Preliminary Energy Audit Report

ICICI Bank

January 2013

Prepared by:
Vivek Gilani
Environmental Engineer (E.I.T)
BEE Certified Energy Auditor (EA-17177)

Co-Founder: The no2co2 Project (www.no2co2.in)
Co-Founder / Member Secretary: The GreenSignal Ecolabelling Body
Founder / Director: cBalance Solutions Hub

Table of Contents

1 Introduction 3
2 Project Scope 4
3 Methodology 4
4 Preliminary Energy Audit Report 4
4.1 Baseline Performance - Measurement 4
4.1.1 Electricity Consumption 4
4.1.2 Lighting System 5
4.1.3 HVAC System 7
4.2 Baseline Performance - Analytics 9
4.2.1 Overall Energy Performance Context 9
4.2.2 Lighting System Analytics 9
4.2.3 HVAC System Analytics 10
4.3 Energy Conservation Opportunities 10
4.3.1 Lighting Efficiency Enhancement Opportunities 10
4.3.2 HVAC Enhancement Opportunities 12
4.3.3 Architectural / Design Modification Opportunities 14
5 Conclusion 16

1 Introduction

The cBalance Solutions Hub was contracted by ICICI Bank to conduct a preliminary energy audit as the primary step of an objective to develop a energy efficiency roadmap to transform and improve their energy performance index (EPI) to enable their commercial buildings to achieve a high Star-Rating as per the Bureau of Energy Efficiency's Building Star Rating Program (Launched in February 2009).

The overarching objectives of the exercise were to:

- Determine the energy conservation potential for a typical bank branch based on technological interventions
- Determine the energy conservation potential for a typical bank branch based on architectural interventions (especially related to building envelope/air conditioned space insulation)
- Determine the energy conservation potential for a typical bank branch based on operational process changes
- Establish the comparative financial feasibility of proposed alternatives on a life-cycle cost basis

Additionally, the cBalance Solutions Hub, on its own accord, determined the GHG mitigation potential for the proposed alternatives to reduce the overall corporate Carbon Footprint of ICICI Bank (Scope 1 and Scope 2 Emissions). This assessment culminates in a marco-level Marginal Abatement Cost Curve Analysis.

MACC Curves: *A enterprise-specific Marginal GHG Abatement Cost Curve (MACC) analysis is a key component of an institutionalized Sustainability Strategy. It is designed to discover the most cost-effective means of mitigating climate change impact through technological interventions or modifications in management practices. It is a vital decision-support input for planning capital expenditure on Energy Efficiency, Water Conservation, Waste Reduction & Management etc. projects in a manner that safeguards the financial sustainability of the Organization while achieving tangible environmental and socio-economic sustainability benefits for the planetary ecosystem. The idea is to harvest the low-hanging fruits first, accumulate the economic benefits from these no-regret options and then steps through more challenging interventions. In this way, it reduces financial risk and ensures longevity of the environmental program at large.*

MACC Methodology: *Costs and benefits are calculated based on real values of financial parameters such as inflation, interest rates, cost of electricity, energy etc. and resource conservation benefits of options reflect the enhancement in technological alternatives available over time*.

2 Project Scope

The geographical scope of the project comprised execution of a preliminary 2-day energy audit of one ICICI bank branch in Pune (Maharashtra, India). The branch chosen for the exercise was the Bhandarkar Road "Nayantara" Branch in Pune.

The systems studied and assessed as part of the Energy Audit and Energy Conservation Strategy devising process included the follwing:

- HVAC Systems: Split ACs, Cassette ACs
- Lighting Systems: TFL Lights and CFL Bulbs
- Architectural Features: Glazing, Doors

3 Methodology

The field measurement methodology adopted included the following processes and equipments:

1. Fluke 434 and 435 Power Analyzer: for verifying total connected electrical load of commercial building (kVA), the overall system Power Factor (PF), and other parameters including total current drawn (A) and Voltage (V), and measuring electrical parameters of HVAC equipment clusters - to establish baseline system performance
2. MECO Harmonater – Clamp-On Meter: for measuring electrical parameters of individual HVAC equiment - to establish baseline system performance
3. Lutron Luxmeter: for measuring lux levels on the working planes of the workspaces and human occupancy areas
4. Lutron Anemometer: for measuring flowrate (velocity) of condenser cooling air exiting the outdoor-units to determine the heat rejected by the individual HVAC equipment (equivalent to delivered cooling – tonnes of refrigeration or TR)
5. Psychrometer: for measuring the dry bulb temperature (DBT) and wet bulb temperature (WBT) of the ambient and condenser-cooling air to establish the enthalpy change across the condensers of the outdoor units.
6. Measuring Tape: to measure the diameter of outdoor unit fans to convert air velocity into mass flow rate.

4 Preliminary Energy Audit Report

4.1 Baseline Performance - Measurement

4.1.1 Electricity Consumption

The baseline energy consumption of the branch was researched through utility bills. The monthly energy consumption and other electrical load parameters for the period of Jan 2012 to Jan 2013 was:

Sr.No.	Month	kVAh	kWh	PF	Max. Demand (kVA)	Demand Charged (kVA)	Contract Demand (kVA)
1	Jan-12	20,279	16,550	0.816	66	125	250
2	Feb-12	22,413	19,343	0.863	79	125	250
3	Mar-12	30,271	26,878	0.888	95	125	250
4	Apr-12	27,297	23,512	0.861	98	125	250
5	May-12	33,073	29,474	0.891	100	125	250
6	Jun-12	34,911	30,188	0.865	93	125	250
7	Jul-12	28,261	25,094	0.888	96	125	250
8	Aug-12	24,259	21,034	0.867	81	125	250
9	Sep-12	25,117	22,103	0.880	81	125	250
10	Oct-12	26,848	23,305	0.868	86	125	250
11	Nov-12	23,328	19,535	0.837	86	125	250
12	Dec-12	23,347	19,886	0.852	52	125	250
	Total	**3,19,404**	**2,76,902**	*0.865*	*84*	*125*	*250*

4.1.2 Lighting System

The lighting system of the Bank Branch was assessed through visual observation, technical specification data recording and luxmeter readings. The resulting information related to the lighting fixture types, loads and lux levels is presented below.

Overall Lighting System Characteristics

Area	Fitting Type	
	2 x 36 W	1 x 18 W
Basement	20	-
Ground Floor	53	103
1st Floor	44	41
Total Fittings	117	144
Total Load (kW)	**8.42**	**2.59**

Detailed Lighting Breakdown: Basement

Area	Fitting Type	Fitting Load (W)	Qty.	Load (W)	Lux Levels
Pantry	TFL	36	4	144	Lux 210,332,166
Locker Rm. (Bankers)	TFL	36	14	504	Lux 222,371,60,121,98,126
Locker Rm. (Passage)	TFL	36	6	216	Lux 136,180,233,142
Store room	TFL	36	16	576	Lux 397,205,333,140,397,325,180,90
		Totals	**40**	**1.44**	**kW**

Detailed Lighting Breakdown: Ground Floor

Area	Fitting Type	Fitting Load (W)	Qty.	Load	Lux Levels
ATM	TFL	36	4	144	Lux 129,106,228
ATM	CFL / PL	18	3	54	
ATM UPS Rm	TFL	36	4	144	Lux 90,202,100
Lobby Entrance	CFL / PL	18	4	72	---------
Deputy Manager	CFL / PL	18	4	72	Lux 174,187,
Wealth Rm	CFL / PL	18	18	324	Lux 115,137,139,202,196,178
Nr Wealth Rm	CFL / PL	18	20	360	Lux 160,53,115
Counter Nos.9 to 18	TFL	36	12	432	Lux 138,143,145,149,227, 438,107,175,368,238, 218,211,220,182
Counter Nos.9 to 18	CFL / PL	18	12	216	
Common area	TFL	36	30	1,080	Lux 404,366,435,385,264,280,370,331,
NRI Services	TFL	36	4	144	Lux 395
Nr Photocopy Area	CFL / PL	18	8	144	Lux 139,142,146,158,170,162
Pantry	CFL / PL	18	3	54	Lux 140
Bank Manager	TFL	36	6	216	Lux 473,450
Nr Bank Manager Rm	CFL / PL	18	4	72	Lux 139,170
Nr Deputy Manager	CFL / PL	18	4	72	Lux 195,145
Sales Cabin	TFL	36	6	216	Lux 470,495,416
Toilet Area	CFL / PL	18	16	288	Lux 106,151,110,120
SMEAG Rm	TFL	36	28	1,008	Lux 430,560,475,330,270,305,360,432,438,322,143
Way to Toilet Passage	CFL / PL	18	4	72	Lux 78,108,127
Conference Rm	TFL	36	4	144	-------
Conference Rm	CFL / PL	18	3	54	
Pantry Rm	TFL	36	4	144	------
Elect Rm	TFL	36	4	144	Lux 216
		Totals	**209**	**5.67**	**kW**

Detailed Lighting Breakdown: 1st Floor

Area	Fitting Type	Fitting Load (W)	Qty.	Load (W)	Lux Levels
Server/UPS Rm	TFL	36	4	144	Lux 134,420
Locker Rm (Employee)	TFL	36	4	144	Lux 140,99
Pantry	TFL	36	4	144	Lux 275,224,214
Pantry	TFL	36	2	72	
Passage	CFL / PL	18	3	54	Lux 120,120
Toilet	CFL / PL	18	4	72	-------
Visitor Rm	CFL / PL	18	8	144	Lux 104,107,82,121,109,132
Conference Rm	CFL / PL	18	6	108	Lux 75,13,154,82,177
Conference Rm	TFL	36	4	144	
Work Cell 1	TFL	36	12	432	Lux 403,130,450,239,195,63
Work Cell 2(OPS)	TFL	36	10	360	Lux 183,398,223,309,236
Work Cell 2(OPS)	CFL / PL	18	2	36	
Work Cell 3(RMU+BCM)	TFL	36	12	432	Lux 238,224,216,480,335,99
Work Cell 4 (BCM+RSM)	TFL	36	2	72	Lux 360,192,98,393,156
Work Cell 4 (BCM+RSM)	CFL / PL	18	4	72	
Work Cell 5 (Lombard + Sale)	TFL	36	6	216	Lux 256,443,949,1295
Work Cell 5 (Lombard + Sale)	CFL / PL	18	3	54	
Sales Hall	TFL	36	20	720	Lux 125,330,238,250,196, 217,347,265,338,295,436,362,155,227,186
Sales Hall	CFL / PL	18	4	72	
Cabin 1	CFL / PL	18	7	126	Lux 200,109,218,190
Cabin 2	TFL	36	2	72	Lux 250
Cabin 3	TFL	36	2	72	Lux 152
Store Rm	TFL	36	4	144	Lux 90
		Totals	**129**	**3.91**	**kW**

4.1.3 HVAC System

The HVAC system of the Bank Branch was assessed through visual observation, technical specification data recording and power analyzer, anemometer and psychrometer readings. The resulting information related to the HVAC unit types, theoretical capacities, calculated capacities, power consumption and Coefficient of Performance (COP) or EER (Energy Efficiency Ratio, kW cooling / kW input power) is presented below.

Overall HVAC System Characteristics

AC Type	Machine Model	Qty.	Rated TR/Unit	Total TR	Rated EER[1]
Split Unit AC	HWE-181YBK	15	1.5	22.5	2.74
Cassette	HWE-241YBK	22	2	44	2.72
Cassette	SCR361SB	7	3	21	2.82
Cassette	SCR481SB	4	4	16	2.95
	Totals	**48**		**103.5**	

Detailed HVAC Breakdown: Ground Floor (Branch)

AC Type	Machine Model	Qty.	Rated TR/Unit	Total TR	Rated EER
Split Unit AC	HWE-181YBK	7	1.5	10.5	2.74
Cassette	HWE-241YBK	19	2	38	2.72
	Totals	**26**		**48.5**	
			Floor Area	**4549**	**ft^2**
			Installed TR/unit area	**0.0106**	**TR/ft^2**
			Total Recorded Power (30 TR Load)[2]	**37.86**	**kW**
			Avg. Measured kW/TR	**1.262**	**kW/TR**
			Avg. Measured EER	**2.79**	**EER**

Detailed HVAC Breakdown: 1st Floor

AC Type	Machine Model	Qty.	Rated TR/Unit	Total TR	Rated EER
Split Unit AC	HWE-181YBK	8	1.5	12	2.74
Cassette	HWE-241YBK	3	2	6	2.72
Cassette	SCR361SB	7	3	21	2.82
Cassette	SCR481SB	4	4	16	2.95
	Totals	**22**		**55**	
			Floor Area	**4549**	**ft^2**
			Installed TR/unit area	**0.0121**	**TR/ft^2**
			Total Recorded Power (20 TR Load)[3]	**16.85**	**kW**
			Avg. Measured kW/TR	**1.262**	**kW/TR**
			Avg. Measured EER	**2.79**	**EER**

[1] Obtained from Technical Specifications of Bluestar AC

[2] Only a partial load of 30 TR was estimated to be exerted due to reduced heat load conditions

[3] It can be seen from the power analyzer trend that the power variation is on larger scale in case of 1st Floor compared to that on the Ground Floor. Not all the A/C units are operational (especially owing to season at the time) therefore overall power consumption of 1st floor is also lesser compared to that on the Ground Floor. From the power consumption and based on KW/TR for ground floor, about 20 TR of A/C load could estimated.

4.2 Baseline Performance - Analytics

4.2.1 Overall Energy Performance Context

Table for Building Energy Star Rating Programme:
More than 50 % air conditioned built up area , Climatic Zone - Hot and Dry

EPI(Kwh/sqm/year) Star Label	EPI(Kwh/sqm/year) Star Label
180-155	1 Star
155-130	2 Star
130-105	3 Star
105-80	4 Star
Below 80	5 Star

The total built-up area of the Branch (excluding basement[1]) is 9,098 sq. ft or 845.2 sq.m. The current EPI of the Branch, based on the BEE Index for Hot & Dry Climatic Zone (Pune), is 328 kW/m2/year. As per the table above, ***the Branch currently does NOT qualify for any of the star ratings available.***

4.2.2 Lighting System Analytics

Recommended Illuminance (Lux) levels for general offices (including counters) is 300 lux (i.e. 300 lm/m2)[4]

The lighting system audit results presented earlier indicate many locations where the lux readings were significantly higher.

46 out of the total 161 Lux readings taken indicated lux levels higher than 300. This indicates a **significant opportunity for reducing lighting power density in the branch in numerous locations**.

The Installed Load Efficiency Ratio (ILER) for the Branch is assessed as follows:

For Branch:
Area = 422.6 m2
Room Index (RI) = (L x W) / (Hm x (L + W)) = (20.6 x 20.6) / (2.44 x (20.6 + 20.6)) = 4.2
Total Circuit Watts = 5670 W
W/m2 = 13.4

[4] ANNEXURE-1: RECOMMENDED ILLUMINANCE LEVELS, Bureau of Energy Efficiency, BEE Code, Lighting

$E_{av.\ maint}$ = 240.6 Lux
Existing Lux/W/m2 = 19.0
Target Lux/W/m2 = 52 (for room index of 4.2)
ILER = 18.0/52 = 0.35

Since the ILER is below 0.5 – the BEE Energy Audit Methodology recommends URGENT ACTION

4.2.3 HVAC System Analytics

The effective BEE Star Rating of the HVAC System (Split Units and Cassette ACs) based on a EER of 2.79 is "2 Star". The BEE Star Rating System is presented as under:

Star	Min EER	Max EER
1	2.5	2.69
2	2.7	2.89
3	2.9	3.09
4	3.1	3.29
5	3.3	

This indicates a significant potential for HVAC Energy Conservation through upgrading the EER of HVAC System.

4.3 Energy Conservation Opportunities

4.3.1 Lighting Efficiency Enhancement Opportunities

Intervention 1: Replacement for 2 x 36 W type Fitting with 18W LED REB Tube Fitting
Specifications:

- Power Factor: >0.92
- Lighting Efficiency: > 85%
- CRI: >75
- Work Frequency: 50/60Hz
- Constant Circuit Error: <2%
- Microwave/Noise: <240mV
- Short Circuit Protection: OK
- Operation Temp: -20C~65C (-4F~149F)
- Lighting Source: SMD3528 Episar
- Efficiency: 100 lm/w
- Beam Angle: 120degree

Existing Fitting							
Fitting Type	**Actual Elec. Cons. (Watts)**	**Total Fittings**	**Oper. Hrs. / Day**	**Annual Working Days**	**Annual Elec. Cons. (KWH)**	**Unit Charges (Rs.)**	**Annual Energy Charges (Rs.)**
2 x 36W FTL	80	117	12	300	33,696	9.83	3,31,232
Proposed Led Fitting							
2 x18W Reb Tube	40	117	12	300	16,848	9.83	1,65,616

Payback Calculations

Electricity Cost for 36W F. T. L Fittings			3,31,232.00
Electricity Cost for 18W LED Fittings			1,65,616.00
Cost of (1 x 18W) LED Fitting	234 nos. x Rs. 750	**A**	**1,75,500.00**
Annualized Savings in Electricity Cost		**B**	**1,65,616.00**
Replacement Cost of Filament during 16 Years	234 (Nos.) x 10 (No. of Replacements) x 45/-		1,05,300.0
Replacement & Labour cost of Ballast during 16 Years	234 (Nos.) x 4 (No. of Replacements) x150/-		1,40,400.0
Annualized Savings in Replacement Cost		**C**	**15,356.00**
Simple Payback Time		**(A) / (B+C)**	**0.96 yrs**

Intervention 2: Replacement for 1 x 18 W type Fitting with 8W LED Bulb

Specifications:

- Colour: Cool White,
- Watts: 8w
- Lumen: 500 lm,
- Beam Spread: 270
- Dimmable: Yes
- Lifespan: 25000 Hrs
- MRP: Rs.825.00
- Mercury free led bulb with 1 year service warranty

Existing Fitting							
Fitting Type	**Actual Elec. Cons. (Watts)**	**Total Fittings**	**Oper. Hrs. / Day (Hrs.)**	**Annual Working Days**	**Annual Elec. Cons. (KWH)**	**Unit Charges (Rs.)**	**Annual Energy Charges (Rs.)**
1 x 18W PL	20	144	12	300	10,368	9.83	1,01,918
Proposed Led Fitting							
1 x 8W LED	10	144	12	300	5,184	9.83	50,959

Payback Calculations

Electricity Cost for 18W PL Fittings			1,01,918.00
Electricity Cost for 8W LED Fittings			50,959.00
Cost of (1 x 8W) LED Fitting	144 nos. x Rs. 825	**A**	**1,18,800.00**
Annualized Savings in Electricity Cost		**B**	**50,959.00**
Replacement Cost of Filament during 16 Years	144 (Nos.) x 8 (No. of Replacements) x 300/-		3,45,600.0
Replacement & Labour cost of Ballast during 16 Years	144 (Nos.) x 8 (No. of Replacements) x 20/-		23,040.0
Annualized Savings in Replacement Cost		**C**	**23,040.00**
Simple Payback Time		**(A) / (B+C)**	**1.6 yrs**

Intervention 3: Occupancy Sensors for Infrequently Occupied Areas

Energy consumption from building interiors and exteriors that do not require continual lighting and cooling due to infrequent occupancy (eg. stairwell and compound lighting in buildings and fan/light operation in toilets and elevators in commercial and residential premises) can be significantly diminished by use of Passive Infrared Sensors- PIR Sensors to controls HVAC and lighting fixtures. Incorporating PIR Sensor-control in tubelights, used 12 hours per day (approximate usage in stairwell lighting applications), can mitigate energy consumption by approximately 160 kWh per fixture.

4.3.2 HVAC Enhancement Opportunities

Intervention 1: Replacement of Existing ACs with 5-Star Rated ACs

Intervention 2: Replacement of Existing ACs with "7-Star" Natural Refrigerant Rated ACs (R290 Based)

Preliminary HVAC Energy, Cost, and GHG Mitigation Analysis: ICICI Bank
Case Scenario: Replacement of 1 Branch, 50 x 2 TR, BEE 2-Star Rated Split-ACs with BEE 5-Star Rated ACs, and with "7-Star" ACs, Operating 3600 hrs/year

Baseline	Intervention	Capex (Rs.)	Incr. Capex over BAU (Rs.)	Annual Cost Savings (Rs.)	Payback (Yrs - for Total Capex)	Payback (Yrs - for Incr. Capex)	Annual En. Con. (kWh/yr)	Annual GHG Mitig. (tons CO2e)
Split AC - 2 Ton - 2 Star	Split AC - 2 Ton - 5 Star	32,99,000	18,97,016	7,86,970	4.2	2.4	80,058	100.1
Split AC - 2	Split AC - 1.5	25,89,928	11,87,944	10,89,164	2.4	1.1	1,10,800	165.4

Ton - 2 Star	Ton - 7 Star							

Intervention 3: Replacement with Inverter ACs

Digital Inverter technology maintains precise control of room temperature and creates a comfortable environment. In conventional split Air Conditioners, the compressor switches off once the set temperature is reached, and switches on again after temperature drops. The time it takes for the Split Air Conditioner to switch on and off causes the room temperature to greatly fluctuate.

With Digital Inverter, the inverter control reduces the compressor power once the desired temperature has been reached, but continues operating at a reduced state to maintain a stable room temperature with minimal fluctuations. By putting an end to on/off compressor operation, the inverter technology also allows Digital Inverter to significantly reduce noise levels; Superior reliability has been achieved, due to the reduction of the compressor ON/OFF cycles. Digital DC Inverter Air Conditioners provide this benefit to consumers, helping them to achieve various benefits such as saving of at least 25% of their energy costs. These air conditioners are much quieter and offer higher levels of efficiency as their noisier counterparts.

The average AC power consumption as recorded during winter (present time) is about 54.71 KW. This is likely to be 30 to 35% higher during hot season. The average consumption could be put at 60 KW/month over year. The power savings with digital inverter type AC units would at 20% would be 12 KW/month.

The annual energy conservation potential of this intervention is: 94,000 kWh/year

Intervention 4: Incorporating Evaporative Air Cooling

Dry Climates (like Pune) are ideally suitable for Evaporative Cooling. Double circuit evaporative cooling would be worth looking into, contingent upon availability of water and space.

An evaporative cooler produces effective cooling by combining a natural process - water evaporation - with a simple, reliable air-moving system. Fresh outside air is pulled through moist pads where it is cooled by evaporation and circulated through a house or building by a large blower. As this happens, the temperature of the outside air can be lowered as much as 30 degrees. This technology can provide significant savings relative to conventional electric compressor-based AC systems in areas with low humidity. Furthermore, this system will drastically improve air quality for and occupational health of kitchen and office staff since these systems do not recirculate air unlike Air Conditioning systems. Incidences of building-sickness with these systems will be largely eliminated and will improve overall workforce productivity. Evaporative Cooling comes at 40% lesser cost compared to refrigerant based cooling.

Intervention 5: Direct Evaporative Water Spraying Technology

This technology essentially comprises of spraying water on exterior building walls to reduce the temperature of the interior environment and thereby reducing Air Conditioning load and increasing operational energy efficiency of the built space. While this system does increase water consumption and the associated energy for pumping, these impacts might be mitigated by utilizing the grey water recycled or stored harvested rain water from the building rooftop during the wet months and putting it to use in the dry months. This technology is not expected to yield significant benefit in humid climates or seasons. Also, the paint selection for building exteriors must account for the increased fungal growth potential due to increased surface moisture – and hence must have strong anti-fungal properties.

Intervention 6: Overhaul of Refrigerant Piping Insulation & Filter Maintenance

The Gas pipe insulation was found to be damaged at various points on the AC units. Mending / replacement of insulation would improve the performance of AC units. Cleaning of filters of all indoor units and cleaning of condenser fins by jet pumps. Average life of typical Split Units is considered to be 10 years in dry climates without corrosive pollutants.

Intervention 7: Optimal AC Temperature Setting

Using all Units at Specific Set Points can greatly reduce HVAC energy consumption. It was observed that the set-point for ACs was generally at 19^0C in the Bank Branch. All AC units may be set at 23/24 ^{o}C for optimum power consumption.

The annual energy conservation potential of this intervention is: 28,500 kWh/year

4.3.3 Architectural / Design Modification Opportunities

Intervention 1: Enhanced Use of Natural Lighting

Natural lighting available at the premises through the existing glass facades needs to be exploited to reduce the lighting load exerted. **Currently, most of the glass facades are shielded using vertical-blinds and artificial lighting is used even in areas in the vicinity of glass panes.**

This intervention has the twin beneficial impact of reducing manufacturing related LCA impacts of lighting fixtures as well as reduced energy consumption. Some green architecture guidelines specify design lighting loads in the vicinity of 7.5 W/sq.m. For building occupancy of 10 hours/day, the average annual electricity conservation and GHG emissions mitigation per sq. m of naturally lit space relative to conventionally lit space is estimated to be 27 kWh/sq.m and 24 kgCO2e/sq. m.

Intervention 2: Building-Envelope & Air-Conditioned Space Insulation

Weather-Stripping of All Doors, especially the main entrance doors into all building cavities.

Currently, **the MAIN DOOR of the entrance to the Branch has a significant air-gap between the frame and the door** while all back-office doors meant to separate Air Conditioned Spaces from non-conditioned spaces are either missing or kept ajar at all times.

Use of Air curtain on Ground Floor Entrance to curtail infiltration losses: Frequenting clients on Ground Floor through main entrance incurs losses due to infiltration. These could be curtailed using Air Curtains. The advantage would be more prominent during summer

Intervention 3: Solar-Hear Gain Reduction

Double-Glazed Panes and Spectrally-Selective Window Films

Double and Triple-Glazed Windows enhance the insulation properties and reduce the operational energy requirement of the buildings. The advantage of these methods of insulation over other window systems which rely upon solar reflection (such as tinted and coated window films) is that they achieve heat gain reduction without greatly compromising visible light transmission. Solar reflection based systems, while achieving comparable heat gain reduction, are compromised by the increased interior lighting load necessitated by their application. Through Double and Triple Glazed Systems the heat gain/loss can be reduced by approximately 50% to 75% relative to Single Pane Glass Systems.

Heat Gain Reducing Paint

The Heat Gain Reducing Paint technology has the ability to reflect heat causing infrared rays from solar radiation. This intervention was designed to help reduce the internal temperature of the building i.e. reduce heat gain. Certification conducted by the Centre for Energy Studies and Research (CESR, India) indicates that Weather Shield Paints (i.e. solar reflective paints) can reduce the temperatures of walls by upto 5^0Cand that reflectivity rate for solar radiation through these paints is 0.40 relative to ordinary

exterior wall paint which exhibit a reflectivity rate of 0.21. i.e. these paints are approximately twice as effective in curbing building wall temperature rise due to solar radiation.

5 Conclusion

Summary of the Energy Conservation Potential of above mentioned alternatives

Sr. No.	Intervention	Annual Energy Cons. Potential (kWh/year)	Capital Cost (INR)	Annual Cost Savings (INR)	Payback Period (yrs)
1	Lighting Replacement – 36 W	16,848	1,75,500	1,80,972	0.96
2	Lighting Replacement – 18 W	5,184	1,18,800	73,999	1.6
3	AC Replacement – 5-Star	80,058	32,99,000	7,86,970	4.2
4	Optimal AC Setting	28,500	0	2,80,155	NA
5	Optimal Use of Natural Lighting	15,400	0	1,51,382	NA
6	Occupancy Sensor Controlled Lights	4,800	62,080	47,184	1.3
7	Weather Stripping	Needs detailed modelling			
8	Window Glazing	Needs detailed modelling			
9	Heat Gain Reducing Pain	Needs detailed modelling			
10	Evaporative Air Cooling	Needs detailed modelling			
	Minimum Potential	**1,50,790 kWh savings/year**	**36,55,380 INR**	**15,20,662 INR**	**2.4 yrs**

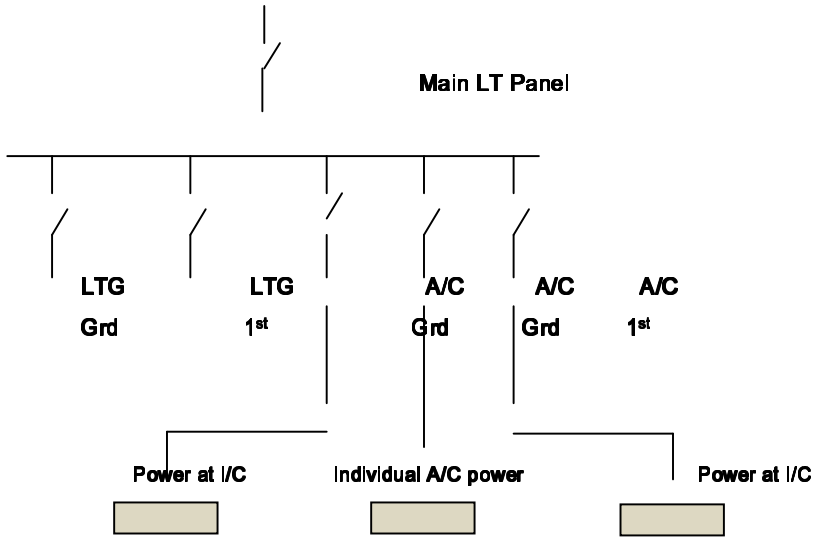
In summary:

- Post implementation of these interventions, it is estimated that the EPI of the Building will reduce to 149 kWh/m2/year and lead to a minimum of 2-Star Rating
- The annual cost savings will be approximately INR 15.2 Lac
- The initial capital cost for the projects will be INR 36.6 Lac
- The overall payback period for the interventions will be approximately 2.4 years

APPENDIX

Power Profiling of Air Conditioning units

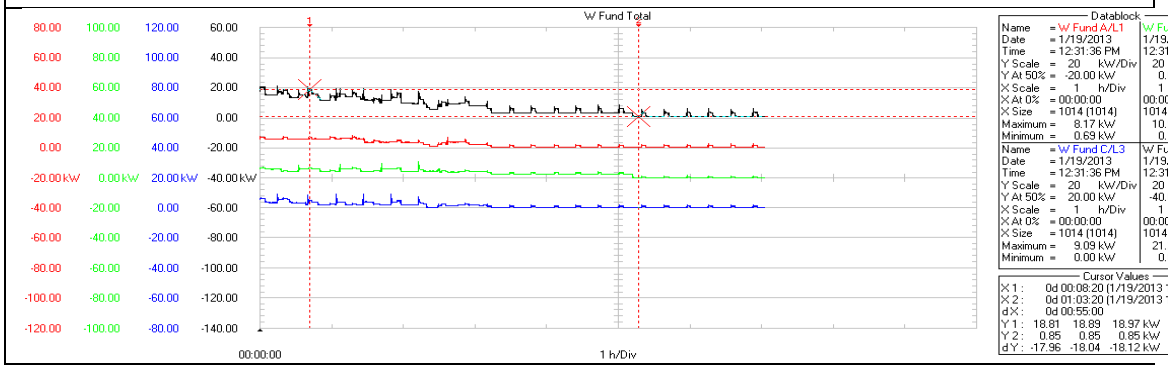
(a) Ground Floor A/C Power



Simplistic Power Distribution for A/C (Ground Floor)

Locations where power measurement was done for individual A/C unit outgoing feeders and cumulative power for all A/C units

Ground Floor Lobby AC Power



Recorded AC DB (Avg.)Power = 18.89 KW

MCB-11 => R/Y/B => 8.8/7.3/7.6 => 7.9A (Avg.)

MCB-12 => R/Y/B => 8.4/5.6/6.4 => 6.8A (Avg.)

MCB-13 => R/Y/B => 6.8/5.6/5.7 => 6.0A (Avg.)

MCB-14 => R/Y/B => 5.0/4.2/4.2 => 4.5A (Avg.)

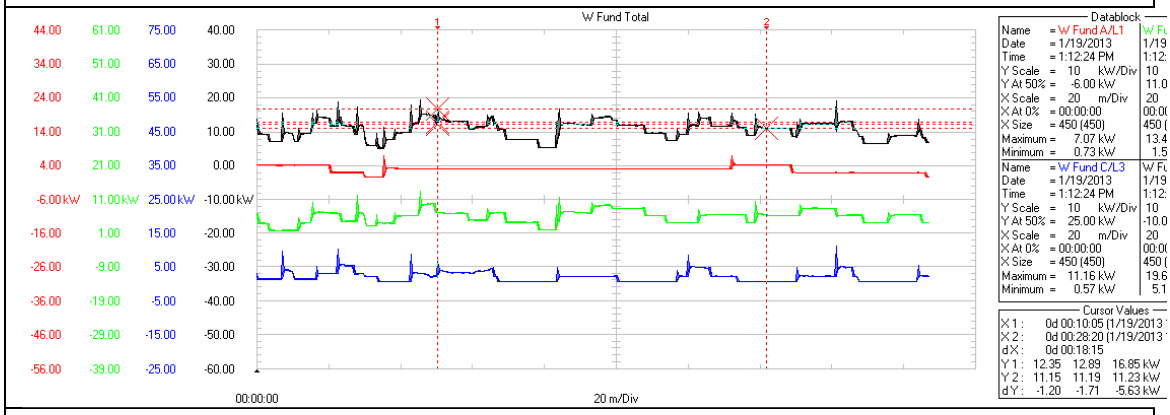
MCB-16 => R/Y/B => 6.8/5.4/5.3 => 5.8A (Avg.)

Total (Avg.)Amps => 31.0 A KW => 1.732x.411x 31x.86 => 18.97 KW

Indiusal Power + Recorded Power => 18.97+18.89 =>37.86 KW

The Screen above and the appended table thereto, show total recorded power of 37.86 KW for 30 TR A/C. The recorded KW/TR → 1.262

1ST Floor AC Power



Recorded AC DB (Avg.)Power = 16.85 KW

It can be seen from the trend above that the power variation is on larger scale in case of 1st Floor compared to that on the Ground Floor. Not all the A/C units are operational (especially owing to season at the time) therefore overall power consumption of 1st floor is also lesser compared to that on the Ground Floor. From the power consumption and based on above KW/TR, about 20 TR of A/C load could e estimated. Total power consumption of air conditioning load at the time of field visit: 54.71 KW.

Performance Assessment of individual A/C units

The A/C units under consideration are Split and Cassette units. Unlike the Chillers flow Chilled water flow and ΔT measurement was not possible. Thus the recording of parameters (dealt with computations herein under) of the outdoor units was the only option to assess TR being delivered by the units various capacities installed.

TR Delivered

3 TR Units: 9000

Approx. Outlet area for hot air rejection = 0.849 sq. Mtr.

Average (anemometer) velocity across outlet = 3.06 m/sec (2.598 m^3/Sec)

Average CFM at the outlet = 5504 CFM

Hot air:	D.B.T = 25 ºC	W.B.T. = 20 ºC
Conditioned Space (Average):	D.B.T = 23.5ºC	W.B.T. =18.5 ºC
Ambient =	D.B.T. = 24 ºC	W.B.T. 18 ºC

Enthalpy Difference: Cold Air & Hot air (heat) rejected 59.87 – 54.69 = 5.18 KJ/Kg

TR delivered (as computed) = 3.46 TR

2 TR Units: 6000

Approx. Outlet area for hot air rejection = 0.6358 sq. Mtr.

Average (anemometer) velocity across outlet = 3.52 m/sec		(2.238 m^3/Sec)
Hot air:	D.B.T = 24.5 ºC	W.B.T. = 19.5 ºC
Conditioned Space (Average):	D.B.T = 23.5ºC	W.B.T. =18.5 ºC
Ambient =	D.B.T. = 24 ºC	W.B.T. = 18 ºC

Enthalpy Difference: Cold Air & Hot air (heat) rejected 58.10 – 54.69 = 3.41 KJ/Kg

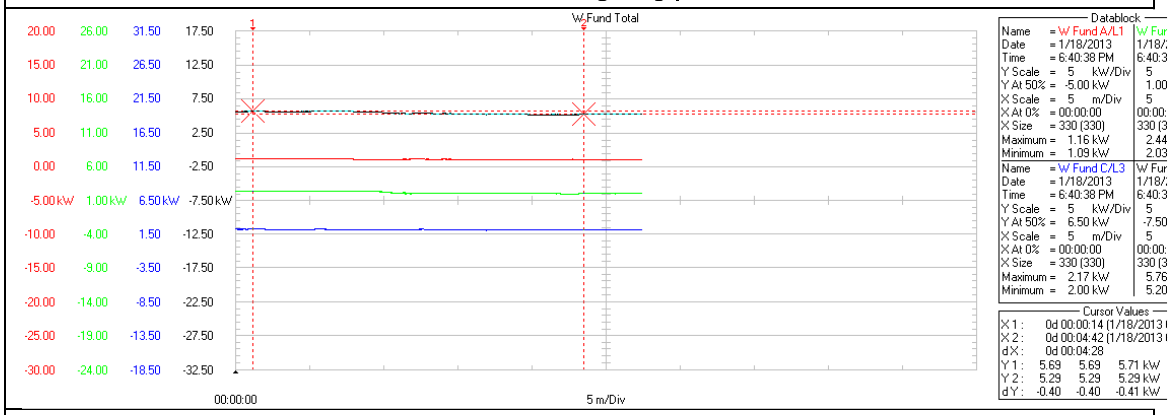
TR delivered (as computed) = 1.96 TR

Remarks:

- The delivered TR of unit rated 3 TR is slightly more whereas the delivered TR for unit rated 2 TR is close to the rating. Instrument errors plus misreading of DBT, WBT values could result in errors.
- Summarily, Cooling by A/C units picked up random basis was found OK.
- Performance of A/C units would depend upon ambient conditions and heat load; both are variable on daily and seasonal basis.

LIGHTING

Ground Floor Lighting power



Recorded Lighting DB (Avg.)Power => 5.71KW

1ST Floor Lighting DB => R/Y/B => 10.7/5.3/5.5 => 7.17A (Avg.)

KW => 3x.242x 7.17x.74 => 3.85 KW

Basement Lighting KW => .242x4x.74 => 0.716 KW

1 Minimize Recommendation No. 1

Intervention Type: External Paint
Site Location: Exterior Walls (except areas earmarked for Specialty Paints)

Background: Heat reflective paint would keep the interiors cooler by upto 5 degrees Celsius (because of it's high Solar Reflectance Index, double that of regular exterior paints) as compared to outside temperatures. This is expected to reduce Air Conditioning related energy consumption by up to 15%. Low-VOC paints have a lower environmental and health impact on inhabitants

Carbon Footprint and Cost Benefit Analysis:

Item	BAU	Intervention
Technology	Conventional Emulsion Paint	Heat Reflective Paint
Description/Brand	*BERGER PAINT Breathe Easy Emulsion*	*ICI DULUX Weathershield paint*
System Capacity/Size	9300 sq. ft	9300 sq. ft
Material Cost	24,180 INR	32,550 INR
Annual Energy Cost (Cooling)	44,52,937 INR	37,84,997 INR
Increased Capital Cost	NA	8,370 INR
Annual Energy Cost Savings	NA	6,67,941 INR
Payback Period	NA	0.0125 years
Carbon Footprint Mitigation	NA	84.9 tonnes CO2e/year

Recommended Brand: Heat-Reflective Low-VOC Dulux Weathershield
http://www.dulux.in/weathershield.jsp

2 Minimize Recommendation No. 2

Ducted Evaporative Air Cooling

Item	BAU	Units	Intervention	Units
Technology	Split-Unit AC (3 Star Rated)		Ducted Evaporative Air Cooling System	
Description/Brand	Bluestar		Breezair / Symphony	
System Capacity/Size	103.5	TR	89,783	cfm
Equipment Cost	20,79,041	INR	40,40,241	INR
Annual Energy Consumption	4,52,995	kWh/year	81,972	kWh/year
Annual Energy Cost (Cooling)	44,52,937	INR	8,05,785	INR/year
Increased Capital Cost	NA		19,61,200	INR
Annual Energy Unit Savings	NA		3,71,023	kWh/year
Annual Energy Cost Savings	NA		36,47,152	INR
Payback Period	NA		0.54	years
Carbon Footprint Mitigation	NA		464	tonnes CO2e/year