Energy Audit
at
Whispering Palms, Goa

6th June, 2009

Objectives of Energy Audit

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- ✓ To study the present pattern of energy consumption
- ✓ Examination and evaluation of energy efficiency of major energy consuming systems, processes and equipments
- ✓ Identify the potential areas for energy optimization
- ✓ Indication of process management inefficiencies with negative impact on energy consumption
- ✓ To recommend energy conservation proposals with cost benefit analysis

Analysis of Situation – Data Collection & Measurements

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Major instruments used for energy audit

- ✓ 3 phase power quality analyser
- ✓ Single phase power analyser
- ✓ Flue gas analyser
- ✓Contact type temperature indicators
- ✓ Infra-red non contact temperature indicator
- ✓ Ultrasonic flow meter

Our Approach

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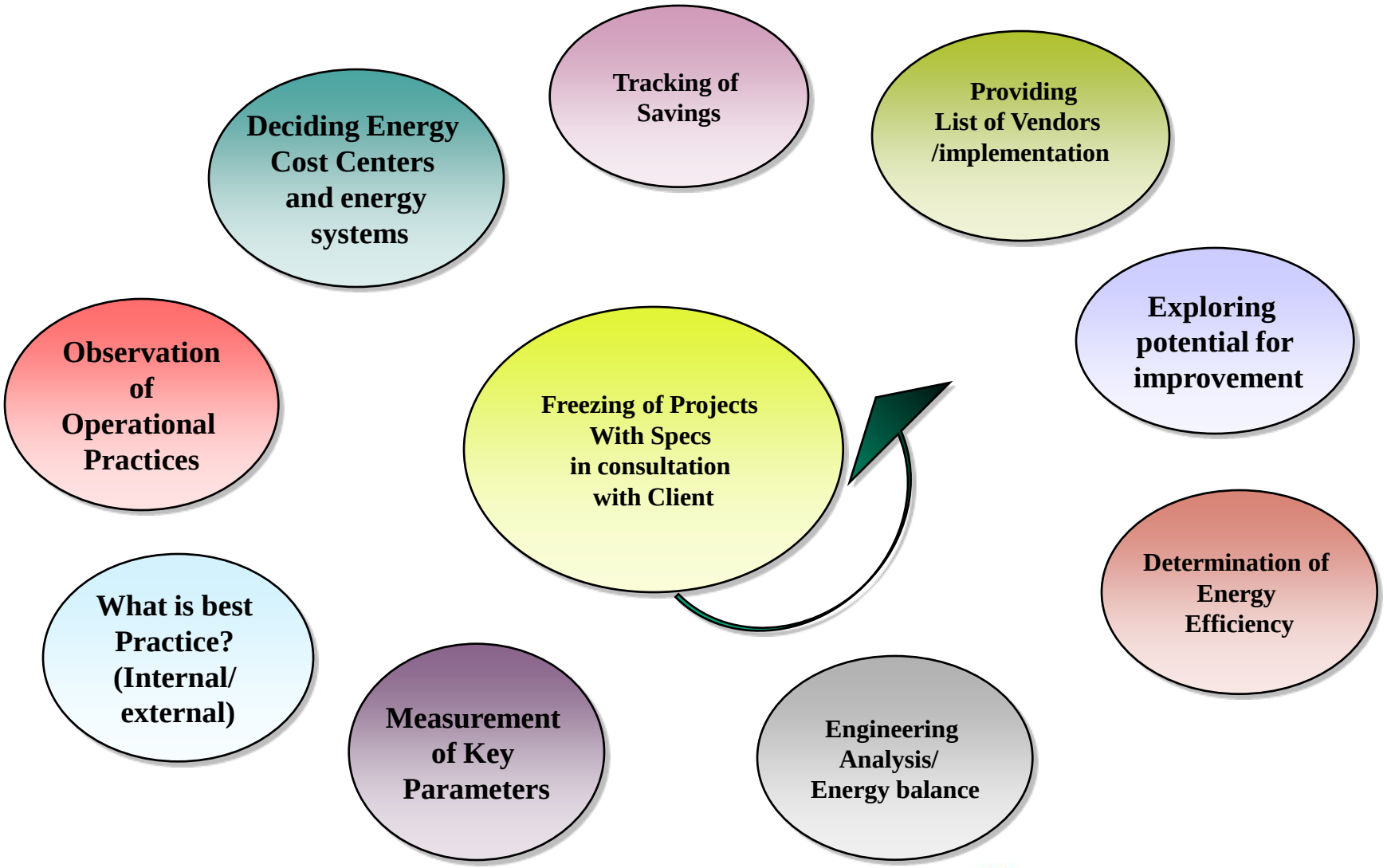

Energy cost reduction through EA at macro level …

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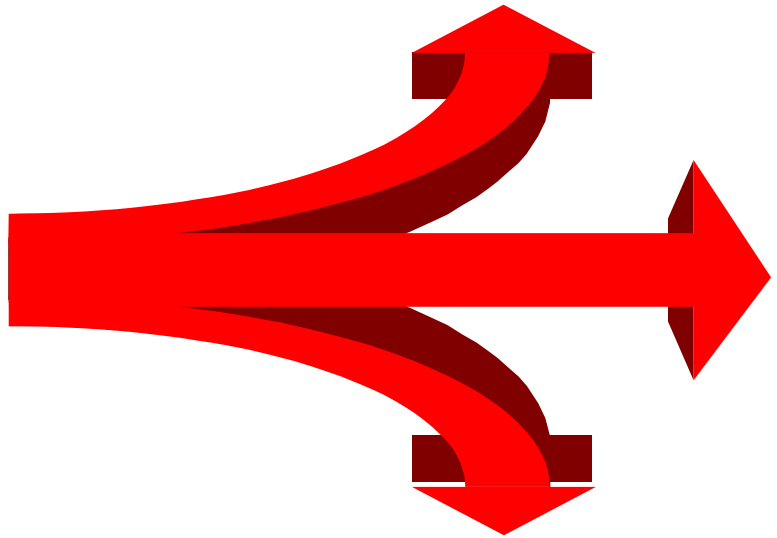
Three-pronged approach



Fuel substitution

Fine-tuning

Technology up gradation

Energy Cost Scenario – Thermal, Electrical

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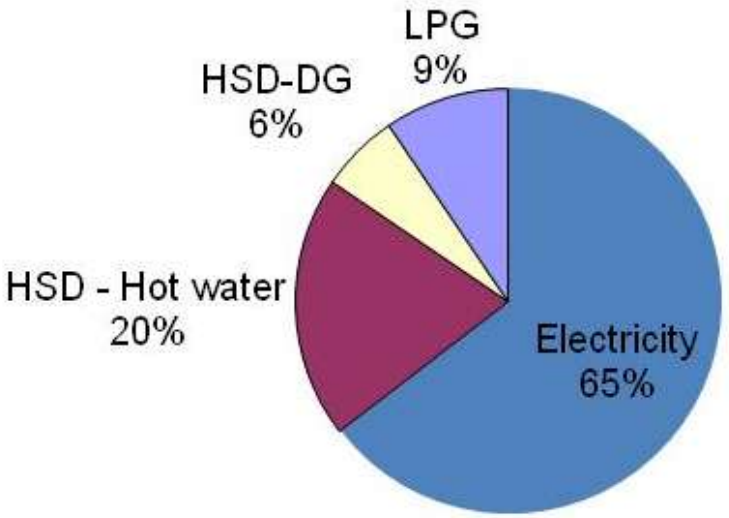
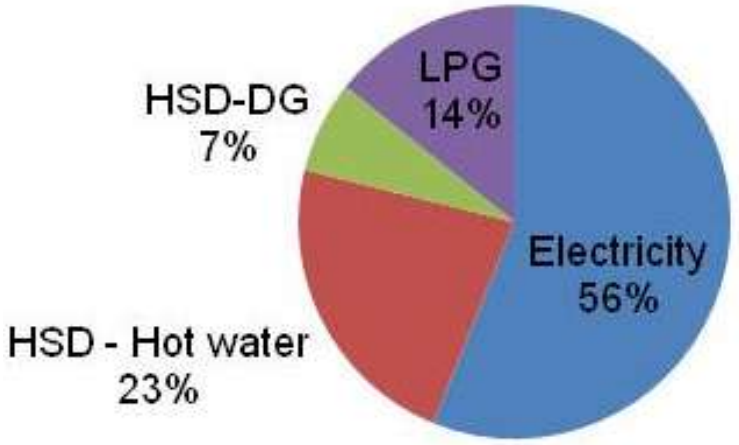


Cost wise



Energy wise

Total Energy Cost Rs 5.6 lakh per month

Average electricity cost	~	Rs. 3.6 Lakh per month
Average HSD cost for hot water	~	Rs. 1.1 lakh per month
Average LPG cost	~	Rs. 0.5 Lakh per month
Average HSD cost for DG	~	Rs. 0.3 lakh per month

Summary of Savings

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	Saving potential	Present Total annual bill	Percentage
	Rs Lakh/yr	Lakh	
Thermal (HSD + LPG)	3.3	23	14%
Electrical	8.8	43	20%

Energy Monitoring – Specific Energy Consumption

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SEC in terms of energy units /occupied room per day

SEC	Minimum	Maximum	Average
Month	January	May	
kWh/room occupied	28	66	44

SEC	Minimum	Maximum	Average
Month	March	July	
Lit diesel for hot water/room occupied	1.06	2.87	1.64

Contribution of Solar Collectors (5000 LPD) =16 lit HSD per day equivalent
=14 % of total hot water requirement

Additional Parameters to be monitored

- DG units generation and total kWh / occupied room
- Average SEC of diesel for hot water / occupied room
- Solar contribution to hot water in terms of actual lit per day by solar
- Water consumption – total, hot water, drainage

Energy Monitoring – Specific Energy Consumption

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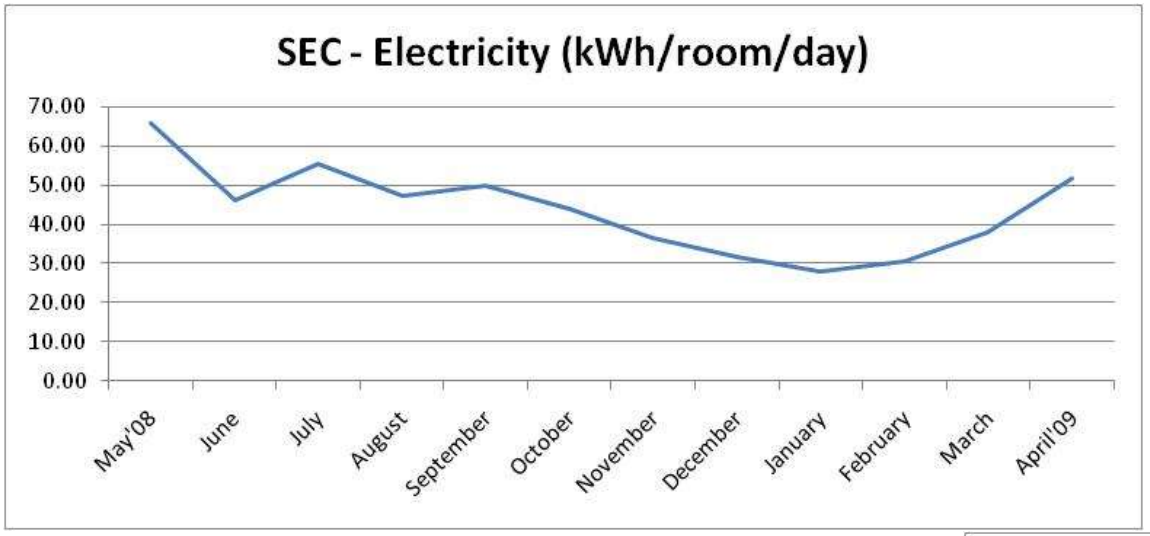

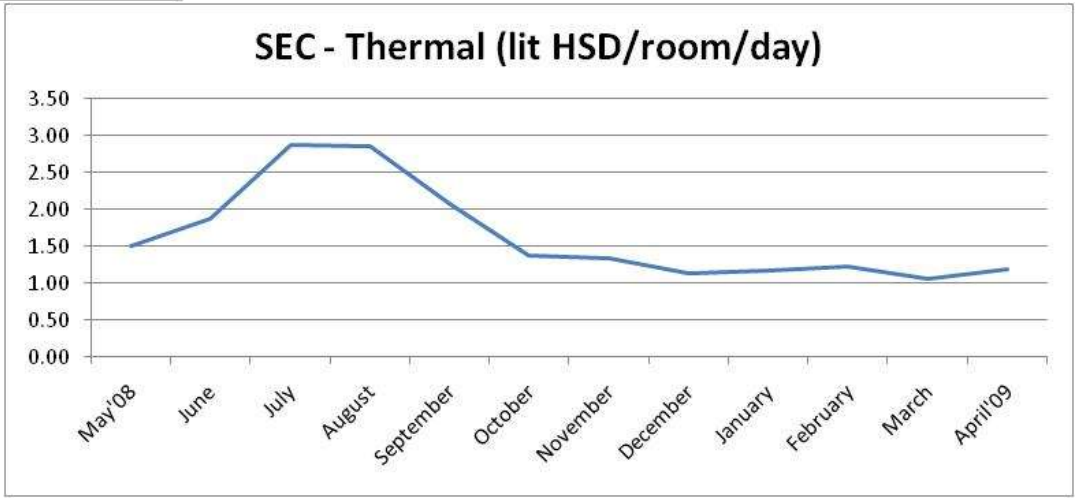

Thermal Energy – Contributors and evaluation studies

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MAJOR THERMAL ENERGY COST CENTERS

- Hot water for rooms
- Hot water for kitchen

EVALUATION TESTS DONE DURING AUDIT

- Efficiency of hot water generator
- Quantification of hot water requirement

Flue gas analysis		**Hot water generator**
% Oxygen in flue gas	:	8 %
Excess Air %	:	61 %
CO ppm	:	160 ppm
Flue gas temperature	:	389 deg C
Efficiency of hot water generator	**:**	**70.1%**

Observations :

- Flue gas temperature and excess air levels are high compared to standards
- CO is also high. Therefore incomplete combustion is taking place.
- Efficiency of the equipment is low and energy is being lost to atmosphere
- Radiation loss is within acceptable limits
- Burner needs to be cleaned regularly, tuning should be done so as to maintain oxygen at 5%, flue gas temp. at 160 to 180 deg C

Thermal Energy Monitoring

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Additional Parameters to be monitored

- Regular flue gas analysis for steam boiler
- Regular checking of burners
- Make-up water for the hot water requirements to be monitored

Additional recommended gauges/metering equipment

- Stack temperature indicators
- Portable flue gas analyser
- Flow meter for make up water

Electrical Energy – Contributors and evaluation studies

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MAJOR ELECTRICAL COST CENTERS

- Air conditioning for rooms / other areas
- Lighting for rooms and other areas
- Kitchen equipments
- Water Pumps for cold water, hot water etc.
- Blowers for kitchen exhaust, STP etc.

EVALUATION TESTS DURING AUDIT

- Data logging for transformer
- Study of power quality – Unbalances, harmonics etc.
- Loads of individual machines
- Performance of air conditioning equipment

Electrical Energy – Contributors and evaluation studies

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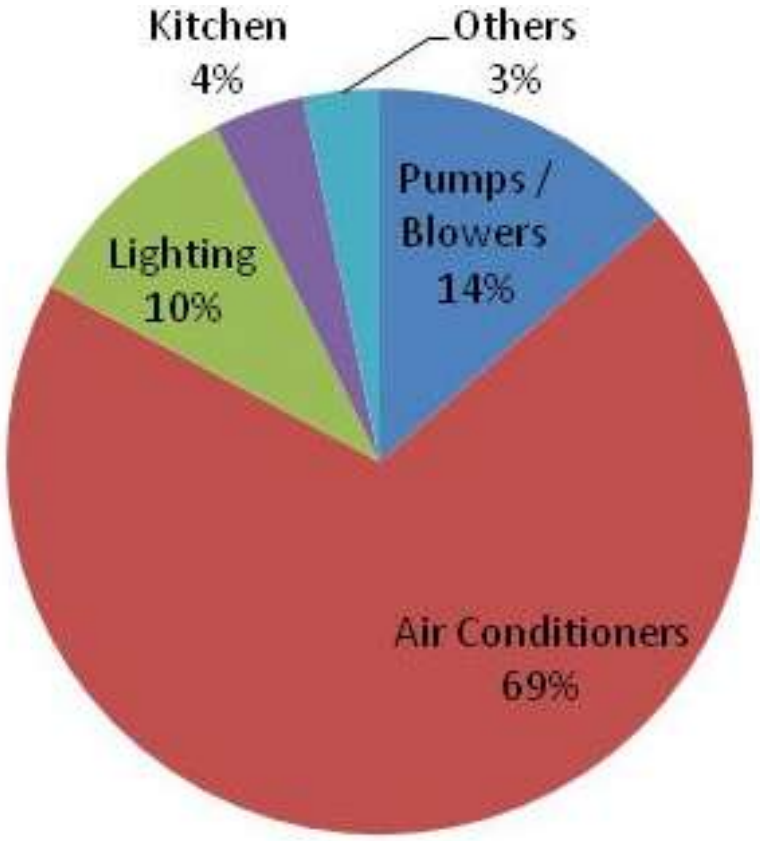

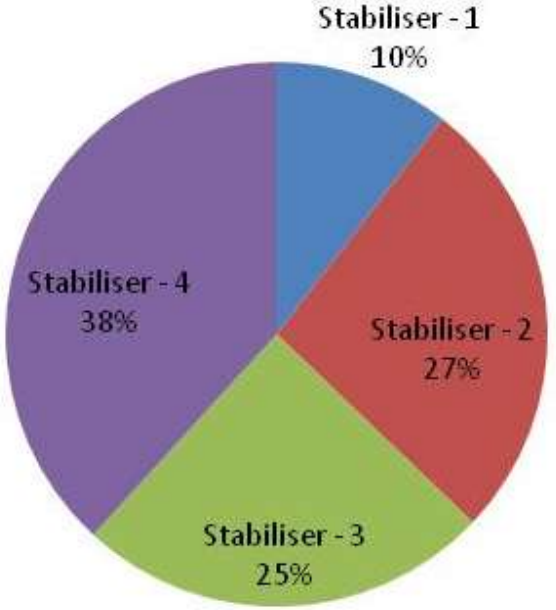

	Loads
Stabiliser - 1	Main building
Stabiliser - 2	Hot water pumps, STP, Swimming pool pumps, Cold water pumps, Room blocks - L, J, M, K
Stabiliser - 3	Room blocks - A,B, C, D, E, F, G, H, I
Stabiliser - 4	Room blocks - N,O,P,Q,R, New wing basement

Major Observations – Electrical logging data

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Transformer Rating (kVA)	Voltage variation (V)	Current variation (A)	Power variation (kW)	Power factor variation	Harmonics (%)
500	384 V to 452 V, Average - 410	80 A to 272 A Average – 210 A	52 kW to 185 kW, Average -136 kW Occupancy 56 rooms	0.87 to 0.96 Average 0.91	Current Harmonics - 3.3 %, Average 1 % voltage harmonics

- There is imbalance if loading of the 3 phases
- Total Harmonics Distortion (THD) is within acceptable limit
- Power factor average during logging period was 0.9, It can be improved to 1 by addition of capacitors and Automatic Power Factor Controller to maintain it
- Voltage variation is also very high from the grid.

Major Observations – Electrical logging data

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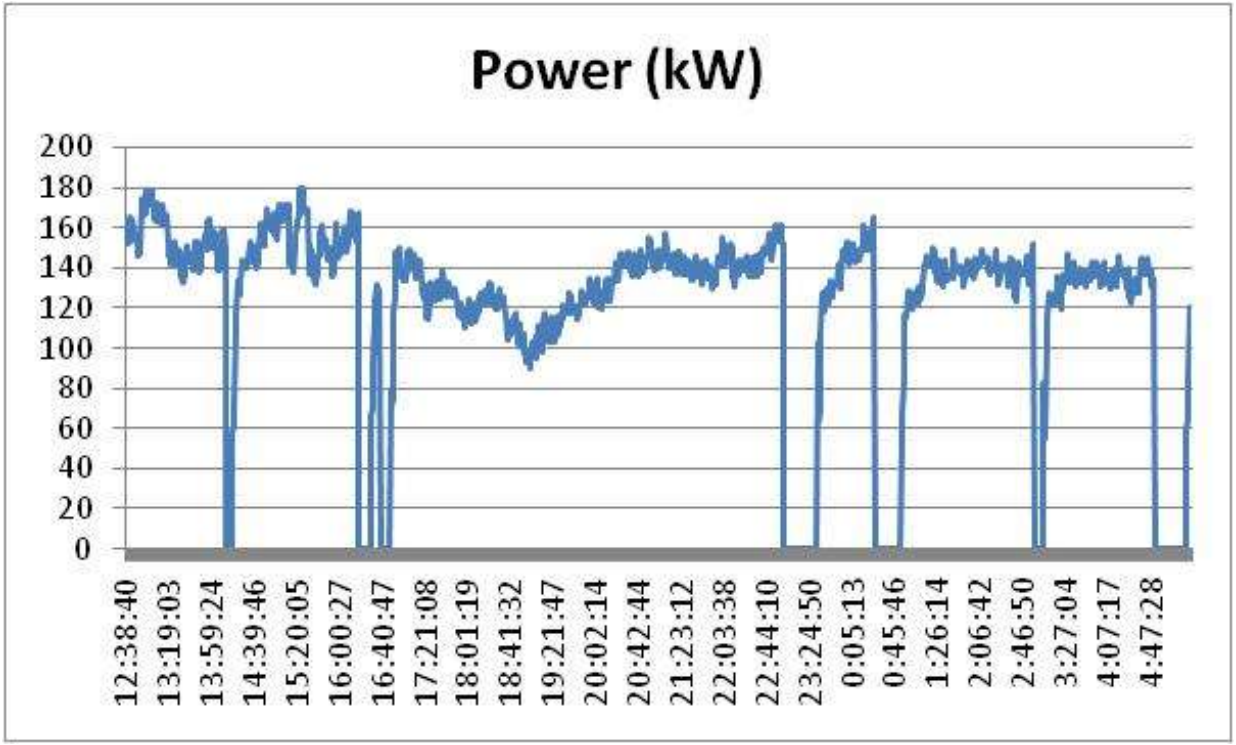

L1
Minimum Current – 91
Maximum current – 317
Average current - 225

L2
Minimum Current – 58
Maximum current – 237
Average current - 166

L3
Minimum Current – 77
Maximum current – 347
Average current - 237

Major Observations – Window Air Conditioners

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No. of AC s of National make – 31
No. of AC s of Blue star make – 38
No. of AC s of Godrej make – 40

Power consumption of sample AC of National make – 2.5 kW
Power consumption of sample AC of Blue Star make – 1.75 kW
Power consumption of sample AC of Godrej make – 1.65 kW

BEE standards for 1.5 TR AC are available

Power for AC s other than rooms:

- Restaurant = 15 kW
- Conference = 10 kW
- Administration = 13 kW
- Others = 14 kW

Energy Conservation/Cost reduction Proposals

ECP 1 : Install APFC for improving system performance

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Present System

Average power factor in last 12 months = 0.84

Average Maximum Demand in last 12 months = 259

Phase imbalance is observed in the electrical system. The single phase loads in all phases are not uniformly distributed.

Proposed System

It is proposed to install an automatic power factor controller of 125 kVAr. This system will maintain a constant power factor of 1 continuously.

The following will be the advantages of this installation:

- PF incentive from the Goa Electricity Board (5 % of energy charges)
- Reduction in Maximum Demand charges (about 40 kVA)
- Improvement in the electrical system due to reduced losses

It is also proposed to balance the electrical loads in the 3 phases to avoid problems of voltage imbalance and better functioning of the capacitors.

Saving calculation

Expected reduction in electricity bill by PF incentive	=	Rs. 1.5 lakh / year
Expected reduction in electricity bill due to lower demand charges	=	Rs. 0.7 lakh / year
Estimated reduction in electricity bill due to improvement in system	=	Rs. 0.6 lakh / year
Total saving potential	**= Rs. 2.8**	**lakh / year**
Investment	**= Rs. 1.5**	**lakh**
Payback Period	**= 7**	**months**

ECP 2- Improvement in efficiency of hot water generator by tuning

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Present System

Present flue gas temperature	=	389	C
Present oxygen % in the flue gas	=	8	%
Present efficiency	=	70	%

Proposed System

It is possible to reduce the flue gas temperature by improving the heat exchange between flue gas and water in the economiser and also by installing low capacity nozzle for the burner.

Expected flue gas temperature after tuning	=	200	^{0} C
Expected oxygen % after tuning	=	5	%
Expected efficiency after tuning	=	81	%

Saving calculation

Present diesel consumption per month	=	3393	lit /month
Expected saving	=	3393 – (3393x 0.7 / 0.81) = 461 lit /month	
Total saving potential	=	461 x 12 x 33	Rs./ month
(@ 12 months per year, Rs. 33 /lit)			
	=	Rs. 1.8 lakh per year	
Investment	~	Minimum	
Payback Period	=	Immediate	

ECP 3 : Fuel substitution from Diesel to LPG

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Present System

At present HSD is being used as fuel boiler.

Cost of HSD	=	Rs. 33 /lit
GCV	=	9100 kcal/lit
Efficiency of HSD fired hot water generator	=	80 %

Proposed System

It is proposed to utilise LPG in place of HSD in the hot water generator

Cost of LPG	=	Rs. 42 / kg
GCV of LPG	=	12000 kcal/kg
Efficiency of LPG fired hot water generator	=	87 %
Total diesel consumption	=	3393 lit/month
Cost of diesel per month	=	Rs. 1.11 lakh /month

Equivalent LPG consumption (with above mentioned GCV and efficiency)

	=	2392 kg LPG / month
Cost of LPG	=	0.98 lakh / month
Total saving potential	=	Rs. 1.5 lakh / year
Investment	=	To be determined

ECP 4 : Replacement of old ACs by energy efficient ACs

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Present System

During audit it is observed that there are about 31 AC s operating with low efficiency.
Average power consumption for these AC s of 1.5 TR = 2.5 kW

Proposed System

It is proposed to replace the old air conditioners by new energy efficient AC s. Standards of Bureau of Energy Efficiency (BEE star rating) should be followed and maximum star AC should be preferred.
Expected power consumption for 1.5 TR AC = 1.65 kW

Saving calculation

Expected saving in the power = 0.85 kW / AC

Total saving potential = 0.85 x 31 x 0.7 x 16 x 365 x 4.1
(@ 31 AC s, 70 occupancy, 16 hours/day, 365 days / year, Rs. 4.1 / kWh)
= Rs. 4.4 lakh/yr
Investment = Rs. 4.3 lakh
Payback period = 12 months

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Present System

During audit it was observed that about 30 incandescent lamps of 25 W are in operation for fence and outdoor lighting.

Proposed System

It is recommended to replace these by 8 W CFL lamps.

Saving calculation

Expected reduction in power	=	30 x (25-8)/1000
	=	0.5 kW
Saving potential	:	0.5 x 14 x 365 x 4.1
(@ 14 hrs/day, 365 days / year, Rs. 4.1 / kWh)		
	:	Rs. 10,685 per year
Investment	:	Rs. 3,600
Payback period	:	4 months

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Present System

During audit it was observed that 106 rooms with 2 lamps of 40 W are installed on bed sides.

Proposed System

It is recommended to replace these by 8 W LED lamps.

Saving calculation

Expected reduction in power	=	106 x 2 x (40-8)/1000
	=	6.8 kW
Occupancy	=	70 %
Usage	=	5 hrs/day
Saving potential	:	6.8 x 0.7 x 5 x 365 x 4.1
(@ 5 hrs/day, 365 days / year, Rs. 4.1 / kWh)		
	:	Rs. 35,532 per year
Investment	:	Rs. 1.3 lakh
Payback period	:	44 months

Other proposals which are under consideration

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- Occupancy sensor for Account room, staff locker area
- VFD for cold water circulation pump
- Arresting water leakages for saving water as well as pumping power
- Optimum bathroom fittings to reduce water consumption during flushing
- Automatic voltage controller to replace present faulty stabilisers

General recommendations

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Lighting

- Door opening based lighting in cold rooms
- Occupancy sensor based lighting in less used areas
- Stop excess lighting by increasing awareness

Important recommendations for which saving potential cannot be fully quantified

AC system

- Maintain optimum set temperatures for rooms and chiller evaporator
- Avoid frequent door openings of AC rooms

General

- Use energy efficient motors for replacement or new installations
- Increase energy awareness among kitchen staff
- Consider energy efficient laundry equipment

General recommendations

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FOOD PREPARATION – KITCHEN

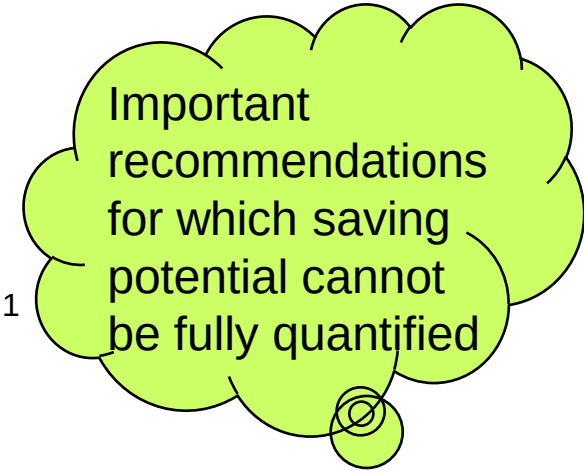
- Reduce peak loading by:-

(a) Intensive cooking such as baking and roasting during non-peak demand hours.
(b) Use minimum number of electric appliances at a time. Stager their operation.
(c) Try to use electrical appliances between 6 AM to 10 AM or after mid night if possible.

- Turn off lights in the walk – in refrigerators and freezers when not required. Lights not only waste energy but add load to the box.

BANQUETS

- When setting up for a function, make certain that heating, cooling and lighting are off until ½ hour to 1 hour before function starts. Turn off systems as soon as the function is over. In fact, air conditioning can be turned off even ½ hours before function finishes. Air conditioning effect will stay for ½ hour.
- Assign an individual responsible for turning lights on and off.
- Keep the light off whenever any function area is vacant or unoccupied.



ENGINEERING DEPARTMENT

- Eliminate or reduce duct air leakage.
- Repair or replace damaged hot or chilled water line insulation.
- Clean AC coils and fans periodically, check chilled water sample to know the internal condition of coil. Do periodic cleaning of coil.
- AC filter must be cleaned periodically.
- Clean burner nozzle periodically

Summary of Savings

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No.	Name of proposal	Saving potential (Rs. per year in lakh)	Investment (Rs. lakh)	Payback months
1	Install APFC for improving system performance	2.8	1.5	7
2	Improvement in efficiency of hot water generator by tuning	1.8	Minimum	Immediate
3	Fuel substitution from Diesel to LPG	1.5	To be determined	-
4	Replacement of old ACs by energy efficient ACs	4.4	4.3	9
5	Replacement of fence and outdoor incandescent bulbs by 8 W CFLs	0.11	0.04	4
6	Replacement of bed side lighting (2 lamps) by LED lamps	0.35	1.3	44

Summary of Savings

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	Saving potential	Present Total annual bill	Percentage
	Rs Lakh/yr	Lakh	
Thermal (HSD + LPG)	3.3	23	14%
Electrical	7.7	43	18%


Thank You