



Whole Building Energy Modeling

Tools and Resources for Efficient
Buildings

Brian Dean, ICF International
Working in Support of ENERGY STAR®



Learn more at energystar.gov



Session Overview



- ENERGY STAR & Energy Efficiency
- Integrating Energy Performance into New and Existing Buildings
- Energy Modeling Demonstration
- Target Finder Demonstration
- Federal Recognition
- Available Tools and Resources

What is ENERGY STAR?



A voluntary
program
(*est. 1991 by the EPA*)



that enables organizations of all types
to achieve their best in energy efficiency

Recognized by over 70% of U.S. Households

Eligible Space Types



MOBs



Hospitals



K-12 Schools



Supermarkets



Hotels



Offices



 Others include: Warehouse, Residence Halls, Courthouses, Financial Centers

Energy Use in Healthcare



- Healthcare Industry spends **\$8.4 billion*** per year on energy
- Existing buildings can be **35%** more efficient (EPA)
- Newly designed buildings can be **50%** more efficient (LBNL)



*Source: 2003 EIA CBECS data for healthcare, converted to 2006 dollars

Missed Opportunities



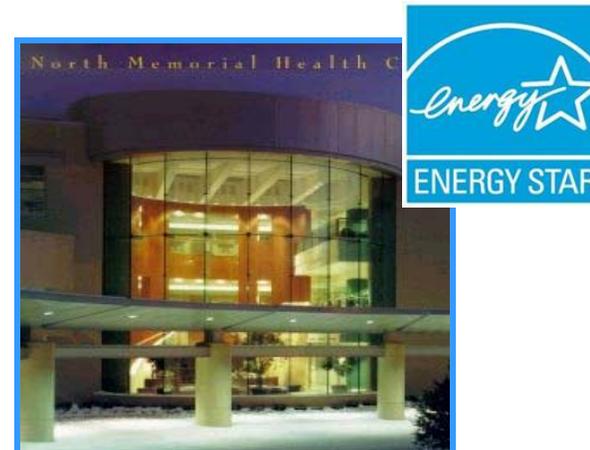
Hospital A



120 Beds
150,000 Square Feet

\$820,000
\$5.42/SF

Hospital B



120 Beds
150,000 Square Feet

\$720,000
\$4.76/SF

The Difference...



Hospital A:

- No commitment to energy-efficient design
- Energy modeling not used in decision making
- Addressed first costs rather than life cycle costs
- Design decisions made purely on aesthetics and function
- No energy performance improvements post-construction



The Difference...



Hospital B:

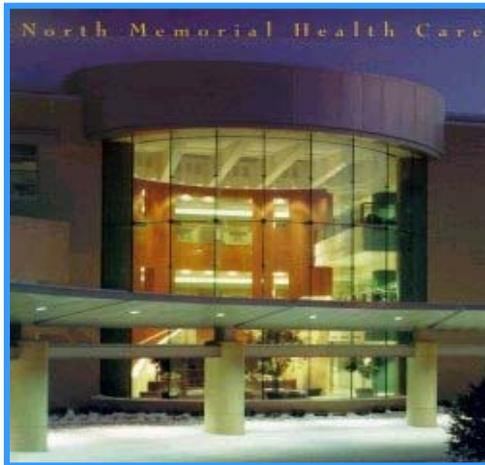
- Attention to energy performance post-construction
- Assessed performance with benchmarking
- Retro-commissioned facility years after opening
- Used low-cost O&M improvements
- Earned the **ENERGY STAR**



What if Hospital B was Designed to be Energy Efficient?



Hospital B



120 Beds

150,000 Square Feet

~~\$620,000~~

~~\$4.13/SF~~

- Incorporated energy efficiency at all design stages
- Used energy modeling to earn the designation:
- Continued improving post construction



The 2030 °C Challenge



- All new buildings designed to use **50%** less fossil fuel
- 60% by 2010
- 70% in 2015
- 80% in 2020
- 90% in 2025
- Carbon-Neutral by 2030

www.architecture2030.org

How Does Your Design Compare?



EPA's Target Finder Energy Modeling Tools

Your Design



Existing Buildings



Target Finder & Energy Modeling

- Help optimize the building design
- Help prioritize investment in the strategies
- Evaluate energy efficiency
- Allows for national recognition



DESIGNED
TO EARN THE
ENERGY STAR

The estimated energy performance for this design meets US EPA criteria. The building will be eligible for ENERGY STAR after maintaining superior performance for one year.



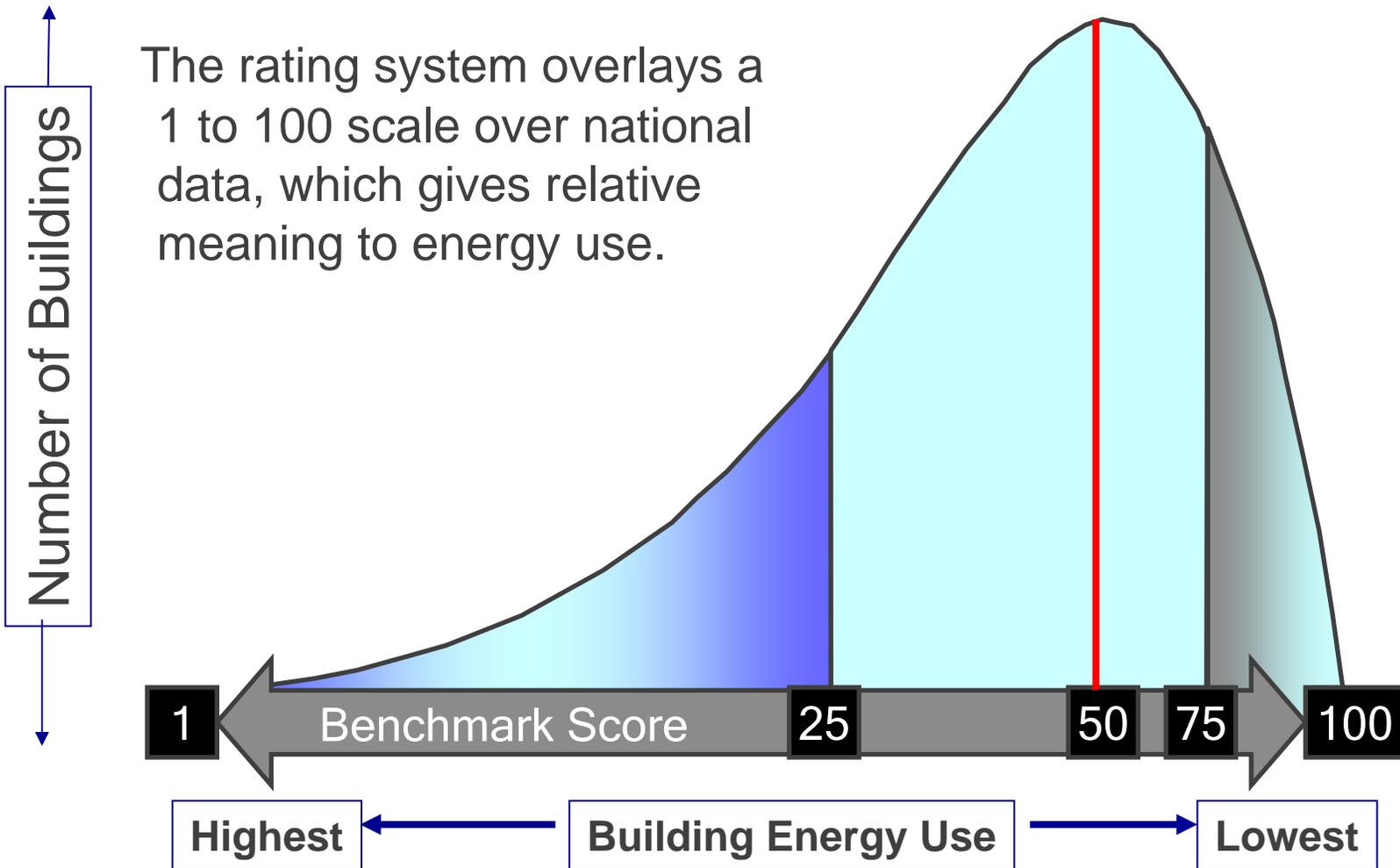
Target Finder



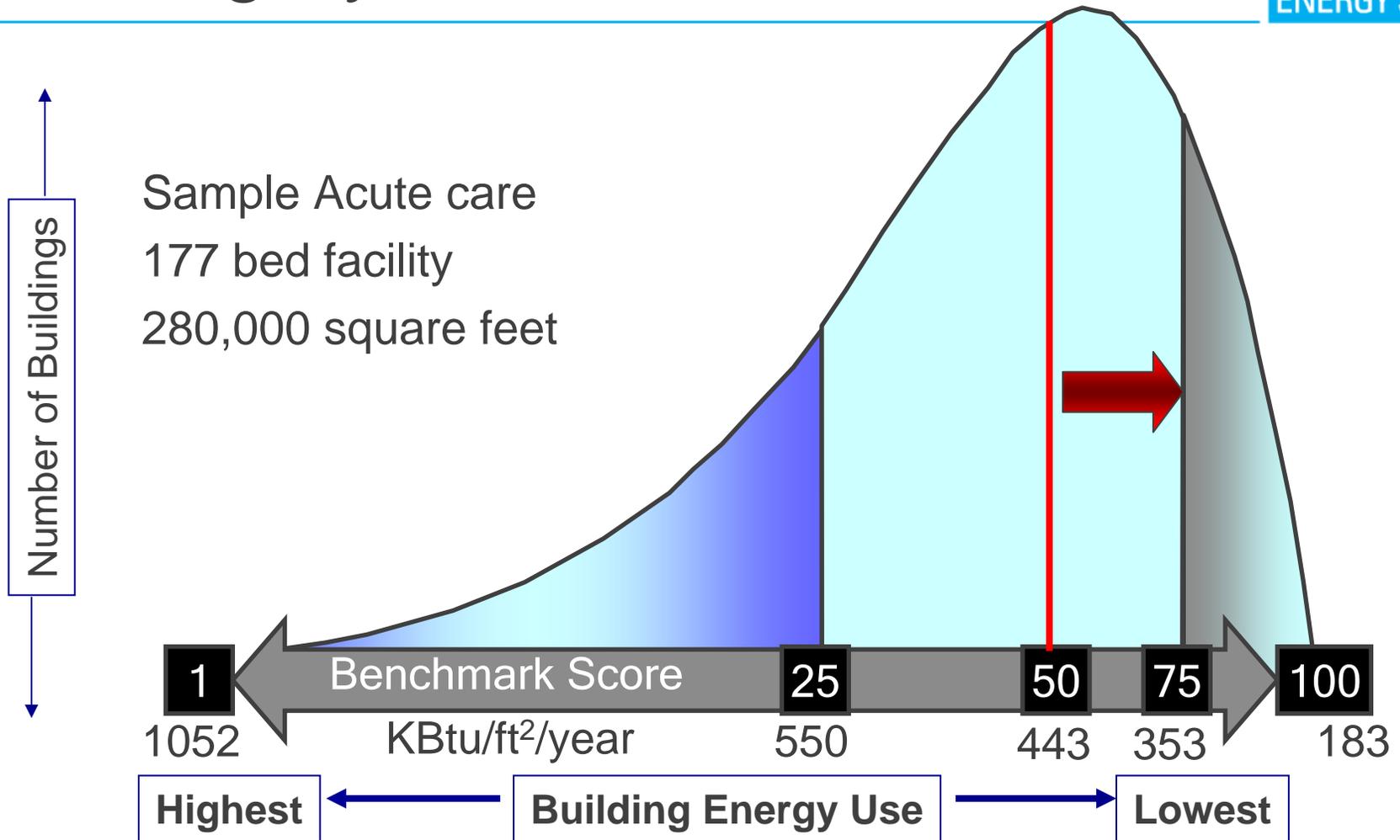
- Rates the energy performance on a 1-100 scale
- Inputs include basic building characteristics
- Estimated annual energy consumption
 - Energy Modeling Tools



US EPA Energy Performance Rating System



US EPA Energy Performance Rating System



Where is Target Finder?

A blurred, high-angle photograph of architectural blueprints or floor plans, showing various lines and shapes representing building structures.

www.energystar.gov/newbuildingdesign



SUPERIOR ENERGY MANAGEMENT CREATES ENVIRONMENTAL LEADERS

U.S. Environmental Protection Agency

About ENERGY STAR - News Room - FAQs

Search Go

ENERGY STAR

- Products
- Home Improvement
- New Homes
- Buildings & Plants
- Partner Resources

Buildings & Plants

Guidelines for Energy Management

Tools & Resources Library

Expert Help

New Building Design

Benefits & Recognition

ENERGY STAR Challenge for Architects

See the Results

Energy-Efficient Design Projects

Target Finder - EPA Rating

Building Design Guidance

News & Resources

Classes & Conferences

Green Buildings

Getting Started for...

Commercial Real Estate

Corporate Real Estate

Government

Healthcare

Home > Buildings & Plants > Tools & Resources Library > New Building Design



New Building Design

Help protect our environment by designing buildings with superior energy efficiency resulting in top energy performance. This site offers information to help architects and building design professionals take advantage of tools and resources from EPA:



[Benefits and Recognition](#)

Find out how to join the ENERGY STAR partnership, distinguish your design projects among the nation's best for energy performance, and receive recognition from EPA.

[A&E Firms Meet the 2007 ENERGY STAR Challenge](#)

See the list of 23 architecture firms and their engineering teams that are leading the way and showing others that building designs can earn the ENERGY STAR and prevent greenhouse gas emissions.

[Energy-Efficient Design Projects](#)

See the current list of architecture/engineering (A&E) firms creating designs that meet EPA performance criteria to earn the ENERGY STAR.

[Target Finder — EPA's Energy Performance Rating](#)

Learn about the easy-to-use online rating tool for estimating design energy use.

[Building Design Guidance](#)

Refer to "best practices" guidelines to help incorporate energy efficiency strategies into your building design process.

[News and Resources](#)

ARCHITECTS:



Quick Finder

[Portfolio Manager Login](#)

[Target Finder](#)

[ENERGY STAR Challenge](#)

[ENERGY STAR Leaders](#)

[Earn the ENERGY STAR](#)

[Purchasing & Procurement](#)

[Service Providers Directory](#)

[Find Labeled Buildings](#)

[Communications Materials](#)

[Training](#)

What is an Energy Model?



- Computer based tool
- Simulates annual energy use of a building
- Methodical and iterative process to evaluate potential decisions and achieve long-term goals



Energy Modeling Tools



- eQuest (DOE-2) – Today's Session
www.doe2.com
- EnergyPlus – a tool of the future
- HAP & Trace (available from Equipment Manufacturers)



eQUEST



- The Quick Energy Simulation Tool
- It's FREE and available online (www.doe2.com)
- Useful to ALL design team members
- Used at any or all design phases



When do you use these tools?



New Building Design/Expansion

- In all stages of design
- When design changes are proposed
WHY? Educates design decisions

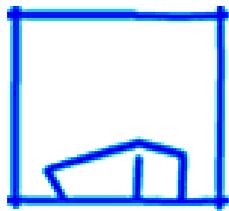
Existing Buildings/Renovations

- To identify cost-effective projects
WHY? Maximize whole building efficiency

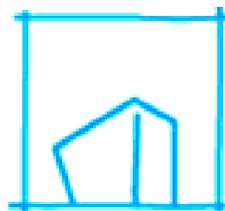


**New Construction/
Expansion**

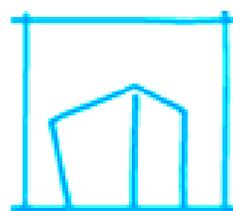
Pre-Design



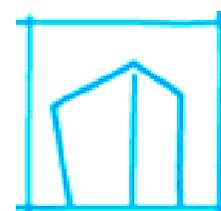
PRE-DESIGN



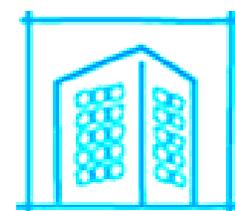
SCHEMATIC
DESIGN



DESIGN
DEVELOPMENT



CONSTRUCTION
& BID
DOCUMENTS

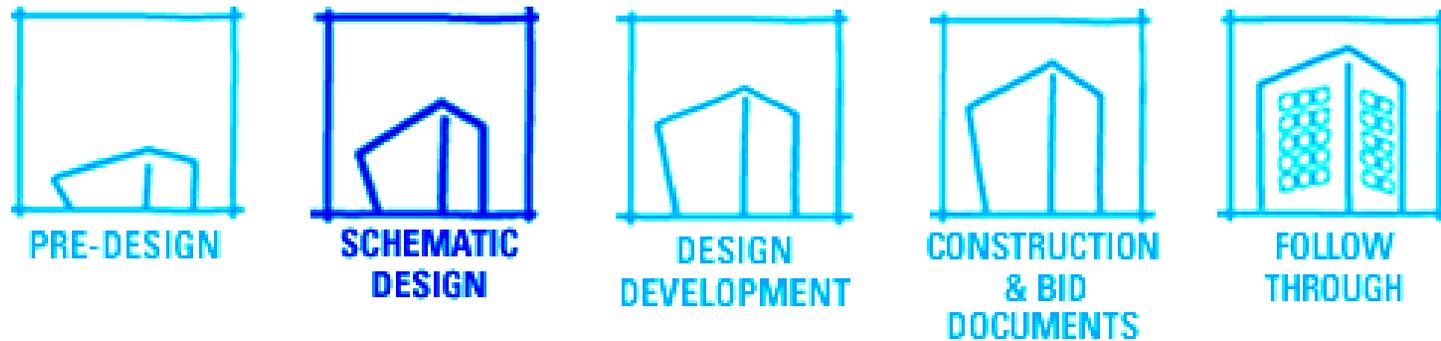


FOLLOW
THROUGH

- Broaden your design team to include staff that will use the space
- Review case studies
- Set high energy performance goals
- Select energy modeling software

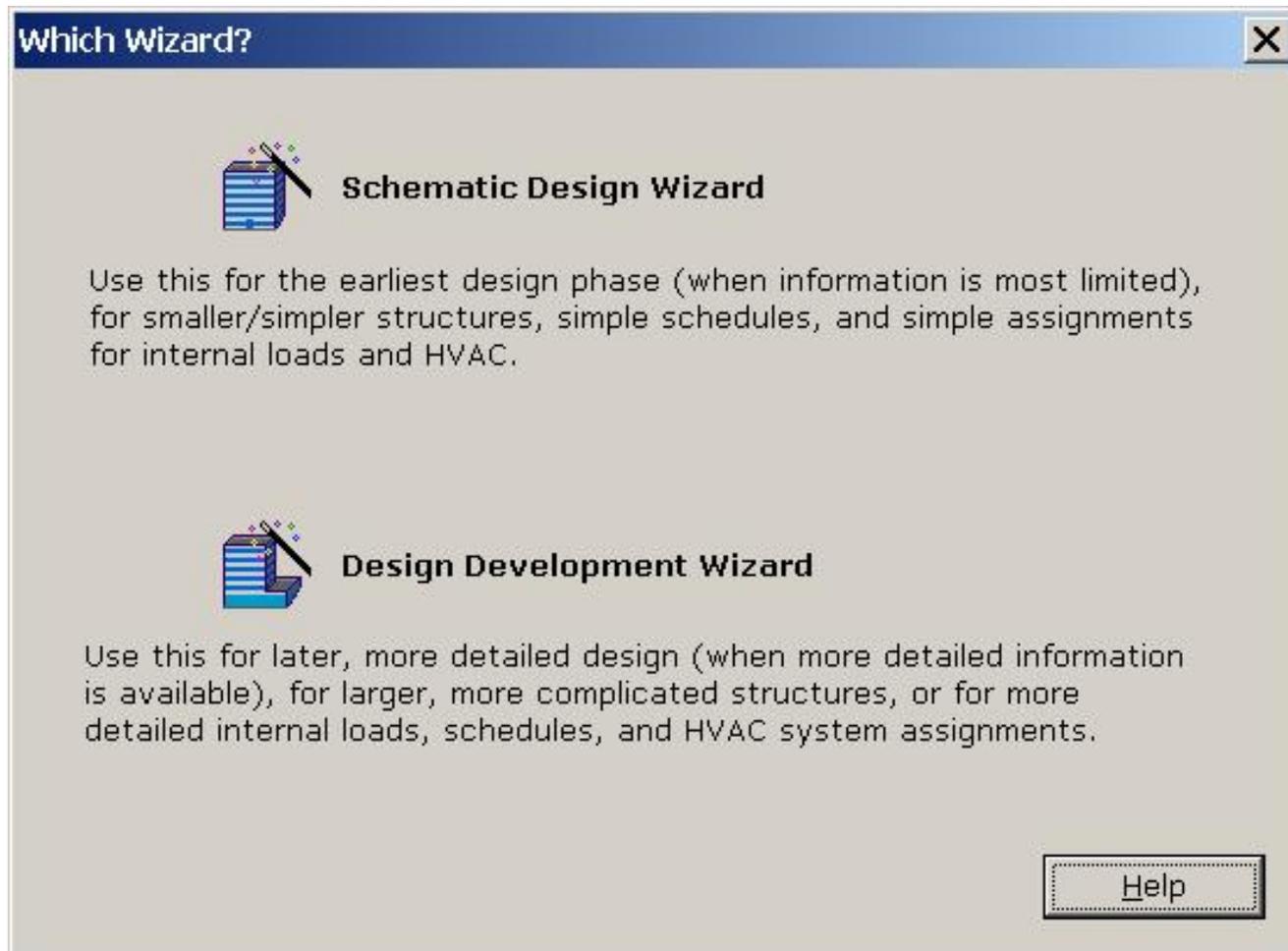
Schematic Design

Biggest Opportunities



- Use a simplified model of the building
- Test site and basic design features
- Utilize default values in the model
- Compare alternative scenarios

eQuest Wizard Intro Screen



Schematic Design Wizard Screen 1



eQUEST Schematic Design Wizard

General Information

Project Name: Energy Code Compliance Analysis:

Building Type:

Building Location, Utilities and Rates

Coverage: Utility: Electric: Rate:

Region: Gas: Rate:

City:

Area and Floors

Building Area: ft² Number of Floors: Above Grade: Below Grade:

Cooling and Heating

Cooling Equip: Heating Equip:

Other Data

Analysis Year: Daylighting Controls: Usage Details:

Wizard Screen

Help Previous Screen Next Screen Finish

All Red Inputs are User-defined

All Green Inputs are Defaults

Schematic Design Wizard – Using F1



The screenshot shows the eQUEST Schematic Design Wizard software interface. The main window is titled "eQUEST Schematic Design Wizard" and contains several sections for inputting building information:

- General Information:** Project Name: Hospital Building 2030; Energy Code Compliance: none.
- Building Type:** Health, Hospital (inpatient).
- Building Location, Utilities and Rates:** Coverage: All eQUEST Locations; Region: Illinois; City: Chicago; Utility: Electric: - fire -; Gas: - fire -; Rate: - none -.
- Area and Floors:** Building Area: 250,000 ft²; Number of Floors: Above Grade: 4.
- Cooling and Heating:** Cooling Equip: Chilled Water Coils; Heating Equip: Hot Water Coils.
- Other Data:** Analysis Year: 2016; Daylighting Controls: No; Usage Details: Simplified.

The "Wizard Screen" indicator shows "1 of 30". At the bottom, there are buttons for "Help", "Previous Screen", and "Next Screen".

Overlaid on the right side is a "Wizard Help Contents" window titled "HVAC System - Heating Source". It provides the following information:

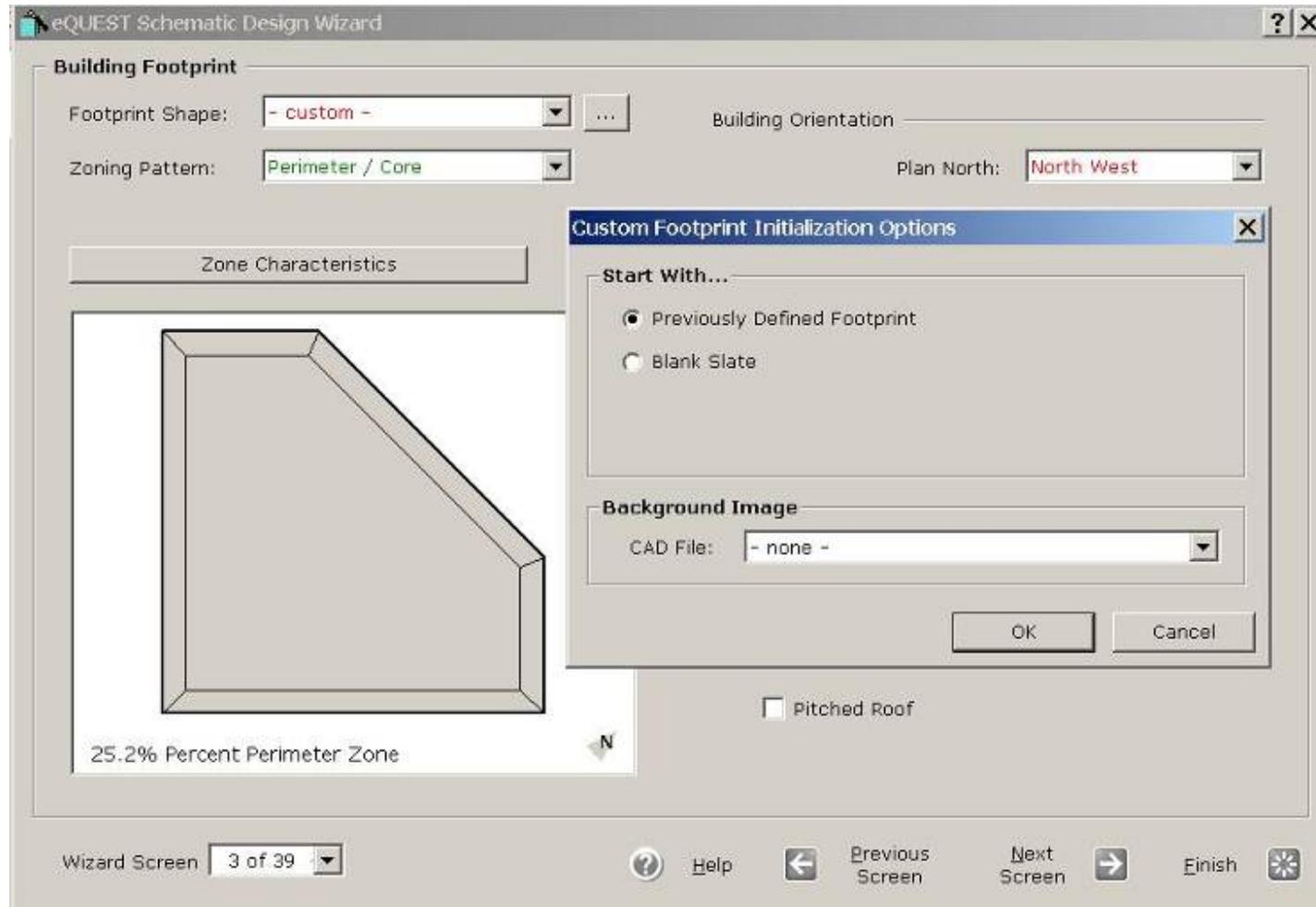
Heating Source.

Heating Source is used to indicate the source of Heating, if any, for the HVAC **System Type**. The available choices for **Heating Source** is governed by the choice for **Cooling Source**. The choices for **Heating Source** and **Cooling Source**, govern the available selections for **System Type**.

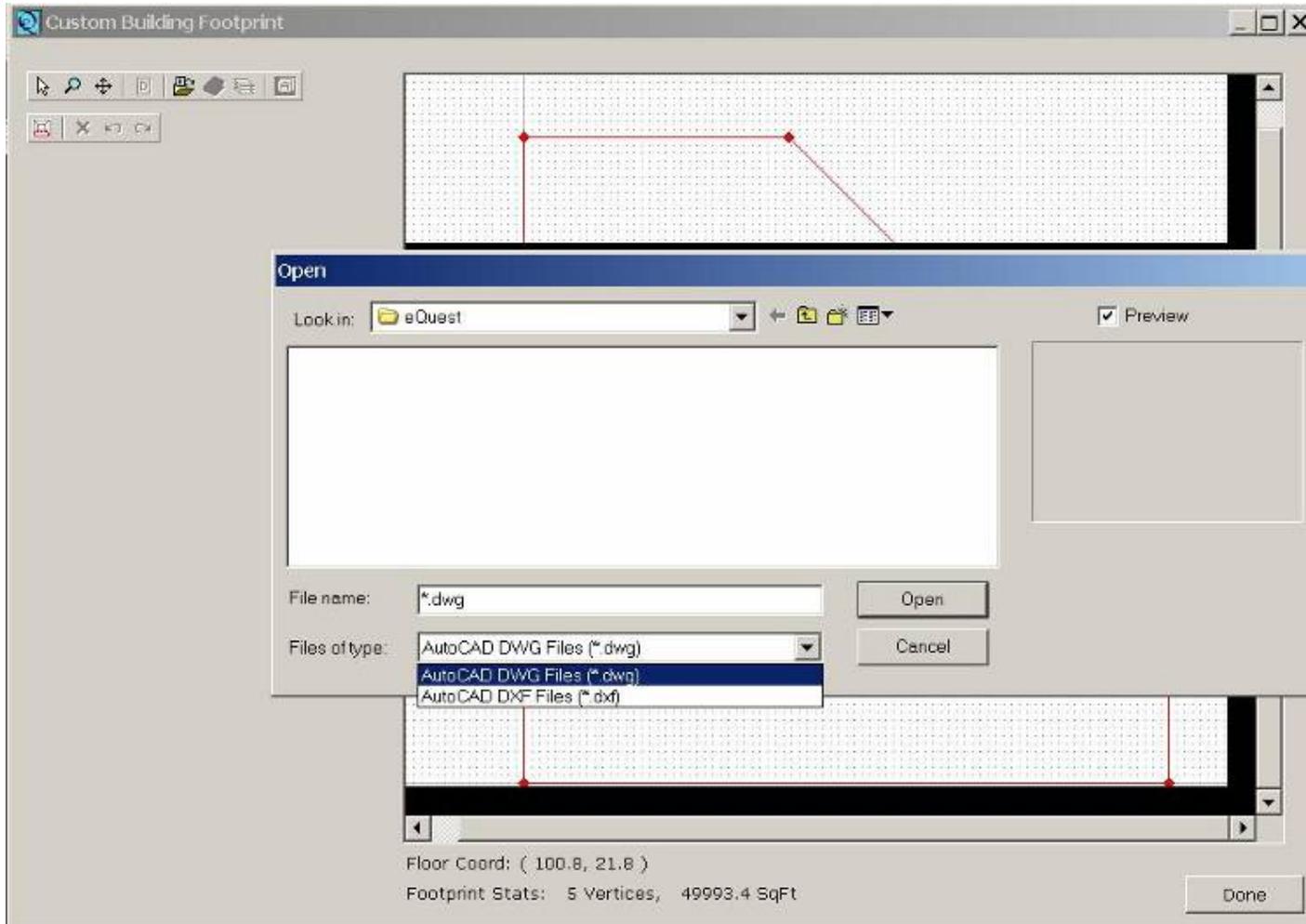
Choices for **Heating Source** are:

- "No Heating"** yields choices for **System Type** that have no heating capability (including no reheat) — available for all choices of **Cooling Source**
- "Furnace"** yields choices for **System Type** whose heating capability are provided by a combustion furnace — not available for **Cooling Source** = "Chilled Water Coils"
- "DX Coils (Heat Pump)"** yields choices for **System Type** that have only DX (Direct Expansion) heating (i.e., heat pumps) — available only for **Cooling Source** = "DX Coils"
- "Hot Water Coils"** yields choices for **System Type** that have only HW central heating coils or zone reheat coils — not available for **Cooling Source** = "Evaporative Cooler"
- "Electric Resistance"** yields choices for **System Type** that have only electric resistance central heating

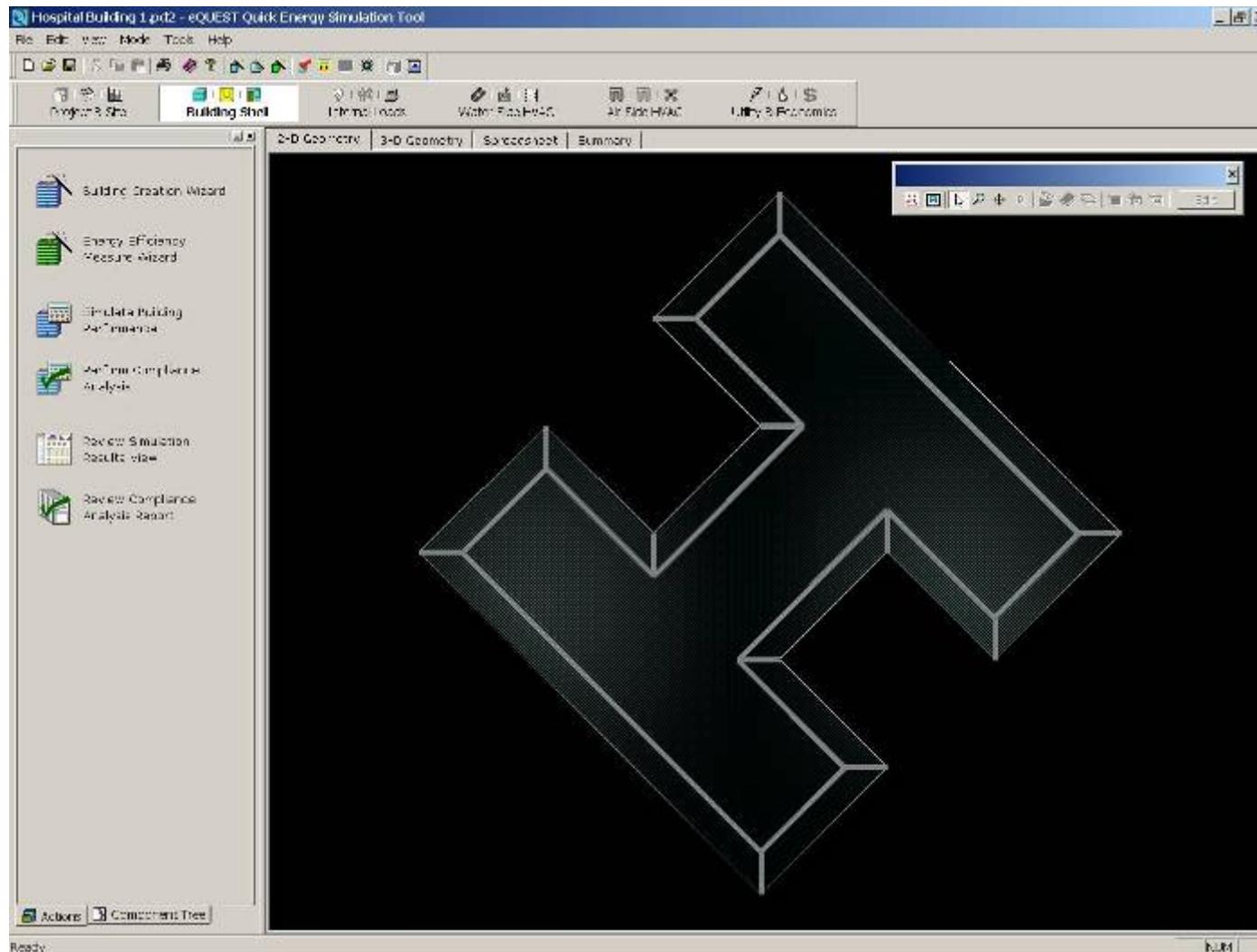
Schematic Design Wizard – Custom Footprint



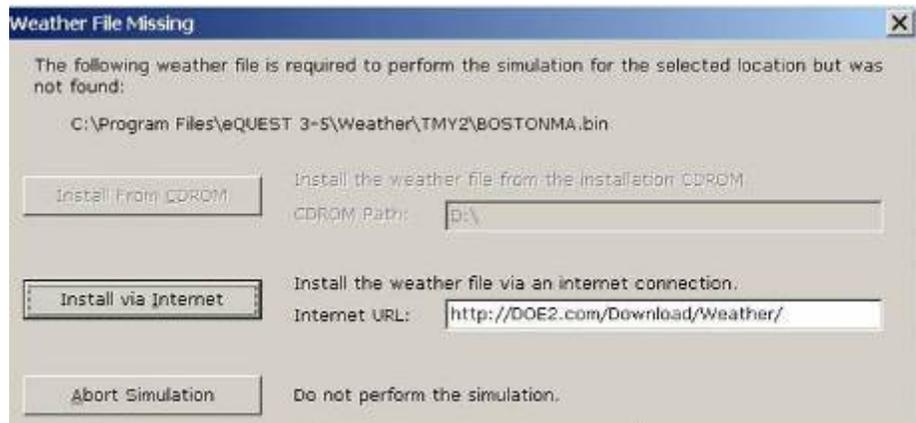
Schematic Design Wizard – Import CAD File



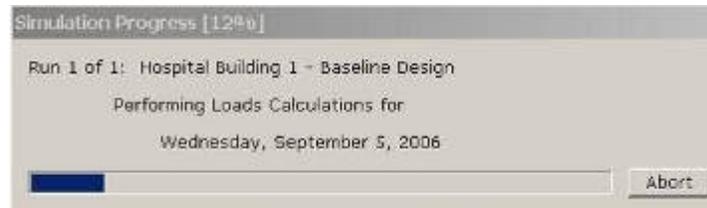
Full eQuest Mode Intro Screen



Full eQuest Mode – Simulation Process

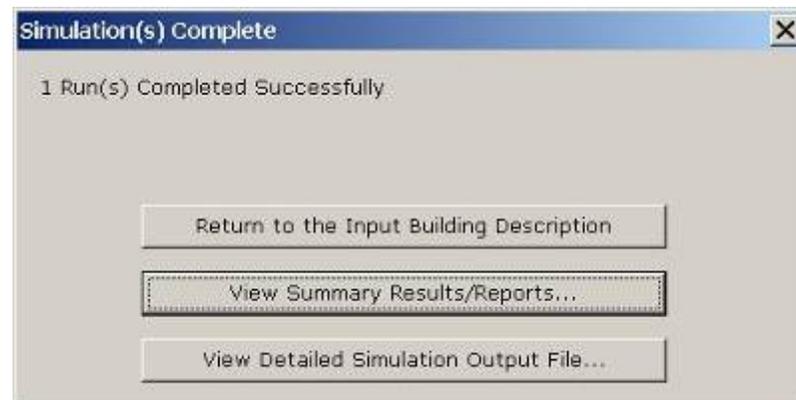


← Finding Weather File

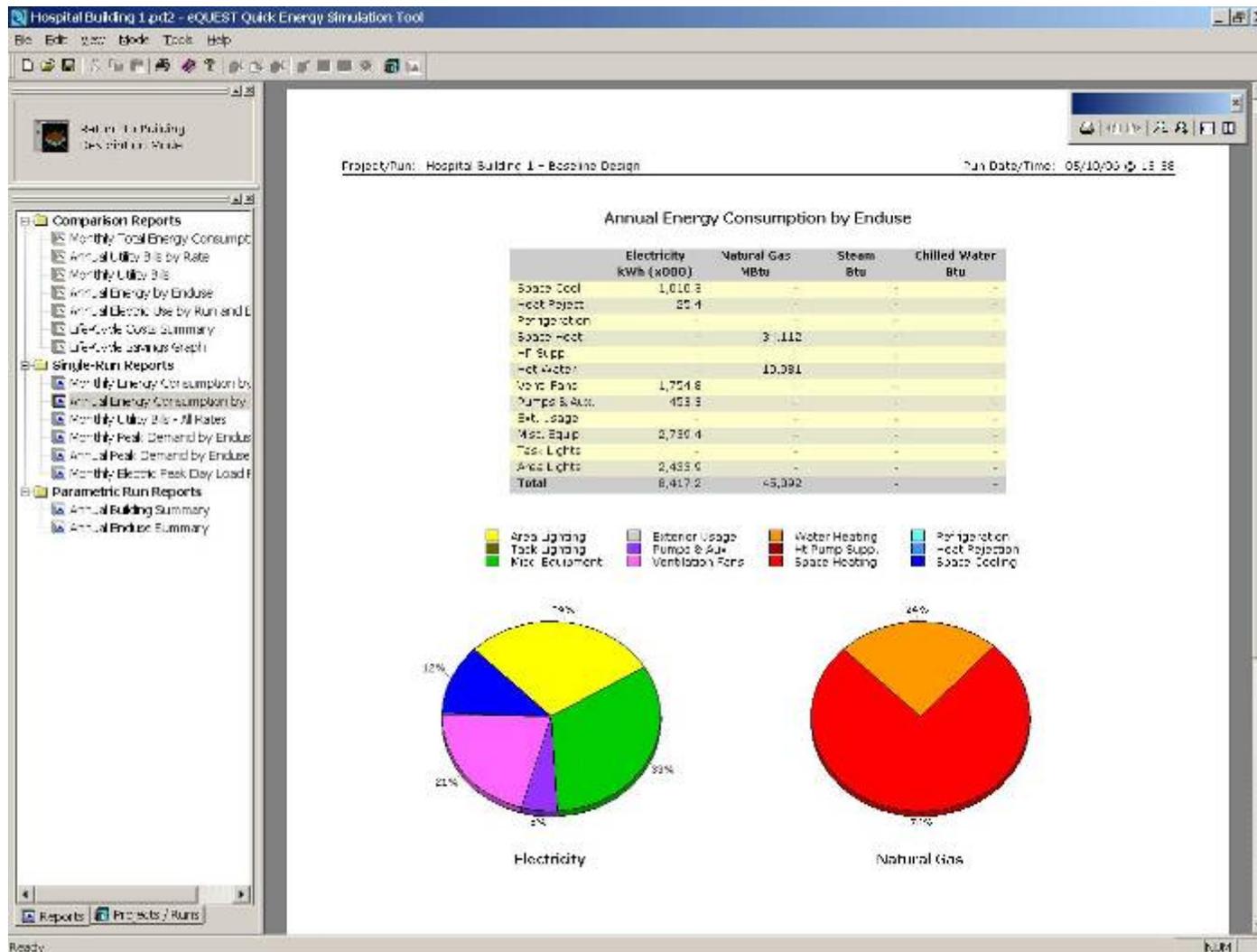


← Simulation

Simulation Complete →



eQuest Results



eQuest Results – Quick and Simple



Shaped Building

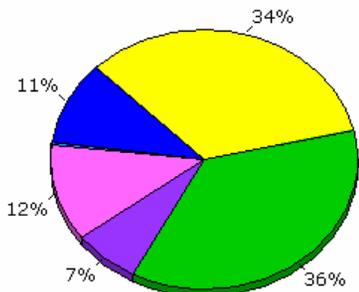
Annual Energy Consumption by Enduse

	Electricity kWh (x000)	Natural Gas MBtu	Steam Btu	Chilled Water Btu
Space Cool	629.2	-	-	-
Heat Reject.	13.7	-	-	-
Refrigeration	-	-	-	-
Space Heat	-	7,321	-	-
HP Supp.	-	-	-	-
Hot Water	-	3,497	-	-
Vent. Fans	729.7	-	-	-
Pumps & Aux.	417.7	-	-	-
Ext. Usage	-	-	-	-
Misc. Equip.	2,159.6	-	-	-
Task Lights	-	-	-	-
Area Lights	2,041.0	-	-	-
Total	5,987.8	13,818	-	-

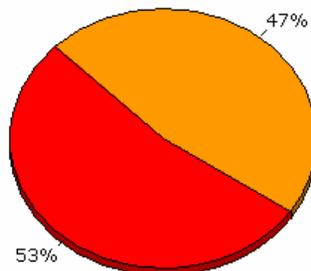
5,988 MWh

13,818 MBTU

- Area Lighting
- Pumps & Aux.
- Space Heating
- Task Lighting
- Ventilation Fans
- Refrigeration
- Misc. Equipment
- Water Heating
- Heat Rejection
- Exterior Usage
- Hot Pump Supp.
- Space Cooling



Electricity



Natural Gas

H Shaped Building

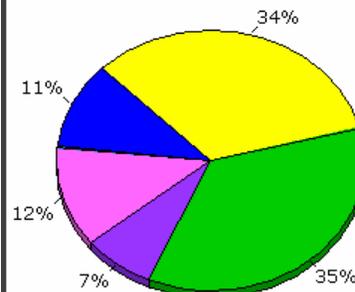
Annual Energy Consumption by Enduse

	Electricity kWh (x000)	Natural Gas MBtu	Steam Btu	Chilled Water Btu
Space Cool	658.7	-	-	-
Heat Reject.	13.2	-	-	-
Refrigeration	-	-	-	-
Space Heat	-	8,478	-	-
HP Supp.	-	-	-	-
Hot Water	-	6,387	-	-
Vent. Fans	756.3	-	-	-
Pumps & Aux.	456.0	-	-	-
Ext. Usage	-	-	-	-
Misc. Equip.	2,161.6	-	-	-
Task Lights	-	-	-	-
Area Lights	2,041.0	-	-	-
Total	6,089.5	14,865	-	-

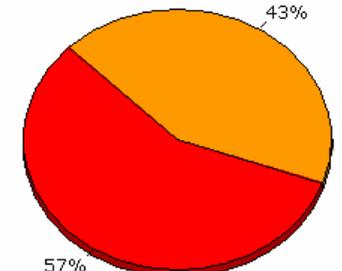
6,090 MWh

14,865 MBTU

- Area Lighting
- Pumps & Aux.
- Space Heating
- Task Lighting
- Ventilation Fans
- Refrigeration
- Misc. Equipment
- Water Heating
- Heat Rejection
- Exterior Usage
- Hot Pump Supp.
- Space Cooling



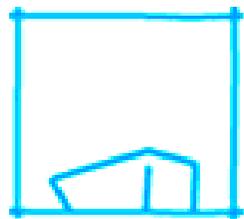
Electricity



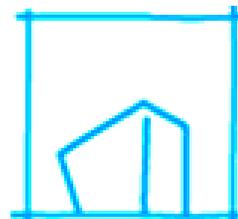
Natural Gas



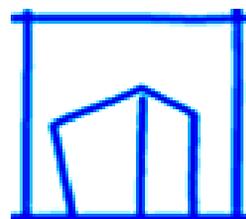
Design Development



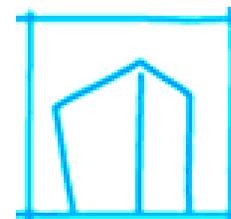
PRE-DESIGN



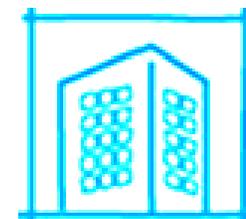
SCHEMATIC
DESIGN



DESIGN
DEVELOPMENT



CONSTRUCTION
& BID
DOCUMENTS



FOLLOW
THROUGH

Inputs

- Building characteristics
- Occupant characteristics
- System characteristics
- Plant characteristics

Outputs

- Monthly consumption by end use/ equipment type

Building Characteristics



- A developed design will have location, size and material characteristics for:
 - Envelope
 - Windows & Doors
 - Roof
 - Foundation



Design Development

Building Envelope Construction



eQUEST Schematic Design Wizard

Building Envelope Constructions

Roof Surfaces		Above Grade Walls	
Construction:	Metal Frame, > 24 in. o.c.	Construction:	Metal Frame, 2x6, 24 in. o.c.
Ext. Finish / Color:	Roof, built-up 'Medium' (abs=)	Ext. Finish / Color:	Wood/Plywood 'Medium' (abs=)
Exterior Insulation:	3 in. polyurethane (R-18)	Exterior Insulation:	3/4in. fiber bd sheathing (R-2)
Add'l Insulation:	- no batt or rad barrier -	Add'l Insulation:	R-19 batt
Interior Insulation:		Interior Insulation:	- no board insulation -

Ground Floor

Exposure:	Earth Contact	Interior Finish:	Vinyl Tile
Construction:	6 in. Concrete		
Ext/Cav Insul.:	- no perimeter insulation -		

Infiltration (Shell Tightness): Perim: 0.038 CFM/ft2 (ext wall area) | Core: 0.001 CFM/ft2 (floor area)

Wizard Screen 4 of 39

Help Previous Screen Next Screen Finish

Design Development

Building Interior Construction



eQUEST Schematic Design Wizard

Building Interior Constructions

Ceilings

Int. Finish: Lay-In Acoustic Tile Batt Insulation: - no ceiling insulation -

Vertical Walls

Wall Type: Air (none)

Floors

Int. Finish: Vinyl Tile Rigid Insulation: - no board insulation -

Construction: 6 in. Concrete Slab Penetrates Wall Plane

Concrete Cap: - no concrete cap -

Wizard Screen 5 of 39

Help Previous Screen Next Screen Finish

Design Development

Exterior Doors



eQUEST Schematic Design Wizard

Exterior Doors

Describe Up To 3 Door Types

Door Type	# Doors by Orientation:			
	North	South	East	West
1: Glass	1	1	1	1
2: - select another -				

Door Dimensions and Construction / Glass Definitions

Ht (ft)	Wd (ft)	Construction -or- Glass Category and Glass Type	Frame Type	Frame Wd (in)	
1: 7.0	6.0	Single Clr/Tint	Single Clear 1/4in (1001)	Alum w/o Brk	3.0

Wizard Screen 6 of 39

Help Previous Screen Next Screen Finish

Design Development Exterior Windows



eQUEST Schematic Design Wizard

Exterior Windows

Window Area Specification Method:

Describe Up To 3 Window Types

	Glass Category	Glass Type	Frame Type	Frame Wd (in)
1:	<input type="text" value="Double Clr/Tint"/>	<input type="text" value="Double Clear 1/4in, 1/2in Air (2004)"/>	<input type="text" value="Alum w/o Brk, Fixed"/>	<input type="text" value="1.30"/>
2:	<input type="text" value="Double Clr/Tint"/>	<input type="text" value="Double Bronze 1/4in, 1/4in Air (2203)"/>	<input type="text" value="Alum w/o Brk, Fixed"/>	<input type="text" value="1.30"/>
3:	<input type="text" value="- select another -"/>			

Window Dimensions, Positions and Quantities

	Typ Window Width (ft)*	Window Ht (ft)	Sill Ht (ft)	% Window (floor to floor, including frame):			
				North	South	East	West
1:	<input type="text" value="0.00"/>	<input type="text" value="5.22"/>	<input type="text" value="3.00"/>	<input type="text" value="40.0"/>	<input type="text" value="0.0"/>	<input type="text" value="0.0"/>	<input type="text" value="0.0"/>
2:	<input type="text" value="0.00"/>	<input type="text" value="5.22"/>	<input type="text" value="3.00"/>	<input type="text" value="0.0"/>	<input type="text" value="40.0"/>	<input type="text" value="40.0"/>	<input type="text" value="40.0"/>

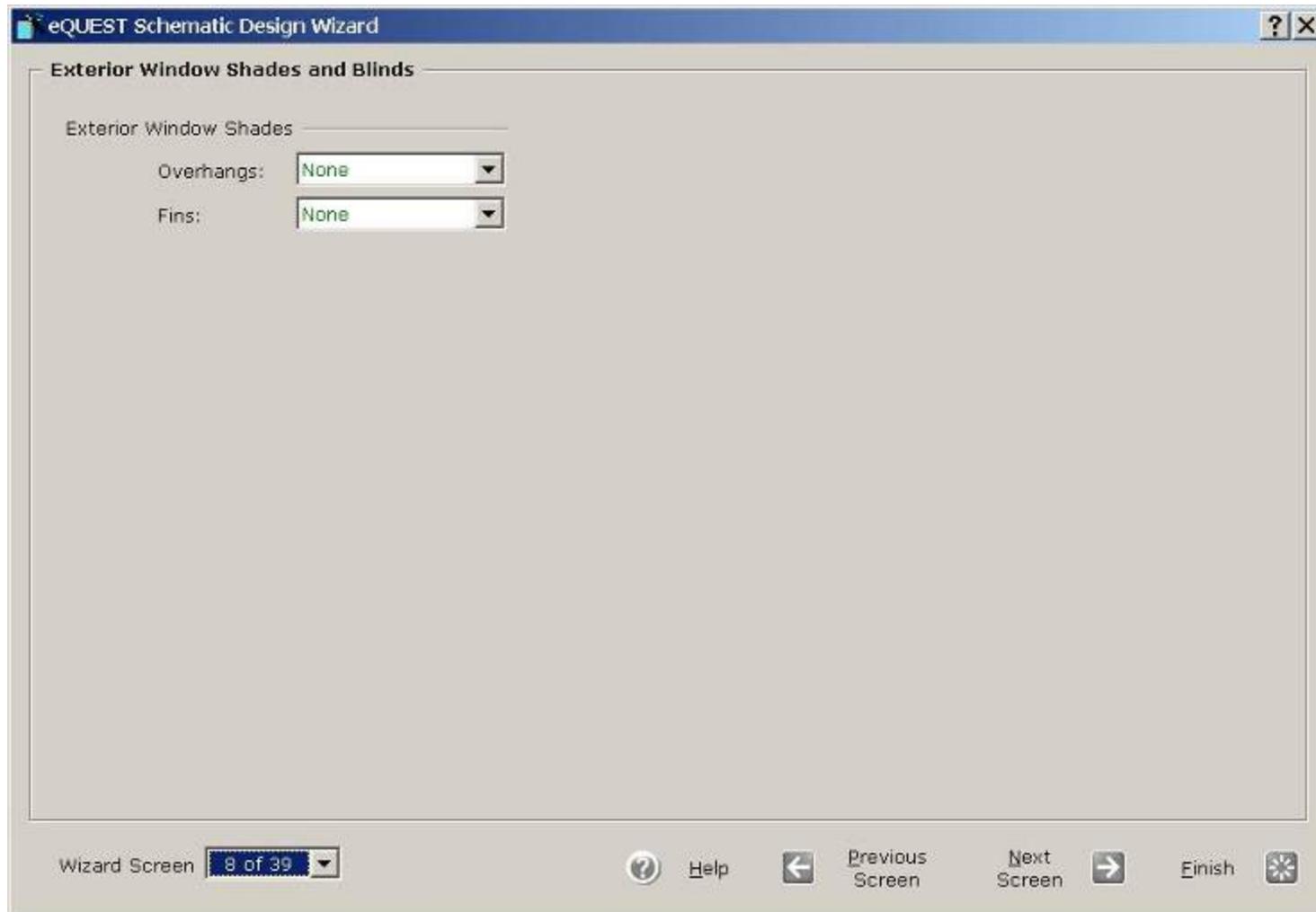
Estimated building-wide gross (flr-to-flr) % window is 40.0% and net (flr-to-ceiling) is 53.3%.

* - A window width of 0 results in one long window per facet (check adjoining box if window width is to take precedence over % window)

Wizard Screen

Design Development

Exterior Window Shades



Design Development

Roof Skylights



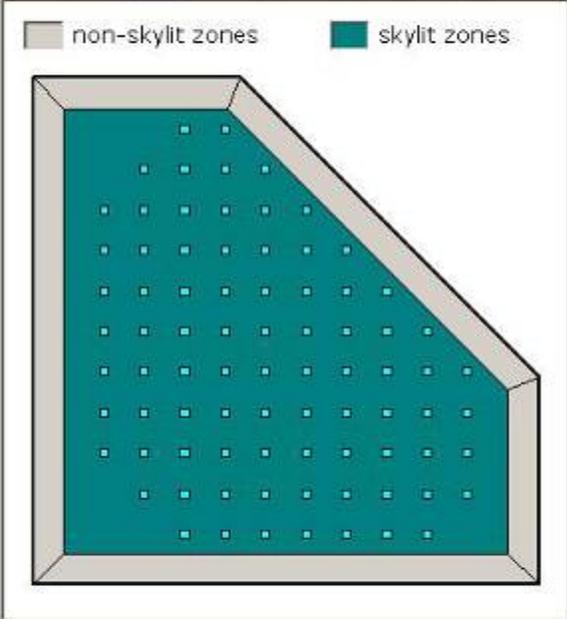
eQUEST Schematic Design Wizard

Roof Skylights

Skylit Rooftop Zones: None All Perimeter Only Core Only Custom

Click inside zones to add/remove skylights

non-skylit zones skylit zones



Amount of Skylights

% Coverage: % # of Skylights:

Typical Skylight Dimensions

Width 1: ft Width 2: ft

Skylight Glazing Type

Category:

Type:

Wizard Screen

Help Previous Screen Next Screen Finish

Occupant Activity



- Space use and occupant type includes the energy use of:
 - Activity by spaces
 - Outside air
 - Lighting schedules
 - Temperature settings
 - Equipment



Design Development Activity by Area



eQUEST Schematic Design Wizard

Activity Areas Allocation

Area Type	Percent Area (%)	Design Max Occup (sf/person)	Design Ventilation (CFM/per)	Assign First To:		
				1st Flr	Core	Perim
1: Office (Executive/Private)	70.0	225.0	20.00	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>
2: Corridor	10.0	150.0	7.50	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>
3: Lobby (Office Reception/Waiting)	5.0	150.0	15.00	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>
4: Restrooms	5.0	52.5	50.00	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>
5: Conference Room	4.0	22.5	20.00	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
6: Mechanical/Electrical Room	4.0	450.0	22.50	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>
7: Copy Room (photocopying equipment)	2.0	187.5	93.75	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>
8: - select another -						

Percent Area Sum: 100.0

Wizard Screen 13 of 39

Help Previous Screen Next Screen Finish

Design Development Occupied Loads



eQUEST Schematic Design Wizard

Occupied Loads by Activity Area

Area Type	Percent Area (%)	Lighting (W/SqFt)	Task Lt (W/SqFt)	Plug Lds (W/SqFt)	Schedule Main	Alt
1: Office (Executive/Private)	70.0	1.30	0.00	1.50	<input checked="" type="radio"/>	<input type="radio"/>
2: Corridor	10.0	0.60	0.00	0.20	<input checked="" type="radio"/>	<input type="radio"/>
3: Lobby (Office Reception/Waiting)	5.0	1.10	0.00	0.50	<input checked="" type="radio"/>	<input type="radio"/>
4: Restrooms	5.0	0.60	0.00	0.20	<input checked="" type="radio"/>	<input type="radio"/>
5: Conference Room	4.0	1.60	0.00	1.00	<input checked="" type="radio"/>	<input type="radio"/>
6: Mechanical/Electrical Room	4.0	0.70	0.00	0.20	<input checked="" type="radio"/>	<input type="radio"/>
7: Copy Room (photocopying equipment)	2.0	1.50	0.00	3.00	<input checked="" type="radio"/>	<input type="radio"/>

Wizard Screen 14 of 39

Help Previous Screen Next Screen Finish

Design Development

Unoccupied Loads



eQUEST Schematic Design Wizard

Unoccupied Loads by Activity Area (% of occupied load)

Area Type	Percent Area (%)	Occupancy (%)	Lighting (%)	Task Lt (%)	Plug Lds (%)
1: Office (Executive/Private)	70.0	<input type="text" value="0.0"/>	<input type="text" value="0.0"/>	<input type="text" value="0.0"/>	<input type="text" value="20.0"/>
2: Corridor	10.0	<input type="text" value="0.0"/>	<input type="text" value="10.0"/>	<input type="text" value="0.0"/>	<input type="text" value="0.0"/>
3: Lobby (Office Reception/Waiting)	5.0	<input type="text" value="0.0"/>	<input type="text" value="10.0"/>	<input type="text" value="0.0"/>	<input type="text" value="0.0"/>
4: Restrooms	5.0	<input type="text" value="0.0"/>	<input type="text" value="0.0"/>	<input type="text" value="0.0"/>	<input type="text" value="0.0"/>
5: Conference Room	4.0	<input type="text" value="0.0"/>	<input type="text" value="0.0"/>	<input type="text" value="0.0"/>	<input type="text" value="0.0"/>
6: Mechanical/Electrical Room	4.0	<input type="text" value="0.0"/>	<input type="text" value="0.0"/>	<input type="text" value="0.0"/>	<input type="text" value="20.0"/>
7: Copy Room (photocopying equipment)	2.0	<input type="text" value="0.0"/>	<input type="text" value="0.0"/>	<input type="text" value="0.0"/>	<input type="text" value="20.0"/>

Wizard Screen 16 of 39

Help Previous Screen Next Screen Finish

Design Development Occupant Main Schedule



eQUEST Schematic Design Wizard

Main Schedule Information

First (& Last) Season:
01/01/06 - 12/31/06

Has Second Season

	Mo	Tu	We	Th	Fr	Sa	Su	Hol	CD	HD
Day 1	<input checked="" type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input checked="" type="radio"/>	<input checked="" type="radio"/>				
<input checked="" type="checkbox"/> Day 2	<input type="radio"/>	<input checked="" type="radio"/>	<input checked="" type="radio"/>	<input checked="" type="radio"/>	<input type="radio"/>	<input type="radio"/>				
<input type="checkbox"/> Day 3										

Opens at: Day 1: 8 am, Day 2: Unocc
Closes at: 5 pm
Occup %: 90.0 %
Lites Ld %: 90.0 %
Equip Ld %: 90.0 %

Wizard Screen 17 of 39

Help Previous Screen Next Screen Finish

Systems



- Systems is the equipment section of eQuest that helps to meet the loads created by the envelope and occupant activity with:
 - Heating
 - Cooling
 - Ventilation



Design Development HVAC System



eQUEST Schematic Design Wizard

HVAC System Definitions

Describe Up To 2 HVAC System Types

	System 1	System 2
Cooling Source:	Chilled Water Coils	No Cooling
Heating Source:	Hot Water Coils	No Heating
Hot Water Src:	Hot Water Loop	
System Type:	Standard VAV with HW Reheat	- none -
Return Air Path:	Direct	

Wizard Screen 19 of 39

Help Previous Screen Next Screen Finish

Design Development

HVAC Zone Temperatures and Air Flow



eQUEST Schematic Design Wizard

HVAC Zones: Temperatures and Air Flows

System(s): 1: Standard VAV, HW Reheat

Thermostat Setpoints

	Occupied	Unoccupied
Cooling Setpoints:	76.0 °F	82.0 °F
Heating Setpoints:	70.0 °F	64.0 °F

Design Temperatures

	Indoor	Supply
Cooling Design Temp:	75.0 °F	55.0 °F
Heating Design Temp:	72.0 °F	95.0 °F

Air Flows

Minimum Design Flow: 0.50 cfm/ft2

	Core	Perimeter
VAV Minimum Flow:	40.0 %	30.0 %

Wizard Screen 20 of 39 -

Help Previous Screen Next Screen Finish

Design Development HVAC System Fan Schedules



eQUEST Schematic Design Wizard

HVAC System # 1 Fan Schedules

HVAC System 1: Packaged Sgl Zone DX, Furnace

Operate fans hours before open and hours after close.

First or Only Season Second Season

01/01/06 - 12/31/06

	Mo	Tu	We	Th	Fr	Sa	Su	Hol	CD	HD
Day 1	<input checked="" type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input checked="" type="radio"/>	<input checked="" type="radio"/>				
<input checked="" type="checkbox"/> Day 2	<input type="radio"/>	<input checked="" type="radio"/>	<input checked="" type="radio"/>	<input checked="" type="radio"/>	<input type="radio"/>	<input type="radio"/>				
<input type="checkbox"/> Day 3										

Day 1 Day 2

On at:

Off at:

Wizard Screen

Help Previous Screen Next Screen Finish

Design Development HVAC Heating and Economizer



eQUEST Schematic Design Wizard

HVAC Zone Heating, Vent and Economizers

System(s): 1: Standard VAV, HW Reheat

Zone Heat Sources & Capacities / Delta T

Baseboards: - none -

Heat / Reheat: Hot Water 30.0 delta °F

Economizer(s)

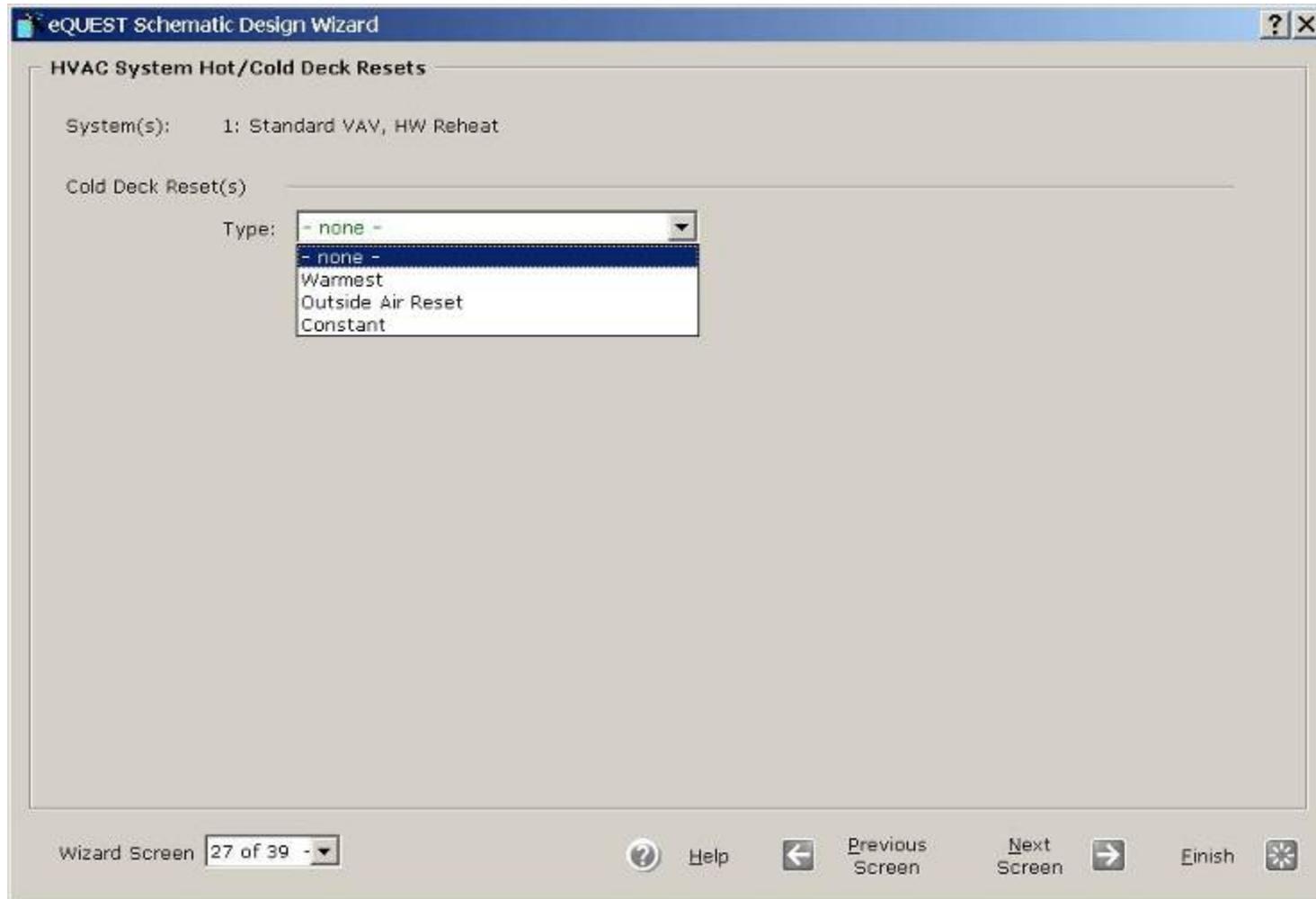
Type: Drybulb Temperature

High Limit: 65.0 °F

Wizard Screen 26 of 39

Help Previous Screen Next Screen Finish

Design Development HVAC System Deck Resets



Plant



- Plant is the large systems section of eQuest that provide energy to the HVAC systems that have just been defined, and include:
 - Chillers
 - Boilers
 - Cooling Towers



Design Development Cooling Equipment



eQUEST Schematic Design Wizard

Cooling Primary Equipment

Chilled Water System

Pump Configuration: Number of System Pumps:

CHW Loop Flow:

Loop Pump: Head: ft Flow: gpm Motor Efficiency:

Estimated CHW Load: 249,967 ft² Served x Size Factor: / ft²/ton = 624.9 tons.
Total Chiller Capacity by Type: Type 1: (auto-sized) Type 2: (none) = (auto-sized)

Describe Up To 2 Chillers

	Chiller 1	Chiller 2
Chiller Type(s):	<input type="text" value="Electric Centrifugal Hermetic"/>	<input type="text" value="- select another -"/>
Condenser Type(s):	<input type="text" value="Water-Cooled"/>	<input type="text" value="- select another -"/>
Compressor(s):	<input type="text" value="Constant Speed"/>	<input type="text" value="Electric Centrifugal Hermetic"/>
Chiller Counts & Sizes:	<input type="text" value="2"/> <input type="text" value="Auto-size"/> <input type="text" value=">300 tons"/>	<input type="text" value="Electric Reciprocating Hermetic"/>
Chiller Efficiency:	<input type="text" value="0.676"/> <input type="text" value="kW/ton"/>	<input type="text" value="Electric Centrifugal Open"/>
		<input type="text" value="Electric Reciprocating Open"/>
		<input type="text" value="Screw"/>
		<input type="text" value="Single Stage Absorption"/>
		<input type="text" value="Two Stage Absorption"/>
		<input type="text" value="Direct-Fired Absorption"/>

Wizard Screen

Design Development

Cooling Towers / Heat Rejection



eQUEST Schematic Design Wizard

Primary Equipment Heat Rejection

Water-Cooled Condenser / Cooling Tower

Condenser Pump: Head: ft Flow: gpm

Condenser Configuration:

Temperature Control: Setpoint: °F

Capacity Control:

- One Speed Fan
- Two Speed Fan
- Variable Speed Fan
- Fluid Bypass
- Discharge Dampers

Wizard Screen 30 of 39

Help Previous Screen Next Screen Finish

Design Development

Chilled Water Control



eQUEST Schematic Design Wizard

Chilled Water System Control and Schedule

Setpoint is: Setpoint Value: °F

Operation:

Wizard Screen

Design Development

Heating Equipment



eQUEST Schematic Design Wizard

Heating Primary Equipment

Hot Water System

Pump Configuration: Number of System Pumps:

HW Loop Flow:

Loop Pump: Head: ft Flow: gpm Motor Efficiency:

Describe Up To 2 Boilers

	Boiler 1	Boiler 2
Boiler Type(s):	<input type="text" value="HW Boiler (Natural Draft)"/>	<input type="text" value="- select another -"/>
Energy / Efficiency:	<input type="text" value="Natural Gas"/> <input type="text" value="80.0"/> %	<input type="text" value="- select another -"/>
Boiler Output:	<input type="text" value="Auto-size"/>	<input type="text" value="- select another -"/>
Electric Demand:		

Wizard Screen

Help Previous Screen Next Screen Finish

Design Development Heating System Control



eQUEST Schematic Design Wizard

Hot Water System Control and Schedule

Setpoint is: Setpoint Value: °F

Operation:

Wizard Screen

Design Development Water Heating Equipment



eQUEST Schematic Design Wizard

Domestic Water Heating Equipment

Heater Type: Input Rating: kBtu/h

Storage Capacity: gal Tank Insulation R-value: h-ft²-°F/Btu

Hot Water Usage: gal/person/day

Supply Temperature: °F

Inlet Water Temp:

Recirculation %: %

Wizard Screen

Help Previous Screen Next Screen Finish

Understanding the Results



1. Load Profile

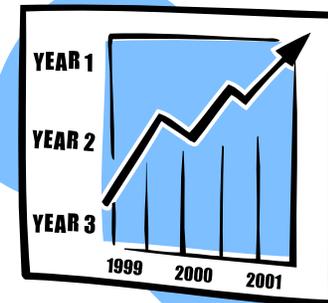
- Use to prioritize the upgrades by largest loads

2. Peak Energy Use

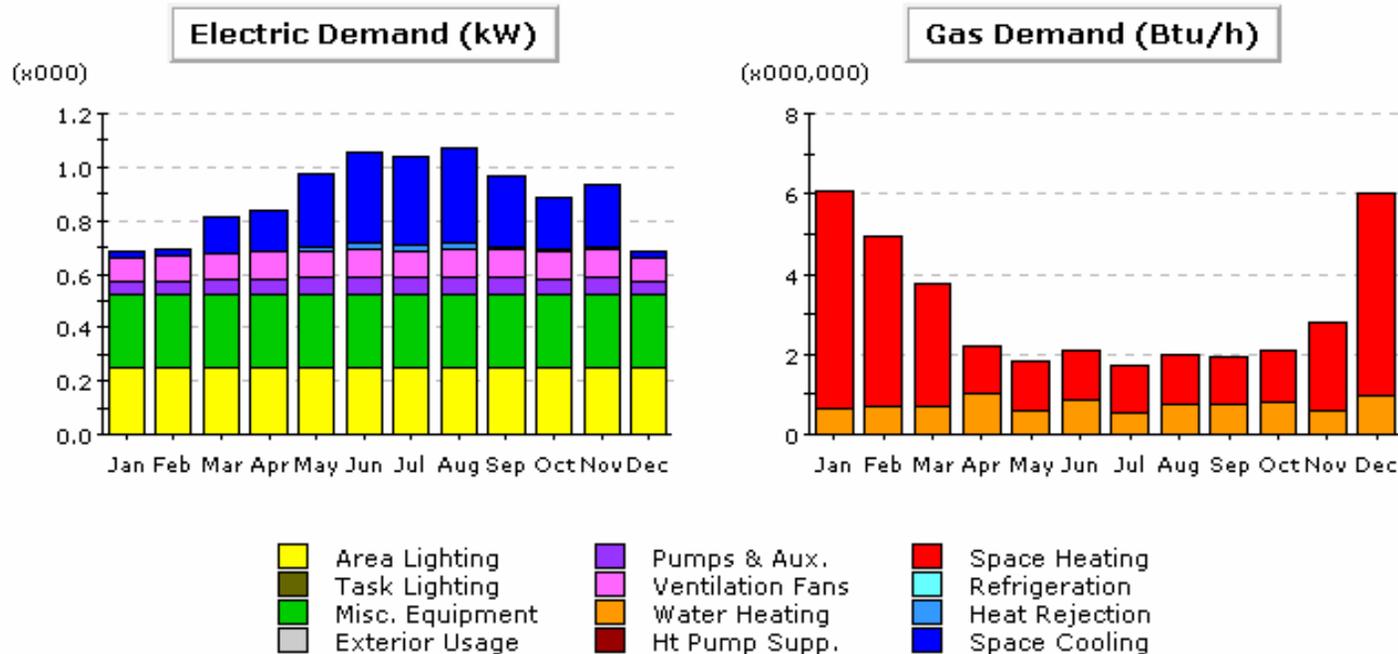
- Use to select the system sizes
- Use to estimate the demand costs

3. Annual Energy Use

- Use to estimate the annual cost



Monthly Peak Demand



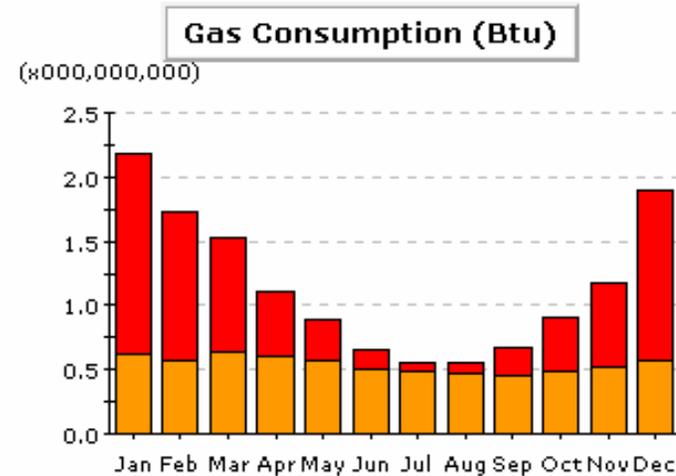
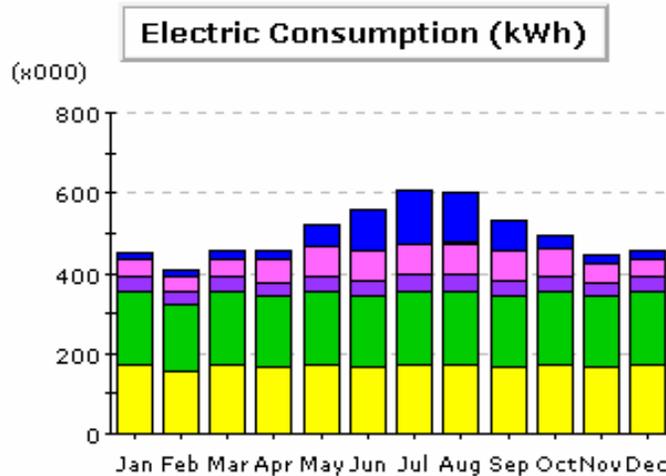
Electric Demand (kW x000)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Space Cool	0.02	0.02	0.13	0.15	0.27	0.34	0.33	0.35	0.26	0.19	0.24	0.02	2.33
Heat Reject.	-	-	-	0.00	0.01	0.02	0.02	0.03	0.01	0.01	0.01	-	0.12
Refrigeration	-	-	-	-	-	-	-	-	-	-	-	-	-
Space Heat	-	-	-	-	-	-	-	-	-	-	-	-	-
HP Supp.	-	-	-	-	-	-	-	-	-	-	-	-	-
Hot Water	-	-	-	-	-	-	-	-	-	-	-	-	-
Vent. Fans	0.09	0.10	0.10	0.11	0.10	0.10	0.10	0.11	0.11	0.11	0.11	0.09	1.23
Pumps & Aux.	0.04	0.04	0.05	0.05	0.06	0.06	0.06	0.06	0.06	0.05	0.06	0.04	0.65
Ext. Usage	-	-	-	-	-	-	-	-	-	-	-	-	-
Misc. Equip.	0.28	0.28	0.28	0.28	0.28	0.28	0.28	0.28	0.28	0.28	0.28	0.28	3.34
Task Lights	-	-	-	-	-	-	-	-	-	-	-	-	-
Area Lights	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	2.96
Total	0.69	0.69	0.81	0.83	0.97	1.05	1.04	1.07	0.97	0.89	0.94	0.68	10.62





Annual Energy Consumption



- Area Lighting
- Task Lighting
- Pumps & Aux.
- Ventilation Fans
- Refrigeration
- Heat Rejection
- Misc. Equipment
- Water Heating
- Ht Pump Supp.
- Exterior Usage
- Space Cooling

Electric Consumption (kWh x000)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Space Cool	17.8	16.1	19.0	21.0	51.4	98.7	131.8	124.6	75.9	35.4	19.7	17.8	629.2
Heat Reject.	-	-	-	0.0	0.5	2.7	4.6	4.3	1.4	0.1	0.1	-	13.7
Refrigeration	-	-	-	-	-	-	-	-	-	-	-	-	-
Space Heat	-	-	-	-	-	-	-	-	-	-	-	-	-
HP Supp.	-	-	-	-	-	-	-	-	-	-	-	-	-
Hot Water	-	-	-	-	-	-	-	-	-	-	-	-	-
Vent. Fans	46.2	41.7	47.5	59.0	74.9	72.5	71.2	74.8	75.9	68.6	49.1	46.3	729.7
Pumps & Aux.	33.2	30.0	33.3	32.5	35.4	37.3	40.2	39.8	36.0	34.6	32.3	33.2	417.7
Ext. Usage	-	-	-	-	-	-	-	-	-	-	-	-	-
Misc. Equip.	183.4	165.7	183.4	177.5	183.4	177.5	183.4	183.4	177.5	183.4	177.5	183.4	2,159.6
Task Lights	-	-	-	-	-	-	-	-	-	-	-	-	-
Area Lights	173.1	156.3	173.1	167.5	173.1	167.5	173.1	173.1	167.5	173.1	167.5	173.1	2,038.0
Total	453.7	409.8	456.3	457.5	518.8	556.1	606.3	600.0	534.2	495.3	446.1	453.8	5,987.8





1. Facility Information

*Zip Code Facility Name
City State

2. Facility Characteristics

*Select Space Type(s) for this project.
[Space Types]

Hospital (Acute Care or Children's) Delete			
*Gross Floor Area	*Number of Licensed Beds	*Maximum Number of Floors	*Tertiary Care
<input type="text"/> Sq. Ft.	<input type="text"/>	<input type="text"/>	<input type="radio"/> Yes <input type="radio"/> No

3. The Target¹

[Target Rating](#) Select Or [Energy Reduction Target](#) 50%

*Choose the design target and select "View Results" to display associated energy use for the

Select Your Target Rating or Percent

Input Energy Use from Energy Model

4. Estimated Design Energy

Use results from energy analysis and enter total estimated energy for the design. Select "View Results" to compare Estimated Energy Use to your Target.

Energy Source	Units	Estimated Total Annual Energy Use ²	Energy Rate (\$/Unit)
Electricity <input type="text"/>	kBtu <input type="text"/>	<input type="text"/>	\$ <input type="text"/> /kBtu
[Select Energy Source] <input type="text"/>	<input type="text"/>	<input type="text"/>	\$ <input type="text"/> /



Target Finder Demonstration

Calculate Rating



NOTE: Values are 60% electricity and 40% other energy source. The Target & Top 10% energy use for this facility are calculated based on fuel mix of input estimated energy use.

[View Statement of Energy Design Intent](#)

Target Energy Performance Results (estimated)			
Energy	Design	Target	Top 10%
Energy Performance Rating (1-100)	88	98	90
Energy Reduction (%)	33	50	55
Source Energy Use Intensity (kBtu/Sq. Ft./yr)	302.8	227.7	292.1
Site Energy Use Intensity (kBtu/Sq. Ft./yr)	137.0	103.0	132.1
Total Annual Source Energy (kBtu)	75,708,403.7	56,934,696.2	73,021,512.5
Total Annual Site Energy (kBtu)	34,249,056.0	25,756,184.3	33,033,556.9
Total Annual Energy Cost (\$)	\$ 564,436	\$ 424,471	\$ 544,404

Compare your design to your target.

Facility Information [Edit](#)

Sample Hospital
Chicago, IL 60601
United States

Change your estimated energy use by selecting edit

Facility Characteristics Edit		Estimated Design Energy Edit			
Space Type	Gross Floor Area (Sq. Ft.)	Energy Source	Units	Estimated Total Annual Energy Use	Energy Rate (\$/Unit)
Hospital (Acute Care or Children's)	250,000	Electricity	MWh	5,988	\$ 74.416/MWh
Total Gross Floor Area	250,000	Natural Gas	MBtu	13,818	\$ 8.600/MBtu

Source: Data adapted from DOE-EIA. See EPA [Technical](#)



Design Development Energy Efficiency Measures



eQUEST Energy Efficiency Measures (EEM) Wizard

EEM Run Information

Select Measure to View/Edit:

- Window Glass Type EEM
- TStat Management EEM
- Chiller Plant EEM
- DHW EEM

EEM Run Name:

Measure Category: Domestic Hot Water

Measure Type:

Apply Measure To:

EEM Run Summary:

*** Press 'EEM Run Details' button ***
*** to describe measure ***

Baseline Run Name:

Project & Baseline Run LCC Data...

EEM Run Details...

EEM Run LCC Data...

Help ? Finish

Design Development EEM Measures



Energy Efficiency Measure Creation

EEM Run Information

Measure Category:

Measure Type:

- Roof Insulation
- Exterior Wall Insulation
- Ground Floor Insulation
- Window Area
- Window Glass Type
- Window Exterior Shading
- Skylight Area

Help ? OK Cancel X

Energy Efficiency Measure Creation

EEM Run Information

Measure Category:

Measure Type:

- Daylighting
- Lighting Power Density
- Equipment Power Density

Help ? OK Cancel X

Energy Efficiency Measure Creation

EEM Run Information

Measure Category:

Measure Type:

- Thermostat Management
- Fan Power & Control
- Ventilation & Economizer
- Deck Reset

Help ? OK Cancel X

Energy Efficiency Measure Creation

EEM Run Information

Measure Category:

Measure Type:

- Chilled Water Loop
- Chiller Plant
- Chilled Water Control

Help ? OK Cancel X

Design Development EEM Run Screen



EEM Run Selection

EEM Runs:

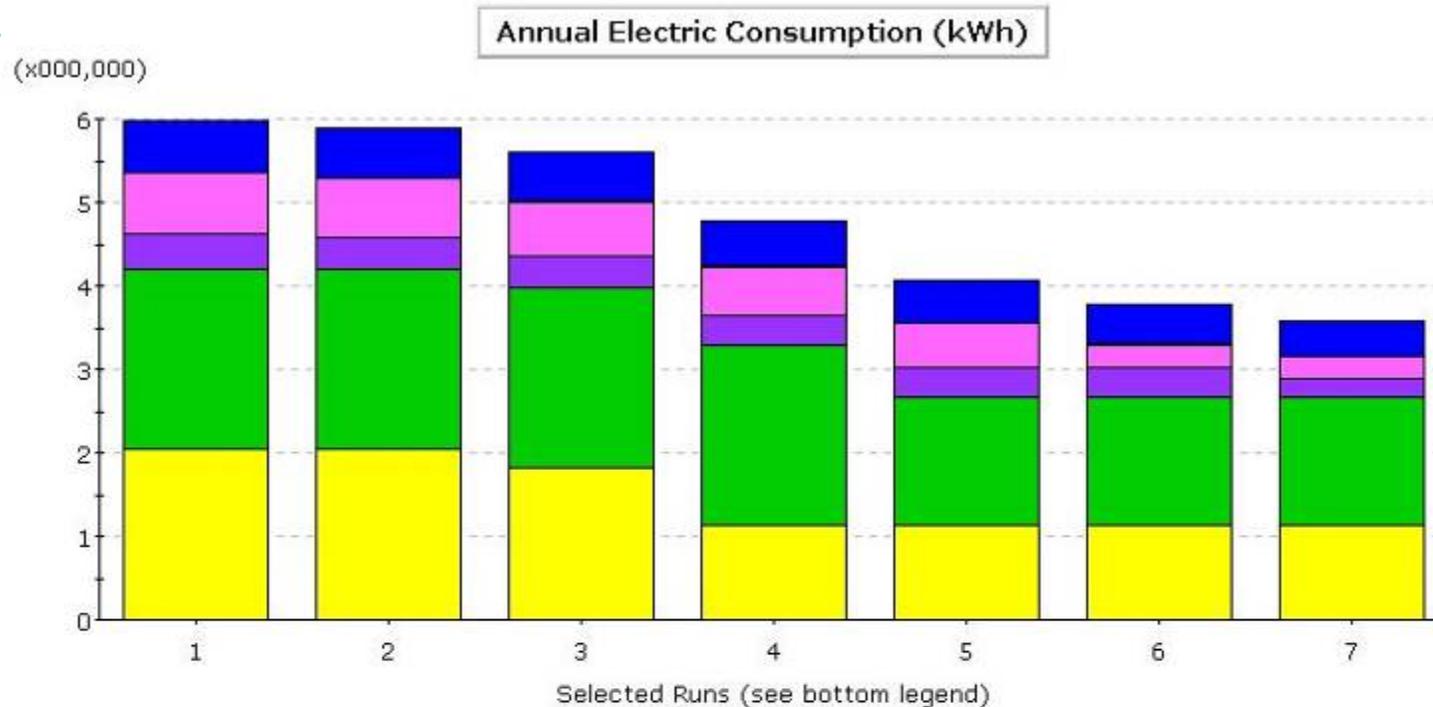
- Baseline Design
- Window Glass Type EEM
- TStat Management EEM
- Chiller Plant EEM
- DHW EEM

Place a check next to each EEM run you would like to have simulated.

Simulate

Cancel

Run Results



1. Hospital Building 1 - Baseline Design (10/23/06 @ 15:43)
2. Hospital Building 1 - Window Area EEM (10/23/06 @ 15:43)
3. Hospital Building 1 - Daylighting EEM (10/23/06 @ 15:43)
4. Hospital Building 1 - Lighting Power EEM (10/23/06 @ 15:43)
5. Hospital Building 1 - Equipment Power EEM (10/23/06 @ 15:43)
6. Hospital Building 1 - Fan Power & Ctrl EEM (10/23/06 @ 15:44)
7. Hospital Building 1 - CHW Loop EEM (10/23/06 @ 15:44)



Tabular Results



Annual Energy and Demand

		Ann. Source Energy		Annual Site Energy		Lighting	HVAC Energy		Peak		
		Total Mbtu	EUI kBtu/sf/yr	Elect kWh	Nat Gas Therms	Electric kWh	Electric kWh	Nat Gas Therms	Total Mbtu	Elect kW	Cooling Tons
Annual Energy USE or DEMAND											
0	Base Design	75,126	300.54	5,987,801	138,176	2,037,953	1,790,229	73,208	13,431	1,069	510
1	0+Window Area EEM	73,825	295.35	5,898,070	134,388	2,037,953	1,700,495	69,420	12,746	1,045	495
2	1+Daylighting EEM	70,850	283.43	5,592,465	135,892	1,820,583	1,612,279	70,924	12,595	964	476
3	2+Lighting Power EEM	53,684	254.77	4,772,926	148,143	1,124,254	1,489,067	83,175	13,400	893	456
4	3+Equipment Power EEM	37,583	230.36	4,057,581	160,378	1,124,254	1,390,770	95,411	14,288	833	437
5	4+Fan Power & Ctrl EEM	35,326	221.34	3,774,573	166,808	1,124,254	1,107,766	101,840	13,965	794	427
6	5+CHW Loop EEM	33,215	212.89	3,568,192	166,808	1,124,254	901,381	101,840	13,260	790	427

Incremental SAVINGS (values are relative to previous measure (% savings are relative to base case use), negative entries indicate increased use)

1	0+Window Area EEM	1,298	5.19 (2%)	89,731 (1%)	3,788 (3%)	0 (0%)	89,734 (5%)	3,788 (5%)	685 (5%)	24 (2%)	15 (3%)
2	1+Daylighting EEM	2,979	11.92 (4%)	305,605 (5%)	1,504 (-1%)	217,371 (11%)	88,216 (5%)	-1,504 (-2%)	151 (1%)	81 (8%)	18 (4%)
3	2+Lighting Power EEM	7,166	28.67 (10%)	819,540 (14%)	-2,251 (-9%)	696,328 (34%)	123,213 (7%)	12,251 (-17%)	-805 (-6%)	71 (7%)	20 (4%)
4	3+Equipment Power EEM	6,101	24.41 (8%)	715,345 (12%)	-2,236 (-9%)	0 (0%)	98,297 (5%)	12,235 (-17%)	-888 (-7%)	60 (6%)	19 (4%)
5	4+Fan Power & Ctrl EEM	2,255	9.02 (3%)	283,008 (5%)	6,430 (-5%)	0 (0%)	283,004 (16%)	-6,430 (-9%)	323 (2%)	39 (4%)	10 (2%)
6	5+CHW Loop EEM	2,113	8.45 (3%)	206,381 (3%)	0 (0%)	0 (0%)	206,385 (12%)	0 (0%)	704 (5%)	3 (0%)	0 (0%)

Cumulative SAVINGS (values (and % savings) are relative to the Base Case, negative entries indicate increased use)

1	0+Window Area EEM	1,298	5.19 (2%)	89,731 (1%)	3,788 (3%)	0 (0%)	89,734 (5%)	3,788 (5%)	685 (5%)	24 (2%)	15 (3%)
2	1+Daylighting EEM	4,276	17.11 (6%)	395,336 (7%)	2,284 (2%)	217,371 (11%)	177,950 (10%)	2,284 (3%)	836 (6%)	104 (10%)	34 (7%)
3	2+Lighting Power EEM	11,442	45.77 (15%)	1,214,876 (20%)	9,967 (-7%)	913,699 (45%)	301,163 (17%)	9,967 (-14%)	31 (0%)	175 (16%)	54 (11%)
4	3+Equipment Power EEM	17,543	70.18 (23%)	1,930,221 (32%)	2,202 (-16%)	913,699 (45%)	399,460 (22%)	22,202 (-30%)	-857 (-6%)	235 (22%)	73 (14%)
5	4+Fan Power & Ctrl EEM	19,798	79.20 (26%)	2,213,229 (37%)	8,632 (-21%)	913,699 (45%)	682,464 (38%)	28,632 (-39%)	-534 (-4%)	275 (26%)	83 (16%)
6	5+CHW Loop EEM	21,911	87.65 (29%)	2,419,609 (40%)	8,632 (-21%)	913,699 (45%)	888,849 (50%)	28,632 (-39%)	170 (1%)	278 (26%)	83 (16%)

Target Finder

Check Your Redesign



NOTE: The Table based on energy sources calculated

Statement of Energy Design Intent

➔

[View Statement of Energy Design Intent](#)

Target Energy Performance Results (estimated)			
Energy	Design	Target	Top 10%
Energy Performance Rating (1-100)	98	98	90
Energy Reduction (%)	53	50	36
Source Energy Use Intensity (kBtu/Sq. Ft./yr)	219.0	227.7	292.1
Site Energy Use Intensity (kBtu/Sq. Ft./yr)	115.4	122.2	156.8
Total Annual Source Energy (kBtu)	53,761,654.0	56,934,696.2	73,021,512.3
Total Annual Site Energy (kBtu)	28,855,016.0	30,558,054.7	39,192,188.9
Total Annual Energy Cost (\$)	\$ 408,972	\$ 433,110	\$ 555,484

Facility Information [Edit](#)

Test
Chicago, IL 60601
United States

Total Energy Reduction

Facility Characteristics Edit		Estimated Design Energy Edit			
Space Type	Gross Floor Area (Sq. Ft.)	Energy Source	Units	Estimated Total Annual Energy Use	Energy Rate (\$/Unit)
Hospital (Acute Care or Children's)	250,000	Electricity	MWh	3,568	\$ 74.416/MWh
Total Gross Floor Area	250,000	Natural Gas	MBtu	16,681	\$ 8.600/MBtu

Source: Data adapted from DOE-EIA. See EPA [Technical Description](#).



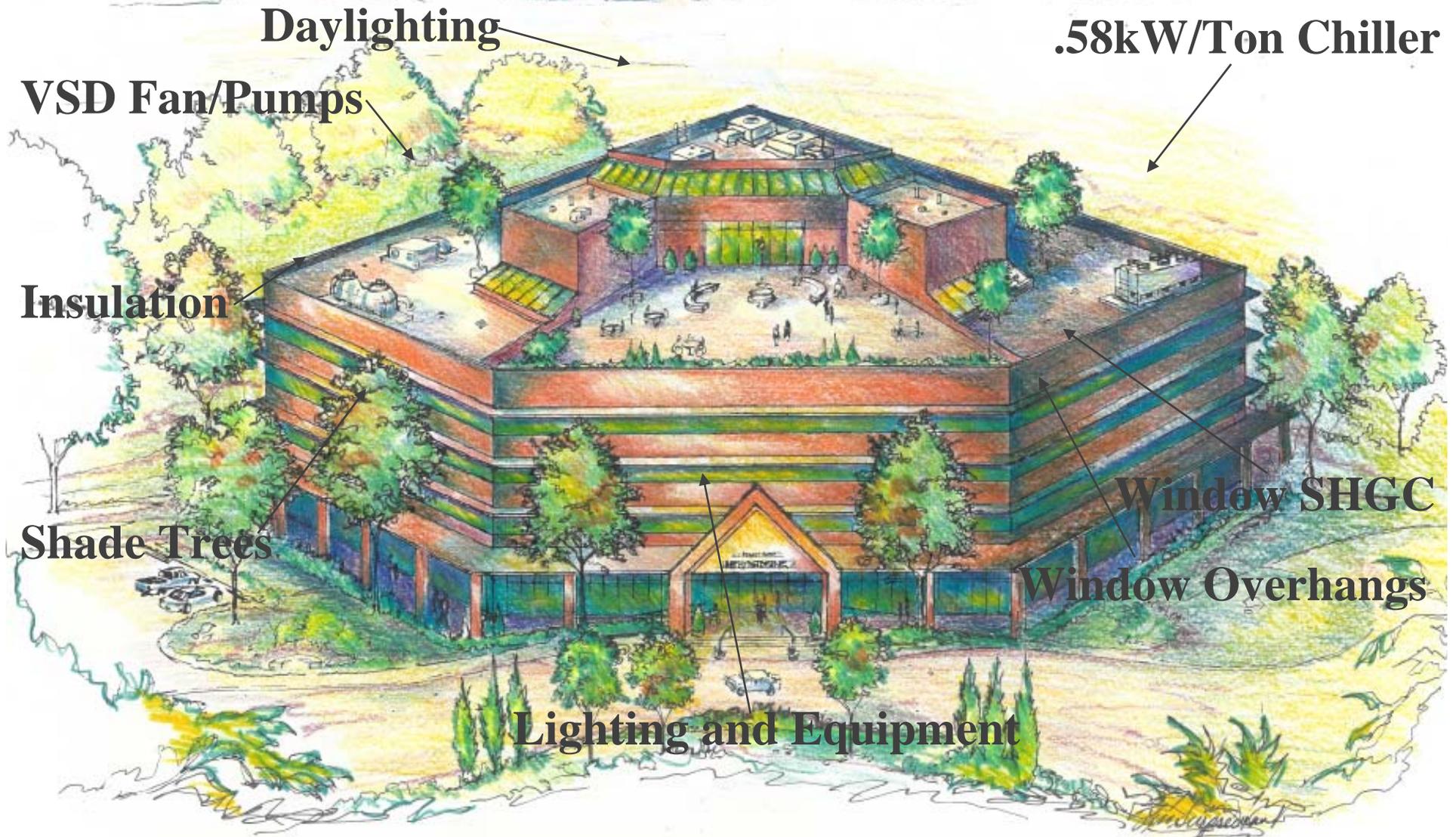
Design Development Modeling Energy Efficiency Measures



Upgrade Measures Used:

- Window area reduction
- Lighting and equipment use reduction when the spaces are not occupied
- Daylighting to further reduce artificial lighting needs
- Chiller with 0.58 kW/ton instead of 0.68 kW/ton
- Variable speed chilled water, fans and cooling tower

Design Development Modeling Energy Efficiency Measures



Daylighting

.58kW/Ton Chiller

VSD Fan/Pumps

Insulation

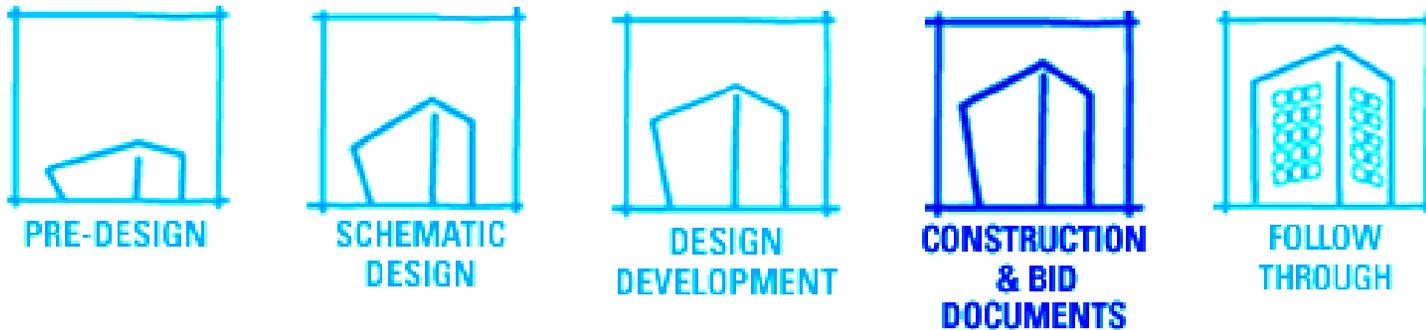
Shade Trees

Window SHGC

Window Overhangs

Lighting and Equipment

Construction Phase & Construction Docs



- Finalize construction document design phase with a complete energy model
- Ensure construction management team is installing designed features
- Model change orders
 - Examine life cycle costs



Energy Modeling in Existing Building/Renovation



Modeling for Existing Buildings



- Modeling Energy Efficiency Measures
- Opportunities with plant design
- Looking for synergies across building systems
- Translate results for both facility management and design
- Justify improvements and upgrades to management



Modeling for Existing Campuses



How?

- Model individual spaces and then add the results together
- Monitor and track each buildings by their actual utility meters

Why?

- Examine loads for lowest performing spaces or equipment
- Look for opportunities to increase usage of under-utilized resources

Overcoming Barriers



Limited resources

- Utilize junior staff
- Utilize default values in models during early design stages

Complicated process

- New tools make it easy
- All design team members can use it

No measure of efficiency

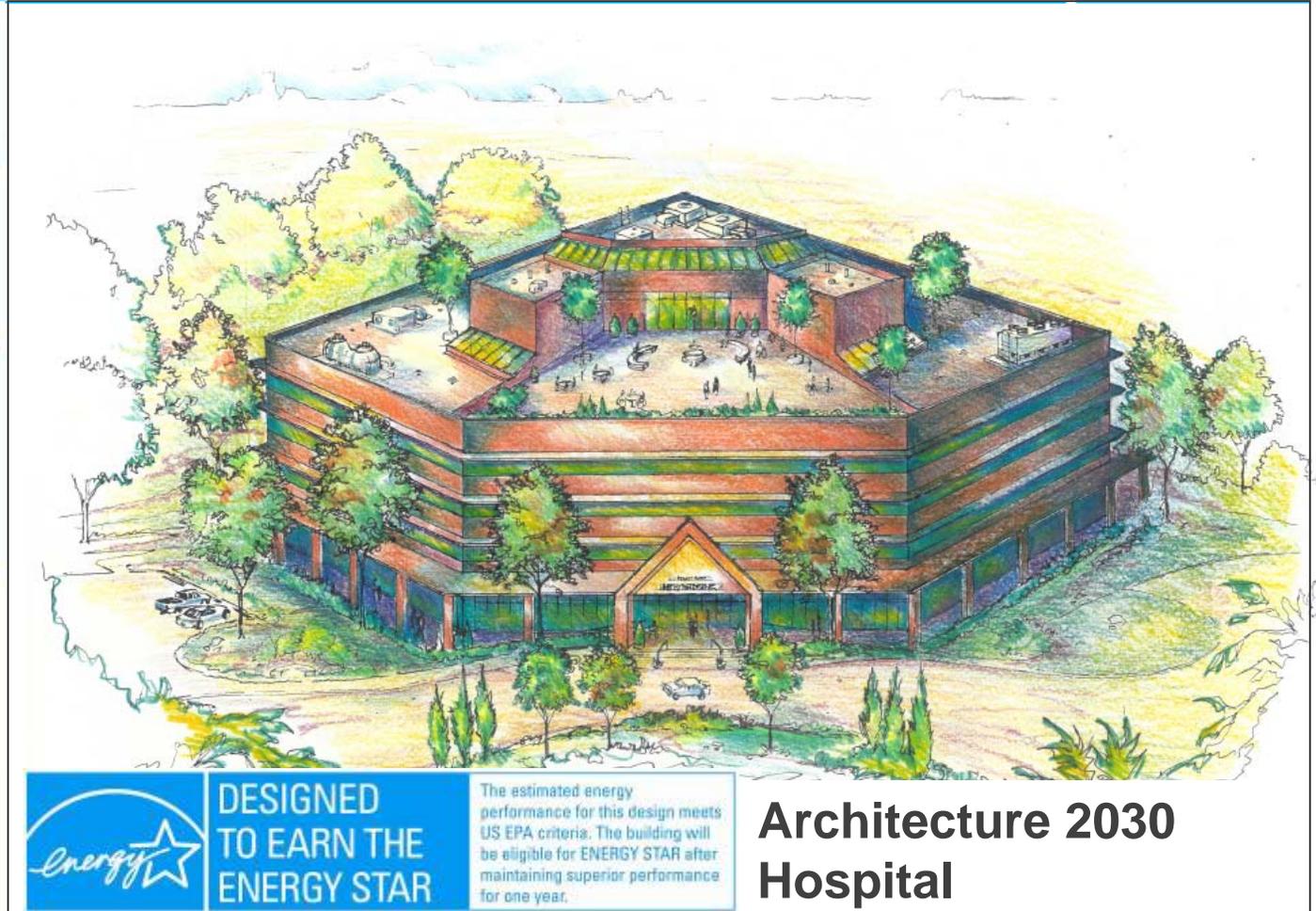
- EPA's Energy Performance Rating System

Design Recognition



**DESIGNED
TO EARN THE
ENERGY STAR**

The estimated energy performance for this design meets US EPA criteria. The building will be eligible for ENERGY STAR after maintaining superior performance for one year.



**DESIGNED
TO EARN THE
ENERGY STAR**

The estimated energy performance for this design meets US EPA criteria. The building will be eligible for ENERGY STAR after maintaining superior performance for one year.

**Architecture 2030
Hospital**



Existing Building Recognition



- ✓ Energy performance rating of 75 or higher
- ✓ Satisfy data and eligibility requirements
 - ✓ Obtain PE Verification
- ✓ Submit application to EPA



More Tools and Resources



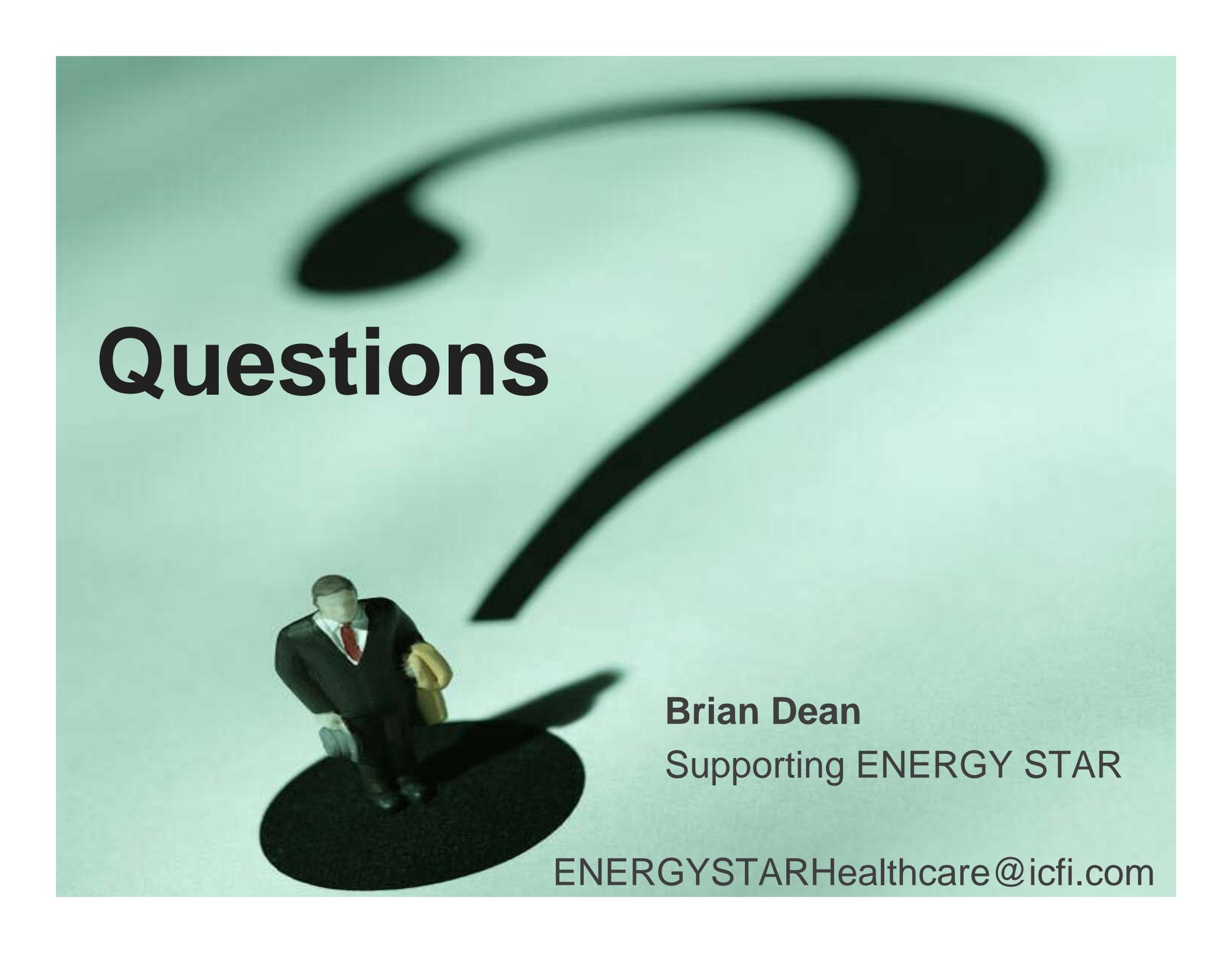
- Download Building Design Resources
- Target Finder
- Find Architects – Select “Active A&E Firms”
- Financial Value Calculator
- Online Training

Next Steps



- Join ENERGY STAR
www.energystar.gov/join
- Download Building Design Resources
www.energystar.gov/newbuildingdesign
- For eQuest go to www.doe2.com

Questions



Brian Dean

Supporting ENERGY STAR

ENERGYSTARHealthcare@icfi.com