuring and monitoring system as per standard. A proper maintenance and hot water cleaning schedule is maintained so that efficiency does not go down and for the long life of the system. It is recommended for proper maintenance of the solar water heater to maintain their working efficiency and life of the system.

III. ELECTRIC LOAD DISTRIBUTION

3.1 PUBLIC AREA LUMINARY DETAILS

The total connected lighting load for public areas, back of the house and banquets are 155.433 KW. By replacing the higher wattage lights with the more energy efficient lights, will result in the reduction of 95 KW of lighting load. The below table represents lighting load for different areas in hotel:

S.NO	Description	Area in Sq. Ft	12 Volts 50 Watt	75 / 80 /120 Watt	13 Watt CFL	Total Watt
1	SPA RECEPTION	1840	8		9	517
2	GYM	1474			58	754
3	YOGA ROOM	650			13	169
4	SHIRODHARA	263			2	26
5	BEAUTY PARLOR	812			14	182
6	MEN'S SALON	314			6	18
7	GENT'S CHANGING ROOM	2250	5		15	445
8	LADIES CHANGING ROOM	1755	2		16	308
9	CAR PARKING AREA BASEMENT	15424				1296
10	ALFRESCO	2890	7			350
11	CAFÉ UNO	55	119	36*		8830
		00		80W		
12	ISLAND BAR	3200	66			3300
13	LOBBY LOUNGE	1800	53			2694
14	LOBBY	3152	3	64*75W		4950
15	RECEPTION	522	80	12*75W		4900
16	LOBBY CHANDELIER					3750
17	RM OFFICE					72
18	SERVICE CENTRE					182
19	MAIN PORCH	3900			256	4288
20	CAFÉ KITCHEN					1104
21	CAFÉ SHOW KIT		24			1600
22	LOBBY TOILET GENTS		12			84
23	GANGA	2379		75*80W		6000
24	YAMUNA	1357		48*80W		6840
25	VYAS	1357		50*80W		7000
26	TAPTI	1384		50*80W		6450
27	PRE FUNCTION AREA	1638		20*80W		7850
28	LADIES REST ROOM	484		12*80W	4	1076
29	GENTS REST ROOM	484	12		4	692
30	MEETING ROOM 1	970	5	27*75W 1*120W		2145
31	MEETING ROOM 2	395	16	12*75W		900
32	MEETING ROOM 3	430	10	11*75W		825
33	BUSINESS CENTRE	430	43	11*75W 1*120		3698
34	CHINESE SECTION		16	72*75W		5150
35	JAPNESE SECTION		10	84*75W		6800
36	THAI SECTION		17	58*75W		5950
37	HORIZON CLUB	1500	135			6858
38	LOBBY FUCTION FLOOR		14	46*80W		7380
Total wattage in KW						**115.43 WATT**

The below table represent the comparison of Installed Bulbs with the Led Bulbs.

Qty.	Installed Bulb	Price (Rs. /Pcs.)	Watt	L.E.D Bulb	Price (Rs. /Pcs.)	Watt
643	12 volt / 50 watt Halogen	150	50 w	5 watt LED MR16	470	5 w
337	80 watt Incandescent	60	80 w	9.5 watt LED MR16	699	9.5 w
351	75 watt Incandescent	50	75 w	9.5 watt LED MR16	699	9.5 w
2	120 watt Incandescent	80	120 w	9.5 watt LED MR16	699	9.5 w
397	Pin type CFL	100	13 w	Plug light LED pin type	700	7 w
200	4 feet T5 Tube-light 36 watt with fitting	1200	36 w	20 watt LED Batten	1250	20 w

Investment for installing LED lighting = (643x470) + (337x699) + (351x699) + (2x699) + (200x1250) = Rs. 1312420 /-
Let average working hours be 8 hrs.
Total consumption for year with Incandescent Bulb:
Quantity x Wattage x Running Hours x 365 (year) x 8.71.
Where 8.71 is the multiplication factor.
Total 12volt/ 50 watt Halogen bulb = 643 Nos.
Wattage: 643x50 = 32.15 KW
Total 75 watt incandescent bulb = 351 Nos.
Wattage: 351x75 = 26.325 KW
Total 80 watt Incandescent bulb = 337 Nos.
Wattage: 337x80 = 26.96 KW
Total 120 watt incandescent bulb = 2 Nos.
Wattage: 120x2 = 0.240 KW
Total 13 watt CFL bulb = 397 Nos.
Wattage: 397x13 = 5.161 KW
Total 36 watt T5 tube-light = 200 Nos.
Wattage: 200x36 = 7.2 KW
Therefore, Total Consumption:
(32.15+26.325+26.96+0.240+5.161+7.2) x 8 x 365 x 8.71 = Rs. 2493369 /-

Total consumption for year with LED Bulb:
Wattage for 5 watt MR 16= 643 x 5 = 3.215 KW.
Wattage for 9.5 watt MR 16 = 690 x 9.5 = 6.555 KW.
Wattage for 7 watt plug type LED 4 pin = 397x7 = 2.78 KW.
Wattage for T5 LED Batten = 200x20 = 4 KW.
Therefore, Total Consumption:
(3.215+6.555+2.78+4) x 8 x 365 x 8.71=
Rs. 420919.5 /-

Total Saving = 2493369 – 420919.5 = 2072449.5 /-
Payback Period = Total Investment for installing LED Lighting / Total Saving = 1312420 / 2072449.5
Payback Period = 0.63 year.

3.2 GUEST ROOM LIGHTNG DETAILS

It was observed that most of the lighting load was provided by the Halogens. Lighting in corridors and stairs was switched on continuously for at least 14 hours, irrespective of any movement of guests in the aforesaid areas.

Room Lighting				
	Type	**Watt**	**QTY.**	**Total Watt**
Bed side light	CFL	8W	2	16W
Bed side ceiling light	Halogen 12v/50w	50W	2	100W
Standing Lamp	CFL	8W	1	8W
Bed room Ceiling light	Halogen 12v/50w	50W	2	10W
Vestibule light	Halogen 12v/50w	50W	1	50W
Mini Bar above spot light	Halogen 12v/50w	50W	1	50W
Word robe Light	CFL	8W	1	8W
vanity Counter light	CFL	8W	2	16W
Bath room Ceiling light	Halogen 12v/50w	50W	2	100W
Bath room Ceiling light	CFL	10W	1	10W
Mini Bar light	Pigmy bulb	15W	1	15W
Night Lamp	LED bulb	4W	3	12W
Trap door Light	Incandescent bulb	60W	1	60W
Total Wattage				**545 Watt**

POWER LOAD			
	Watt	**QTY.**	**Total Watt**
Minibar	90W	1	90W
Iron	1380W	1	1380W
FCU	27W	1	27W
Total Wattage			**1497 Watt**

CORRIDOR LOAD				
	Type	**Watt**	**QTY.**	**Total Watt**
Guest landing Spot light	Halogen 12v/50w	50w	6	300W
Corridor light	CFL	8w	8	64W
service Landing light	PL	10w	4	40W
Centre light in corridor	PL	10w	10	100W
Guest room Entrance Light	PL	10w	10	100W
Total Wattage				**604 Watt**

Led lights are highly recommended as they are the best in technology available in the illumination market and will provide good amount of energy and monetary savings since major lighting includes halogens which are the most inefficient light in the market. LED's also help 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. Occupancy sensors are also recommended for the corridors and other less frequently used spaces to reduce the energy bill. The CIBSE (Chartered Institute of Building Services Engineers) produces a code for interior lighting which gives lighting requirements for area and accounting cell for achieving desired energy saving. A sample is given below:

IL luminance (LUX)	Activity	Area
110	Casual seeing	Corridors, changing room, stores.
150	Some perception of detail	Loading bays, switch rooms, plant rooms.
200	Continuously occupied	Foyers, entrance halls, dining rooms
300	Visual tasks moderately easy	Libraries, sports halls, lecture theatres.
500	Visual tasks moderately difficult	General offices, kitchens, laboratories, retail shops.
750	Visual tasks difficult	Drawing offices, meat inspection, chain stores.
1000	Visual tasks very difficult	General inspection, electronic assembly, paintwork, supermarkets.
1500	Visual tasks extremely difficult	Fine work and inspection, precision assembly.
2000	Visual task exceptionally difficult	Assembly of minute items, finished fabric inspection.

3.3 HEAVY EQUIPMENT LOAD DETAILS

HEAVY EQUIPEMENT ELECTRICAL LOAD DETAIL						
S. No	Description	Rating (KW)	R/H	Kwh.	Rate/ Unit	Cost / Hr.
	HVAC					
1	Chiller no 1 (450 Tr.)	402	1	402	8.56	3441
2	Chiller no 2 (550 Tr.)	364	1	364	8.56	3116
3	Chiller no 3 (550 Tr.)	288	1	288	8.56	2465
4	Lobby Lounge - Mister Chai	5.5	1	5.5	8.56	47.08
5	Lobby Reception	5.5	1	5.5	8.56	47.08
6	Bell Desk	5.5	1	5.5	8.56	47.08
7	Gym A.H.U U/Basement	5.5	1	5.5	8.56	47.08
8	Health Club Reception	5.5	1	5.5	8.56	47.08
9	Pre-Function	5.5	1	5.5	8.56	47.08
10	Yamuna	3.7	1	3.7	8.56	31.672
11	Vyas A.H.U	3.7	1	3.7	8.56	31.672
12	Ganga A.H.U.	5.5	1	5.5	8.56	47.08
13	Guest Floor Toilet Exhaust Awing 2 NOS (3.5 Kw Each)	7.4	1	7.4	8.56	63.344
14	Guest Floor Toilet Exhaust B. Wing 2 NOS (3.5 Kw Each)	7.4	1	7.4	8.56	63.344
15	Tapti A.H.U	3.7	1	3.7	8.56	31.672
16	Lift side Pre-Function	5.5	1	5.5	8.56	47.08
17	Meeting Room - 1	2.2	1	2.2	8.56	18.832
18	Meeting Room - 2&3	1.1	1	1.1	8.56	9.416
19	Business center	0.75	1	0.75	8.56	6.42
20	Lift machine room	3.7	1	3.7	8.56	31.672
21	Horizon Club	3.7	1	3.7	8.56	31.672

22	Accounts	2.2	1	2.2	8.56	18.832
23	Sales & Marketing	2.2	1	2.2	8.56	18.832
24	Santushti AHU	3.7	1	3.7	8.56	31.672
25	Shopping Arcade AHU	2.2	1	2.2	8.56	18.832
26	Santushti air washer	7.5	1	7.5	8.56	64.2
27	Santushti Exhaust	7.5	1	7.5	8.56	64.2
28	Laundry Exhaust	15	1	15	8.56	128.4
29	Laundry Air Washer	11	1	11	8.56	94.16
30	Laundry TFA	3.7	1	3.7	8.56	31.672
31	Laundry TFA IN SIDE	2.2	1	2.2	8.56	18.832
32	Lower basement air washer	3.7	1	3.7	8.56	31.672
33	Lower basements Exhaust	3.7	1	3.7	8.56	31.672
34	D.G Exhaust 3NOS (11 KW each x 3)	33	1	33	8.56	282.48
35	D.G Fresh Air 2NOS (11 KW each x 2)	22	1	22	8.56	188.32
36	Plant Room Exhaust 2NOS (11 KW each x 2)	22	1	22	8.56	188.32
37	Plant Room Fresh Air	11	1	11	8.56	94.16
38	Upper Basement Exhaust	3.7	1	3.7	8.56	31.672
39	Car Parking Exhaust 2NOS (11 KW each x 2)	22	1	22	8.56	188.32
40	Banquet Air Washer	5.5	1	5.5	8.56	47.08
41	Banquet kit. Exhaust	11	1	11	8.56	94.16
42	Banquet Kit. TFA	2.2	1	2.2	8.56	18.832
43	Guest Floor TFA Each Floor(2.2 Kw Each x 16)	35.2	1	35.2	8.56	301.31
	Laundry					
41	Air Compressor	7.5	1	7.5	8.56	64.2
42	Air Compressor	3.75	1	3.75	8.56	32.1
43	Air Compressor	2.25	1	2.25	8.56	19.26
44	Air Compressor(10 HP)	7.5	1	7.5	8.56	64.2
45	Air Compressor(5 HP)	3.7	1	3.7	8.56	31.672
46	Air Compressor(3 HP)	2.24	1	2.24	8.56	19.1744
47	Unimac washer-1	3.7	1	3.7	8.56	31.672
48	Unimac washer-2	3.7	1	3.7	8.56	31.672
49	Unimac washer-3	5	1	5	8.56	42.8
50	Milnor washer-1	7.5	1	7.5	8.56	64.2
51	Milnor washer-2	7.5	1	7.5	8.56	64.2
52	Milnor washer-3	7.5	1	7.5	8.56	64.2
53	D C Machine	6	1	6	8.56	51.36
54	Dryer-1	2	1	2	8.56	17.12
55	Dryer-2	2	1	2	8.56	17.12
56	Dryer-1	3	1	3	8.56	25.68
57	Dryer-2	3	1	3	8.56	25.68
58	Flat work Ironer	15	1	15	8.56	128.4
59	Flat work folder	3.1	1	3.1	8.56	26.536
60	Cuff & Collar	0.5	1	0.5	8.56	4.28
61	Cotton Press(Mushroom)	0.5	1	0.5	8.56	4.28
62	Cotton Press(Hot head)	0.5	1	0.5	8.56	4.28
63	Steam Press-1	0.5	1	0.5	8.56	4.28
64	Steam Press 2 (Mushroom)	0.5	1	0.5	8.56	4.28
65	Steam Press-3(Flat)	0.5	1	0.5	8.56	4.28
66	Shirt Cabinet	0.5	1	0.5	8.56	4.28
67	Domestic washing m/c	0.75	1	0.75	8.56	6.42
68	Domestic Dryer	1.75	1	1.75	8.56	14.98
	Tamra					
69	320 Kg Ice Cube machine	1.6	1	1.6	8.56	13.696
70	Hot case Stand	2	1	2	8.56	17.12
71	Water Boiler	3.2	1	3.2	8.56	27.392
72	Food Warmer	6	1	6	8.56	51.36
73	Electric salamander Vario With	3.3	1	3.3	8.56	28.248

	Pressure Switch					
74	Spreader Plate with Rear splash	4	1	4	8.56	34.24
75	Electric griddle plate	7.2	1	7.2	8.56	61.632
76	Electric range with 4 zone hob e/electric oven	21.4	1	21.4	8.56	183.18
77	Electric range with 4 zone hob e/electric oven	16	1	16	8.56	136.96
78	Electric induction range	25.4	1	25.4	8.56	217.42
79	Deep fat fryer	12	1	12	8.56	102.72
80	Water pipe & faucet cooking suite	1.5	1	1.5	8.56	12.84
81	Four burner range	1.5	1	1.5	8.56	12.84
82	Tilting kettle with faucet 150 liter	26	1	26	8.56	222.56
83	Tilting braising pan	14.6	1	14.6	8.56	124.97
84	knife sterilizer	0.1	1	0.1	8.56	0.856
85	Stick Blender	0.7	1	0.7	8.56	5.992
86	knife sterilizer	0.1	1	0.1	8.56	0.856
87	Food Cutter with 18"stainsteel bowl	0.75	1	0.75	8.56	6.42
88	Food Processor	0.55	1	0.55	8.56	4.708
89	Slicer	0.37	1	0.37	8.56	3.1672
90	Automatic veg juicer	0.7	1	0.7	8.56	5.992
91	Slicer	0.37	1	0.37	8.56	3.1672
92	Food Processor	1.4	1	1.4	8.56	11.984
93	Dualit Toaster 54 slot	2	1	2	8.56	17.12
94	Waffle baker	2.2	1	2.2	8.56	18.832
95	Panini Grill	5	1	5	8.56	42.8
96	Knife sterilizer	0.1	1	0.1	8.56	0.856
97	Automatic veg juicer	0.7	1	0.7	8.56	5.992
98	Food Warmer	1	1	1	8.56	8.56
99	Bar Blender	0.37	1	0.37	8.56	3.1672
100	Drink Mixer	0.37	1	0.37	8.56	3.1672
101	Retractable Heat lamps Ceiling Hung	3.42	1	3.42	8.56	29.2752
102	Drop in induction	10	1	10	8.56	85.6
	warming plate					
103	Sneeze guard	1.75	1	1.75	8.56	14.98
104	Drop in cold & hot plate	2.34	1	2.34	8.56	20.0304
105	Drop in soup & noodle boiler	3.3	1	3.3	8.56	28.248
106	Glass froster	0.37	1	0.37	8.56	3.1672
107	Single keg draught beer dispenser with wheel	0.6	1	0.6	8.56	5.136
108	Drink Mixer	0.37	1	0.37	8.56	3.1672
109	Induction warming plate with generator	0.45	1	0.45	8.56	3.852
110	2 deck baking oven with & steam hood	11.7	1	11.7	8.56	100.15
111	Crepe Machine	3.4	1	3.4	8.56	29.104
112	Wall mounted salamander	4.5	1	4.5	8.56	38.52
113	One piece top	0	1	0	8.56	0
114	Drop in induction plate	21	1	21	8.56	179.76
115	Drop in induction warming plate	10	1	10	8.56	85.6
116	Spreader plate with tilting waste bin		1	0	8.56	0
117	Spreader Plate		1	0	8.56	0
118	Electric chargrill	7	1	7	8.56	59.92
119	Electric griddle plate	7.3	1	7.3	8.56	62.488
120	Electric induction range with electric oven	18.55	1	18.5	8.56	158.78
121	Electric induction Plate	14	1	14	8.56	119.84
122	Sneeze guard	1.75	1	1.75	8.56	14.98
123	Veg Juicer	0.7	1	0.7	8.56	5.992
124	Sneeze guard		1	0	8.56	0
125	Drawer type Freezer	1.2	1	1.2	8.56	10.272
126	Display Ice Cream cabinet	1	1	1	8.56	8.56
	Bakery					
127	Kitchen add mixture	1	1	1	8.56	8.56
128	Wipe cream	1.5	1	1.5	8.56	12.84
129	Microwave	1.25	1	1.25	8.56	10.7
130	under counter	1	1	1	8.56	8.56
131	Deep Freezer	0.21	1	0.21	8.56	1.7976
132	Rolling	1	1	1	8.56	8.56

	Machine					
133	Proving chamber	2	1	2	8.56	17.12
134	Oven	43	1	43	8.56	368.08
135	Bread slicer	0.8	1	0.8	8.56	6.848
	Health Club					
136	Steam Generator (21 Kw*4)	84	1	84	8.56	719.04
TOTAL				1892		16199

IV. ENERGY CONSERVATION TIPS

4.1 ELECTRICITY DISTRIBUTION SYSTEM [2]

- Optimize the tariff structure with utility supplier.
- Schedule operations to maintain a high load factor.
- Shift load to off peak times if possible.
- Correct power factor to at least 0.90 under rated load condition.
- Check utility electric meter with your own meter.
- Shut-off unnecessary computers, printers and copiers at night.

4.2 MOTORS [2]

- Properly size to the load for optimum efficiency. (high efficiency motors offer of 4-5% higher efficiency than standard motor)
- Use energy efficient motor where economical
- Use synchronous motor to improve power factor.
- Check alignment.
- Check for under-voltage and over-voltage condition.
- Balanced three phase. (an unbalanced voltage can reduce 3-5% in motor input power)

4.3 CHILLERS [2]

- Increase the chilled water temperature set point if possible.
- Use the lowest water temperature of condenser available that the chiller can handle. (reducing condensing temperature by 5.5^0C, results in a 20-25% decrease in power consumption)
- Increase the evaporator temperature. (5.5^0C increase in evaporator temperature reduces compressor power consumption by 20-25%)
- Clean heat exchanger when fouled. (1 mm scale build-up condenser tubes can increase energy consumption by 40%)

4.4 COOLING TOWER [2]

- Control cooling tower fans based on leaving water temperature.
- Use two speed or variable speed drives for cooling tower fan control if the fans are few. Stage the cooling tower fans with on-off control if there are many.
- Turn off unnecessary cooling tower fans when loads are reduced.
- Cover hot water basin to minimize algae growth that contributes to fouling.
- Balance flow to cooling tower hot water basin.
- Periodically clean plugged cooling tower water distribution nozzle.
- Install new nozzles to obtain a more-uniform water pattern.
- Re-line leaking cooling tower cold water basin.

4.5 LIGHTING [2]

- Reduce excessive illumination levels to standard levels using switches, dimmers etc.
- Control lighting with clock timers, delay timers, photocells and occupancy timers.
- Select ballasts and lamps carefully with high power factor and long term efficiency in mind.
- Consider the painting the walls with lighter color and using less lighting fixtures or lower wattages.
- Consider day lighting, skylights etc.

4.6 DG SETS [2]

- 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 properly.
- Insulate exhaust pipes to reduce DG se room temperature.
- Use cheaper heavy fuel oil for capacities more than 1MW.

4.7 INSULATION [2]

- Repair damage insulation. (A bare steam pipe of 150mm diameter and 100m length, carrying saturated steam at 8kg/cm^2 would waste 25000 liters of furnace oil in a year)
- Infrared gun to check for cold wall areas during cold weather or hot wall areas during weather.
- Ensure that all insulted surfaces are cladded with aluminum.
- Insulate all flanges, valves and coupling.
- Insulate open tanks. (70% heat losses can be reduced by floating a layer of 45mm diameter polypropylene plastic balls on the surface of 90^0C hot liquid/condensate)
- Insulate any hot or cold metal.
- Replace wet insulation.
- Use

V. SUGGESTION FOR WATER CONSERVATION

5.1 KITCHEN [2]

- Install a low-flow faucet aerator, which can cut water use in half.
- Soak pots and pans before washing. When washing dishes by hand, fill one sink or basin with soapy water.

- Fill the basin or a pan with water to wash fruits and vegetables.
- Keep a pitcher of water in the refrigerator rather than running tap water until it is cool enough to drink.
- When buying a new dishwasher, consider purchasing a water-saving model. Newer models can cut water use by 25 % and are no more expensive than non-conserving models.
- Wash only full loads in the dishwasher.

5.2 BATHROOM [2]

- Bathrooms use accounts for 65% of the water used inside the home.
- Check regularly for any leaks and fix them. Most common bathroom leaks are found in faucets and in and around toilets.
- Replace older, larger-use toilets with the newer ultra-low flush models. Standard toilets manufactured prior to the 1980's usually require 15 to 20 litres per flush. Toilets sold during the 80's and early 90's use 13 litres per flush.
- Do not use the toilet to dispose of paper, facial tissues, or cigarettes.
- Take a five minutes shower.
- Use the minimum amount of water needed for a bath by closing the drain and filling the tub 1\3 full.
- Install a low flow shower head. It can save about half the amount of water you typically uses in the shower, while still providing a refreshing, cleaning shower.
- Turn the tap water off while brushing your teeth, shaving or washing your face.
- If the toilet flush handle frequently sticks in the flush position, letting water run constantly, replace or adjust it.

5.3 LAUNDRY [2]

- When buying a new clothes washer, consider purchasing a water-saving model. New horizontal axis models can save up to 40% of the water used by a conventional model. Check with your municipality to see if they provide rebates on the purchase of water-saving clothes washer.
- Wash only full loads in the clothes washer.
- Insulate your water pipes. You'll get hot water faster plus avoid washing water while it heats up.

VI. CONCLUSION

As we know that for any building: - workers, raw material and energy are the three basic requirements. Out of which we can only reduce energy consumption without hampering the output. This can only be achieved through the process of energy audit. Energy Audit is a simple process through which short and long term savings can be achieved. Now days Hotels are investing huge amount of money on audits so that wastage can be prevented and long term saving can be achieved.

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