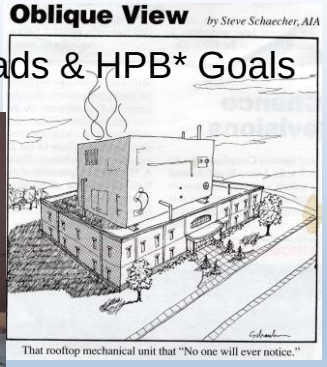
Building Loads & HPB* Goals



* High Performing Building

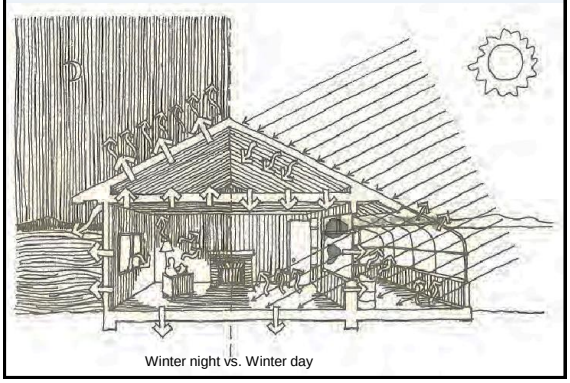
1

Two sources of loads: Skin & Internal

Skin Loads	winter	summer
Conduction	Heat Loss	Heat Gain
Infiltration	Heat Loss	Loss or Gain
Radiation	Heat Gain	Heat Gain
Internal Loads	**winter**	**summer**
People	Heat Gain	Heat Gain
Lights	Heat Gain	Heat Gain
Equipment	Heat Gain	Heat Gain

2

Loads also vary diurnally.



Winter night vs. Winter day

3

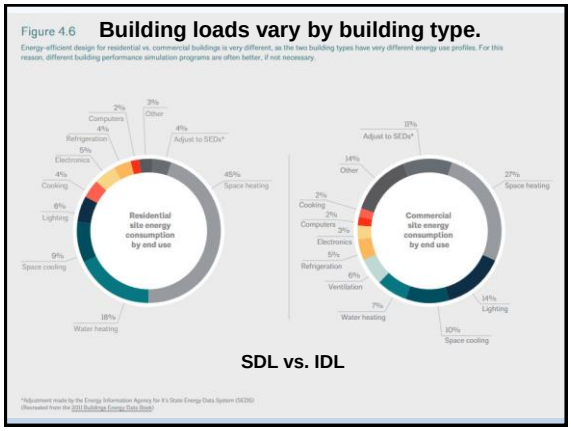
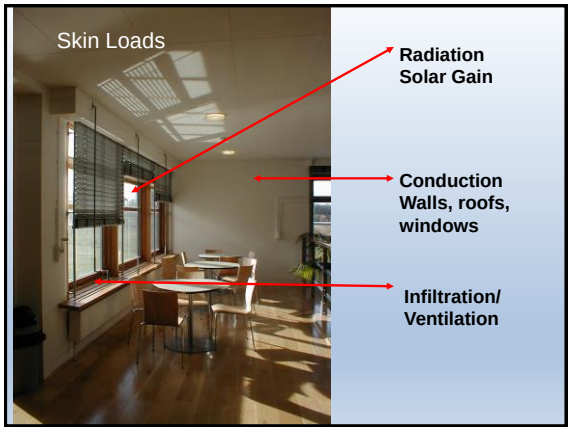


Figure 4.6
Building loads vary by building type.
Energy-efficient design for residential vs. commercial buildings is very different, as the two building types have very different energy use profiles. For this reason, different building performance simulation programs are often better, if not necessary.
Residential site energy consumption by end use
Commercial site energy consumption by end use
SDL vs. IDL

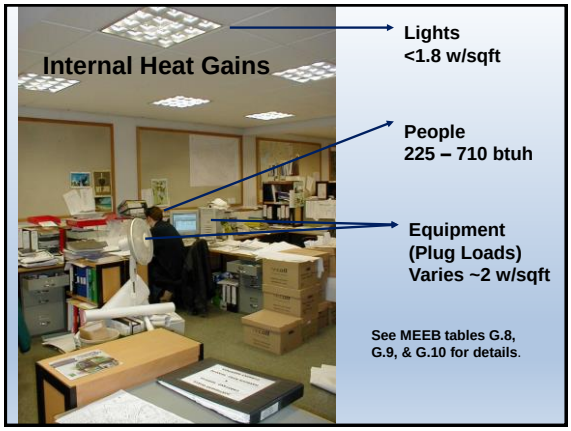
4


Skin Loads
Radiation
Solar Gain
Conduction
Walls, roofs,
windows
Infiltration/
Ventilation

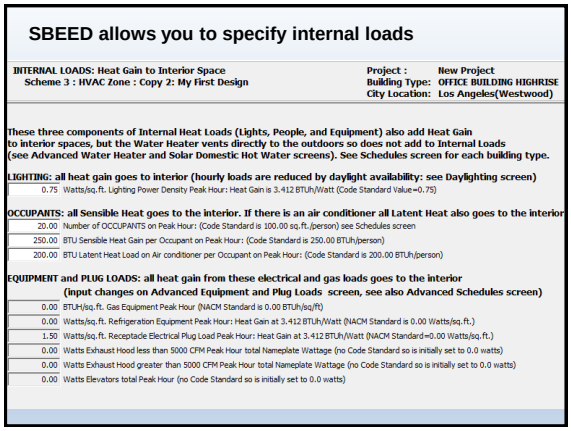
5


PROJECT: My Project
SCHEME: Scheme 1
LOCATION: Pullman Moscow Rgnl, WA, USA
LATITUDE: 46.75° North
Opaque
Allows you to discover and design the thermal attributes of walls and roofs.
Available for free from UCLA. See Arch463 web site.

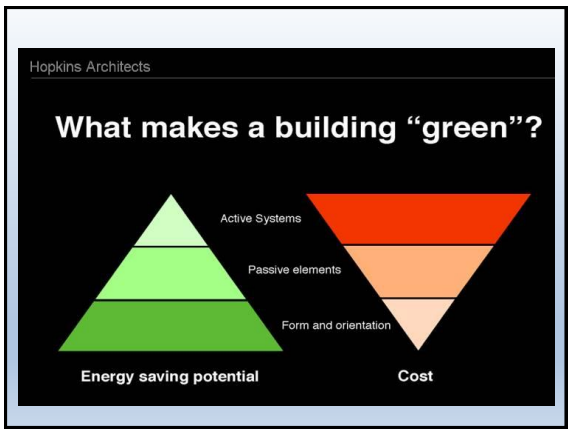
6


Internal Heat Gains
Lights
<1.8 w/sqft
People
225 – 710 btuh
Equipment
(Plug Loads)
Varies ~2 w/sqft
See MEEB tables G.8,
G.9, & G.10 for details.

7


SBEED allows you to specify internal loads
INTERNAL LOADS: Heat Gain to Interior Space
Scheme 3 : HVAC Zone : Copy 2: My First Design
Project : New Project
Building Type: OFFICE BUILDING HIGHRISE
City Location: Los Angeles(Westwood)
These three components of Internal Heat Loads (Lights, People, and Equipment) also add Heat Gain to interior spaces, but the Water Heater vents directly to the outdoors so does not add to Internal Loads (see Advanced Water Heater and Solar Domestic Hot Water screens). See Schedules screen for each building type.
LIGHTING: all heat gain goes to interior (hourly loads are reduced by daylight availability: see Daylighting screen)
0.75 Watts/sq.ft. Lighting Power Density Peak Hour: Heat Gain is 3.412 BTUh/Watt (Code Standard Value =0.75)
OCCUPANTS: all Sensible Heat goes to the interior. If there is an air conditioner all Latent Heat also goes to the interior
20.00 Number of OCCUPANTS on Peak Hour: (Code Standard is 100.00 sq.ft./person) see Schedules screen
250.00 BTU Sensible Heat Gain per Occupant on Peak Hour: (Code Standard is 250.00 BTUh/person)
200.00 BTU Latent Heat Load on Air conditioner per Occupant on Peak Hour: (Code Standard is 200.00 BTUh/person)
EQUIPMENT and PLUG LOADS: all heat gain from these electrical and gas loads goes to the interior
(input changes on Advanced Equipment and Plug Loads screen, see also Advanced Schedules screen)
0.00 BTUH/sq.ft. Gas Equipment Peak Hour (NACM Standard is 0.00 BTUh/sq/ft)
0.00 Watts/sq.ft. Refrigeration Equipment Peak Hour: Heat Gain at 3.412 BTUh/Watt (NACM Standard is 0.00 Watts/sq.ft.)
1.50 Watts/sq.ft. Receptacle Electrical Plug Load Peak Hour: Heat Gain at 3.412 BTUh/Watt (NACM Standard=0.00 Watts/sq.ft.)
0.00 Watts Exhaust Hood less than 5000 CFM Peak Hour total Nameplate Wattage (no Code Standard so is initially set to 0.0 watts)
0.00 Watts Exhaust Hood greater than 5000 CFM Peak Hour total Nameplate Wattage (no Code Standard so is initially set to 0.0 watts)
0.00 Watts Elevators total Peak Hour (no Code Standard so is initially set to 0.0 watts)

8


Hopkins Architects
What makes a building “green”?
Active Systems
Passive elements
Form and orientation
Energy saving potential
Cost

9

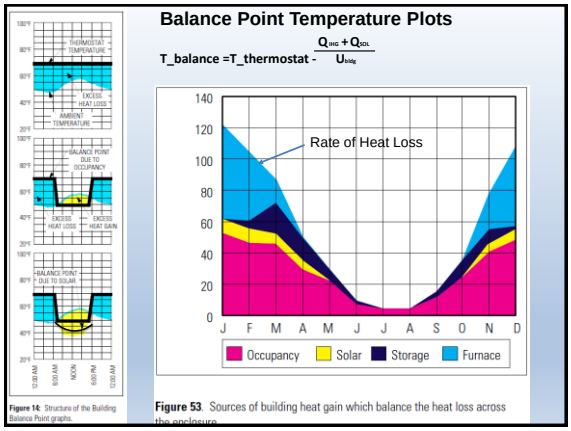
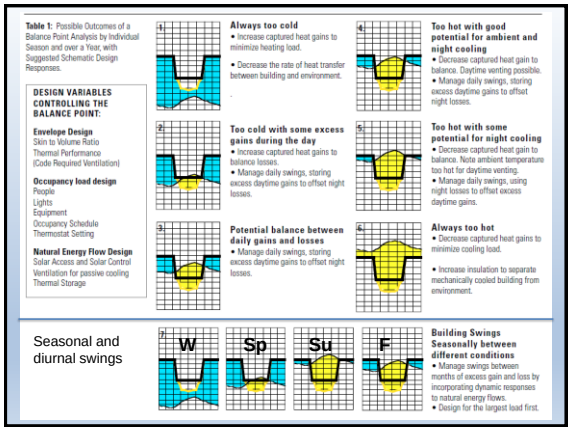


Figure 14: Structure of the Building Balance Point graphs.

Figure 53. Sources of building heat gain which balance the heat loss across the enclosure.

10



11

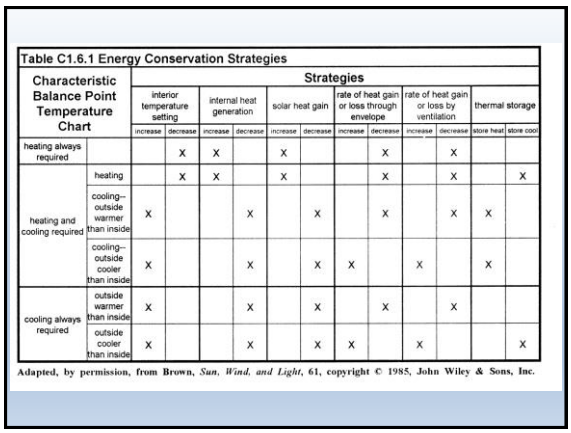
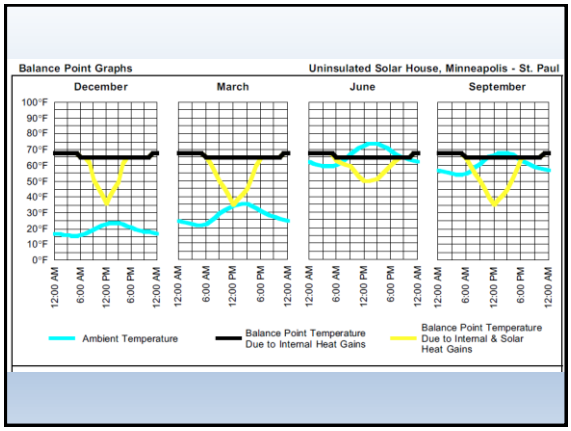


Table C1.6.1 Energy Conservation Strategies

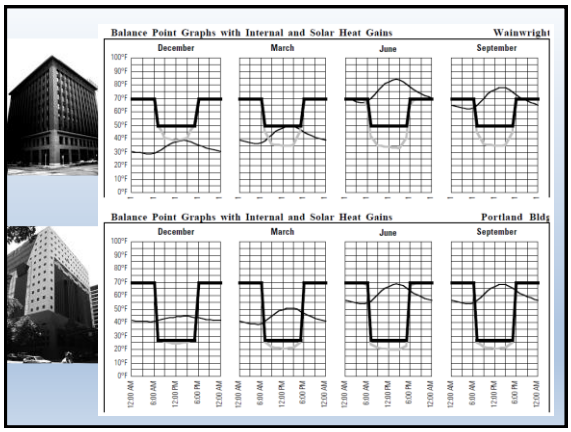
Characteristic Balance Point Temperature Chart		Strategies: interior temperature setting		internal heat generation		solar heat gain		rate of heat gain or loss through envelope		rate of heat gain or loss by ventilation		thermal storage	
		increase	decrease	increase	decrease	increase	decrease	increase	decrease	increase	decrease	store heat	store cool
heating always required			X	X		X			X		X		
heating and cooling required	heating		X	X		X			X		X		X
	cooling–outside warmer than inside	X			X		X		X		X	X	
	cooling–outside cooler than inside	X			X		X	X		X		X	
cooling always required	outside warmer than inside	X			X		X		X		X		
	outside cooler than inside	X			X		X	X		X			X

Adapted, by permission, from Brown, *Sun, Wind, and Light*, 61, copyright © 1985, John Wiley & Sons, Inc.

12

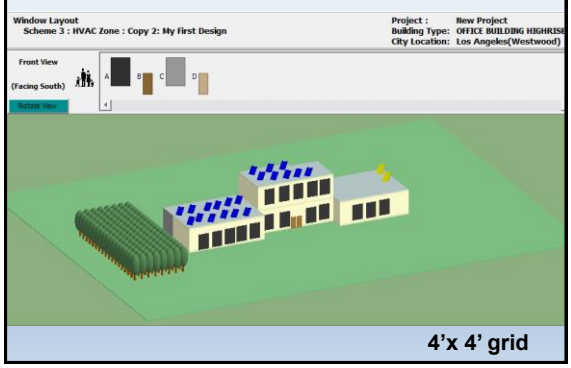


13



14

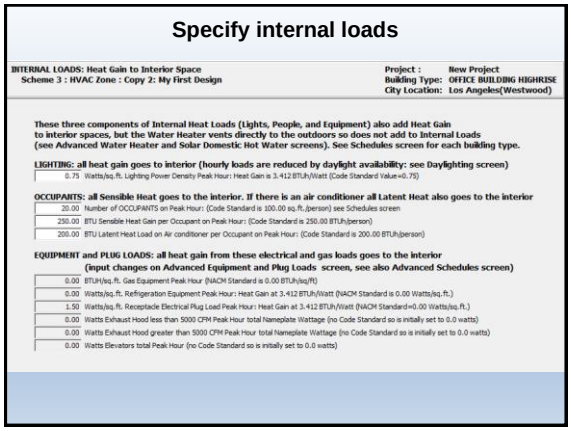
Use SBEED for initial building design…



4'x 4' grid

15

Specify internal loads



INTERNAL LOADS: Heat Gain to Interior Space
Scheme 3 : HVAC Zone : Copy 2: My First Design

Project : New Project
Building Type: OFFICE BUILDING HIGHRISE
City Location: Los Angeles(Westwood)

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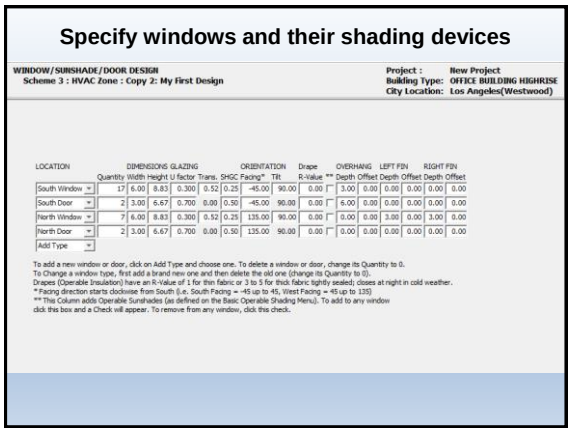
250.00 BTU Sensible Heat Gain per Occupant on Peak Hour: (Code Standard is 250.00 BTUh/person)
200.00 BTU Latent Heat Load on Air conditioner per Occupant on Peak Hour: (Code Standard is 200.00 BTUh/person)

EQUIPMENT and PLUG LOADS: all heat gain from these electrical and gas loads goes to the interior (input changes on Advanced Equipment and Plug Loads screen, see also Advanced Schedules screen)

0.00 BTUH/sq.ft. Gas Equipment Peak Hour (NACM Standard is 0.00 BTUh/sq/ft)
0.00 Watts/sq.ft. Refrigeration Equipment Peak Hour: Heat Gain at 3.412 BTUh/Watt (NACM Standard is 0.00 Watts/sq.ft.)
1.50 Watts/sq.ft. Receptacle Electrical Plug Load Peak Hour: Heat Gain at 3.412 BTUh/Watt (NACM Standard=0.00 Watts/sq.ft.)
0.00 Watts Exhaust Hood less than 5000 CFM Peak Hour total Nameplate Wattage (no Code Standard so is initially set to 0.0 watts)
0.00 Watts Exhaust Hood greater than 5000 CFM Peak Hour total Nameplate Wattage (no Code Standard so is initially set to 0.0 watts)
0.00 Watts Elevators total Peak Hour (no Code Standard so is initially set to 0.0 watts)

16

Specify windows and their shading devices



WINDOW/SUNSHADE/DOOR DESIGN
Scheme 3 : HVAC Zone : Copy 2: My First Design

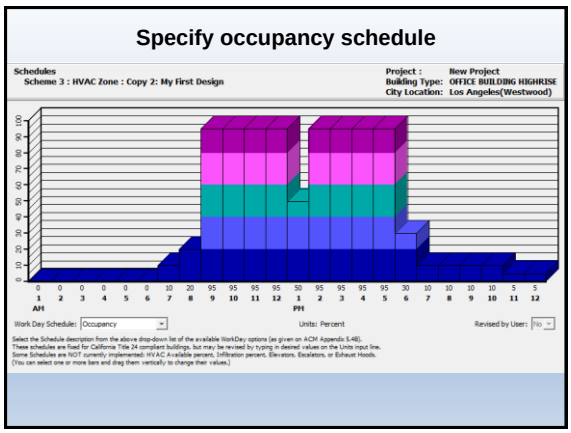
Project : New Project
Building Type: OFFICE BUILDING HIGHRISE
City Location: Los Angeles(Westwood)

LOCATION	DIMENSIONS Quantity	Width	Height	GLAZING U factor	Trans.	SHGC	ORIENTATION Facing*	Tilt	Drape R-Value **	OVERHANG Depth	Offset	LEFT FIN Depth	Offset	RIGHT FIN Depth	Offset
South Window	17	6.00	8.83	0.300	0.52	0.25	-45.00	90.00	0.00	3.00	0.00	0.00	0.00	0.00	0.00
South Door	2	3.00	6.67	0.700	0.00	0.50	-45.00	90.00	0.00	6.00	0.00	0.00	0.00	0.00	0.00
North Window	7	6.00	8.83	0.300	0.52	0.25	135.00	90.00	0.00	0.00	0.00	3.00	0.00	3.00	0.00
North Door	2	3.00	6.67	0.700	0.00	0.50	135.00	90.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Add Type															

To add a new window or door, click on Add Type and choose one. To delete a window or door, change its Quantity to 0.
To Change a window type, first add a brand new one and then delete the old one (change its Quantity to 0).
Drapes (Operable Insulation) have an R-Value of 1 for thin fabric or 3 to 5 for thick fabric tightly sealed; closes at night in cold weather.
* Facing direction starts clockwise from South (i.e. South Facing = -45 up to 45, West Facing = 45 up to 135)
** This Column adds Operable Sunshades (as defined on the Basic Operable Shading Menu). To add to any window click this box and a Check will appear. To remove from any window, click this check.

17

Specify occupancy schedule



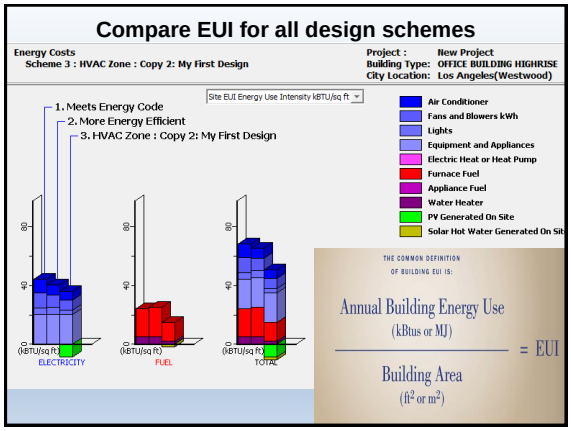
Schedules
Scheme 3 : HVAC Zone : Copy 2: My First Design

Project : New Project
Building Type: OFFICE BUILDING HIGHRISE
City Location: Los Angeles(Westwood)

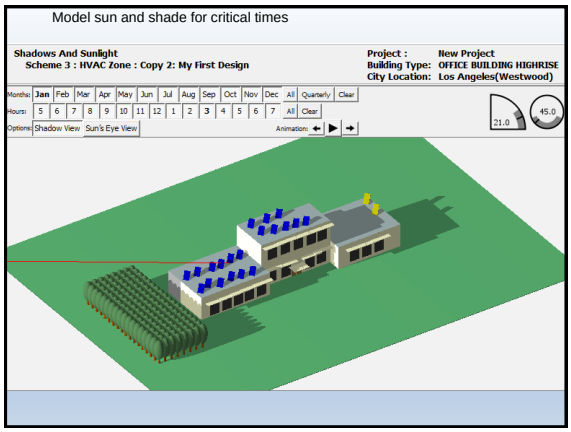
Work Day Scheduler: Occupancy
Units: Percent
Revised by User: No

Select the Schedule description from the above drop-down list of the available WorkDay options (as given on ACM Appendix 5.4B).
These schedules are fixed for California Title 24 compliant buildings, but may be revised by typing in desired values on the Units input line.
Some Schedules are NOT currently implemented: HVAC Available percent, Infiltration percent, Elevators, Escalators, or Exhaust Hoods.
(You can select one or more bars and drag them vertically to change their values.)

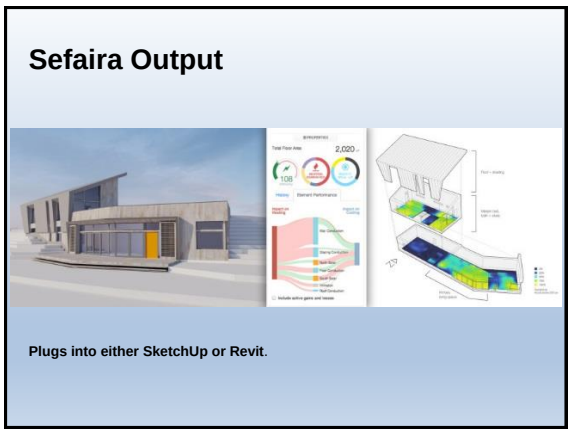
18


Compare EUI for all design schemes
Energy Costs
Scheme 3 : HVAC Zone : Copy 2: My First Design
Project : New Project
Building Type: OFFICE BUILDING HIGHRISE
City Location: Los Angeles(Westwood)
Site EUI Energy Use Intensity kBTU/sq ft
1. Meets Energy Code
2. More Energy Efficient
3. HVAC Zone : Copy 2: My First Design
Air Conditioner
Fans and Blowers kWh
Lights
Equipment and Appliances
Electric Heat or Heat Pump
Furnace Fuel
Appliance Fuel
Water Heater
PV Generated On Site
Solar Hot Water Generated On Sit
ELECTRICITY
FUEL
TOTAL
THE COMMON DEFINITION OF BUILDING EUI IS:
Annual Building Energy Use (kBtus or MJ)
Building Area (ft² or m²)
= EUI

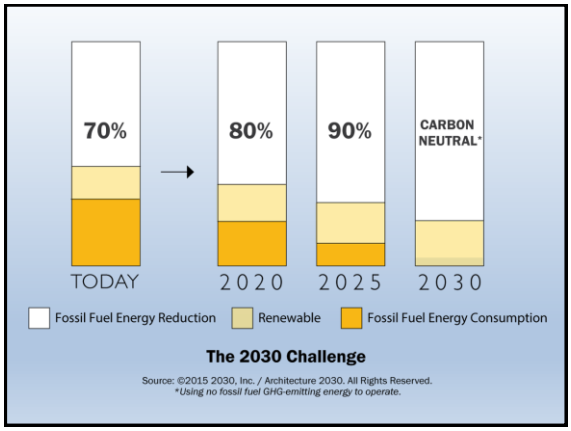
19


Model sun and shade for critical times
Shadows And Sunlight
Scheme 3 : HVAC Zone : Copy 2: My First Design
Project : New Project
Building Type: OFFICE BUILDING HIGHRISE
City Location: Los Angeles(Westwood)

20

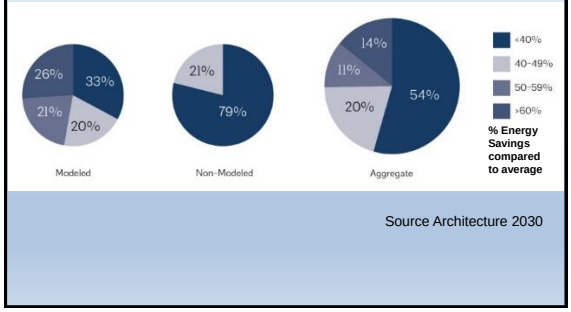

Sefaira Output
Plugs into either SketchUp or Revit.

21



22

The value of energy modeling



Source Architecture 2030

23

THE COMMON DEFINITION OF BUILDING EUI IS:

$$\frac{\text{Annual Building Energy Use (kBtus or MJ)}}{\text{Building Area } (ft^2 \text{ or } m^2)} = \text{EUI}$$

24

Convert Fuel Use to Source Energy Worksheet

Fuel	Annual fuel use	Fuel units		Multiplier		Annual energy use in source kBtu[1]
Electricity		kWh	x	10.3	=	
Electricity		MWh	x	10300	=	
Natural gas		MCF	x	1000	=	
Natural gas		CCF	x	100	=	
Natural gas		CF	x	1	=	
Natural gas		MMBtu[2]	x	1000	=	
Natural gas		therms	x	100	=	
Fuel oil #2		gallons	x	139	=	
Kerosene		gallons	x	135	=	
Propane		gallons	x	91	=	
Coal[3]		tons	x	22000	=	
District steam		lbs	x	1.6124	=	
District steam		klbs	x	1612.4	=	
District steam		kBtu	x	1.39	=	
District steam		MMBtu	x	1390	=	
District hot water			x		=	
District hot water			x		=	
District hot water			x		=	
District chiller water		ton-hrs	x	12	=	
District chiller water		kBtu	x	1	=	
District chiller water		MMBtu[2]	x	1000	=	
Total annual source energy use (kBtu)					=	

[1]Calculate using your fuel uses and appropriate multipliers. Then sum column for total.
[2]MMBtu = 1,000,000 Btu.
[3]The coal multiplier could be as low as 16000 and as high as 26000 kBtu/ton. Check with supplier.

25

Key Terms: "Scopes" 1, 2, and 3

Combustion

- Scope 1: Direct GHG emissions - Direct GHG emissions occur from sources that are owned or controlled by the company, for example, emissions from combustion in owned or controlled boilers, furnaces, vehicles, etc.

Electricity

- Scope 2: Electricity indirect GHG emissions - Scope 2 accounts for GHG emissions from the generation of purchased electricity consumed by the company. Purchased electricity is defined as electricity that is purchased or otherwise brought into the organizational boundary of the company.

Off-Site

- Scope 3: Other indirect GHG emissions Scope 3 is an optional reporting category that allows for the treatment of all other indirect emissions. Scope 3 emissions are a consequence of the activities of the company, but occur from sources not owned or controlled by the company.

"The Greenhouse Gas Protocol, A Corporate Accounting and Reporting Standard," World Business Council for Sustainable Development and World Resources Institute, 2004.

26

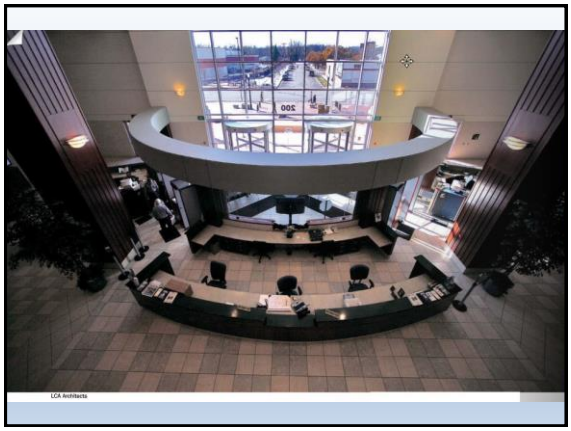
How Will Buildings Measure Emissions?

Scope 1

Scope 2

27

28



29

2009 ENERGY USE

	Electricity kWh	Electricity Cost	Natural Gas Therms	Natural Gas Cost	Geothermal Gallons*	Geothermal Cost	2009 Heating Degree Days	2009 Cooling Degree Days	2002–08 Avg. HDD	2002–08 Avg. CDD
Jan	393,848	$17,828	521	$542	2,184	$8,064	1037	0	1007	0
Feb	363,231	$17,997	387	$408	1,792	$6,620	779	0	812	0
Mar	409,402	$20,129	418	$443	1,427	$5,323	716	0	624	0
Apr	419,814	$20,117	436	$472	936	$3,659	430	7	426	1
May	447,331	$21,311	498	$539	833	$3,260	187	87	199	50
Jun	460,743	$29,114	518	$560	1,054	$4,120	24	114	55	175
Jul	507,434	$31,681	615	$663	863	$3,373	0	428	0	446
Aug	459,462	$28,850	581	$627	223	$889	14	338	5	323
Sep	433,340	$24,346	554	$584	169	$673	40	214	88	96
Oct	389,011	$21,998	475	$421	492	$1,941	505	0	370	10
Nov	361,645	$20,316	986	$801	910	$3,523	701	0	734	0
Dec	396,944	$21,455	2,952	$2,320	1,398	$5,174	1,179	0	958	0
Total	5,042,205	$275,142	8,941	$8,380	12,281	$46,619	5,612	1,188		

*in thousands

36 HIGH PERFORMING BUILDINGS Summer 2010

30

ENERGY AT A GLANCE

Energy Use Intensity (Site) 64 kBtu/ft^2
- Natural Gas 3 kBtu/ft^2
- Electricity 48 kBtu/ft^2
- Geothermal 13 kBtu/ft^2

Annual Source Energy 176 kBtu/ft^2

Annual Energy Cost Index (ECI)
$0.93/ft^2·yr

Peak Load 1450 kW (2009)

Base Load 935 kW (2009)

Load Factor 47.6% (2009)

ENERGY STAR Rating 84 (2009), 85 (2008), 85 (2007), 83 (2006), 75 (2005), 76 (2004)

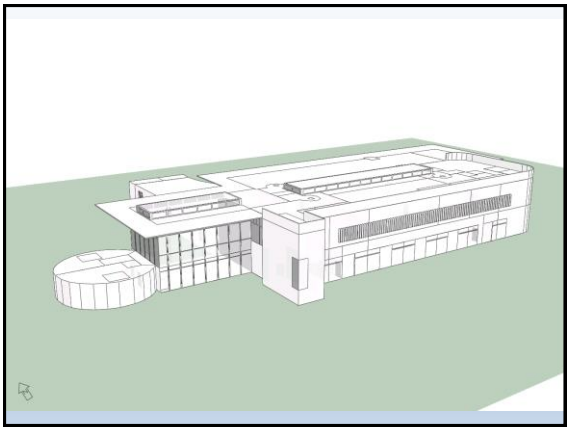
31

John Hope Gateway

RBGE

Cullinan Studio

32



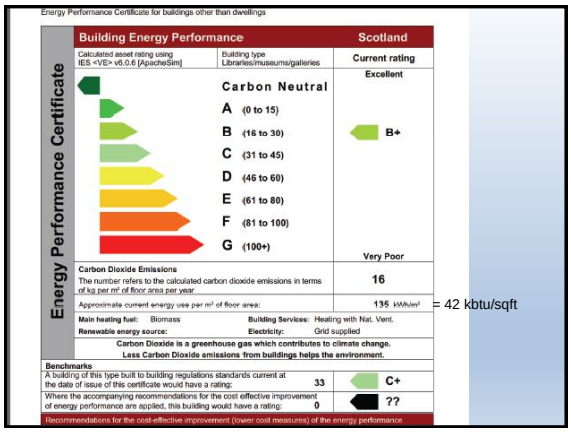
33

34

35

36

37


Energy Performance Certificate for buildings other than dwellings

Building Energy Performance — **Scotland**

Calculated asset rating using IES <VE> v6.0.6 [ApacheSim] | Building type: Libraries/museums/galleries | Current rating

Energy Performance Certificate

Carbon Neutral
A (0 to 15)
B (16 to 30) — B+
C (31 to 45)
D (46 to 60)
E (61 to 80)
F (81 to 100)
G (100+)

Excellent

Very Poor

Carbon Dioxide Emissions
The number refers to the calculated carbon dioxide emissions in terms of kg per m² of floor area per year. — 16

Approximate current energy use per m² of floor area: 135 kWh/m² = 42 kbtu/sqft

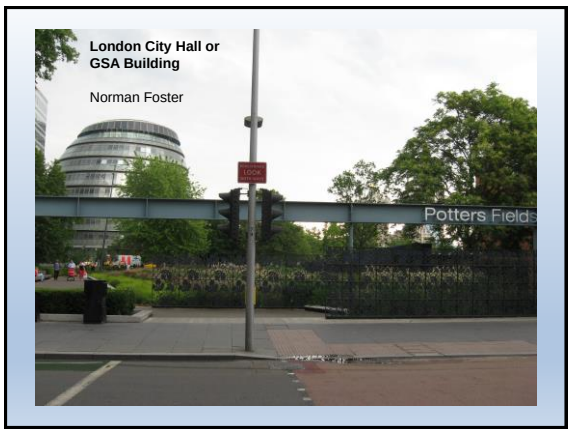
Main heating fuel: Biomass | **Building Services:** Heating with Nat. Vent.
Renewable energy source: | **Electricity:** Grid supplied

Carbon Dioxide is a greenhouse gas which contributes to climate change.
Less Carbon Dioxide emissions from buildings helps the environment.

Benchmarks
A building of this type built to building regulations standards current at the date of issue of this certificate would have a rating: 33 — C+
Where the accompanying recommendations for the cost effective improvement of energy performance are applied, this building would have a rating: 0 — ??

Recommendations for the cost-effective improvement (lower cost measures) of the energy performance

38



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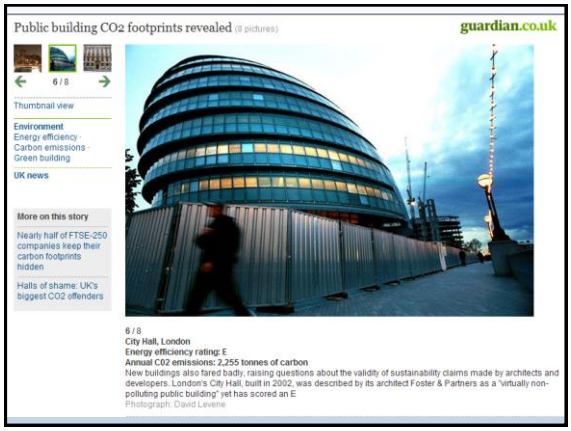
Public building CO2 footprints revealed (6 pictures)
guardian.co.uk
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Thumbnail view
Environment
Energy efficiency · Carbon emissions · Green building
UK news
More on this story
Nearly half of FTSE-250 companies keep their carbon footprints hidden
Halls of shame: UK's biggest CO2 offenders
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City Hall, London
Energy efficiency rating: E
Annual C02 emissions: 2,255 tonnes of carbon
New buildings also fared badly, raising questions about the validity of sustainability claims made by architects and developers. London's City Hall, built in 2002, was described by its architect Foster & Partners as a "virtually non-polluting public building" yet has scored an E
Photograph: David Levene

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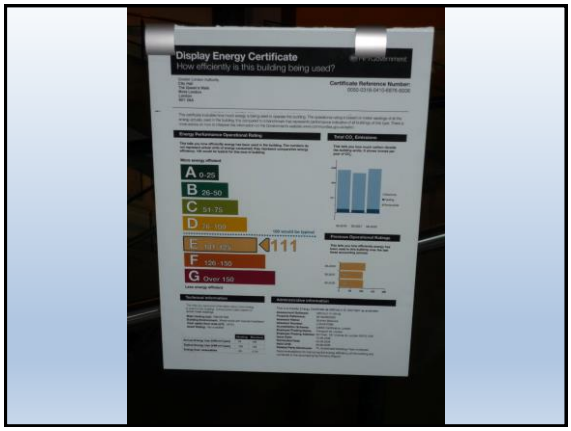
Display Energy Certificate
How efficiently is this building being used?
A 0-25
B 26-50
C 51-75
D 76-100
E 101-125
111
F 126-150
G Over 150

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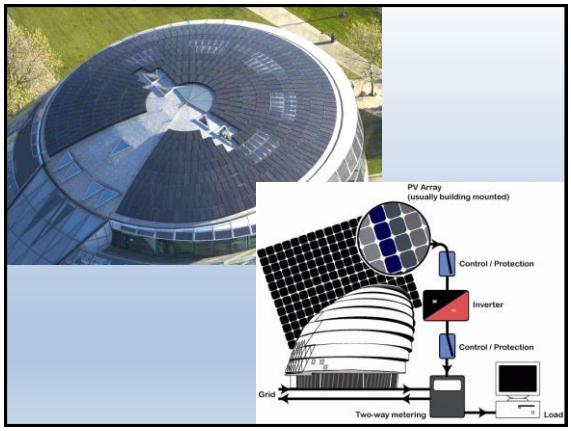
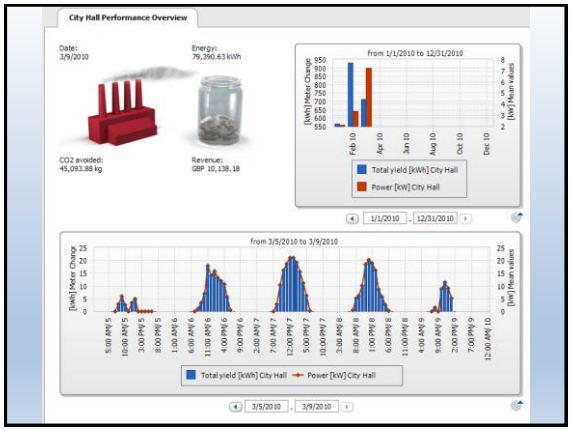

PV Array
(usually building mounted)
Control / Protection
Inverter
Control / Protection
Grid
Two-way metering
Load

42


City Hall Performance Overview
Date:
3/9/2010
Energy:
79,390.63 kWh
CO2 avoided:
45,093.88 kg
Revenue:
GBP 10,138.18
from 1/1/2010 to 12/31/2010
[kWh] Meter Change
[kW] Mean values
Feb 10
Apr 10
Jun 10
Aug 10
Oct 10
Dec 10
Total yield [kWh] City Hall
Power [kW] City Hall
1/1/2010
12/31/2010
from 3/5/2010 to 3/9/2010
Total yield [kWh] City Hall
Power [kW] City Hall
3/5/2010
3/9/2010

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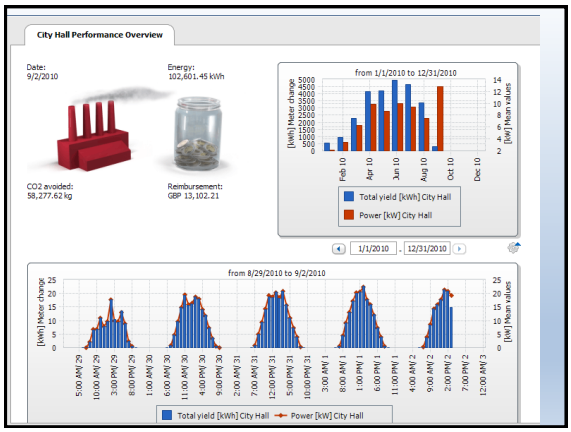
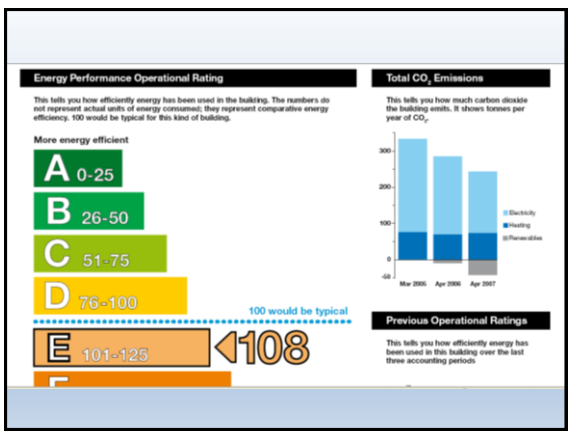

City Hall Performance Overview
Date:
9/2/2010
Energy:
102,601.45 kWh
CO2 avoided:
58,277.62 kg
Reimbursement:
GBP 13,102.21
from 1/1/2010 to 12/31/2010
[kWh] Meter change
[kW] Mean values
Feb 10
Apr 10
Jun 10
Aug 10
Oct 10
Dec 10
Total yield [kWh] City Hall
Power [kW] City Hall
1/1/2010
12/31/2010
from 8/29/2010 to 9/2/2010
Total yield [kWh] City Hall
Power [kW] City Hall

44


Energy Performance Operational Rating
This tells you how efficiently energy has been used in the building. The numbers do not represent actual units of energy consumed; they represent comparative energy efficiency. 100 would be typical for this kind of building.
More energy efficient
A 0-25
B 26-50
C 51-75
D 76-100
100 would be typical
E 101-125
108
Total CO2 Emissions
This tells you how much carbon dioxide the building emits. It shows tonnes per year of CO2
Electricity
Heating
Mar 2005
Apr 2006
Apr 2007
Previous Operational Ratings
This tells you how efficiently energy has been used in this building over the last three accounting periods

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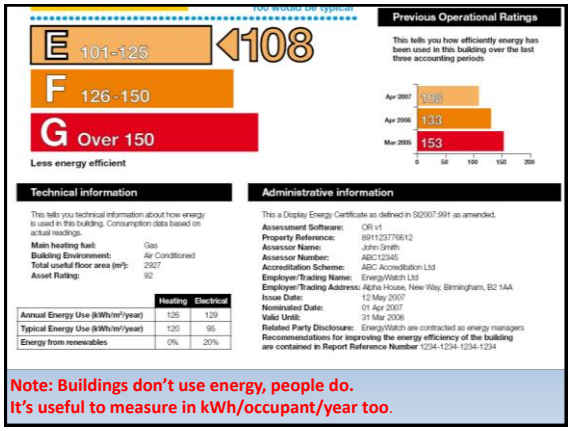

Note: Buildings don't use energy, people do.
It's useful to measure in kWh/occupant/year too.

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