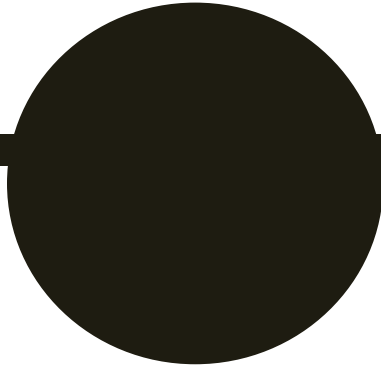


Saving The BlackGold

Optimizing Energy Performance in A
Typical Existing Residential
Apartment Building In Jeddah, Saudi
Arabia



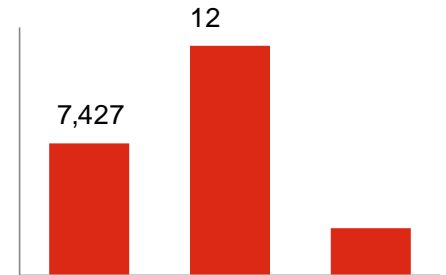
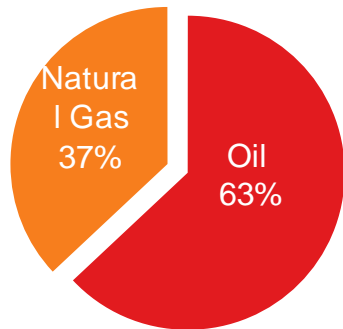
The thesis will test and analyze how much energy can be saved by applying energy conservation measures arrived through passive analyses first, and then through energy simulation in a typical existing residential apartment building in Jeddah, Saudi Arabia. This simulation will model the results of one building in Jeddah, and then the results can be implemented in similar buildings throughout Jeddah.

++Thesis Statement

++Goals

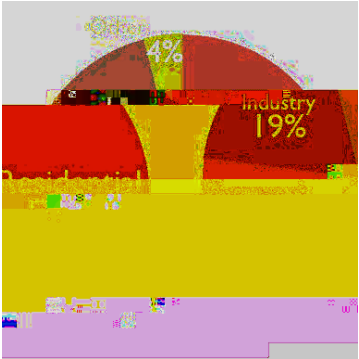
++

The total generated amount of electricity in Saudi Arabia in 2011



++Why Residential Buildings??

Residential buildings in Saudi Arabia consume 50% of the country's



++Why Apartments??

Electricity Consumption
by Sector

Housing Type Breakdown
in Jeddah City

The Major Factor

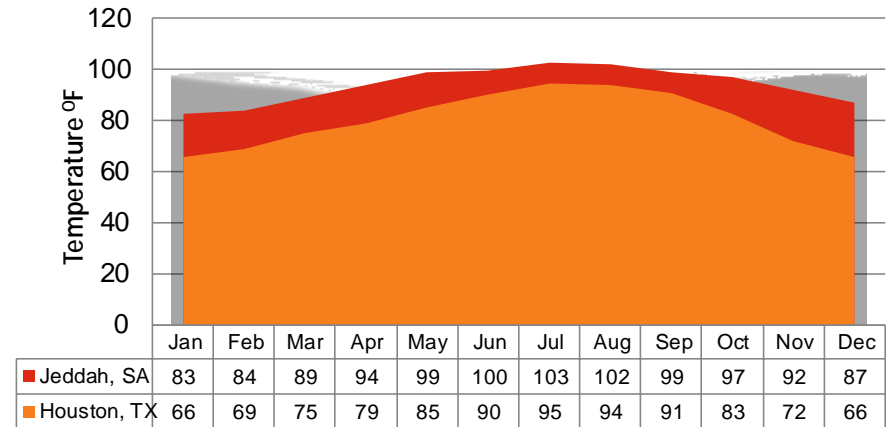
The Climate

++Factors in Electricity Consumption

1-The Climate

Summer94

Average Daytime Temperatures



++Factors in Electricity Consumption

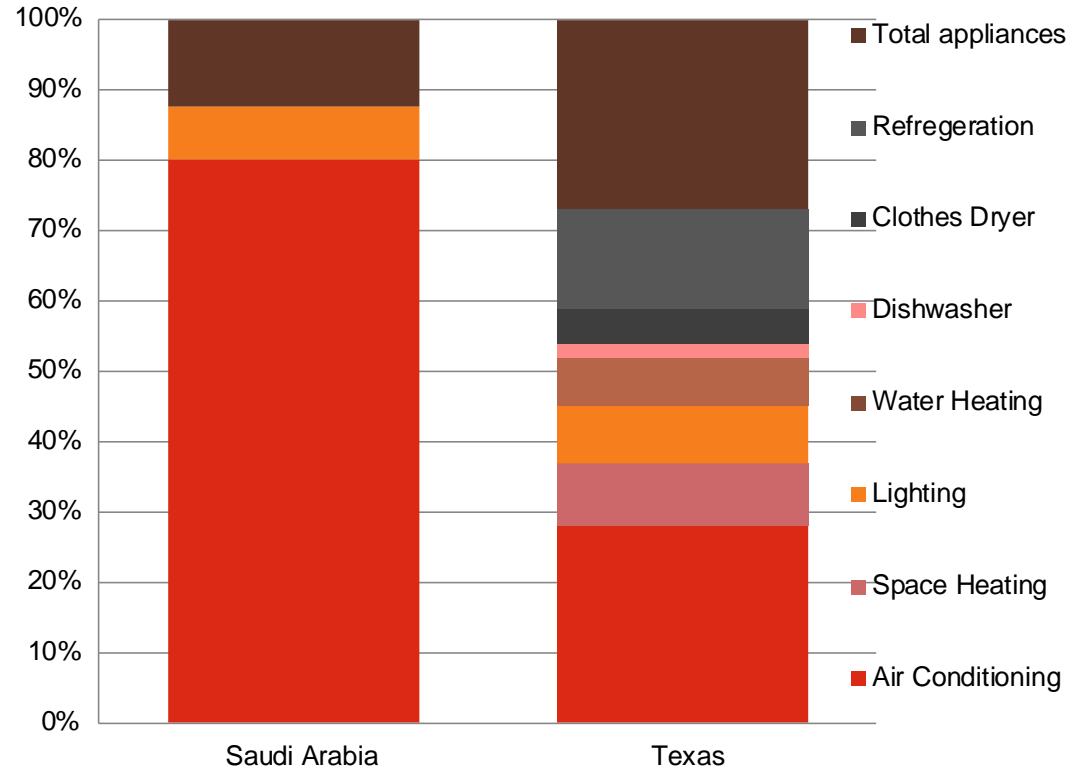
1-The Climate

80%

of the household electricity consumption is by Air Conditioning

The average A/C working hours in Saudi Arabia is between 16-17 hours and 24 hours in some cases

While cooling and heating in Texas is 9 hours



Household End-Use Comparison between Saudi Arabia and Texas

Methodology⁺⁺

Collecting
Data

Weather Data
files

Architectural
Drawings

- Floor Plans
- Elevations
- Sections



Type	Description
Number of	



++The Studied building

3-Building Construction Assembly

Wall
Assembly

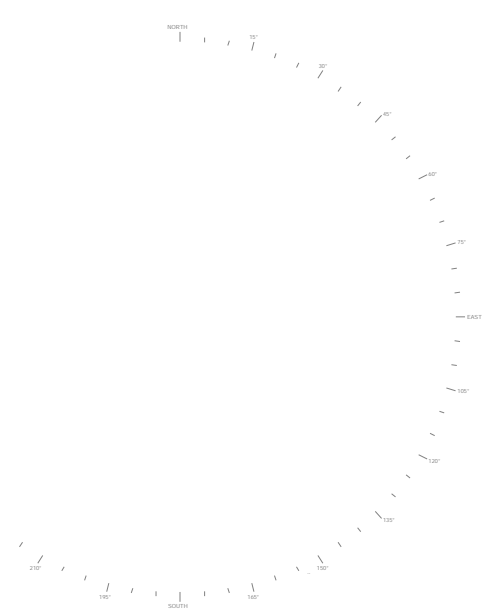
Roof
Assembly

Windows
Assembly

++Climate Analysis

1-Climate Classification

2-Wind Analysis



++

Annual solar radiation collected

Suggested Best Orientation:

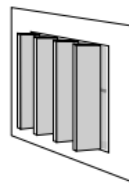
Suggested Worst Orientation:

Studied building Orientation:

Worst Orientation

Annual Incident Solar Radiation Co

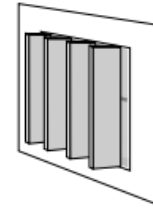
++ Solar Radiation Analysis



Vertical fins: useful on north to block early morning and late afternoon low sun.

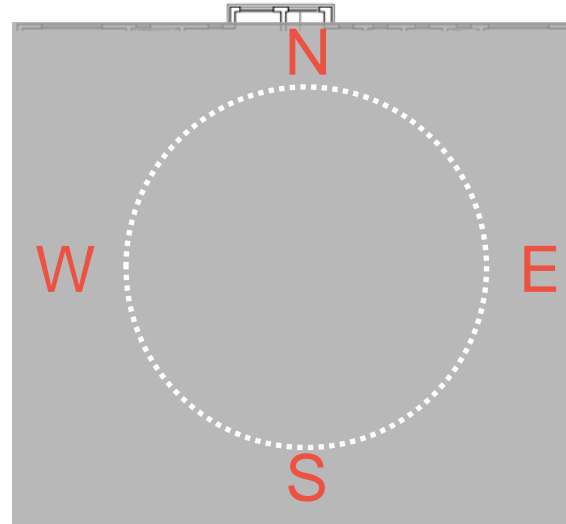
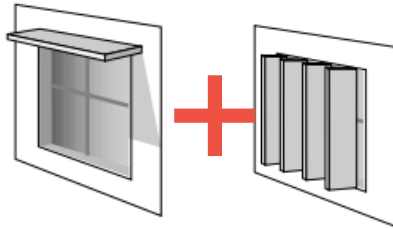
Vertical fins: best on East.

Overhang useful on the east and west.

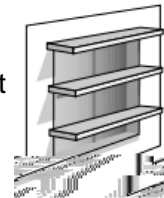


Overhang useful on the east and west.

Vertical fins: best on west.



Horizontal Louvers: best on south



++ Solar Radiation Analysis

Shading and Incident solar radiation Analysis

This analysis was applied for each façade on the 4th floors to identify what type of shading devices were suitable for the building.

Passive Design Analysis ++
[Daylight Analysis]

[Energy Simulation]

Thermal Analysis

Cooling Loads

Autodesk Ecotect

Internal Loads Analysis

Lighting Loads
Electrical Appliances

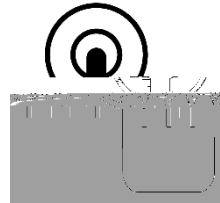
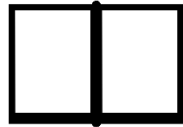
Open Studio
Energy Plus

[Thermal Analysis]

++

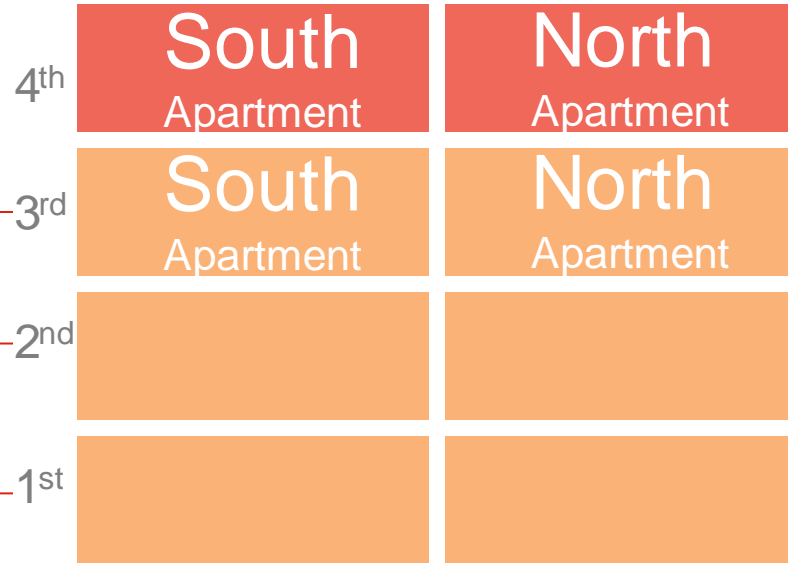
Building Baseline

Energy Conservation Measures FootPaE 92nation 0.002 Tccn /



++Calculation Process

5th-6th Penthouse



The Result

x3

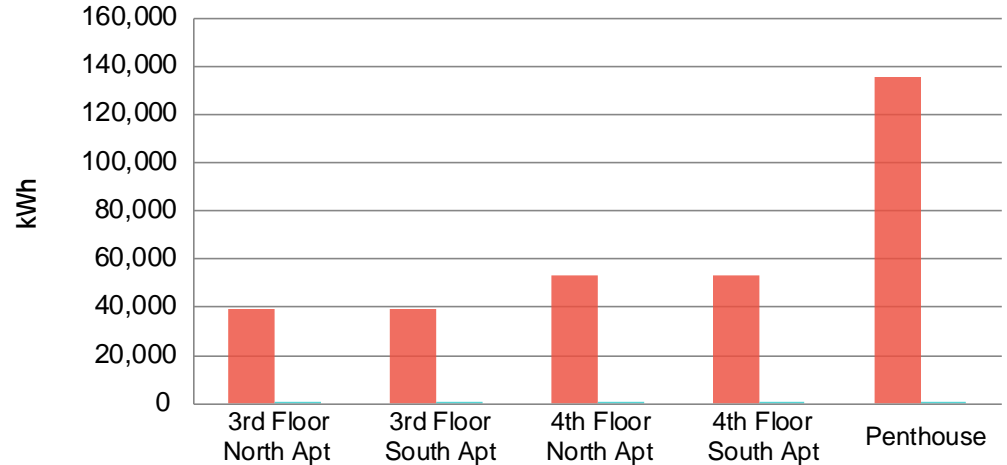
The Result

x3

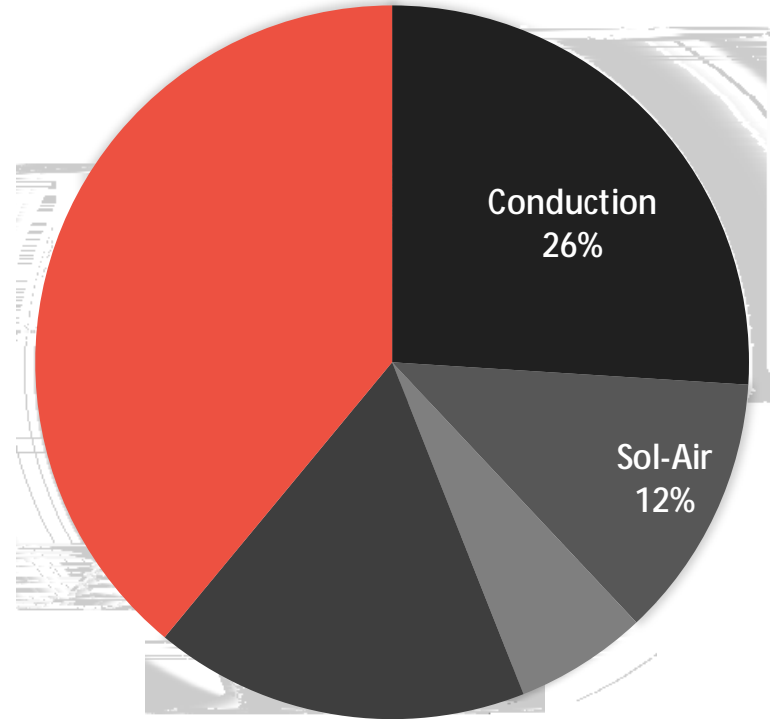
++Thermal Analysis

Building Baseline

Annual Cooling Load Baseline



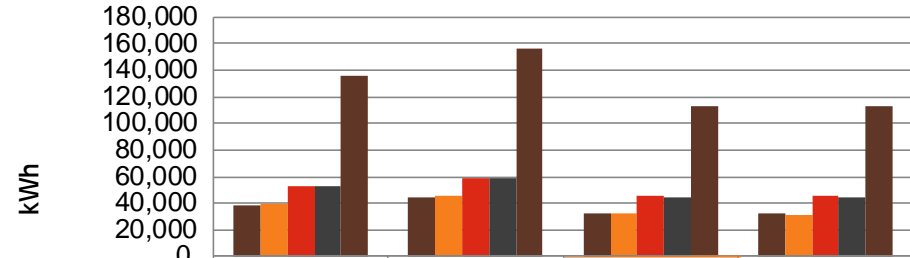
	North Apt. 1 st -3 rd Floors	South Apt. 1 st -3 rd Floors	4th Floor North Apt.	4th Floor South Apt.	Penthouse
Annual Cooling Load kWh	39,073	39,407	53,242	53,502	135,563
Cooling load- kWh/m2	163	164	220	222	244



++Thermal Analysis

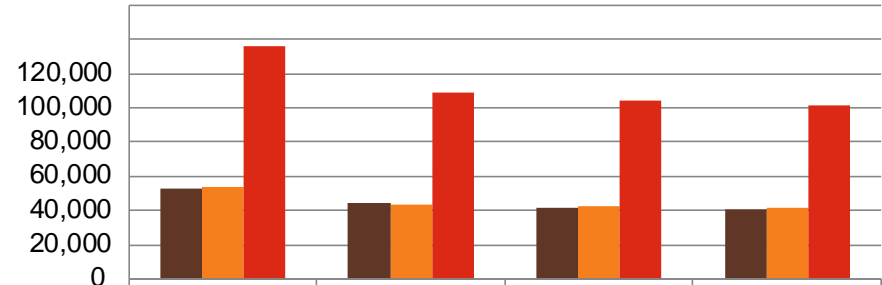
Energy Conservation Measures

Energy Conservation Measures Walls



	(Baseline) Red Clay Brick	(Alt 1) Concrete Block	(Alt 2) Red Clay Brick with 50mm Extruded Polystyrene	(Alt 3) Red Clay Brick with 75mm Extruded Polystyrene
■ 3rd Floor North Apt	39,073	44,332	32,692	32,497
■ 3rd Floor South Apt	39,407	45,625	31,977	31,754
■ 4th Floor North Apt	53,242	58,695	46,115	45,946
■ 4th Floor South Apt	53,502	59,219	44,629	44,423
■ Penthouse	135,563	156,610	113,382	112,854

Insulated Red Clay Brick Wall – Type 1				



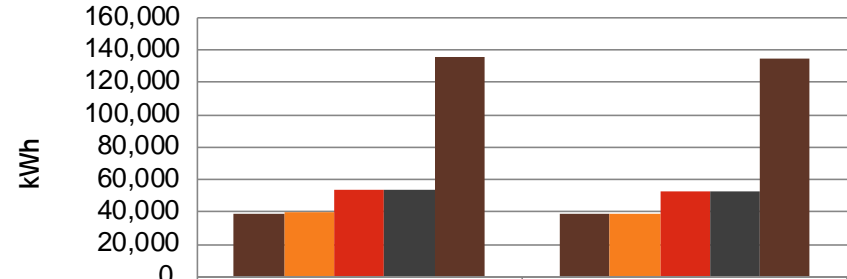
	Concrete Roof (Baseline)	Insulation Type 1 - 25mm	Insulation Type 2 - 50mm	Insulation Type 3 - 75mm
■ 4th Floor North Apt	53,242	44,248	41,849	41,110
■ 4th Floor South Apt	53,502	43,865	42,380	41,703
■ Penthouse	135,563	108,774	103,813	101,617

++Thermal Analysis

Energy Conservation Measures

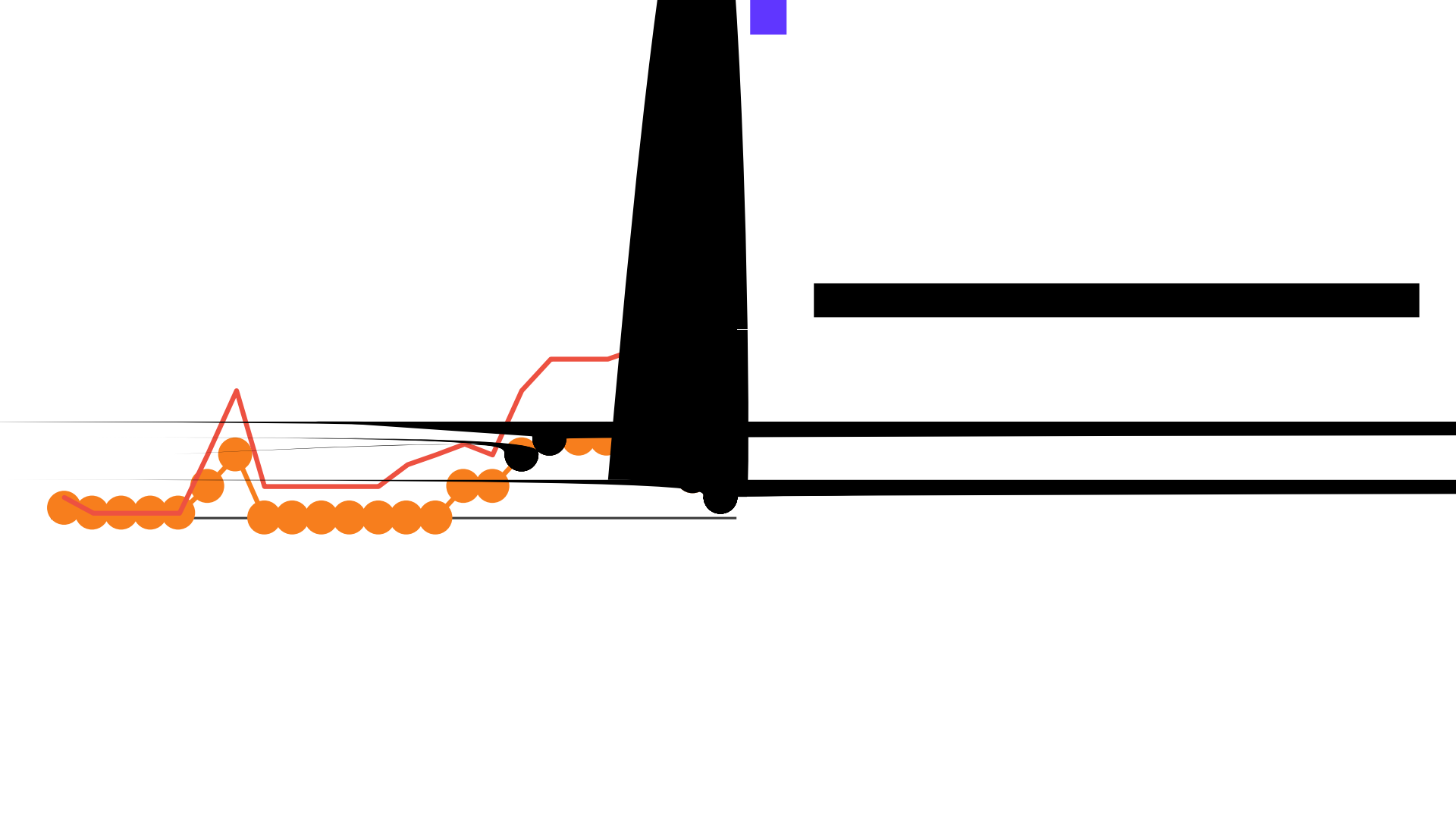
Shading Devices

Energy Conservation Measure
Shading Devices



	Baseline	With Shading Devices
■ 3rd Floor North Apt	39,073	38,838
■ 3rd Floor South Apt	39,407	39,167
■ 4th Floor North Apt	53,242	52,874
■ 4th Floor South Apt	53,502	52,365
■ Penthouse	135,563	134,334

Shading Devices				
Units				



- 30% 3 30% x

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++Thermal Analysis

Energy Conservation Measures

Internal Appliances

Electrical Appliances Loads	Apartments	Penthouse
baseline	5.7 W/m ²	5.7 W/m ²
Efficient Electrical Appliances 1	3.875008 W/m ²	3.875008 W/m ²

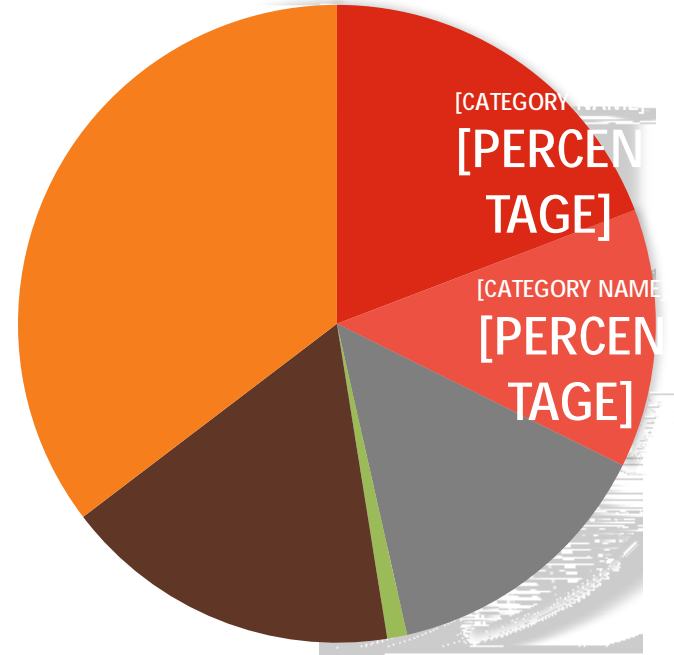
1. ASHRAE_189.1-2009 Climate Zone 1-3 Mid-rise Apartment - Electric Equipment standard (Openstudio Database)

No Cooling Load Reduction

By applying efficient Appliances

++Thermal Analysis

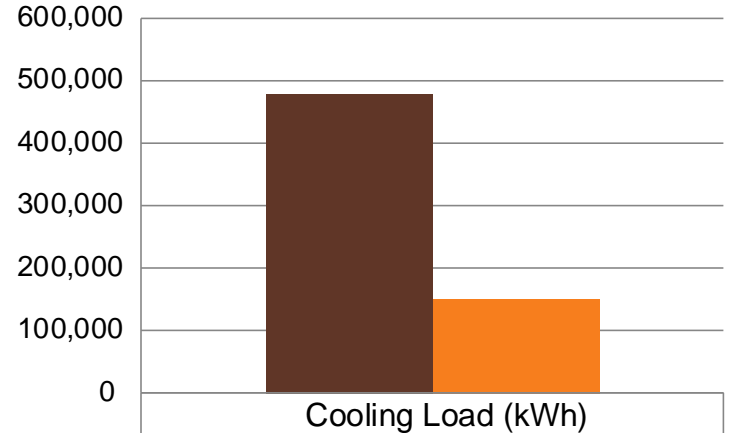
Energy Conservation Measures Summary



++Thermal Analysis

Whole Building Cooling Loads

Whole Building Cooling Loads



■ Required cooling load (Baseline)	477,747
■ Required cooling load after applying all ECM	149,595

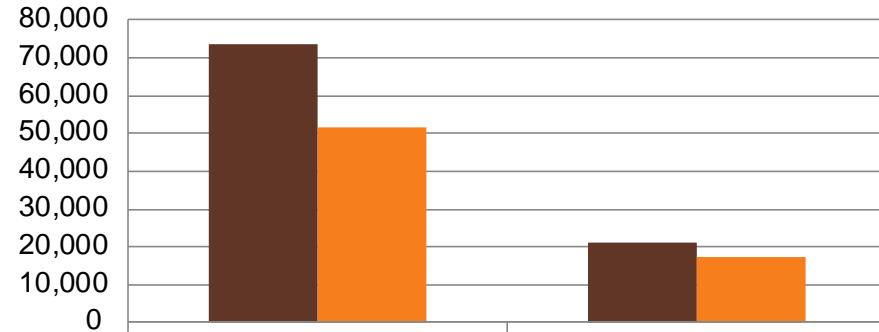
	Annual required Cooling load	Cooling Load kWh/m ²
Baseline	477,747	193
The Building with all EMC	149,595	vi4.14(o)25

++

++Internal Loads

Lighting Usage Pattern

Efficient Lighting Usage Behavior



■ Baseline - kWh	73,530	21,150
■ After Schedule - kWh	51,560	17,400
Savings	30%	18%
Energy Reductd()T4	230 1334(duc)-32(t)-16(d()EOR)-172(t)-16d172(t)-	

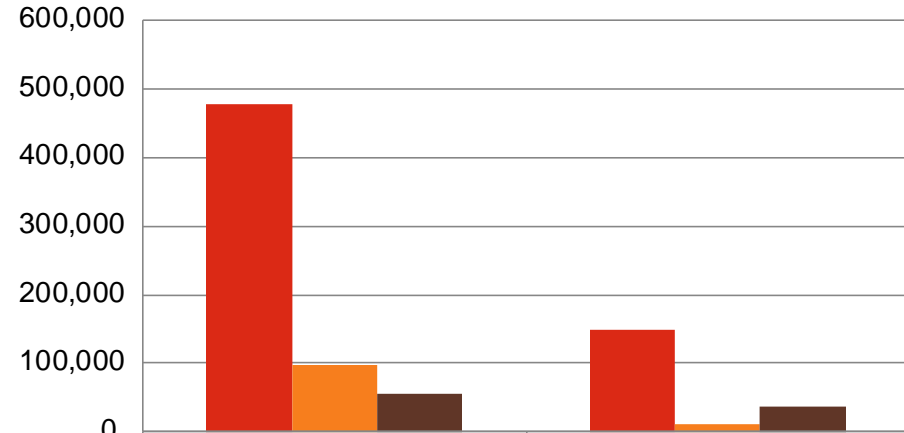
++InternalLoads

Efficient Lighting Fixture

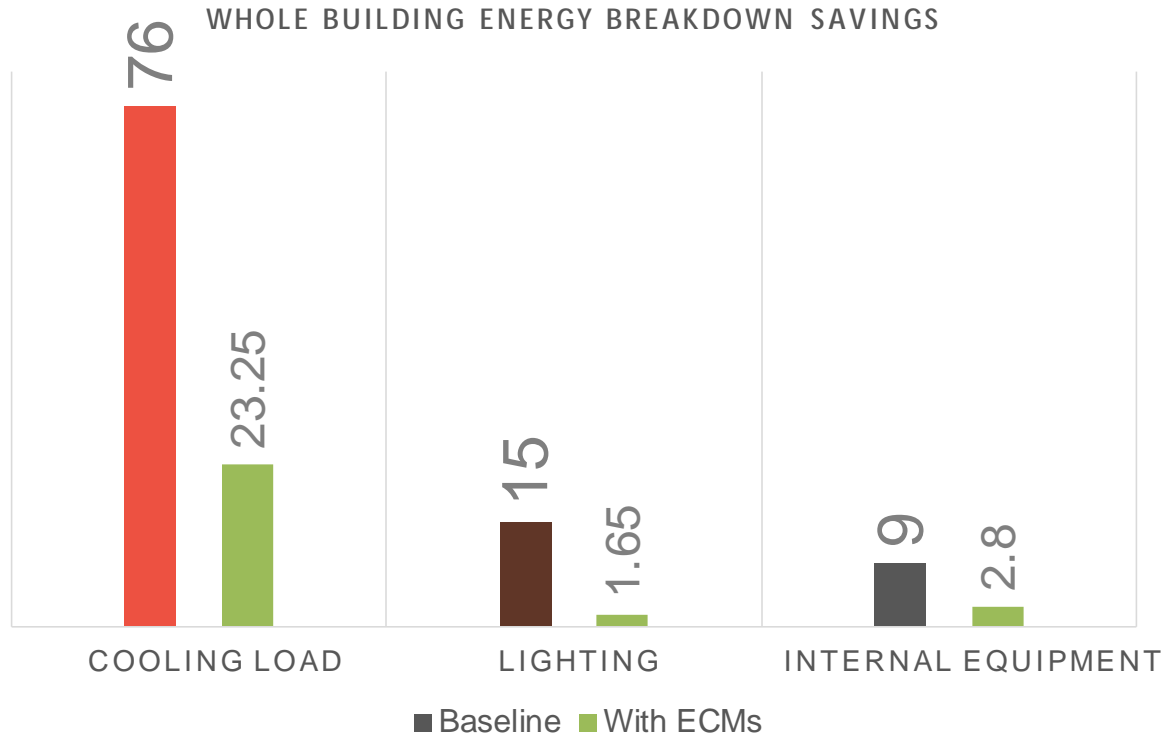
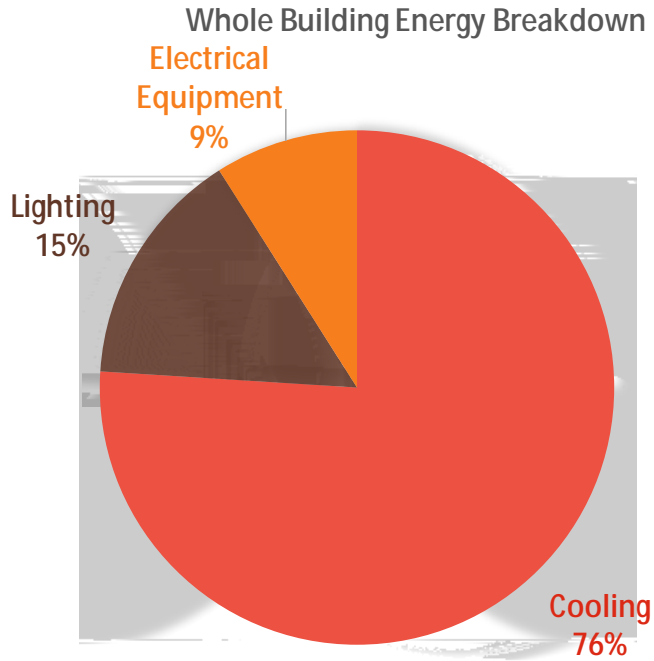
++Energy Simulation

Whole Building Energy Analysis

Whole Building Energy A



	Baseline	After ECM
■ Cooling Loads	477,747	149,595
■ Lightng Loads	96,680	10,883
■ Electrical Equipment	55,880	37,900



++Energy Simulation

Whole Building Energy Analysis

Baseline

The Average three bedroom apartment
In Jeddah City Consume

53,300kWh

Fourbedrooms penthouse
Consume

174,000kWh

With
ECM

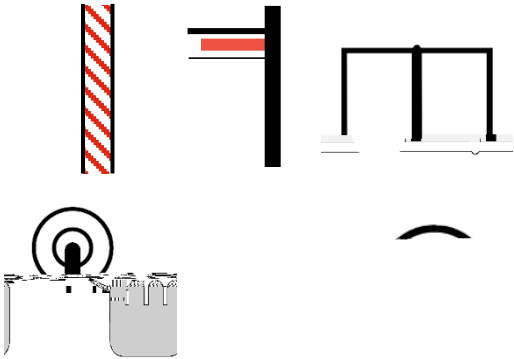
18,000 kWh

66% Reduction

50,800 kWh

71% Reduction

Energy Conservation
Measures



Residential Buildings



Energy Reduction

68%

