ENERGYPLUS™

Using EnergyPlus for Compliance

Hints on using EnergyPlus for Compliance with
Standards and Rating Systems

Date: September 27, 2012

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Introduction

Background

Energy Standards abound throughout the world. This document provides guidance on using EnergyPlus and its reports for compliance with energy standards.

The tabular reports from EnergyPlus were designed to help collate information into a form usually required for reporting on designs for energy use. The tabular reports are fully described in the Output Details document and will be judiciously reproduced here for clarity and reference. In addition, by using the Output:Table:Style object, one can obtain the reports in a variety of formats – ready for incorporating into your own style for submission or presentation.

First, we describe the features available in the tabular report that might be used for energy compliance reporting or presentation of energy designs to clients.

Compliance Objects

To facilitate using EnergyPlus for compliance reporting, a group of Compliance Objects is described in the Input Output Reference document. Currently, there is only one object in this group: **Compliance:Building** which, when fully populated, will describe various aspects that are needed specific to buildings. Other compliance objects will be added to this group when appropriate.

Tabular Summary Reports

Several predefined reports are available from the Output Table:Predefined object including the following.

- Annual Building Utility Performance Summary
- Input Verification and Results Summary
- Demand End Use Components Summary
- Source Energy End Use Components Summary
- Climatic Data Summary
- Equipment Summary
- Envelope Summary
- Surface Shadowing Summary
- Shading Summary
- Lighting Summary
- HVAC Sizing Summary
- System Summary
- Component Sizing Summary
- Outside Air Summary
- Object Count Summary

In addition, specifying "All Summary" will enable all the reports in this category (more than are shown here).

Annual Building Utility Performance Summary

First and foremost, the Annual Building Utility Performance Summary gives a good overview of the energy use by category:

Report: **AnnualBuildingUtilityPerformanceSummary**
For: **Entire Facility**
Timestamp: **2009-09-17 17:30:22**
Values gathered over 8760.00 hours

Site and Source Energy

	Total Energy [GJ]	Energy Per Total Building Area [MJ/m2]	Energy Per Conditioned Building Area [MJ/m2]
Total Site Energy	180.73	194.92	194.92
Net Site Energy	180.73	194.92	194.92
Total Source Energy	1141.64	1231.28	1231.28
Net Source Energy	1141.64	1231.28	1231.28

Source to Site Energy Conversion Factors

	Source=>Site Conversion Factor
Electricity	0.293
Natural Gas	0.010
District Cooling	0.098
District Heating	0.033
Steam	0.250
Gasoline	1.050
Diesel	1.050
Coal	1.050
Fuel Oil #1	1.050
Fuel Oil #2	1.050
Propane	1.050

Building Area

	Area [m2]
Total Building Area	927.20
Net Conditioned Building Area	927.20
Unconditioned Building Area	0.00

End Uses

	Electricity [GJ]	Natural Gas [GJ]	Other Fuel [GJ]	District Cooling [GJ]	District Heating [GJ]	Water [m3]
Heating	0.00	28.16	0.00	0.00	0.00	0.00
Cooling	16.56	0.00	0.00	0.00	0.00	0.00
Interior Lighting	81.24	0.00	0.00	0.00	0.00	0.00
Exterior Lighting	0.00	0.00	0.00	0.00	0.00	0.00
Interior Equipment	47.70	0.00	0.00	0.00	0.00	0.00
Exterior Equipment	0.00	0.00	0.00	0.00	0.00	0.00
Fans	6.59	0.00	0.00	0.00	0.00	0.00
Pumps	0.48	0.00	0.00	0.00	0.00	0.00
Heat Rejection	0.00	0.00	0.00	0.00	0.00	0.00
Humidification	0.00	0.00	0.00	0.00	0.00	0.00
Heat Recovery	0.00	0.00	0.00	0.00	0.00	0.00
Water Systems	0.00	0.00	0.00	0.00	0.00	0.00
Refrigeration	0.00	0.00	0.00	0.00	0.00	0.00
Generators	0.00	0.00	0.00	0.00	0.00	0.00
Total End Uses	152.57	28.16	0.00	0.00	0.00	0.00

Note: Natural gas appears to be the principal heating source based on energy usage.

End Uses By Subcategory

	Subcategory	Electricity [GJ]	Natural Gas [GJ]	Other Fuel [GJ]	District Cooling [GJ]	District Heating [GJ]	Water [m3]
Heating	Boiler	0.00	28.16	0.00	0.00	0.00	0.00
	Boiler Parasitic	0.00	0.00	0.00	0.00	0.00	0.00
Cooling	General	16.56	0.00	0.00	0.00	0.00	0.00
Interior Lighting	GeneralLights	81.24	0.00	0.00	0.00	0.00	0.00
Exterior Lighting	General	0.00	0.00	0.00	0.00	0.00	0.00
Interior Equipment	General	47.70	0.00	0.00	0.00	0.00	0.00
Exterior	General	0.00	0.00	0.00	0.00	0.00	0.00

Equipment							
Fans	General	6.59	0.00	0.00	0.00	0.00	0.00
Pumps	General	0.48	0.00	0.00	0.00	0.00	0.00
Heat Rejection	General	0.00	0.00	0.00	0.00	0.00	0.00
Humidification	General	0.00	0.00	0.00	0.00	0.00	0.00
Heat Recovery	General	0.00	0.00	0.00	0.00	0.00	0.00
Water Systems	General	0.00	0.00	0.00	0.00	0.00	0.00
Refrigeration	General	0.00	0.00	0.00	0.00	0.00	0.00
Generators	General	0.00	0.00	0.00	0.00	0.00	0.00

Normalized Metrics

Utility Use Per Conditioned Floor Area

	Electricity Intensity [MJ/m2]	Natural Gas Intensity [MJ/m2]	Other Fuel Intensity [MJ/m2]	District Cooling Intensity [MJ/m2]	District Heating Intensity [MJ/m2]	Water Intensity [m3/m2]
Lighting	87.62	0.00	0.00	0.00	0.00	0.00
HVAC	25.49	30.37	0.00	0.00	0.00	0.00
Other	51.44	0.00	0.00	0.00	0.00	0.00
Total	164.55	30.37	0.00	0.00	0.00	0.00

Utility Use Per Total Floor Area

	Electricity Intensity [MJ/m2]	Natural Gas Intensity [MJ/m2]	Other Fuel Intensity [MJ/m2]	District Cooling Intensity [MJ/m2]	District Heating Intensity [MJ/m2]	Water Intensity [m3/m2]
Lighting	87.62	0.00	0.00	0.00	0.00	0.00
HVAC	25.49	30.37	0.00	0.00	0.00	0.00
Other	51.44	0.00	0.00	0.00	0.00	0.00
Total	164.55	30.37	0.00	0.00	0.00	0.00

Electric Loads Satisfied

	Electricity [GJ]	Percent Electricity [%]
Fuel-Fired Power Generation	0.00	0.00
High Temperature Geothermal*	0.00	0.00
Photovoltaic Power	0.00	0.00

Wind Power*	0.00	0.00
Net Decrease in On-Site Storage	0.00	0.00
Total On-Site Electric Sources	0.00	0.00
Electricity Coming From Utility	152.57	100.00
Surplus Electricity Going To Utility	0.00	0.00
Net Electricity From Utility	152.57	100.00
Total On-Site and Utility Electric Sources	152.57	100.00
Total Electricity End Uses	152.57	100.00

On-Site Thermal Sources

	Heat [GJ]	Percent Heat [%]
Water-Side Heat Recovery	0.00	
Air to Air Heat Recovery for Cooling	0.00	
Air to Air Heat Recovery for Heating	0.00	
High-Temperature Geothermal*	0.00	
Solar Water Thermal	0.00	
Solar Air Thermal	0.00	
Total On-Site Thermal Sources	0.00	

Water Source Summary

	Water [m3]	Percent Water [%]
Rainwater Collection	0.00	-
Condensate Collection	0.00	-
Groundwater Well	0.00	-
Total On Site Water Sources	0.00	-
-	-	-
Initial Storage	0.00	-
Final Storage	0.00	-
Change in Storage	0.00	-
-	-	-

Water Supplied by Utility	0.00	-
-	-	-
Total On Site, Change in Storage, and Utility Water Sources	0.00	-
Total Water End Uses	0.00	-

Comfort and Setpoint Not Met Summary

	Facility [Hours]
Time Set Point Not Met During Occupied Heating	0.00
Time Set Point Not Met During Occupied Cooling	213.25
Time Not Comfortable Based on Simple ASHRAE 55-2004	72.50

Note 1: An asterisk (*) indicates that the feature is not yet implemented.

Input Verification Summary

The input verification summary gives a good overview of the facility being simulated:

Report: **InputVerificationandResultsSummary**
For: **Entire Facility**
Timestamp: **2009-09-17 17:30:22**
General

	Value
Program Version and Build	EnergyPlus 4.0.0.017, 9/17/2009 5:30 PM
Weather	Climate Zone 6 CA USA WYEC2-C-00006 WMO#=722970
Latitude [deg]	33.90
Longitude [deg]	-118.5
Elevation [m]	30.00
Time Zone	-8.0
North Axis Angle [deg]	30.00
Rotation for Appendix G [deg]	0.00
Hours Simulated [hrs]	8760.00

ENVELOPE

Window-Wall Ratio

	Total	North (315 to 45 deg)	East (45 to 135 deg)	South (135 to 225 deg)	West (225 to 315 deg)

Gross Wall Area [m2]	274.20	91.50	45.60	91.50	45.60
Window Opening Area [m2]	60.90	20.85	9.12	21.81	9.12
Window-Wall Ratio [%]	22.21	22.79	20.00	23.84	20.00

Skylight-Roof Ratio

	Total
Gross Roof Area [m2]	463.60
Skylight Area [m2]	0.00
Skylight-Roof Ratio [%]	0.00

PERFORMANCE

Zone Summary

	Area [m2]	Conditioned (Y/N)	Volume [m3]	Multipliers	Gross Wall Area [m2]	Window Glass Area [m2]	Lighting [W/m2]	People [m2] per person	Plug and Process [W/m2]
PLENUM-1	463.60	Yes	283.20	1.00	54.84	0.00	0.0000		0.0000
SPACE1-1	99.16	Yes	239.25	1.00	73.20	21.81	15.9742	9.01	10.6495
SPACE2-1	42.73	Yes	103.31	1.00	36.48	9.12	16.0056	8.55	10.6704
SPACE3-1	96.48	Yes	239.25	1.00	73.20	20.85	16.4179	8.77	10.9453
SPACE4-1	42.73	Yes	103.31	1.00	36.48	9.12	16.0056	8.55	10.6704
SPACE5-1	182.49	Yes	447.68	1.00	0.00	0.00	16.2420	9.12	10.8280
Total	927.20		1416.00		274.20	60.90	8.0889	17.83	5.3926
Conditioned Total	927.20		1416.00		274.20	60.90	8.0889	17.83	5.3926
Unconditioned Total	0.00		0.00		0.00	0.00			

Source Energy End Use Components Summary

The source energy end use components summary gives a good overview of the source energy consumption broken down by end uses for the facility being simulated:

Report: **SourceEnergyEndUseComponentsSummary**
For: **Entire Facility**
Timestamp: **2011-10-07 20:53:43**
Values gathered over 8760.00 hours

Source Energy End Use Components Summary

	Source Electricity [GJ]	Source Natural Gas [GJ]	Source Other Fuel [GJ]	Source District Cooling [GJ]	Source District Heating [GJ]
Heating	0.00	140.03	0.00	0.00	0.00
Cooling	167.65	0.00	0.00	0.00	0.00
Interior Lighting	569.39	0.00	0.00	0.00	0.00
Exterior Lighting	0.00	0.00	0.00	0.00	0.00
Interior Equipment	325.49	0.00	0.00	0.00	0.00
Exterior Equipment	0.00	0.00	0.00	0.00	0.00
Fans	55.72	0.00	0.00	0.00	0.00
Pumps	7.57	0.00	0.00	0.00	0.00
Heat Rejection	0.00	0.00	0.00	0.00	0.00
Humidification	0.00	0.00	0.00	0.00	0.00
Heat Recovery	0.00	0.00	0.00	0.00	0.00
Water Systems	0.00	0.00	0.00	0.00	0.00
Refrigeration	0.00	0.00	0.00	0.00	0.00
Generators	0.00	0.00	0.00	0.00	0.00
Total Source Energy End Use Components	1125.82	140.03	0.00	0.00	0.00

Normalized Metrics

Source Energy End Use Components Per Conditioned Floor Area

	Source Electricity [MJ/m2]	Source Natural Gas [MJ/m2]	Source Other Fuel [MJ/m2]	Source District Cooling [MJ/m2]	Source District Heating [MJ/m2]
Heating	0.00	151.02	0.00	0.00	0.00
Cooling	180.82	0.00	0.00	0.00	0.00
Interior Lighting	614.09	0.00	0.00	0.00	0.00

Exterior Lighting	0.00	0.00	0.00	0.00	0.00
Interior Equipment	351.05	0.00	0.00	0.00	0.00
Exterior Equipment	0.00	0.00	0.00	0.00	0.00
Fans	60.10	0.00	0.00	0.00	0.00
Pumps	8.16	0.00	0.00	0.00	0.00
Heat Rejection	0.00	0.00	0.00	0.00	0.00
Humidification	0.00	0.00	0.00	0.00	0.00
Heat Recovery	0.00	0.00	0.00	0.00	0.00
Water Systems	0.00	0.00	0.00	0.00	0.00
Refrigeration	0.00	0.00	0.00	0.00	0.00
Generators	0.00	0.00	0.00	0.00	0.00
Total Source Energy End Use Components	1214.22	151.02	0.00	0.00	0.00

Source Energy End Use Components Per Total Floor Area

	Source Electricity [MJ/m2]	Source Natural Gas [MJ/m2]	Source Other Fuel [MJ/m2]	Source District Cooling [MJ/m2]	Source District Heating [MJ/m2]
Heating	0.00	151.02	0.00	0.00	0.00
Cooling	180.82	0.00	0.00	0.00	0.00
Interior Lighting	614.09	0.00	0.00	0.00	0.00
Exterior Lighting	0.00	0.00	0.00	0.00	0.00
Interior Equipment	351.05	0.00	0.00	0.00	0.00
Exterior Equipment	0.00	0.00	0.00	0.00	0.00
Fans	60.10	0.00	0.00	0.00	0.00
Pumps	8.16	0.00	0.00	0.00	0.00
Heat Rejection	0.00	0.00	0.00	0.00	0.00
Humidification	0.00	0.00	0.00	0.00	0.00
Heat Recovery	0.00	0.00	0.00	0.00	0.00
Water Systems	0.00	0.00	0.00	0.00	0.00
Refrigeration	0.00	0.00	0.00	0.00	0.00
Generators	0.00	0.00	0.00	0.00	0.00
Total Source Energy End Use Components	1214.22	151.02	0.00	0.00	0.00

Other Summary Reports

The Climatic Data Summary, Envelope Summary and Equipment Summary reports might be quite important to some reporting or presentation.

Report: **ClimaticDataSummary**
For: **Entire Facility**
Timestamp: 2009-09-17 17:30:22
SizingPeriod:DesignDay

	Maximum Dry Bulb [C]	Daily Temperature Range [C]	Humidity Value	Humidity Type	Wind Speed [m/s]	Wind Direction
LOS_ANGELES_CA_USA HEATING 99% CONDITIONS	7.40	0.00	7.40	0	2.80	70.00
LOS_ANGELES_CA_USA COOLING 1% CONDITIONS DB=>MWB	27.00	6.10	17.60	0	4.40	250.00

Weather Statistics File

	Value
Reference	CZ06RV2
Site:Location	Climate Zone 6 CA USA
Latitude	N 33° 54'
Longitude	W 118° 30'
Time Zone	GMT -8.0 Hours
Elevation	30m above sea level
Standard Pressure at Elevation	100965Pa
Data Source	WYEC2-C-00006
WMO Station	722970
Design Conditions	Climate Design Data 2005 ASHRAE Handbook
Heating Design Temperature 99.6% (C)	4.9
Heating Design Temperature 99% (C)	6.2
Cooling Design Temperature 0.4% (C)	33.1
Cooling Design Temperature 1% (C)	30.9
Cooling Design Temperature 2% (C)	29.2
Maximum Dry Bulb Temperature (C)	31.7°
Maximum Dry Bulb Occurs on	Sep 24
Minimum Dry Bulb Temperature (C)	3.5°

Minimum Dry Bulb Occurs on	Jan 8
Maximum Dew Point Temperature (C)	20.9
Maximum Dew Point Occurs on	Jun 20
Minimum Dew Point Temperature (C)	-21.7
Minimum Dew Point Occurs on	Dec 27
Heating Degree-Days (base 10°C)	2
Cooling Degree-Days (base 18°C)	216
Köppen Classification	Csb
Köppen Description	Mediterranean climate (dry warm summer, mild winter, lat. 30-45°N)
Köppen Recommendation	
ASHRAE Climate Zone	3C
ASHRAE Description	Warm-Marine

Report: **EnvelopeSummary**
For: **Entire Facility**
Timestamp: 2009-09-17 17:30:22
Opaque Exterior

	Construction	Reflectance	U-Factor with Film [W/m2-K]	U-Factor no Film [W/m2-K]	Gross Area [m2]	Azimuth [deg]	Tilt [deg]	Cardinal Direction
WALL-1PF	WALL-1	0.22	0.384	0.408	18.30	210.00	90.00	S
WALL-1PR	WALL-1	0.22	0.384	0.408	9.12	120.00	90.00	E
WALL-1PB	WALL-1	0.22	0.384	0.408	18.30	30.00	90.00	N
WALL-1PL	WALL-1	0.22	0.384	0.408	9.12	300.00	90.00	W
TOP-1	ROOF-1	0.35	0.268	0.282	463.60	210.00	0.00	
FRONT-1	WALL-1	0.22	0.384	0.408	73.20	210.00	90.00	S
F1-1	FLOOR-SLAB-1	0.35	3.119	12.894	99.16	30.00	180.00	
RIGHT-1	WALL-1	0.22	0.384	0.408	36.48	120.00	90.00	E
F2-1	FLOOR-SLAB-1	0.35	3.119	12.894	42.73	300.00	180.00	
BACK-1	WALL-1	0.22	0.384	0.408	73.20	30.00	90.00	N

F3-1	FLOOR-SLAB-1	0.35	3.119	12.894	96.48	74.22	180.00	
LEFT-1	WALL-1	0.22	0.384	0.408	36.48	300.00	90.00	W
F4-1	FLOOR-SLAB-1	0.35	3.119	12.894	42.73	120.00	180.00	
F5-1	FLOOR-SLAB-1	0.35	3.119	12.894	182.49	30.00	180.00	

Fenestration

	Construction	Area of One Opening [m2]	Area of Openings [m2]	U-Factor [W/m2-K]	SHGC	Visible Transmittance	Shade Control	Parent Surface	Azimuth [deg]	Cardinal Direction
WF-1	DBL CLR 3MM/13MM AIR	16.56	16.56	2.720	0.764	0.812	No	FRONT-1	210.00	S
DF-1	SGL GREY 3MM	5.25	5.25	5.894	0.716	0.611	No	FRONT-1	210.00	S
WR-1	DBL CLR 3MM/13MM AIR	9.12	9.12	2.720	0.764	0.812	No	RIGHT-1	120.00	E
WB-1	DBL CLR 3MM/13MM AIR	16.44	16.44	2.720	0.764	0.812	No	BACK-1	30.00	N
DB-1	SGL GREY 3MM	4.41	4.41	5.894	0.716	0.611	No	BACK-1	30.00	N
WL-1	DBL CLR 3MM/13MM AIR	9.12	9.12	2.720	0.764	0.812	No	LEFT-1	300.00	W
Total or Average			60.90	3.22	0.756	0.780				
North Total or Average			20.85	3.39	0.754	0.769				
Non-North Total or Average			40.05	3.14	0.757	0.785				

Report: **ShadingSummary**
For: **Entire Facility**
Timestamp: 2009-09-17 17:30:22
Sunlit Fraction

	March 21 9am	March 21 noon	March 21 3pm	June 21 9am	June 21 noon	June 21 3pm	December 21 9am	December 21 noon	December 21 3pm
WF-1	0.00	0.00	0.26	0.00	0.00	0.00	0.00	0.30	0.74
DF-1	0.75	0.13	0.59	0.00	0.00	0.35	0.92	0.62	0.94
WR-1	1.00	1.00	0.00	1.00	1.00	0.00	1.00	1.00	0.00
WB-1	0.00	0.00	0.00	1.00	0.00	0.00	0.00	0.00	0.00
DB-1	0.00	0.00	0.00	1.00	0.00	0.00	0.00	0.00	0.00
WL-1	0.00	0.00	1.00	0.00	0.00	1.00	0.00	0.00	1.00

Window Control

	Name	Type	Shaded Construction	Control	Glare Control
None					

Report: **LightingSummary**
For: **Entire Facility**
Timestamp: 2009-09-17 17:30:22
Interior Lighting

	Zone	Lighting Power Density [W/m2]	Zone Area [m2]	Total Power [W]	End Use Subcategory	Schedule Name	Average Hours/Week [hr]	Return Air Fraction	Conditioned (Y/N)
SPACE1-1 LIGHTS 1	SPACE1-1	15.9742	99.16	1584.00	GeneralLights	LIGHTS-1	0.00	0.2000	Y
SPACE2-1 LIGHTS 1	SPACE2-1	16.0056	42.73	684.00	GeneralLights	LIGHTS-1	0.00	0.2000	Y
SPACE3-1 LIGHTS 1	SPACE3-1	16.4179	96.48	1584.00	GeneralLights	LIGHTS-1	0.00	0.2000	Y

SPACE4-1 LIGHTS 1	SPACE4-1	16.0056	42.73	684.00	GeneralLights	LIGHTS-1	0.00	0.2000	Y
SPACE5-1 LIGHTS 1	SPACE5-1	16.2420	182.49	2964.00	GeneralLights	LIGHTS-1	0.00	0.2000	Y
Interior Lighting Total		16.1777	463.60	7500.00					

Daylighting

	Zone	Daylighting Type	Control Type	Fraction Controlled	Lighting Installed in Zone [W]	Lighting Controlled [W]
None						

Exterior Lighting

	Total Watts	Astronomical Clock/Schedule	Schedule Name	Average Annual Hours/Week
Exterior Lighting Total	0.00			

Report: **EquipmentSummary**
For: **Entire Facility**
Timestamp: **2009-09-17 17:30:22**
Central Plant

	Type	Nominal Capacity [W]	Nominal Efficiency [W/W]
CENTRAL CHILLER	Chiller:Electric	25311.64	3.20
CENTRAL BOILER	Boiler:HotWater	56191.29	0.80

Cooling Coils

	Type	Nominal Total Capacity [W]	Nominal Sensible Capacity [W]	Nominal Latent Capacity [W]	Nominal Sensible Heat Ratio	Nominal Efficiency [W/W]
MAIN COOLING COIL 1	Coil:Cooling:Water	28159.12	19476.53	8682.60	0.69	-

Heating Coils

	Type	Nominal Total Capacity [W]	Nominal Efficiency [W/W]

SPACE1-1 ZONE COIL	Coil:Heating:Water	10384.85	-
SPACE2-1 ZONE COIL	Coil:Heating:Water	8470.48	-
SPACE3-1 ZONE COIL	Coil:Heating:Water	10477.88	-
SPACE4-1 ZONE COIL	Coil:Heating:Water	11334.29	-
SPACE5-1 ZONE COIL	Coil:Heating:Water	11391.33	-
MAIN HEATING COIL 1	Coil:Heating:Water	4061.83	-

Fans

	Type	Total Efficiency [W/W]	Delta Pressure [pa]	Max Flow Rate [m3/s]	Rated Power [W]	Motor Heat In Air Fraction	End Use
SUPPLY FAN 1	Fan:VariableVolume	0.70	600.00	1.28	1099.23	1.00	General

Pumps

	Type	Control	Head [pa]	Power [W]	Motor Efficiency [W/W]
HW CIRC PUMP	Pump:VariableSpeed	INTERMITTENT	179352.00	312.23	0.90
CW CIRC PUMP	Pump:VariableSpeed	INTERMITTENT	179352.00	231.95	0.90

Service Water Heating

	Type	Storage Volume [m3]	Input [W]	Thermal Efficiency [W/W]	Recovery Efficiency [W/W]	Energy Factor
None						

Features Related to Appendix G and LEED

EnergyPlus has several built-in features to make demonstrating compliance with ASHRAE Standard 90.1 Appendix G easier. Appendix G is used in Energy and Atmosphere Credit 1 Optimize Energy Performance of the U.S. Green Building Council (USGBC) building certification system called Leadership in Energy and Environmental Design (LEED) Green Building Rating System™. The following sections describe the features.

Baseline Building Rotations

Table G3.1 Section 5 Building Envelope of ASHRAE Standard 90.1 Appendix G requires that the baseline building be simulated facing four directions:

Orientation. The baseline building performance shall be generated by simulating the building with its actual orientation and again after rotating the entire building 90, 180, and 270 degrees, then averaging the results.

This provision intends to provide a baseline that is neutral to building orientation so that buildings purposely oriented to minimize energy use can realize a percent savings.

Step 1. The first step of performing the building rotations is to include a Compliance:Building object which contains the Building Rotation for Appendix G field. The value of the field should be different for four simulations, 0, 90, 180 and 270 (see Step 2 below). This is further documented in the Input Output Reference.

```
Compliance:Building,
    90;                 Building Rotation for Appendix G
```

Also make sure that the HTML summary reports will be generated by including the following:

```
OutputControl:Table:Style,
  HTML;                         !- type

Output:Table:SummaryReports,
  AllSummary;                   !- type
```

Step 2. The ParametricPreprocessor automates the creation of the four simulation input files so that only a single simulation file is needs to be created by the user. By setting the file name suffixes (which are appended to the existing file name for each simulation), setting a variable that varies for the four simulations, and setting the Building Rotation for Appendix G to this variable, the user can automatically create the four files when using EnergyPlus. The following example shows what should be included in the EnergyPlus file. The Parametric objects are described further in the Input Output Reference and the ParametricPreprocessor is described in the Auxiliary Programs documentation.

```
Parametric:FileNameSuffix,
  Names,
  G000,
  G090,
  G180,
  G270;

Parametric:SetValueForRun,
  $appGAngle,            !- Parameter Name
  0.0,                   !- Value 1
  90.0,                  !- Value 2
  180.0,                 !- Value 3
  270.0;                 !- Value 4


Compliance:Building,
    =$appGAngle;        !- Building Rotation for Appendix G {deg}

OutputControl:Table:Style,
  HTML;                         !- type

Output:Table:SummaryReports,
  AllSummary;                   !- type
```

Step 3. Run the simulation using EP-Launch. Using the "Single Input File" tab of EP-Launch select the input that contains the Compliance:Building, Parametric:FileNameSuffix, Parametric:SetValueForRun objects as shown above in Step 2 as well as the weather file. In EP-Launch, make sure under VIEW .. OPTIONS .. MISCELLANEOUS that the RUN PARAMETRICPREPROCESSOR option is checked.

Step 4. Review the results and revise the model inputs as needed. You can view the results of the simulation by using the EP-Launch and the History tab. At the bottom of the history list, four simulations that use the G000, G090, G180 and G270 file name suffixes should appear and the result files associated with each can be selected and opened.

Step 5. Use the AppGPostProcess to average results across the simulations. In EP-Launch under the UTILITIES tab, select AppGPostProcess utility and select one of the HTML files

resulting from the multiple simulation runs (e.g., <filename>-G000.html). This will open all four files and generate a new output file with the file suffix GAVG for the HTML and other results files that can be opened on that tab.

Completing LEED Forms from Tabular Reports

The U.S. Green Building Council building certification system called Leadership in Energy and Environmental Design (LEED) Green Building Rating System™ includes Energy and Atmosphere Credit 1 Optimize Energy Performance. Credit 1 includes an option that requires a series of building energy simulations that follow the procedures of ASHRAE Standard 90.1 Appendix G Performance Rating Method. The following section describes how the form for Credit 1 can be completed based on the results reporting in the Tabular Reports. The references shown below are for either to the LEED form (version 2.2) and to the various tables available in EnergyPlus.

LEED Form Section 1.1 – General Information

Form Input	Table	Subtable	Output Field
Principal Heating Source	Annual Building Utility Performance Summary	End Use	Table Footnote
Weather File	Climatic Data Summary	Weather Statistics File	Reference
Climate Zone	Climatic Data Summary	Weather Statistics File	ASHRAE Climate Zone
New Construction Percent	Economics Results Summary Report	Annual Cost	Cost (compute the percent difference)

LEED Form Section 1.2 – Space Summary

Form Input	Table	Subtable	Output Field
Conditioned Area	Input Verification and Results Summary	Zone Summary	Area (combine like zones which are conditioned)
Unconditioned Area	Input Verification and Results Summary	Zone Summary	Area (combine like zones which are unconditioned)
Total Area	Input Verification and Results Summary	Zone Summary	Area (combine like zones)

LEED Form Section 1.3 – Advisory Messages

Form Input	Table	Subtable	Output Field
Number of hours heating loads not met	Annual Building Utility Performance Summary	Comfort and Setpoint Not Met Summary	Time Set Point Not Met During Occupied Heating
Number of hours cooling loads not met	Annual Building Utility Performance Summary	Comfort and Setpoint Not Met Summary	Time Set Point Not Met During Occupied Cooling
Number of warning messages	<ERR FILE>		Warnings

Number of error messages	<ERR FILE>		Severe Errors
Number of defaults overridden	Object Count Summary	Input Fields	Fields with Defaults minus Defaulted Fields

LEED Form Section 1.4 – Comparison of Proposed Design Versus Baseline Design

Unlike other portions of the LEED forms, Section 1.4 Comparison of Proposed Design Versus Baseline Design is less structured with many possible "Model Input Parameters" to match with the "Proposed Design Input" and "Baseline Design Input". The form lists seven different description areas (show in italics below) that inputs can be varied from the baseline to the proposed model.

1. Exterior wall, underground wall, roof, floor, and slab assemblies including framing type, assembly R-values, assembly U-factors, and roof reflectivity when modeling cool roofs. (Refer to ASHRAE 90.1 Appendix A)

Use the values from the Envelope Summary table, Opaque Exterior subtable for Construction, Reflectance, U-Factor with Film, and U-Factor no Film.

2. Fenestration types, assembly U-factors (including the impact of the frame on the assembly, SHGCs, and visual light transmittances, overall window-to-gross wall ratio, fixed shading devices, and automated movable shading devices

Use the values from Input Verification and Results Summary table, Window-Wall Ratio table Window-Wall Ratio percentage as well as Skylight-Roof Ratio table. Also use the values from the Envelope Summary table, Fenestration subtable for Construction, Area of Openings, U-Factor, SHGC, Visible Transmittance, and Shade Control. For shading use the Shading Summary report including Sunlit Fraction and Window Control.

3. Interior lighting power densities, exterior lighting power, process lighting power, and lighting controls modeled for credit.

Use the values from the Lighting Summary report for Interior Lighting, Daylighting and Exterior Lighting including Lighting Power Density, Schedule Name, Average Hours/Week, Daylighting Type, Control Type, Fraction Controlled, Lighting Installed in Zone, Lighting Controlled.

4. Receptacle equipment, elevators or escalators, refrigeration equipment and other process loads.

Use the values from Input Verification and Results Summary table, Zone Summary subtable for Plug and Process.

5. HVAC system information including types and efficiencies, exhaust heat recovery, pump power and controls, and other pertinent system information. (Include the ASRHAE 90.1-2004 Table G3.1.1B Baseline System Number)

Use the Equipment Summary report, Central Plant subtable for Type, Nominal Capacity and Nominal Efficiency; Cooling Coils subtable for Nominal Total Capacity and Nominal Efficiency; Heating Coils subtable for Type, Nominal Total Capacity and Nominal Efficiency; Fans subtable for Type, Total Efficiency, Delta Pressure, Max Flow Rate, Rated Power, Motor Heat in Air Fraction; Pumps subtable for Type, Control, Head, Power and Motor Efficiency. Use the System Summary report, Economizer subtable for High Limit Shutoff Control and Minimum Outdoor Air; the Demand Controlled Ventilation using Controller:MechanicalVentilation subtable.

6. Domestic hot water system type, efficiency and storage tank volume.

Use the Equipment Summary report, Service Water Heating subtable for Type, Storage Volume, Input, Thermal Efficiency, Recovery Efficiency, and Energy Factor.

7. General schedule information.

Use the Lighting Summary report, Interior Lighting subtable Schedule Name and Average Hours/Week; Exterior Lighting subtable Schedule Name and Average Hours/Week. Use the System Summary report, Demand Controlled Ventilation using Controller:MechanicalVentilation subtable for the Air Distribution Effectiveness Schedule.

LEED Form Section 1.5 – Energy Type Summary

Form Input	Table	Subtable	Output Field
Energy Type	Economic Results Summary Report	Tariff Summary	Meter
Utility Rate Description	Economic Results Summary Report	Tariff Summary	name of rate
Units of Energy	Tariff Report		units

LEED Form Section 1.6 – Renewable Energy Source Summary

Form Input	Table	Subtable	Output Field
Renewable Source	Annual Building Utility Performance Summary	Electric Loads Satisfied	Photovoltaic Power or Window Power or High Temperature Geothermal
Annual Energy Generated	Annual Building Utility Performance Summary	Electric Loads Satisfied	Electricity

LEED Form Section 1.8 – Performance Rating Method Compliance Report

Table 1.8.1 Baseline Performance – Performance Rating Method Compliance

Note: EnergyPlus offers utilities to help with the four rotations (ParametricPreprocessor with the Compliance:Building Building Rotation for Appendix G field) and summary of the results (AppGPostProcess).

Form Input	Table	Subtable	Output Field
Energy Use	Annual Building Utility Performance Summary	End Uses	All fields
Demand	Demand End Use Components Summary	End Uses	All fields

LEED Form Section 1.8 – Performance Rating Method Compliance Report

Table 1.8.1(b) - Baseline Energy Costs

Note: EnergyPlus offers utilities to help with the four rotations (ParametricPreprocessor with the Compliance:Building Building Rotation for Appendix G field) and summary of the results (AppGPostProcess).

Form Input	Table	Subtable	Output Field
Energy Type	Economics Results Summary Report	Tariff Summary	Meter
Baseline Cost	Economics Results	Tariff Summary	Annual Cost

	Summary Report		

LEED Form Section 1.8 – Performance Rating Method Compliance Report

Table 1.8.2 – Performance Rating Table – Performance Rating Method Compliance

Form Input	Table	Subtable	Output Field
Energy Use	Annual Building Utility Performance Summary	End Uses	All fields
Demand	Demand End Use Components Summary	End Uses	All fields

LEED Form Section 1.8 – Performance Rating Method Compliance Report

Table 1.8.2(b) – Energy Cost and Consumption by Energy Type – Performance Rating Method Compliance

Form Input	Table	Subtable	Output Field
Energy Use	Annual Building Utility Performance Summary	End Uses	All fields
Cost	Economics Results Summary Report	Tariff Summary	Annual Cost

Features Related to California Title 24 Compliance

EnergyPlus has a reporting feature that is useful for obtaining Time Dependant Valuation (TDV) of source energy use for the entire facility being simulated. Hourly variations of fuel factors can be specified through the 'FuelFactors' input object and will be used to calculate TDV based source energy consumption broken down by end uses. The Source Energy End Use Components Summary report above provides these TDV based values. The source energy consumption is also reported based on area normalized metrics. Refer to 'Fuel Factors' and 'Output:Table:SummaryReports' in the Input-Output Reference manual for more details.

Also included is the California_Title_24-2008.idf dataset (described briefly in the Output Details document).