Draft

Energy Analysis Report

JSW Headquarters

Mumbai, INDIA

Prepared By

(Low Carbon Consultant)

Global Evolutionary Energy Design,

D-15 Abul Fazal Enclave

Jamia Nagar New Delhi – 110025,

M +91 9873588571

O +91 011 24537371

E – Mail: adil@geedindia.org,

Project		Release V1.0
Report		
Date		Signature

Table of Contents

Summary

Project Description	JSW headquarters at Mumbai for LEED NC rating.
Conditioned Area	2, 14,000 sq ft approx

Energy Consumption and Comparison results

ASHRAE 90.1 2004 Budget building average	4,889,702 Kwh
Proposed building	3,643,325 Kwh
% savings	25.49
Kwh savings	1,246,377
Potential LEED points	5

This is a preliminary analysis and several points need discussion before the final analysis.

The savings are likely to go up by 1-2 % as the model is refined further.

1 Energy Issues Addressed in the Report

- Minimum energy performance as per LEED NC
- Optimized energy credits under LEED NC
- Energy conservation opportunities
- Impact of various energy conservation options
- Energy savings for the optimized design

2 Introduction

This report presents the results of an analysis of energy efficiency opportunities for the JSW headquarters building located at Mumbai, India. It is a 2, 14,000 ft^2 of conditioned area building housing office space.

The objective of this analysis is to assess the energy benefits associated with energy-efficient design features focusing on the design, envelope, lighting and system specifications. The features include adding insulation on roofs, using high performance glazing, shading, efficient lighting design and using energy efficient HVAC measures

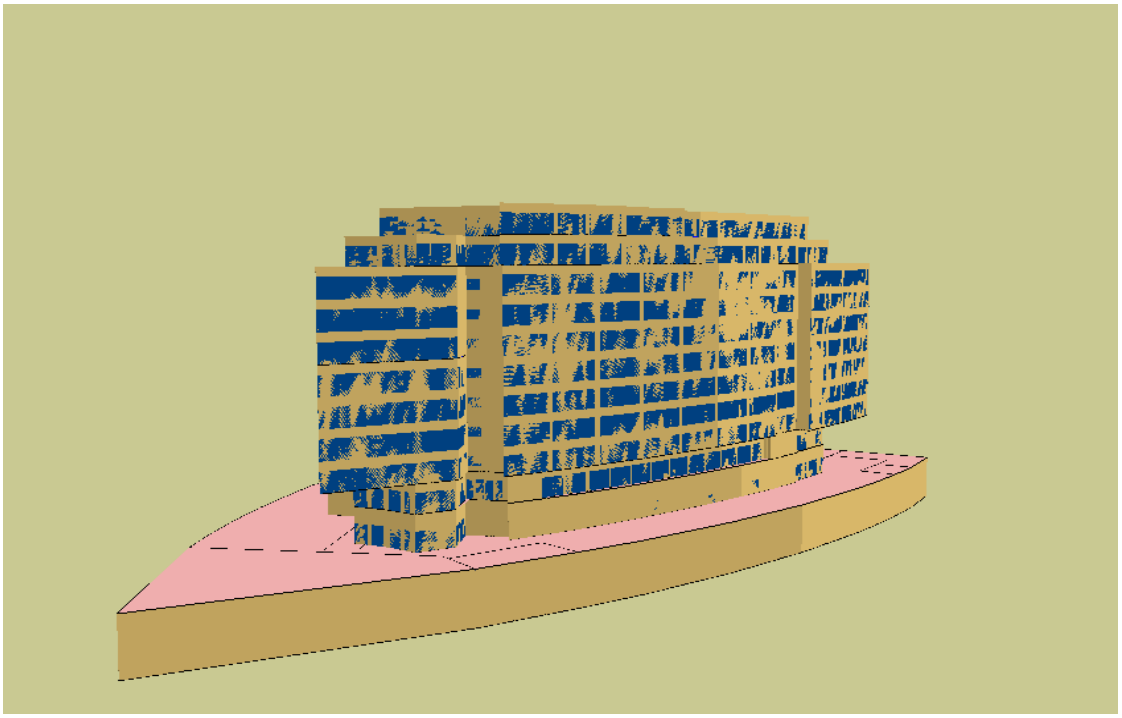


Fig 1: 3D View of simulation model

3 Weather Data and Design Conditions

Location : Mumbai
Latitude (°N) : 18.90
Longitude (°E) : 72.80
Altitude (m) : 8

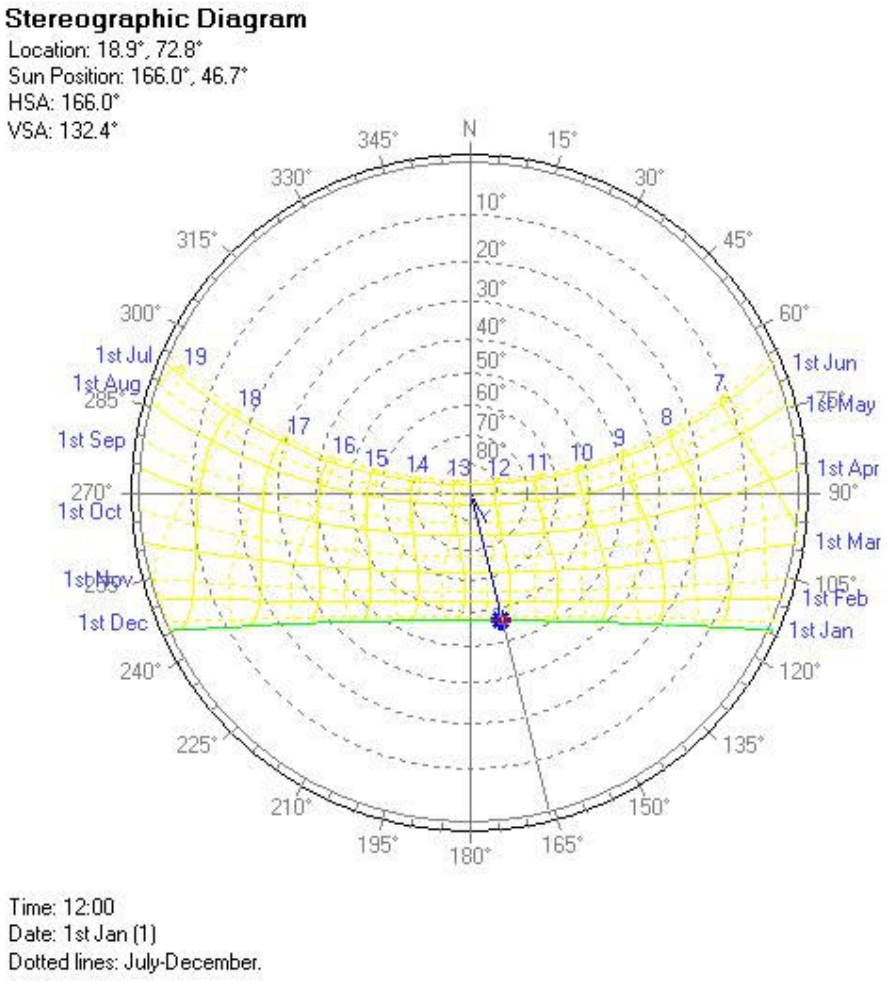


Chart 1. Sun Path Diagram for Mumbai

4 Building Energy Modeling

Building energy performance was modeled using Visual DOE 4.1 program which uses the DOE 2.1 simulation engine. A budget case model minimally complying with ASHRAE/IESNA 90.1-2004 was developed and simulated in Visual DOE 4.1. Various Energy conservation measures (ECMs) focusing on the envelope, lighting and HVAC were identified and incorporated into the model to arrive at the proposed case.

Estimates for occupancy and schedules were obtained from the design team and incorporated into the analysis.

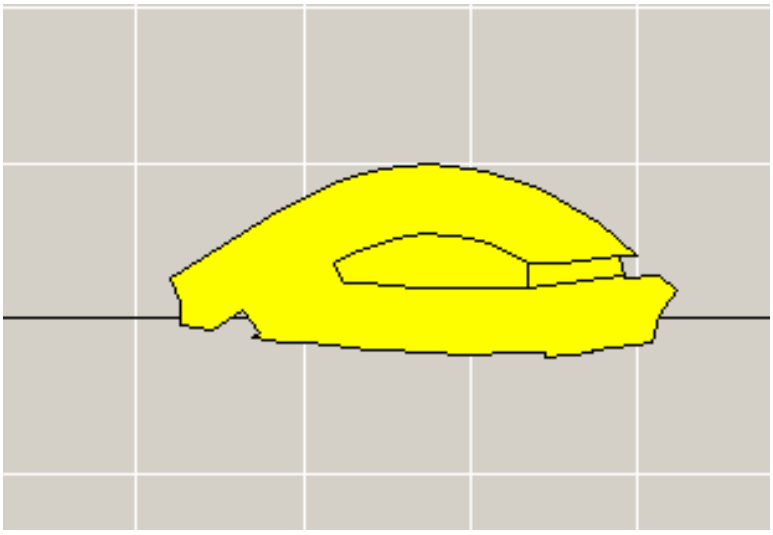


Fig 2: Typical floor outline

5 AHSRAE Base Case Parameters

The Budget Building was developed on the basis of the prescriptive requirements of Appendix G of ASHRAE/IESNA Standard 90.1-2004. The building is simulated with its actual orientation and again after rotating the entire building 90,180,270 degrees, then averaging the results. The Budget Building model input parameters are as follows

Building Envelope

- Exterior Wall Construction: Steel-frame construction, R-13 insulation, U-factor=0.124 Btu/hr.ft^2.ºF
- Roof construction: Insulation entirely above deck, R=15ci,u-factor=0.063,Roof reflectivity=0.30
- Fenestration Type: Percentage of glass is 40 % or as per design, whichever is lower.40 % in this case.
    - U-Value : 1.22 Btu/hr.ft^2.ºF
    - SHGC : 0.19
    - VLT : 19 %
- Shading Device: None

Lighting & Equipment

- An average lighting power density of 1.0 W/ft^2 in office areas (Whole building area method) and LPD of 0.30 W/ft^2 in parking
- No Daylighting controls

System

- A Variable Air Volume (VAV) system with 2 inches of static fan and reset by warmest zone
- No heat recovery

Central Plant

- Water cooled screw chiller with a full load efficiency of 0.639 Kw/T (a COP of 5.5 at ARI conditions)
- Primary secondary pumping with variable speed drives

Electrical End-use Totals (kWh)

Alternative	Lights	Equip.	Cooling	Tower	Pumps	Fans	Ext. Lights	Ext. Equip.	Total
ASHRAE Base Case 0	1,367,122	1,403,584	1,488,598	297,927	73,874	206,183	32,713	126,360	4,996,366
ASHRAE Base Case 90	1,367,122	1,403,584	1,370,504	255,182	67,916	193,663	32,713	126,360	4,817,044
ASHRAE Base Case 180	1,367,122	1,403,584	1,450,353	278,371	72,035	200,719	32,713	126,360	4,931,265
ASHRAE Base Case 270	1,367,122	1,403,584	1,367,693	254,897	67,750	194,012	32,713	126,360	4,814,132
ASHRAE Base Case Average	1,367,122	1,403,584	1,419,287	271,594	70,394	198,644	32713	126,360	4,889,702

Table 1: Energy use comparison for ASHRAE base buildings

6 Proposed Case Parameters

Same as ASHRAE base case but shading is taken into account. Also percentage of glass is as per the design

Building Envelope

- Exterior Wall Construction: Steel-frame construction, R-13 insulation, U-factor=0.124 Btu/hr.ft^2.ºF
- Roof construction: Insulation entirely above deck, R=15ci,U-factor=0.063,Roof reflectivity=0.30
- Fenestration Type: Glass as per design
    - U-Value : 1.22 Btu/hr.ft^2.ºF
    - SHGC : 0.19
    - VLT : 19 %
- Shading Device: Exterior shades as per design

Lighting & Equipment

- An average lighting power density of 1.0 W/ft^2 in office areas (Whole building area method) and LPD of 0.30 W/ft^2 in parking
- No Daylighting controls

System

- A Variable Air Volume (VAV) system with 2 inches of static fan and reset by warmest zone
- No heat recovery

Central Plant

- Water cooled screw chiller with a full load efficiency of 0.639 Kw/T (a COP of 5.5 at ARI conditions)
- Primary secondary pumping with variable speed drives

Alternative	Lights	Equip.	Cooling	Tower	Pumps	Fans	Ext. Lights	Ext. Equip.	Total	% savings over ASHRAE
ASHRAE Base Case Average	1,367,122	1403584	1,419,287	271,594	70,394	198,644	32,713	126360	4,889,702	
Proposed case	1,367,122	1,403,584	1,450,453	276,574	72,018	202,984	32,713	126,360	4,931,810	**-0.86**

Table 2: Energy use comparison for ASHRAE base and Proposed buildings

The proposed design shows negative savings compared to ASHRAE due to its orientation and high percentage of glass.

7 Energy Conservation Measures

Following energy conservation measures were applied

7.1 ECM 1: External Walls - AAC Blocks

Description

This ECM evaluated the impact of using AAC blocks to the base case building. The specification of AAC blocks are as follows

- Conductivity : 0.1216 Btu/hr ft^2 °F
- Density : 42.03 lb/ft^3
- Specific Heat : 0.3 Btu/lb-°F

7.2 ECM 2: High Albedo Roof with insulation

Description

A typical roof reaches temperatures higher temperature in sunlight than a white roof. With a lower temperature roof, less air conditioning is necessary. This ECM models the impact of adding 3 inches of extruded polystyrene insulation overdeck and a white reflective surface on top.

7.3 ECM 3: High Performance Glazing

Description

The base case glazing was selected based on the prescriptive requirements ASHRAE 90.1-2004, and is very energy efficient. This ECM evaluates the impact of replacing the base case glazing with another high performance glass. The glass simulated in this case has the following specifications

- U-Value : 0.33 Btu/hr.ft^2.ºF
- SHGC : 0.16
- VLT : 30%

7.4 ECM 4: Reduced Lighting

Description

The average lighting power density in the base case was 1.0W/ft2. In this ECM, the lighting power density was reduced to 0.9 W/ft2 in all areas and 0.23 in parking.

7.5 ECM 5: Occupancy Sensors

Description

On/off occupancy sensors for common areas like stairs, lobbies etc have been modeled by reducing the lighting power density by 10 % in these areas. This is as per ASHRAE guidelines.

7.6 ECM 6: Chiller with COP 10

Description

A Water cooled centrifugal chiller with a full load efficiency of 0.351 Kw/T (a COP of 10 at ARI Conditions)

7.7 ECM 7: Heat Recovery from Exhaust

Description

A heat recovery ventilator (HRV) can help make mechanical ventilation more cost effective by reclaiming energy from exhaust airflows. HRVs use heat exchangers to heat or cool incoming fresh air, recapturing 60 to 80 percent of the conditioned temperatures that would otherwise be lost. Models that exchange moisture between the two air streams are referred to as Energy Recovery Ventilators (ERVs). ERVs are especially recommended in climates where cooling loads place strong demands on HVAC systems. A heat recovery wheel with 75 % effectiveness has been modeled for each Ahu.

7.8 ECM 8 Cooling Tower Measures

Description

Adding variable frequency drives for cooling tower. This reduces the energy consumption and in some periods may reduce billed demand.

7.9 ECM 9: Daylight Sensors

Description

Dimming daylight sensors have been modeled in office areas.

Electrical End-use Totals (kWh)

Alternative	Lights	Equip.	Cooling	Tower	Pumps	Fans	Ext. Lights	Ext. Equip.	Total	% savings over Proposed case
Case 01 Wall AAC	1,367,122	1,403,584	1,450,084	274,398	72,036	204,041	32,713	126,360	4,930,338	0.03%
Case 02=01+Roof Ins	1,367,122	1,403,584	1,446,892	274,140	71,875	203,226	32,713	126,360	4,925,912	0.12%
Case 03 =02+HP Glass	1,367,122	1,403,584	1,394,338	252,907	69,424	199,313	32,713	126,360	4,845,761	1.74%
Case 04 =03+LPD	1,209,792	1,403,584	1,370,228	249,753	68,214	193,087	32,713	126,360	4,653,731	5.64%
Case 05 =04+Occ sensors	1,196,567	1,403,584	1,367,848	249,466	68,094	192,540	32,713	126,360	4,637,172	5.97%
Case 06 =05+Chiller COP 10	1,196,567	1,403,584	751,772	248,470	68,094	192,540	32,713	126,360	4,020,100	18.49%
Case 07 =06+Heat Recovery 75 Eff	1,196,567	1,403,584	597,327	201,825	54,473	189,255	32,713	126,360	3,802,104	22.91%
Case 08 =07+Cooling tower VFD	1,196,567	1,403,584	597,327	197,313	54,473	189,255	32,713	126,360	3,797,592	23.00%
Case 09 =08+ Daylight sensors	1,065,560	1,403,584	584,796	194,153	53,342	182,817	32,713	126,360	3,643,325	26.13%

Table 3: Energy use comparison for various ECMs

8 Optimized Case Parameters

8.1 Optimized Case

Building Envelope

- Exterior Wall Construction: The basic wall section consists of 9 inch thick AAC blocks
- Roof construction: 3 inches of overdeck extruded polystyrene insulation and a white reflective surface., U factor=0.057 Btu/hr.ft^2.ºF
- Fenestration Type:
  - U-Value : 0.33 Btu/hr.ft^2.ºF
  - SHGC : 0.16
  - VLT : 30%
- Shading Device: External Shading is modeled

Lighting & Equipment

- The average lighting power of 0.9 W/ft2 in all areas and 0.23 in parking.
- Occupancy Sensors in common areas like lifts, lobbies etc

System

- A Variable Air Volume (VAV) system with 2 inches of static fan and reset by warmest zone
- Heat recovery with 75 % efficiency

Central Plant

- Water cooled centrifugal chiller with a full load efficiency of 0.351 Kw/Ton (a COP of 10.0 at ARI conditions)
- Primary secondary pumping with variable speed drives
- VFD drive on in cooling towers

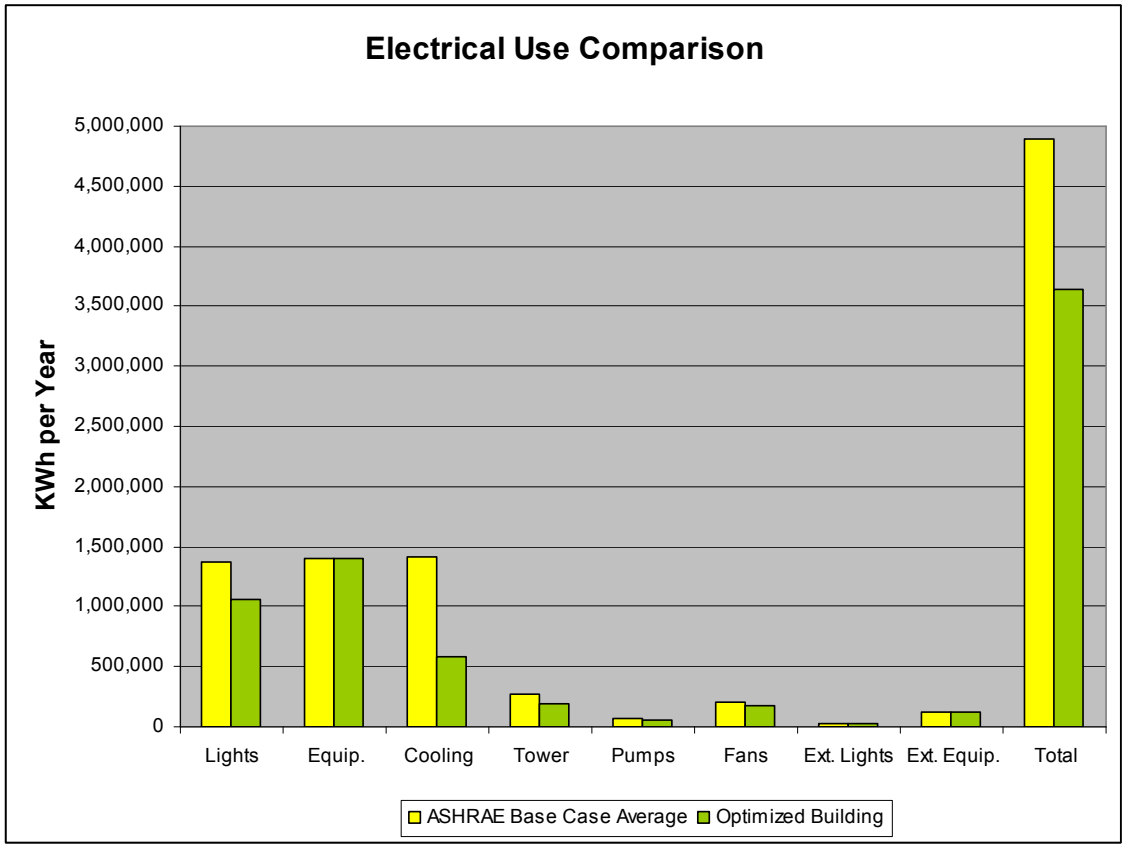
9 Results and Conclusion

Electrical End-use Totals (kWh)

Alternative	Lights	Equip.	Cooling	Tower	Pumps	Fans	Ext. Lights	Ext. Equip.	Total	% savings over ASHRAE
ASHRAE Base Case Average	1,367,122	1403584	1,419,287	271,594	70,394	198,644	32,713	126360	4,889,702	
Optimized Case	1,065,560	1,403,584	584,796	194,153	53,342	182,817	32,713	126,360	3,643,325	**25.49**

Table 4: Energy use comparison for ASHRAE base and Optimized buildings

The proposed case with energy conservation measures applied shows 25.49 % or 1,246,377 Kwh savings over the ASHRAE 90.1.2004 baseline building



10 Energy Efficiency Credits in the LEED NC Energy Rating

Intent

Achieve increasing levels of energy performance above the baseline in the prerequisite standard to reduce environmental and economic impacts associated with excessive energy use.

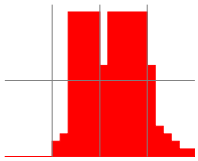
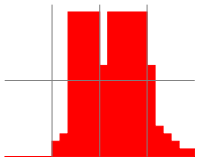
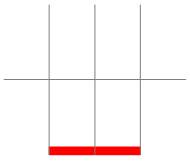
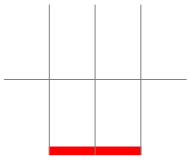
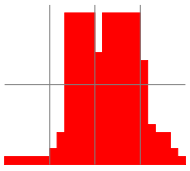
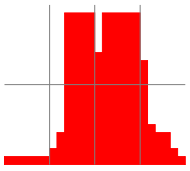
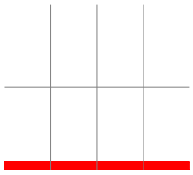
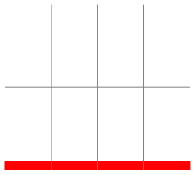
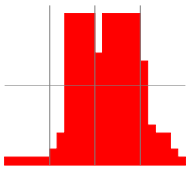
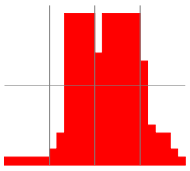
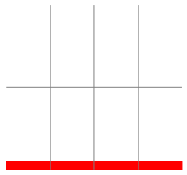
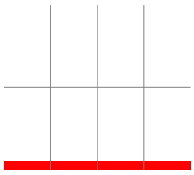
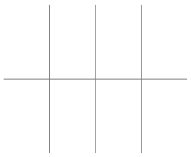
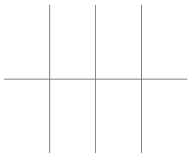
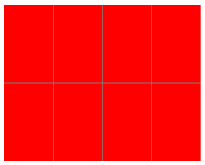
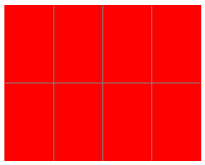
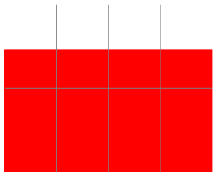
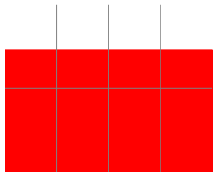
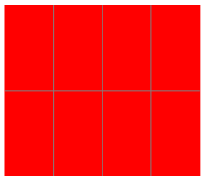
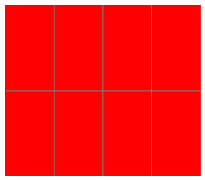
Whole Building Energy Simulation **(1–10 Points)**

Demonstrate a percentage improvement in the proposed building performance rating compared to the baseline building performance rating per ASHRAE/IESNA Standard 90.1-2004 by a whole building project simulation using the Building Performance Rating Method in Appendix G of the Standard. The minimum Energy cost savings percentage for each point threshold is as follows:

New Buildings	Existing Building Renovations	Points
10.5%	3.5%	1
14%	7%	2
17.5%	10.5%	3
21%	14%	4
24.5%	17.5%	5
28%	21%	6
31.5%	24.5%	7
35%	28%	8
38.5%	31.5%	9
42%	35%	10

11 Appendix B: Schedules

Table B-2 Schedules Used for Office Area

	Weekday	Saturday	Sunday	Holiday
Schedule	600 1200 1800	600 1200 1800	600 1200 1800	600 1200 1800
Office Occupants				
Office Lights				
Office Equipment				
Office Infiltration				
Office Cooling Temperature (74 F)				
Office Fan