Michelle Farrell
Sustainability Chair

ASHRAE 90.1 Standard and Energy Modeling

Standards

- Developing standards since 1922
- Some 130 active standard or guideline projects
- Standards are reviewed and republished to ensure they are up-to-date, e.g., existing code-intended standards are on a three year review cycle
- www.ashrae.org/standards

Most Well-Recognized Standards

- 15, Safety Standard for Refrigeration Systems
- 34, Designation and Safety Classification of Refrigerants
- 55, Thermal Comfort
- 62.1, Indoor Air Quality for Commercial Buildings
- 62.2, Indoor Air Quality for Residential Buildings
- **90.1, Energy Efficiency for Commercial/High-Rise Residential Buildings**
- Standard 188, Legionellosis: Risk Management for Building Water Systems
- 189.1, Green, High Performing Commercial Buildings

ASHRAE 90.1 Standards in Green Rating Systems

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LEED
USGBC
LEED v4

RE-R1: Minimum Energy Performance

Intent

To create a decision-support tool to assist the project team in making informed decisions about the options, implications and benefits of various aspects of the building design in order to achieve a minimum level of energy efficiency.

Credit Requirements

GENERAL

Develop an energy model for the proposed building(s) using appropriate dynamic simulation modeling software and calculate the baseline building energy consumption according to the building performance rating method outlined in Appendix G of ANSI/ASHRAE/IESNA Standard 90.1-2007, using the minimum acceptable standards for building fabric, HVAC, service water heating, power, lighting and other equipment.

Demonstrate a minimum 12% performance improvement compared to the baseline building performance demonstrated by the energy simulation model as per the methodology outlined within Appendix G of Standard 90.1-2007.

LEED BD+C: Retail | v4 - LEED v4

Minimum energy performance

Required

Language | Guide | Resources | Addenda | Forum

Intent

To reduce the environmental and economic harms of excessive energy use by achieving a minimum level of energy efficiency for the building and its systems.

Requirements

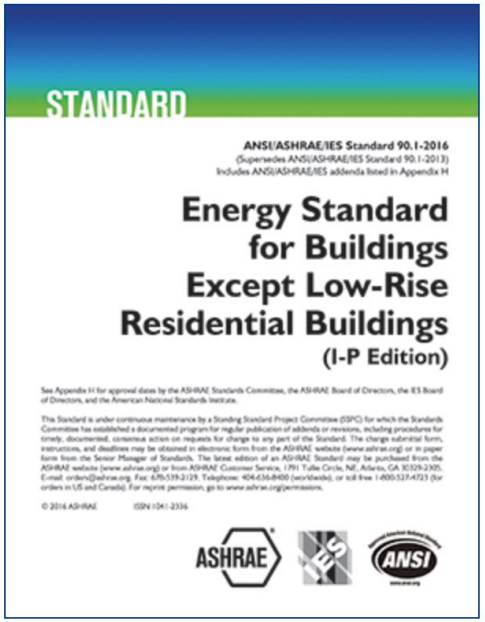
Option 1. Whole-building energy simulation

Demonstrate an improvement of 5% for new construction, 3% for major renovations, or 2% for core and shell projects in the proposed building performance rating compared with the baseline building performance rating. Calculate the baseline building performance according to ANSI/ASHRAE/IESNA Standard 90.1–2010, Appendix G, with errata (or a USGBC-approved equivalent standard for projects outside the U.S.), using a simulation model.

ASHRAE 90.1 Standards

Standard 90.1

ANSI/ASHRAE/IES Standard 90.1-2016 -- Energy Standard for Buildings Except Low-Rise Residential Buildings



Standard 90.1 has been a benchmark for commercial building energy codes in the United States and a key basis for codes and standards around the world for more than 35 years.

Structure and Form

In general, there are two means, or paths for building designers to comply with ASHRAE 90.1:

1. Prescriptive path: All components of the building meet the minimum standards specified by ASHRAE 90.1.
2. Performance path: A proposed building design is demonstrated (through building energy simulation) to use less energy than a baseline building built to ASHRAE 90.1 specifications. This now has three paths. For code compliance there is Chapter 11, which compares an energy model for your building to an energy model for a barely compliant building with the same HVAC system and in the 2016 edition an Appendix G path was added that compares an energy model of your building against a baseline model based on the 2004 edition of Standard 90.1 and requires lower energy consumption that varies depending on the building type.

Within the sections of the standard, there are some variations to this. Some sections have mandatory provisions, simplified approaches, or trade-off opportunities.

Prescriptive path

ASHRAE 90.1 includes prescriptive requirements for the following:

- Building Envelope (Section 5): minimum wall insulation, minimum roof insulation, roof reflectance, minimum glazing performance
- HVAC (Section 6): minimum equipment efficiency, minimum system features, limitation on reheat, limitation on fan power
- Domestic Hot Water (Section 7): minimum equipment efficiency, minimum system features
- Power (Section 8): transformer efficiency, automatic receptacle controls, energy monitoring
- Lighting (Section 9): maximum indoor lighting power density (LPD, expressed in Watts/Sq.Ft.), minimum lighting controls, exterior lighting, parking garage lighting
- Other Equipment (Section 10): electric motors, potable water booster pumps, elevators, and escalators

Performance Path

In the performance approach, a baseline Energy Cost Budget (ECB) is established, based on the building size and program. This baseline ECB is established using building energy simulation to model a building with the same size and program as the project building, built according to the prescriptive requirements of ASHRAE 90.1 (sections 5-10). The ECB is expressed in units of dollars.

A building energy simulation is then performed on the proposed building design. The proposed energy cost budget must be less than or equal to the baseline energy cost budget to achieve compliance.

The performance approach is also used to demonstrate design energy efficiency, often expressed as percent better than ASHRAE Standard 90.1. Building designs will stated their performance as "40% better than ASHRAE 90.1-2007" or "20% better than ASHRAE 90.1-2010". Percent improvement over ASHRAE 90.1 is the basis for awarding energy points within the LEED and Estidama rating systems.

ASHRAE 90.1 forms the baseline for which we can compare our designs against or perform to.

It also is the baseline of many sustainability rating systems because performing BETTER than it's baseline means you are achieving a well performing building.

What do you need to do an ASHRAE 90.1 energy model to prove performance path?

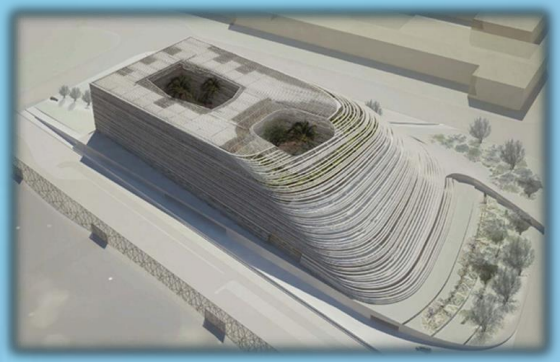
Common Energy Modeling Tools

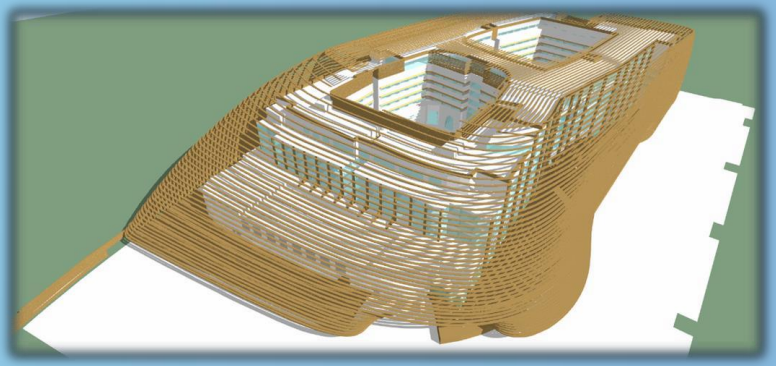
- EnergyPlus
- TRACE 700
- Carrier HAP
- IES <Virtual Environment>
- DesignBuilder
- eQUEST
- TRNSYS
- IDA ICE
- AECOsim

Table 1: Data Required for Energy Modeling

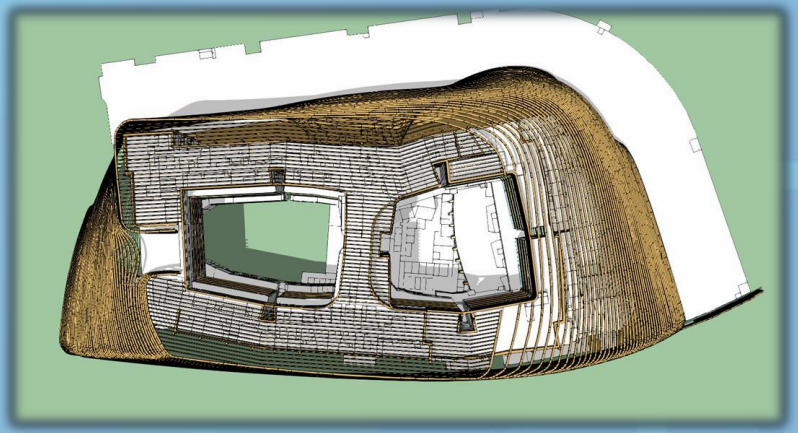
Category	Purpose	Source
Geographical location (climate)	Accurate load calculation based on external environment	Weather file
Geometry • Plan • Section • Elevation	Model geometrical attributes of buildings and any site specific features (shading, reflection by tree or building)	Architectural drawings
Construction • Wall • Roof • Window • Overhangs	Model building envelope attributes for thermal load and daylighting calculations	• ECBC • ISHRAE • CBRI • Software library • Vendors • ASHRAE
Daylighting and lighting • Layout • Technology and controls	• Visual comfort • Reducing LPD • Integration with daylight	• Lighting consultant • Vendors • ISLE/IES
Internal Load • Usage (e.g. number of hours) • Schedule • People, equipment, lighting	Accurately capture sources of internal heat gain within building	• Client • Energy modeler • Benchmarking data • Nameplate data
HVAC (type and controls) • Component specification • Control strategy • Layout and distribution	• Sizing the system • Design optimization • Comfort satisfaction	• HVAC consultant • ASHRAE/ISHRAE • ARI • ECBC

Solis Hotel

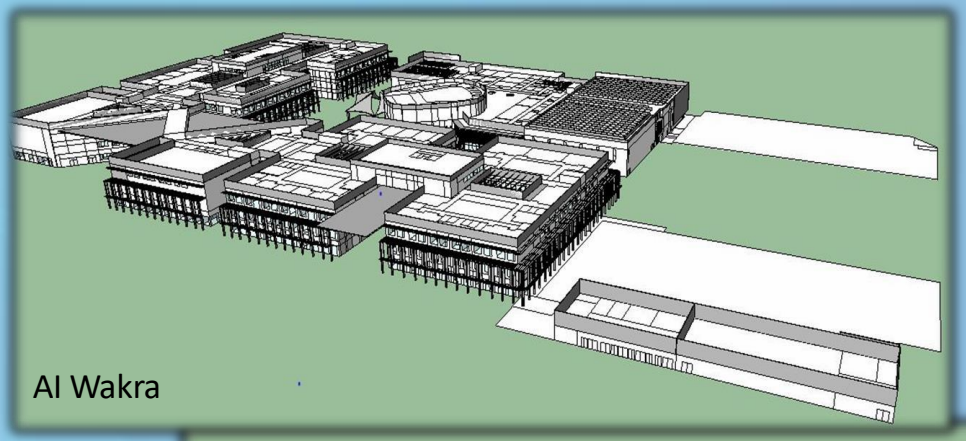


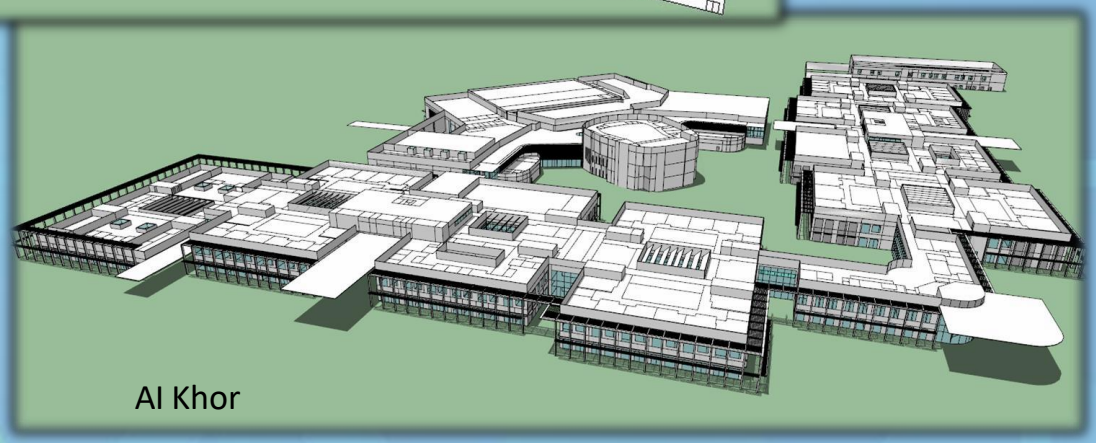


A hotel development featuring 250 guest rooms across 7 stories. It features a unique organic wraparound shading to protect the building from high solar loads. IES performed energy modelling for ASHRAE 90.1 PRM toward LEED Certification.



Al Khor & Al Wakra Schools

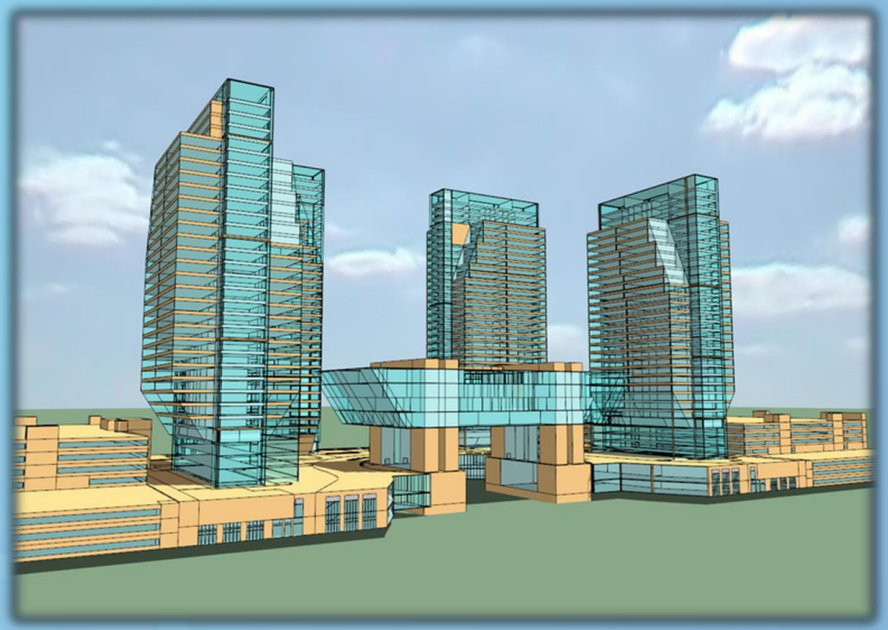




LEED energy models for 2 large school campus developments

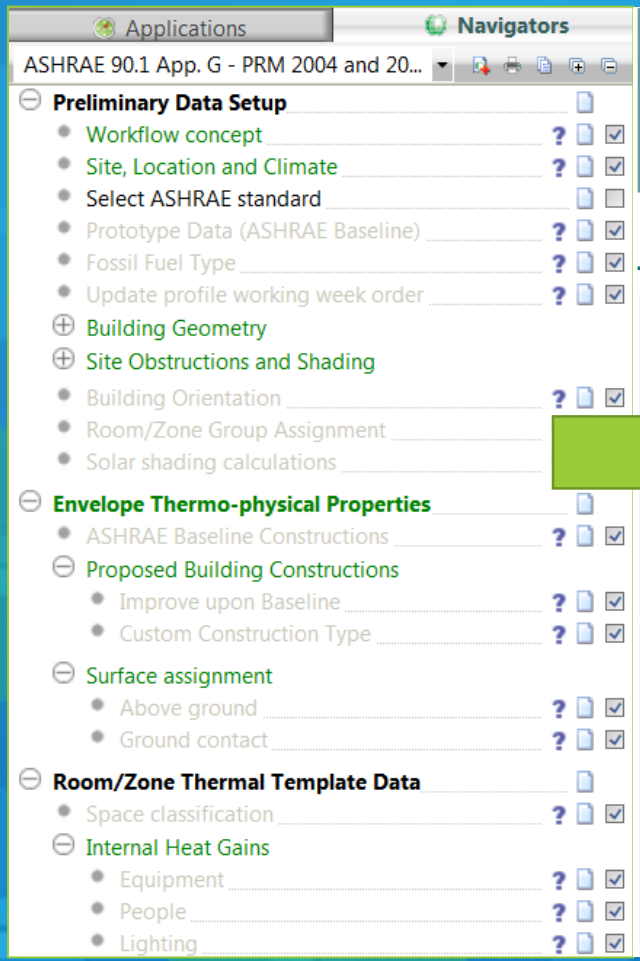
IES

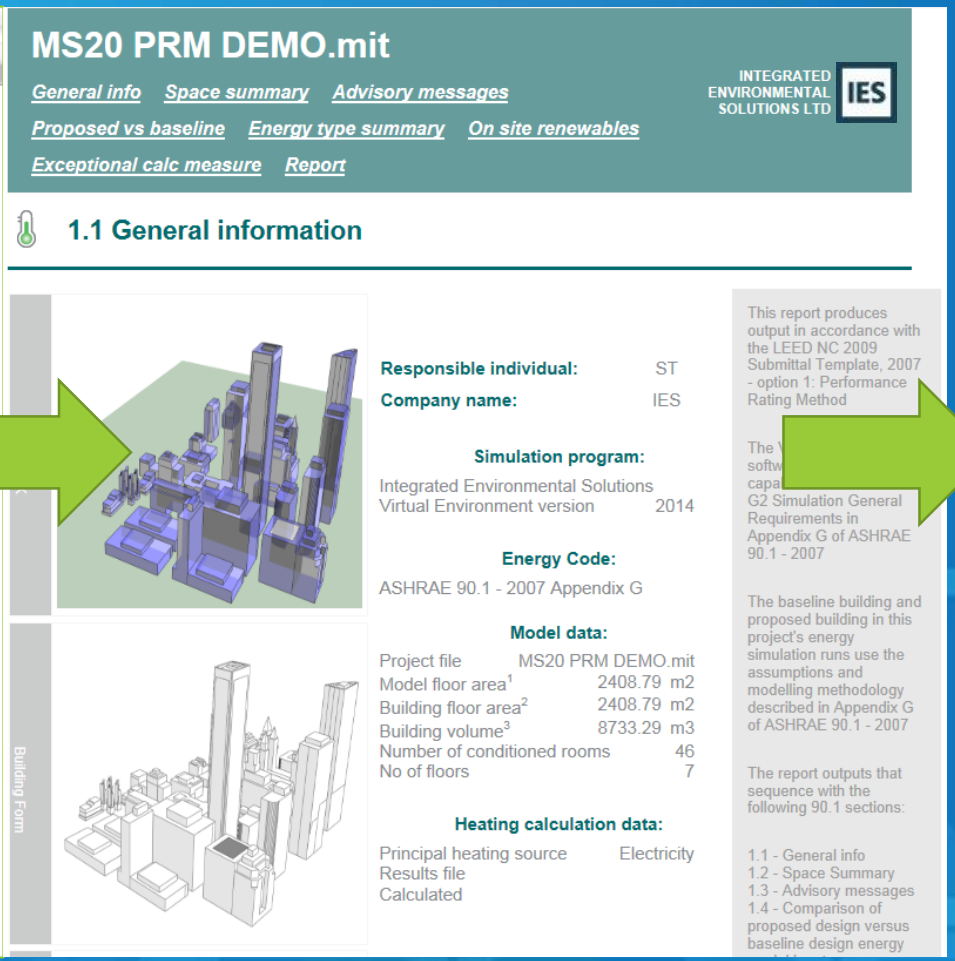
Sowwah Square, Abu Dhabi, UAE



Detailed energy modelling analysis of a 6,100,000 sq.ft. mixed use facility. The development at Sowwah Square consists of eight buildings in total; 4 commercial towers greater than 30 stories, the central stock exchange, a retail podium and 2 parking garages . The energy model was compared against ASHRAE 90.1-2004 (LEED Gold) and has a number of innovative features.

Compliance Reporting





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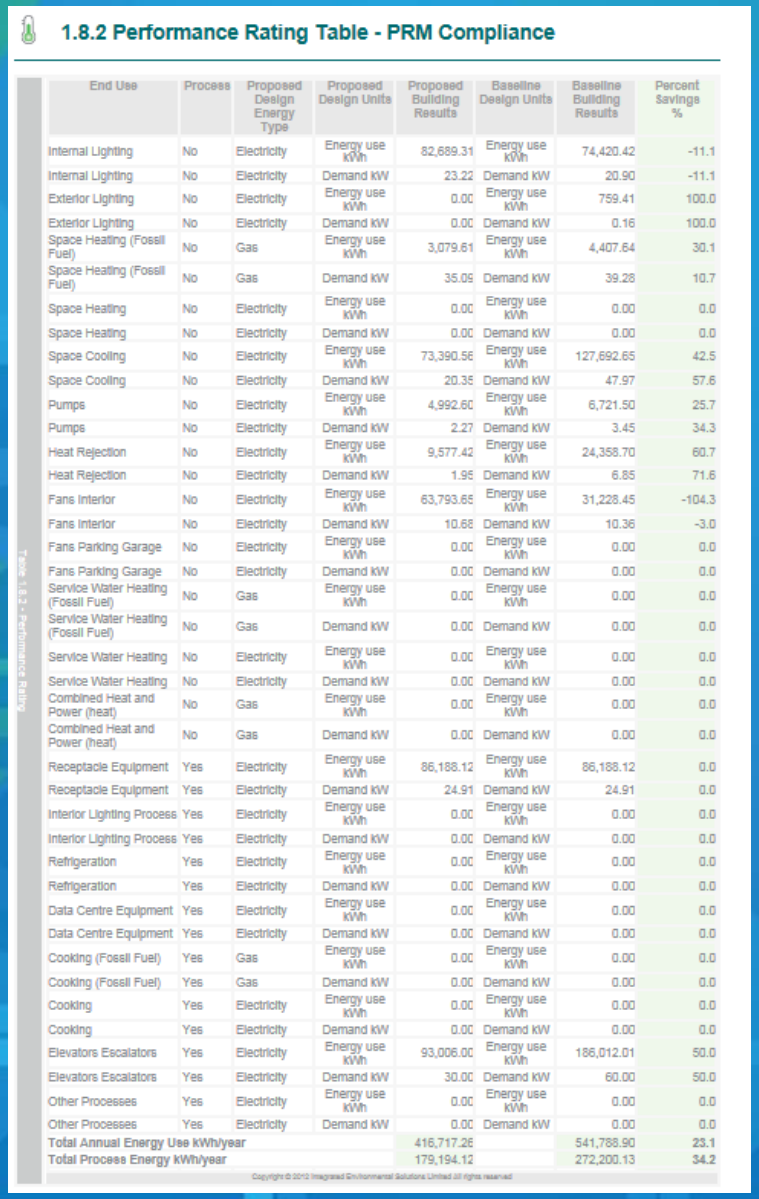
LEED - ASHRAE 90.1 Compliance Documents



1.8.2 Performance Rating Table - PRM Compliance

End Use	Process	Proposed Design Energy Type	Proposed Design Units	Proposed Building Results	Baseline Design Units	Baseline Building Results	Percent Savings %
Internal Lighting	No	Electricity	Energy use kWh	82,689.31	Energy use kWh	74,420.42	-11.1
Internal Lighting	No	Electricity	Demand kW	23.22	Demand kW	20.90	-11.1
Exterior Lighting	No	Electricity	Energy use kWh	0.00	Energy use kWh	759.41	100.0
Exterior Lighting	No	Electricity	Demand kW	0.00	Demand kW	0.16	100.0
Space Heating (Fossil Fuel)	No	Gas	Energy use kWh	3,079.61	Energy use kWh	4,407.64	30.1
Space Heating (Fossil Fuel)	No	Gas	Demand kW	35.09	Demand kW	39.28	10.7
Space Heating	No	Electricity	Energy use kWh	0.00	Energy use kWh	0.00	0.0
Space Heating	No	Electricity	Demand kW	0.00	Demand kW	0.00	0.0
Space Cooling	No	Electricity	Energy use kWh	73,390.56	Energy use kWh	127,692.65	42.5
Space Cooling	No	Electricity	Demand kW	20.35	Demand kW	47.97	57.6
Pumps	No	Electricity	Energy use kWh	4,992.60	Energy use kWh	6,721.50	25.7
Pumps	No	Electricity	Demand kW	2.27	Demand kW	3.45	34.3
Heat Rejection	No	Electricity	Energy use kWh	9,577.42	Energy use kWh	24,358.70	60.7
Heat Rejection	No	Electricity	Demand kW	1.95	Demand kW	6.85	71.6
Fans Interior	No	Electricity	Energy use kWh	63,793.65	Energy use kWh	31,228.45	-104.3
Fans Interior	No	Electricity	Demand kW	10.68	Demand kW	10.36	-3.0
Fans Parking Garage	No	Electricity	Energy use kWh	0.00	Energy use kWh	0.00	0.0
Fans Parking Garage	No	Electricity	Demand kW	0.00	Demand kW	0.00	0.0
Service Water Heating (Fossil Fuel)	No	Gas	Energy use kWh	0.00	Energy use kWh	0.00	0.0
Service Water Heating (Fossil Fuel)	No	Gas	Demand kW	0.00	Demand kW	0.00	0.0
Service Water Heating	No	Electricity	Energy use kWh	0.00	Energy use kWh	0.00	0.0
Service Water Heating	No	Electricity	Demand kW	0.00	Demand kW	0.00	0.0
Combined Heat and Power (heat)	No	Gas	Energy use kWh	0.00	Energy use kWh	0.00	0.0
Combined Heat and Power (heat)	No	Gas	Demand kW	0.00	Demand kW	0.00	0.0
Receptacle Equipment	Yes	Electricity	Energy use kWh	86,188.12	Energy use kWh	86,188.12	0.0
Receptacle Equipment	Yes	Electricity	Demand kW	24.91	Demand kW	24.91	0.0
Interior Lighting Process	Yes	Electricity	Energy use kWh	0.00	Energy use kWh	0.00	0.0
Interior Lighting Process	Yes	Electricity	Demand kW	0.00	Demand kW	0.00	0.0
Refrigeration	Yes	Electricity	Energy use kWh	0.00	Energy use kWh	0.00	0.0
Refrigeration	Yes	Electricity	Demand kW	0.00	Demand kW	0.00	0.0
Data Centre Equipment	Yes	Electricity	Energy use kWh	0.00	Energy use kWh	0.00	0.0
Data Centre Equipment	Yes	Electricity	Demand kW	0.00	Demand kW	0.00	0.0
Cooking (Fossil Fuel)	Yes	Gas	Energy use kWh	0.00	Energy use kWh	0.00	0.0
Cooking (Fossil Fuel)	Yes	Gas	Demand kW	0.00	Demand kW	0.00	0.0
Cooking	Yes	Electricity	Energy use kWh	0.00	Energy use kWh	0.00	0.0
Cooking	Yes	Electricity	Demand kW	0.00	Demand kW	0.00	0.0
Elevators Escalators	Yes	Electricity	Energy use kWh	93,006.00	Energy use kWh	186,012.01	50.0
Elevators Escalators	Yes	Electricity	Demand kW	30.00	Demand kW	60.00	50.0
Other Processes	Yes	Electricity	Energy use kWh	0.00	Energy use kWh	0.00	0.0
Other Processes	Yes	Electricity	Demand kW	0.00	Demand kW	0.00	0.0
Total Annual Energy Use kWh/year				416,717.26		541,788.90	**23.1**
Total Process Energy kWh/year				179,194.12		272,200.13	**34.2**

1.8.2 Performance Rating Table - PRM Compliance

End Use	Process	Proposed Design Energy Type	Proposed Design Units	Proposed Building Results	Baseline Design Units	Baseline Building Results	Percent Savings %
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Internal Lighting	No	Electricity	Demand kW	23.22	Demand kW	20.90	-11.1
Exterior Lighting	No	Electricity	Energy use kWh	0.00	Energy use kWh	759.41	100.0
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Space Heating	No	Electricity	Energy use kWh	0.00	Energy use kWh	0.00	0.0
Space Heating	No	Electricity	Demand kW	0.00	Demand kW	0.00	0.0
Space Cooling	No	Electricity	Energy use kWh	73,390.56	Energy use kWh	127,692.65	42.5
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Pumps	No	Electricity	Demand kW	2.27	Demand kW	3.45	34.3
Heat Rejection	No	Electricity	Energy use kWh	9,577.42	Energy use kWh	24,358.70	60.7
Heat Rejection	No	Electricity	Demand kW	1.95	Demand kW	6.85	71.6
Fans Interior	No	Electricity	Energy use kWh	63,793.65	Energy use kWh	31,228.45	-104.3

LEED - ASHRAE 90.1 Compliance Documents

1.8.2 (b) Energy Cost & Consumption by energy Type - PRM Compliance

Table 1.8.2 (b) - Energy Cost

Energy Type	Units	Proposed Design		Baseline Design		Percent Savings	
		Energy Use	Cost (GBP)	Energy Use	Cost (GBP)	Energy Use	Cost
Electricity	kWh	413,637.65	38,977.40	537,381.26	50,634.05	23.03	23.02
Gas	kWh	3,079.61	101.31	4,407.64	140.76	30.13	28.03
Subtotal (Model Outputs):		416,717.26	39,078.71	541,788.90	50,774.81	23.08	23.04

On site Renewable Energy	Energy Generated (kWh)	Renewable Energy Cost (GBP)	Narrative
Photovoltaic Panels	0.00	0.00	Generated from source
Wind Power	0.00	0.00	Generated from source
Combined Heat and Power (electricity)	0.00	0.00	Generated from source
Solar Water Heating	0.00	0.00	Generated from source

Exceptional Calculations	Energy Savings	Cost Savings	Narrative

Summary	Units	Proposed Design		Baseline Design		Percent Savings	
		Energy use	Cost (GBP)	Energy use	Cost (GBP)	Energy use	Cost
Total	kWh	416,717.26	39,078.71	541,788.90	50,774.81	23.08	23.04

Percent Savings	
Energy use	Cost
23.08	23.04

Thank you!

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