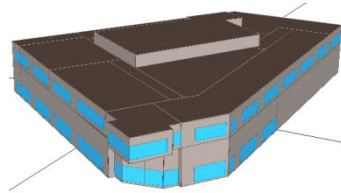


# An introduction to eQUEST



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For  
The Massachusetts Energy Efficiency Partnership

By  
Andelman and Lelek Engineering, Inc.

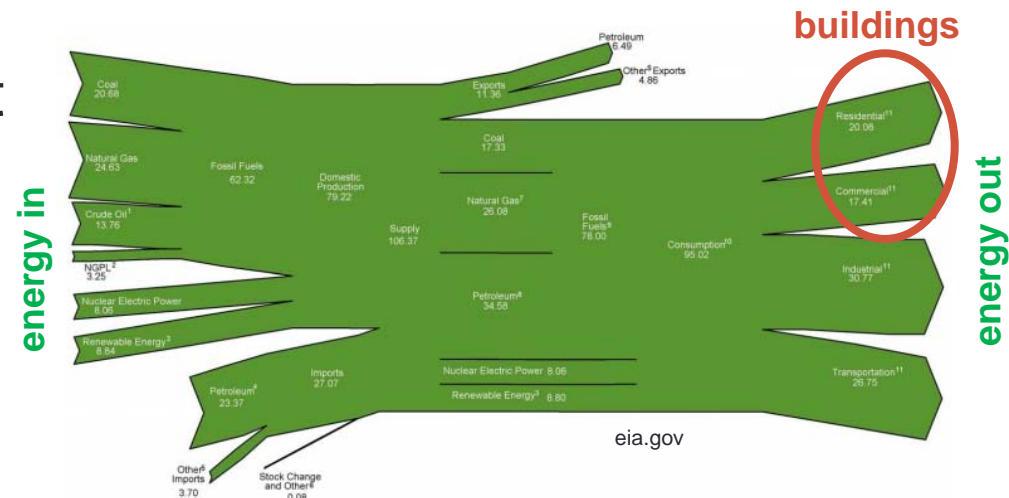
29 April 2014

# Agenda

- Introduction to energy modeling
- eQUEST program overview
- eQUEST worked example (SD and EEM wizards)
- Modeling in detailed mode
- Where to go for help
- Parametric runs
- Output reports and model checking
- Advanced modeling topics:
  - Hourly reports
  - User expressions
  - Custom performance curves
  - Modeling examples: cogen systems, heat recovery, equipment controls, infiltration

# Motivation

- US buildings use 40 quadrillion Btus of energy annually (40% of the primary energy consumed in the US; 70% of electric use)
- Many reasons to care about energy consumption:
  - Energy cost
  - Pollution (including CO<sub>2</sub>)
  - Energy security
- Leading to:
  - Government regulations (federal, state, city levels)
  - Incentives (utilities, tax breaks)
  - Corporate and institutional efficiency goals
  - Higher rents for green buildings
- **Need to understand consumption to control it**

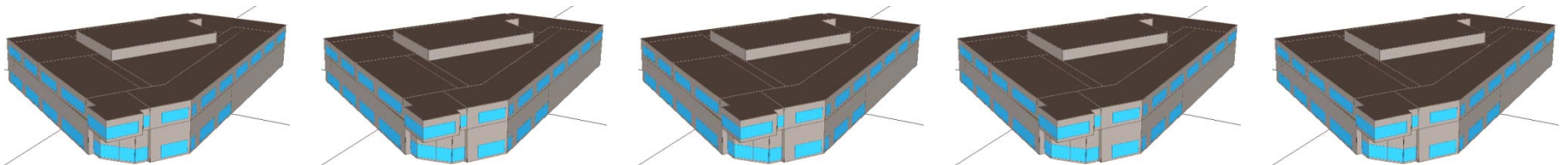


# What is building energy modeling?

- Various interpretations
- For our purposes:
  - The use of building energy analysis software designed to predict hourly energy use and energy cost for a building, using hourly weather data and a description of the building including its HVAC equipment and controls, its operating schedules, and its utility rate structure
- Energy modeling vs. building simulation

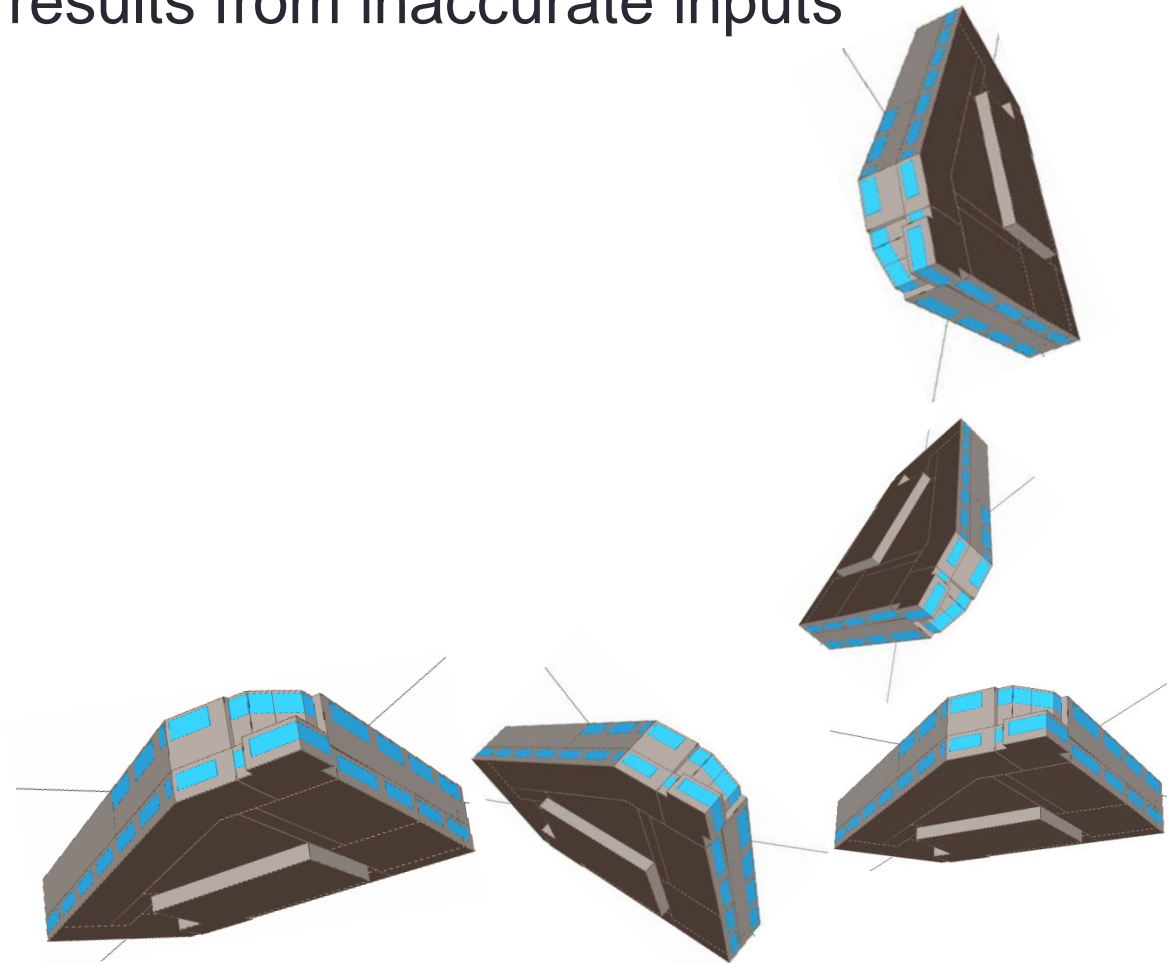
# What energy modeling can do

- 1) Quantify energy savings (new and existing buildings)
- 2) Code compliance analysis
- 3) Whole building design optimization
- 4) Help with commissioning and M&V
- 5) Predict operating costs



# What energy modeling can't do

- Be a substitute for understanding what you're modeling
- Produce useful results from inaccurate inputs



# 1) Quantify energy savings

- Determine cost-effectiveness of individual measures
- Participate in utility incentive programs
- Obtain LEED certification
- Understand interaction of energy efficiency measures
- Obtain federal tax credits

## RETROFIT

### 2014 Custom Application

ALL FIELDS ON THIS PAGE ARE REQUIRED TO COMPLETE YOUR APPLICATION.

Indicate Program Administrator for Application:

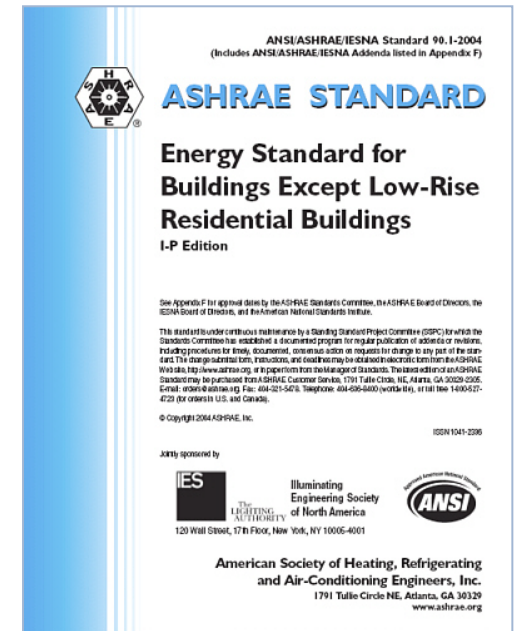
- |  |   |  |
|--|---|--|
| <input type="checkbox"/> Berkshire Gas Company | <input type="checkbox"/> Cape Light Compact                     | <input type="checkbox"/> Columbia Gas of Massachusetts |
| <input type="checkbox"/> Liberty Utilities     | <input type="checkbox"/> National Grid                          | <input type="checkbox"/> NSTAR                         |
| <input type="checkbox"/> Unitil                | <input type="checkbox"/> Western Massachusetts Electric Company |  |

## CUSTOMER/ACCOUNT HOLDER INFORMATION

COMPANY NAME	CONTACT PERSON	APPLICATION DATE
INSTALL SITE	PHONE	FAX NUMBER
EMAIL ADDRESS	SQUARE FEET (COVERED BY THIS APPLICATION)	

## 2) Code compliance analysis

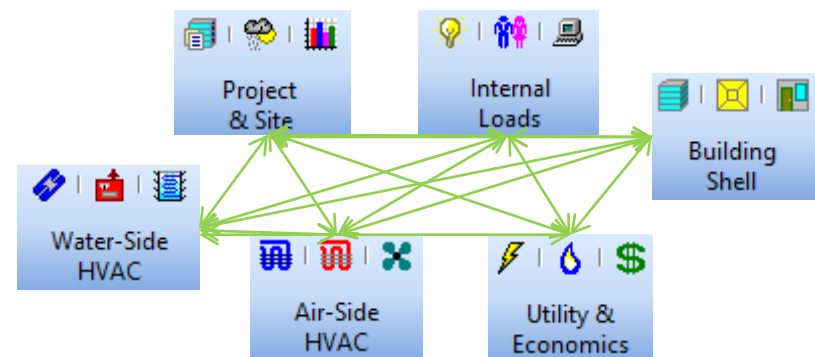
- MA Stretch Code (large buildings)
- ASHRAE 90.1 Energy Cost Budget Method
- Corporate/institutional requirements
  - e.g. emissions goals, energy savings targets





# 3) Whole building design

- Integrated approach to system design
  - e.g. interaction of daylight controls, window shading, VAV box turndowns
- System optimization
  - Compare alternative building and system designs (geometry, orientation, envelope, HVAC system type, control strategies, utility selection)
  - Life cycle costing of alternatives
  - Determine interactivity of proposed alternatives
- Determine renewables required for net zero designs



# Energy modeling and the design process

- Conceptual / early schematic (throw-away)
  - Siting and building shape analysis
  - Early evaluation of HVAC system alternatives
- Design Development
  - Evaluation of building shell and HVAC system alternatives
  - First pass estimate of LEED credit points
- Progress / first final
  - Estimate LEED credit points; evaluate utility incentives
- 4) Post-construction
  - Check performance against model; identify issues

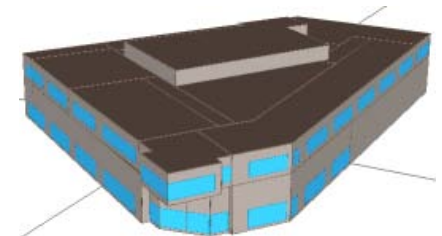
Best  
place to  
start



Don't  
stop until  
here

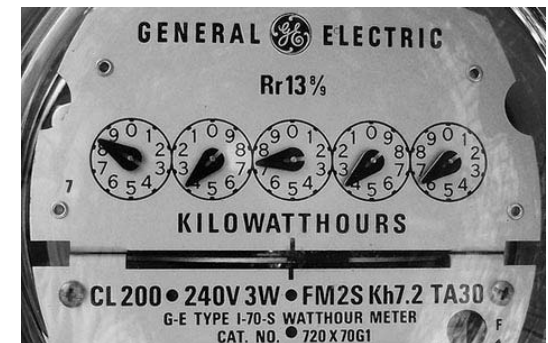
# Energy modeling and the design process (2)

- Keep updating the model
  - Update model as design progresses
  - Use model to check impact of proposed changes before implementing
  - Calibrate to utility bills or submeters after construction



# 5) Predict operating costs

- Whole building costs
- Individual building components or end uses (chillers, pumps, lighting system, tenant areas, etc.)
- Seasonal operating costs and patterns
- Building load analysis
  - Hourly/daily/weekly/monthly load profiles
  - Seasonal/annual load profiles
  - Peak load for individual zones/systems or entire building



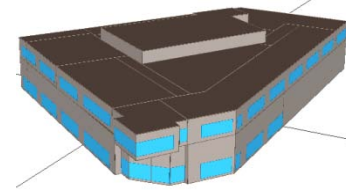
# The energy modeling process

- Define scope and set priorities
  - Purpose of model (e.g. utility ECMs, LEED, overall EUI)
  - Confirm objectives with designer/owner
- Gather data
  - From design team, owner, facilities staff
- Create model
  - Existing building or
  - Baseline building (code minimum or ASHRAE App G base)
- Calibrate model (existing buildings)
- Model alternatives
- Repeat steps as required



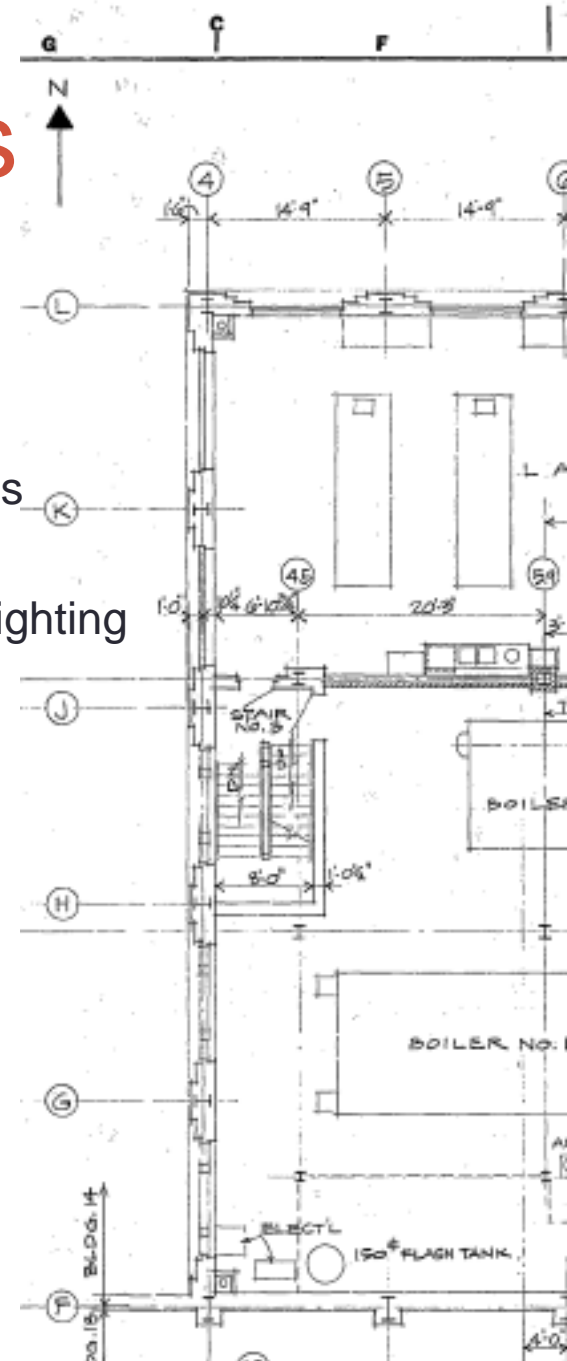
# Keep scope in mind

- Prioritize - keep in mind purpose of analysis
- Save detailing for critical elements
- Use custom performance curves only for critical or non-standard equipment



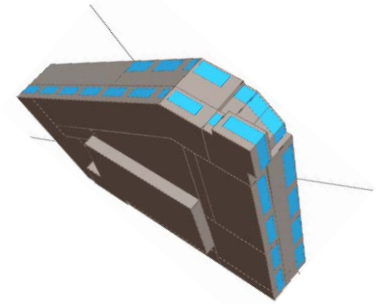
# Modeling data requirements

- Architectural
  - Plans, wall sections, building elevations, window specs
- Mechanical
  - HVAC plans, schedules, specifications, control sequences
- Electrical
  - Lighting plans, lighting take-off, occupancy sensors, daylighting
- Internal Loads
  - Peak occupancy, lighting, equipment loads
- Operations
  - Schedules of operation (occupancy, lighting, equipment, thermostats, fans, ventilation)
- Economics
  - Utility rates
- Level of detail depends on stage of modeling and purpose of model



# Common sources of error

- Lack of familiarity with:
  - Modeling program
  - Systems being modeled
- Insufficient communication with design team
- Common modeling issues (more on this later):
  - Incorrect control strategies
  - Incorrect building and equipment schedules
  - Systems over- or under-sized
  - Ventilation air over- or under-sized
  - Wrong weather data used
  - No sanity checks performed



DETAIL  $\frac{9}{101}$   
SCALE:  $1\frac{1}{2}'' = 1'-0''$

DRAWN BY - NAME - DATE ..... 1-27-77	DEPT. BU
CHECKED BY - NAME - DATE ..... 1-28-77	PLANT Q
MATERIAL	BLDG. NO.
	DWG. LIST
	SCALE AS



# What to model with?

- >140 whole-building simulation tools listed on DOE website
- Examples:
  - DOE-2 based tools (eQUEST, VisualDOE)
  - Energy Plus (interfaces include DesignBuilder, Simergy)
  - Others (e.g. BLAST, HAP, Trace 700, TRNSYS, IES Virtual Environment)
- Each program has strengths and weaknesses
- eQUEST is good value for money, widely used in industry, and has a good balance of speed and precision

Contrasting the Capabilities of Building Energy Performance Simulation Programs

	BLAST	BSim	DeST	DOE-2.1E	ECOTECH	Ener-Win	Energy Express	Energy-10	EnergyPlus	eQUEST	ESP-r	HAP	HEED	IDA ICE	IES <VE>	PowerDomus	SUNREL	Tas	TRACE	TRNSYS
Coils											156									
• Water heating coil	X	X	X	X		X	X		X	X	X	X		X	X	P	R	X	X	X
• Electric heating coil	X	X	X	X		X	X	X	X	X	X	X		R	X	X	R	X	X	X
• Gas heating coil	X			X		X	X		X	X	X	X			X	X	R	X	X	X
• Water cooling coil	X	X	X	X		X	X		X	X	X	X		X	X	X	R	X	X	X
• Detailed fin/tube water cooling coil	X <sup>163</sup>								X		X			X		X				X <sup>158</sup>
• DX coil																				
o Bypass factor cooling empirical	X								X			X			X <sup>164</sup>					
o Multispeed cooling empirical	X								X						164					
o Heating empirical	X								X						164					
o Coil frost control									X	X	X	X			164				X	X
• Water-to-air heat pump <sup>165</sup>	X		X	X			P		I	X	X	X			X			X	X	X

# Intro to DOE2.2

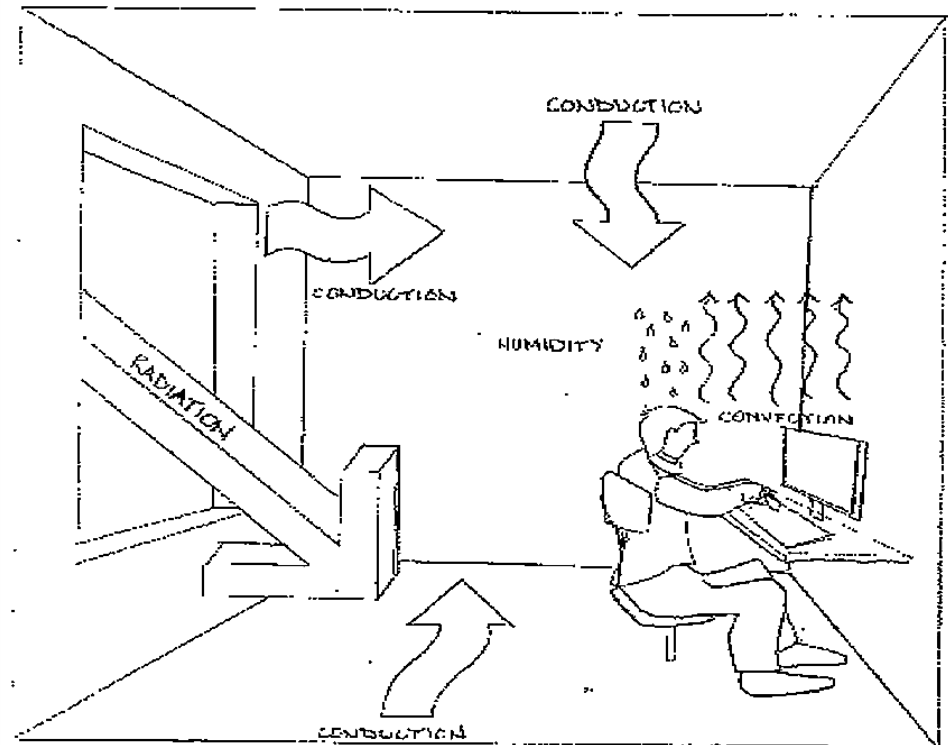
- Building energy simulation engine used by eQUEST
- **History**
  - Started in the 1970s
  - Continually tested and revised to allow for new developments in industry
- **Capabilities**
  - Calculates hour-by-hour building energy consumption over an entire year
  - Accounts for hourly schedules, building shell parameters, HVAC system interactions

# Intro to DOE2.2 (2)

- Inputs to DOE-2.2:
  - Schedules for
    - Occupants, lighting, equipment, and thermostat settings
  - Building constructions and features
    - Exterior wall constructions, roof constructions, fenestration, shades, building mass
  - HVAC system features
    - Hourly fan schedules
    - Dynamic air-side and water-side system interaction to meet space loads
  - **All of these inputs were text-based!**

# DOE-2.2 program structure

- Loads
  - Constant temperature
  - Transfer function methodology
- HVAC
  - Systems
  - Plant
- Economics
  - Utility costs



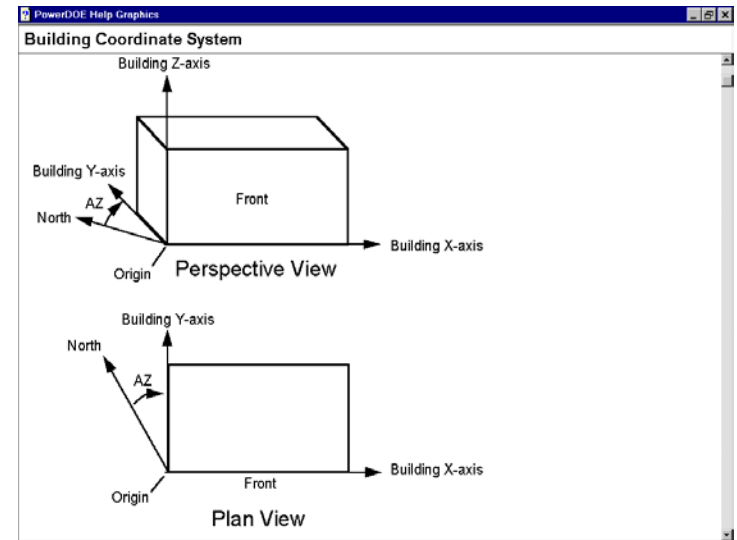
# BDL

- BDL = Building Description Language
- Free format text file
- Commands
- Keywords
- Parent/ child ordering

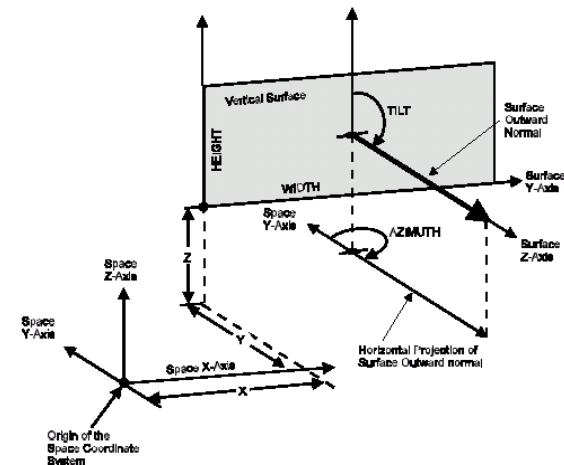
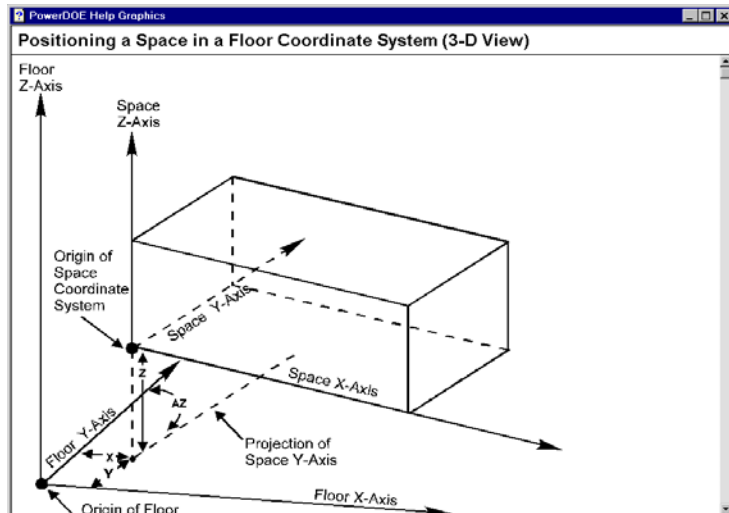
```
SET-DEFAULT FOR SPACE
  PEOPLE-SCHEDULE = "equip-sch"
  LIGHTING-SCHEDUL = ( "equip-sch" )
  EQUIP-SCHEDULE = ( "equip-sch" )
  LIGHTING-W/AREA = ( 1.5 )
  EQUIPMENT-W/AREA = ( 30 )
  AREA/PERSON = 400
  ..
"First Floor" = FLOOR
  SHAPE = BOX
  FLOOR-HEIGHT = 15
  WIDTH = 82
  DEPTH = 118
  ..
"north-1" = SPACE
  SHAPE = POLYGON
  POLYGON = "Default LongTrapPoly"
  LOCATION = FLOOR-V2
  ..
"Default Wall" = EXTERIOR-WALL
  CONSTRUCTION = "brick-wall"
  LOCATION = SPACE-V1
  ..
"window-1" = WINDOW
  GLASS-TYPE = "Double glazed"
  MULTIPLIER = 1
  X = 10
  Y = 3
  HEIGHT = 7
```

# BDL Geometry

- Reference coordinate system
- Building coordinate system
- Floor/space coordinate system
- Surface coordinate system
- Very confusing



Angle between the y-axis of the building coordinate system and the y-axis of the floor's coordinate system. Positive values are measured clockwise; negative values are measured counter-clockwise.



# DOE-2.2 to eQUEST

```
SET-DEFAULT FOR SPACE
  PEOPLE-SCHEDULE = "equip-sch"
  LIGHTING-SCHEDUL = ( "equip-sch" )
  EQUIP-SCHEDULE = ( "equip-sch" )
  LIGHTING-W/AREA = ( 1.5 )
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  LOCATION = SPACE-V1
  ..
"window-1" = WINDOW
  GLASS-TYPE = "Double glazed"
  MULTIPLIER = 1
  X = 10
  Y = 3
  HEIGHT = 7
```

text to visual



# eQUEST overview

- **QU**ick **E**nergy **S**imulation **T**ool
- Fully functional version of DOE2.2
- Graphical interface with wizards and help
- Creates standard DOE2.2 input and output files
- Can import standard DOE2.2 input files (\*.inp)
  
- Latest version: eQUEST v3.65 (2014)
- Free download from [doe2.com](http://doe2.com)





# eQUEST features

- Wizards
  - Schematic Design Wizard
  - Design Development Wizard
  - Energy Efficiency Measure Wizard
- Detailed Interface
  - Add refined inputs
  - Model HVAC systems that are unavailable in wizard
  - .INP detailed interface allows BDL editing of model
  - Create parametric runs (more detailed control of design alternatives)
  - View graphical reports

# eQUEST capabilities

- Complex geometries
- Sunspaces and trombe walls
- Custom glazing
- Daylighting with optional sun control
- Various methods for air infiltration
- 50+ HVAC system configurations available in wizards; more in detailed mode
- Flexible HVAC equipment control strategies
- Ground-source heat pumps
- Dual-fuel cooling plants

# eQUEST capabilities (cont)

- Primary/secondary hydronic loops
- Variable flow hydronic loops
- Custom performance curves
- Cogeneration
- Thermal energy storage
- Photovoltaics
- Energy recovery ventilators
- Ice rinks
- Many more

# eQUEST limitations



- Daylighting limitations:
  - Calculations not reliable for
    - Light shelves, skylights with deep wells
    - Rooms with internal obstructions
  - Daylighting only calculated through exterior windows
- Natural ventilation modeling only for residential and single zone type systems
- No interzonal air flow
- No calculation of air stratification within zones
- No more than one HVAC system per thermal zone
- Work-arounds for some system types require significant user judgement

# eQUEST file structure

- Four important eQUEST files:

Name	Size	Type
Sample Project - Baseline Design.lin	0 KB	DWG TrueView Line...
Sample Project - 1.lin	0 KB	DWG TrueView Line...
Sample Project.inp	83 KB	INP File
Sample Project.pd2	6 KB	eQUEST project file
Sample Project.prd	1 KB	PRD File
Sample Project - Baseline Design.CTL	12 KB	CTL File
Sample Project - Baseline Design.inp	83 KB	INP File
Sample Project - Baseline Design.nhk	8 KB	NHK File
Sample Project - Baseline Design.STD	255 KB	STD File
Sample Project - Baseline Design.lrp	286 KB	LRP File
Sample Project - Baseline Design.DSN	10 KB	Data Source Name
Sample Project - Baseline Design.erp	18 KB	ERP File
Sample Project - Baseline Design.LOG	5 KB	Text Document
Sample Project - Baseline Design.PLO	622 KB	PLO File
Sample Project - Baseline Design.SIM	7,479 KB	DOE-2 Simulation R...
Sample Project - Baseline Design.sin	1,767 KB	SIN File

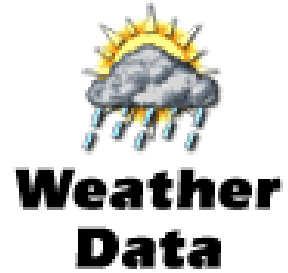
\*.inp  
\*.pd2  
\*.prd  
\*.sim

- and the weather file (\*.bin)

# eQUEST file structure, cont.

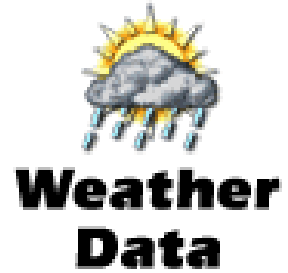
- Wizard mode writes to PD2 file (and overwrites INP file)
- Detailed mode writes to INP file (also need PD2 file)
- Parametric runs (detailed mode) saved in PRD file
- SIM file contains output data
  
- One way street: SD → DD → Detailed
- Reversing order means losing edits
  
- Sending an eQUEST model to someone else (detailed mode):
  - Include PD2, INP, and PRD files
  - Include weather file if not standard

# Weather data



- Weather file contains:
  - Location info (lat, long, elev)
  - 8,760 hours of weather data, including:
    - Drybulb temperature, %RH
    - Solar irradiance (sometimes modeled)
    - Wind speed and direction
    - Ground temperature
- eQUEST accepts BIN weather file format
- Can convert from other formats (e.g. from EnergyPlus EPW format or from a text file)
- Always good to check weather data before use

# Weather datasets



- Examples include:
  - Typical Meteorological Year (TMY, TMY2, TMY3) **(FREE)**
  - Weather Year for Energy Calculations (WYEC, WYEC2)
  - International Weather for Energy Calculations (IWEC, IWEC2)
  - Actual meteorological year (AMY) – good for calibration
- TMY data (available in BIN format from [doe2.com](http://doe2.com)):
  - Assembled from typical months from collection period
  - TMY (1952-1975)
  - TMY2 (1961-1990; 239 locations)
  - TMY3 (1991-2005; 1,020 locations)
- eQUEST automatically downloads TMY2 BIN files



# Using the SD wizard

- An eQUEST worked example
- Topics include:
  - Setting up location and basic properties
  - Thermal zoning
  - Wall constructions
  - Infiltration
  - Windows
  - Daylight harvesting controls
  - Internal loads and schedules
  - HVAC systems
  - Central plant equipment

# First SD wizard screen

eQUEST Schematic Design Wizard

**General Information**

Project Name:  Code Analysis:

Building Type:

Location Set:

Region:  Jurisdiction:

City:

Utility: Rate:

Electric:

Gas:

Area, HVAC Service & Other Data

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

Cooling Equip:  Heating Equip:

Analysis Year:  Daylighting Controls:  Usage Details:

Wizard Screen

Help Previous Screen Next Screen Finish

# Thermal zoning

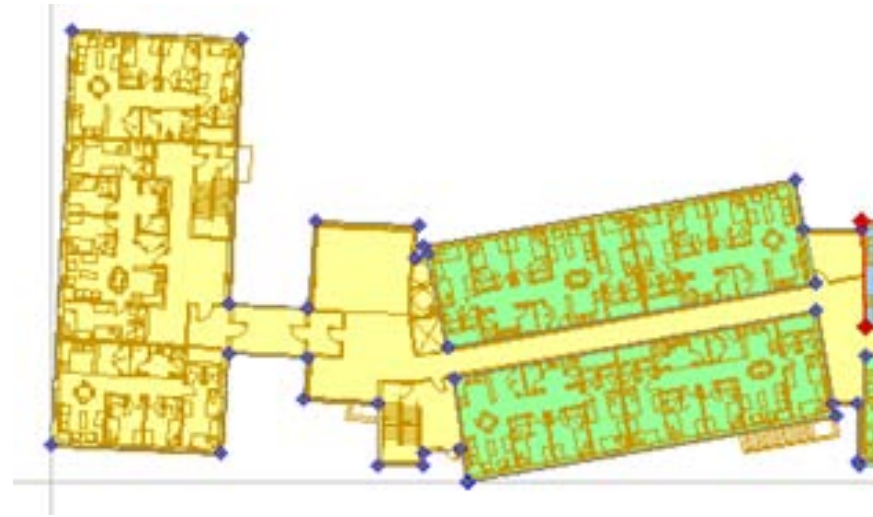
- Everything should be made as simple as possible but not simpler – Albert Einstein

# Defining zones

- By exposure
  - Interior / perimeter
- By operation schedules
- By temperature / humidity / outside air requirements
- By HVAC system
  - Thermostat location
- General rules:
  - One zone per exposure
    - Perimeter zones 15ft-20ft
    - One interior zone (at SD stage)
    - Plenum zones (sometimes)
    - No more than one airside system per zone

# Custom zoning in eQUEST

- Create polygon (counter-clockwise)
- Trace over CAD drawing
  - \*.DWG up to 2009 format
  - Set snaps to CAD and/or grid
- Note color of vertex point
  - Blue: new point
  - Yellow: move existing point
- Snap to existing vertex when entering spaces
- Coordinate zoning with activity allocation screen



# Custom zoning (2)

The screenshot displays the 'Custom Building Zoning' window in eQUEST. The main workspace shows a floor plan with a custom zone highlighted in green. The zone is defined by four vertices, with the first three listed in the table below. The status bar at the bottom of the window provides details for the active zone.

	X	Y
Vert. 1	196.00	63.00
Vert. 2	196.95	37.35
Vert. 3	285.40	37.60
Vert. 4	286.00	63.00

Floor Coord: ( 206.3, 79.3 )      dX: 0.6    dY: 25.4    dAngle: 88.5°  
Active Zone (4 of 4): 4 Vertices, 2,277.5 SqFt      Length: 25.4    Angle: 88.6°

NUM

# Wall constructions

- In SD wizard:
  - Assign construction type and insulation layers
- eQUEST stores constructions as hierarchical structures:
  - Materials
    - Large library – can create unique materials
      - Heat conductivity
      - Heat capacity
  - Layers
    - Grouping of materials – from outside to inside
  - Construction
    - Layers with surface properties for radiant transfer
- Infiltration
  - Basic options in SD wizard
  - More on this later

# Wall constructions (2)

**eQUEST Schematic Design Wizard** [?] [X]

**Building Envelope Constructions**

Roof Surfaces		Above Grade Walls	
Construction:	Metal Frame, > 24 in. o.c.	Metal Frame, 2x6, 24 in. o.c.	
Ext Finish / Color:	Roof, built-up   'Medium' (at)	Brick	Red, mason
Exterior Insulation:	3 in. polyurethane (R-18)	2 in. polystyrene (R-8)	
Add'l Insulation:	- no batt or rad barrier -	R-19 batt	
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/ft<sup>2</sup> (ext wall area) | Core: 0.001 CFM/ft<sup>2</sup> (floor area)

Wizard Screen 4 of 41 [?] Help [←] Previous Screen [→] Next Screen [Finish] [⚙]



# Windows

- Window types:
  - Simple (“specify properties”)
    - Enter shading coefficient and U-value
  - Library (choose a glass category)
    - Optical properties vary with sun angle
  - Custom
    - LBNL Window 4 or 5 output can be imported directly into eQUEST
- SD window options include:
  - Custom window placement (make sure zoning is complete first)
  - Overhangs
  - Fins

# Windows (2)

**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 Pilkington"/>	<input type="text" value="SuperGrey/Arg/Energy Adv LowE 3mm (682€)"/>	<input type="text" value="Alum w/o Brk, Fixed"/>	<input type="text" value="1.30"/>
2:	<input type="text" value="- specify proper"/>	<input type="text" value="NFRC Ufact=0.83 NFRC SHGC=0.67 VT=0.81"/>	<input type="text" value="Alum w/o Brk, Fixed"/>	<input type="text" value="0.00"/>
3:	<input type="text" value="- select another"/>	<input type="text" value="Specify the individual glass properties"/>		

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

# Daylight harvesting

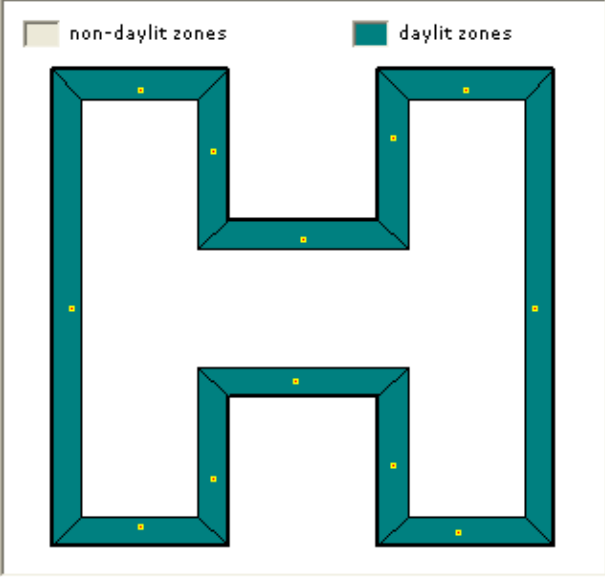
eQUEST Schematic Design Wizard Whole Building EEM Input

**Ground Floor Daylight Zoning**

Daylit From:  None  Side Lighting  Custom

Click inside zones to add/remove daylighting

non-daylit zones  daylit zones



Note: White-filled zones cannot be daylit.

Daylit Area Me  
14,236 Sq

Design Light L

Lighting Contr

Dimming: 30% Light (30% pwr)  
On/Off  
Switched: Full - 1/2 - Off  
Switched: Full - 2/3 - 1/3 - Off  
Switched: Full - 1/2  
Switched: Full - 2/3  
Switched: Full - 2/3 - 1/3  
Fluorescent: Dimming: down to 5% Light (21%  
Fluorescent: Dimming: down to 10% Light (19  
Fluorescent: Dimming: down to 20% Light (36  
Fluorescent: Hi/Lo Ballast (Full - 60% pwr)  
Metal Halide: HighBay: Dimming: down to 25%  
Metal Halide: HighBay: Hi/Lo Ballast (Full - 48°  
Metal Halide: HighBay: 3-Phs Hi/Lo Bal. (Full -  
Metal Halide: LowBay: Dimming: down to 20%  
Metal Halide: LowBay: Hi/Lo Ballast (Full - 57%  
Metal Halide: LowBay: 3-Phs Hi/Lo Bal. (Full -  
HiPres Sodium: HighBay: Dimming: down to 5  
HiPres Sodium: HighBay: Hi/Lo Ballast (Full - 4  
HiPres Sodium: HighBay: 3-Phs Hi/Lo Bal. (Ful  
HiPres Sodium: HighBay: 3-Level Ballast (Full  
HiPres Sodium: LowBay: Dimming: down to 10  
HiPres Sodium: LowBay: Hi/Lo Ballast (Full - 2  
HiPres Sodium: LowBay: 3-Phs Hi/Lo Bal. (Full  
HiPres Sodium: LowBay: 3-Level Ballast (Full -

Dimming: 30% Light (30% pwr)

Wizard Screen 10 of 41

Help Previous Screen Next Screen Finish

# Schedules in eQUEST

- Day / Week / Annual schedules
- Wizard assigns schedules based on building type
- Always check wizard defaults and verify against 24 hour load profiles
  
- Note for reference: DOE-2 uses hour ending convention for time of day
  - 12am-1am is hour #1
  - 1am-2am is hour #2
  - etc

# Activity areas

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	200.0	20.00	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>
2: Corridor	10.0	1,000.0	50.00	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>
3: Lobby (Office Reception/Waiting)	5.0	100.0	15.00	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>
4: Restrooms	5.0	300.0	50.00	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>
5: Conference Room	4.0	50.0	20.00	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
6: Mechanical/Electrical Room	4.0	2,000.0	100.00	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>
7: Copy Room (photocopying equipment)	2.0	200.0	100.00	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>
8: - select another -						

Percent Area Sum: 100.0  Show/Enable Zone Group Definitions

Occupancy Profiles by Season

Entire Year

Occup Profile (S1) ...

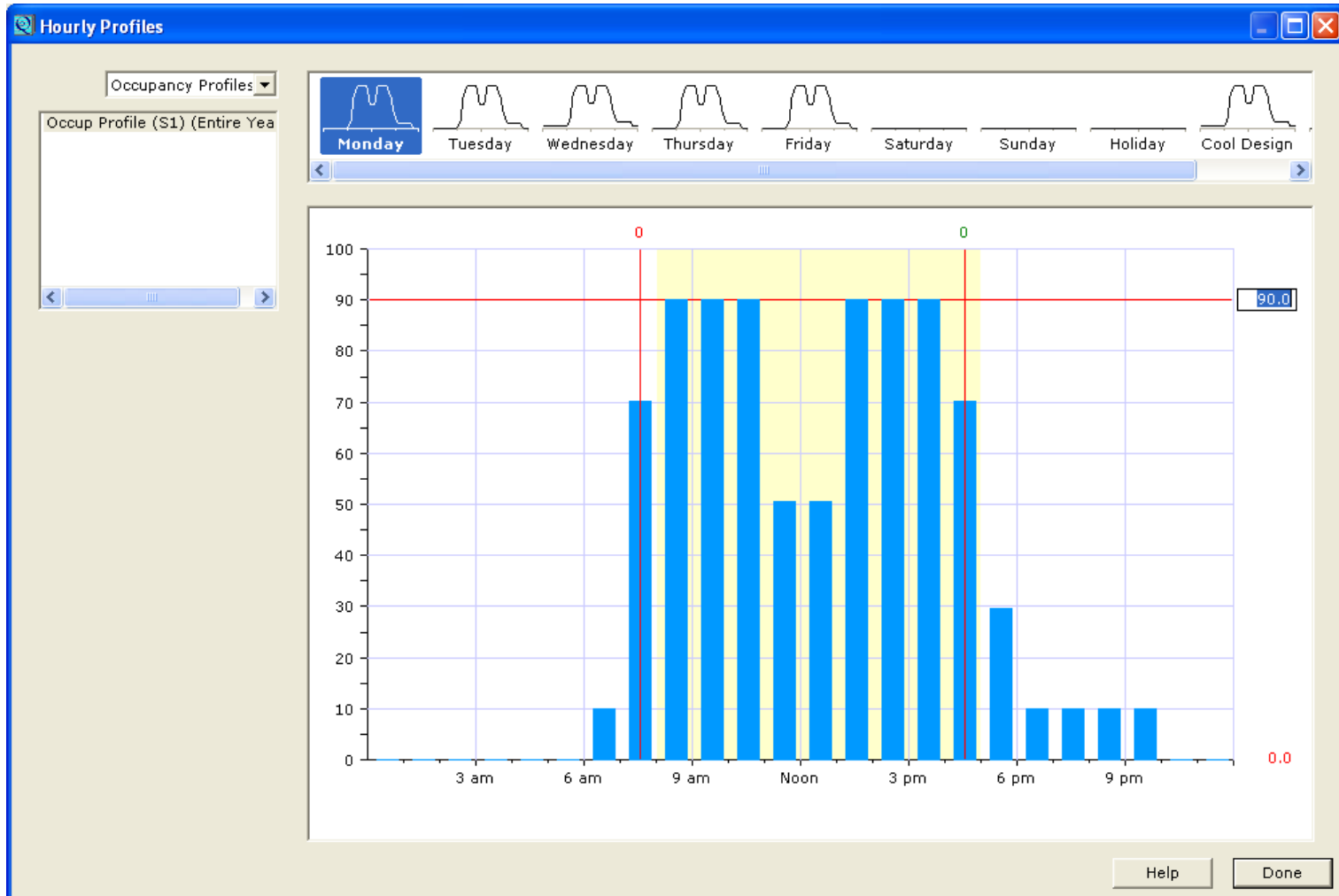
Wizard Screen 15 of 51

Help Previous Screen Next Screen Finish

# Internal loads

- “Non-HVAC end uses”
  - Lights
  - People
  - Equipment (plug loads)
  - Process loads
    - Sources other than building utility meters
    - Fraction to space (latent and sensible)
  - Always check wizard defaults against known values

# Viewing and editing hourly schedules



# Air-side HVAC systems

- SD wizard allows 1 or 2 systems to be specified
- Options for system assignment
  - One per building
  - Core / perimeter
  - By floor
- System equipment defaults depend on system sizing
  - Wizard will size system CFM based on rule of thumb; can override by assigning “0” CFM to have the design CFM calculated based on cooling load
- SEER/EER assignment



# Zonal HVAC systems

- Zonal system types:
  - Fan coil
  - PTAC
  - Heat pump
- Zonal system characteristics:
  - One system assignment can be used for whole building
  - Can cycle individual fans when no heating or cooling demand
  - Cannot implement airside economizer (except for fan coil units)
  - Check fan power – defaults apply to non-ducted units

# Central HVAC systems

- Central system types:
  - VAV
  - Dual duct
  - Multizone
  - Single zone reheat
  - Induction units
- Central system characteristics:
  - One supply / one return fan for each system
  - Zonal reheat / baseboard
    - Induction units have zonal heating and cooling
  - Return fan can be relief / exhaust fan

# Water-side HVAC

- Circulation loops
- Plant equipment
- Pumps

eQUEST Schematic Design Wizard

### Cooling Primary Equipment

Chilled Water System

CHW Loop: Head:  ft Design DT:  °F

Pump Configuration:  Number of System Pumps:

CHW Loop Flow:

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

Estimated CHW Load: **11,616 ft<sup>2</sup> Served** x Size Factor:  /  ft<sup>2</sup>/ton = **29.0 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 Reciprocating Hermetic"/>	<input type="text" value="- select another -"/>
Condenser Type(s):	<input type="text" value="Packaged Air-Cooled"/>	

Chiller Counts & Sizes:

Chiller Efficiency:

Wizard Screen

# Circulation loops

- Hot water
- Chilled water
- Condenser water
- Two pipe
- Domestic hot water
  
- Notes:
  - Make sure to check wizard defaults
  - HW and CHW loop default control is standby (i.e. runs continuously)
  - Pumps default to high efficiency

# Plant equipment

- Chillers
- Boilers
- Cooling towers
- Ground loop heat exchangers
- Pumps
- Thermal storage
- Electric generators
- PV

# Chillers

- Chiller types:
  - Air-cooled
  - Evap-cooled condenser
  - Water-cooled
- Compressor options:
  - Recipricating
  - Centrifugal
  - Screw
- Default chiller size and efficiency based on rule-of-thumb sizing

# Chillers

**eQUEST Schematic Design Wizard**

### Cooling Primary Equipment

Chilled Water System

CHW Loop: Head:  ft Design DT:  °F

Pump Configuration:  Number of System Pumps:

CHW Loop Flow:  Pump Control:

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

Estimated CHW Load: 125,033 ft<sup>2</sup> Served x Size Factor:  /  ft<sup>2</sup>/ton = 312.6 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"/>	
Compressor(s):	<input type="text" value="Constant Speed"/>	
Chiller Counts & Sizes:	<input type="text" value="Constant Speed"/>	
Chiller Efficiency:	<input type="text" value="Variable Speed"/>	
	<input type="text" value="Sml Frictionless Water 3F"/>	
	<input type="text" value="Sml Frictionless Water 10F"/>	

Wizard Screen

# Heat rejection

- Open cooling tower
- Open cooling tower with heat exchanger
- Evaporative fluid cooler
- Dry cooler



# Heat rejection

eQUEST DD Wizard: CHW Plant Equipment

**Primary Equipment Heat Rejection**

Water-Cooled Condenser / Cooling Tower

Cnd. Water Loop: Head:  ft    Design DT:  °F

Condenser Pump: Head:  ft    Flow:  gpm

Condenser Configuration:

Temperature Control:     Setpoint:  °F

Capacity Control:

Fan Efficiency and Type:    

Water-Side Economizer

Wizard Screen

Help    Previous Screen    Next Screen    Return to Navigator

# Boilers

- Boiler types:
  - Natural draft
  - Forced draft
  - Condensing
    - Efficiency based on EWT and part-load ratio

# Boilers

eQUEST Schematic Design Wizard

### Heating Primary Equipment

Hot Water System

HW Loop: Head:  ft Design DT:  °F

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) / Fuel:	<input type="text" value="HW Boiler (Natural Dr. / Nat. Gas)"/>	<input type="text" value="- select another -"/>
Boiler Count / Output:	<input type="text" value="1"/> <input type="text" value="0 kB"/>	
Boiler Efficiency:		

Boiler 1 dropdown menu:

- select another -
- HW Boiler (Natural Draft)
- HW Boiler (Forced Draft)
- Electric HW Boiler
- Steam Boiler (Natural Draft)
- Steam Boiler (Forced Draft)
- Electric Steam Boiler
- Condensing HW Boiler

Wizard Screen

Help Previous Screen Next Screen Finish

# Utility rates

eQUEST Schematic Design Wizard

### Electric Utility Charges

Rate Name:  Type:  Block Type:

Second Season: \_\_\_\_\_

Entire Year

Customer Charge:  \$ / Month

Uniform Charges:  \$ / kW     \$ / kWh

	Energy Blocks	Blk Size	\$ / kWh
1	kWh Block	99,999	0.000000
2	- select another -		

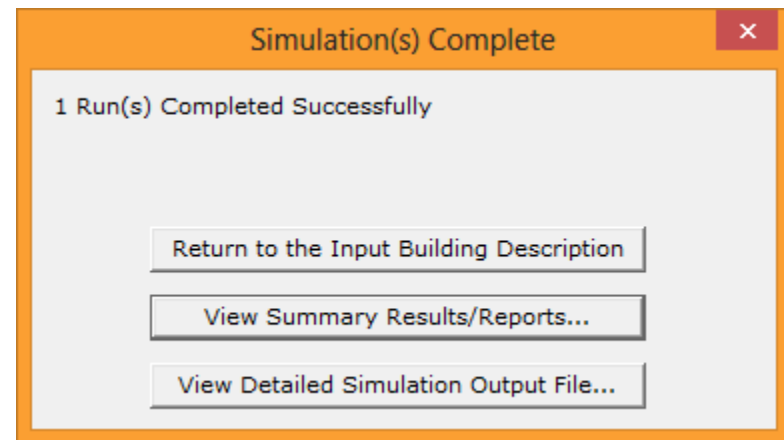
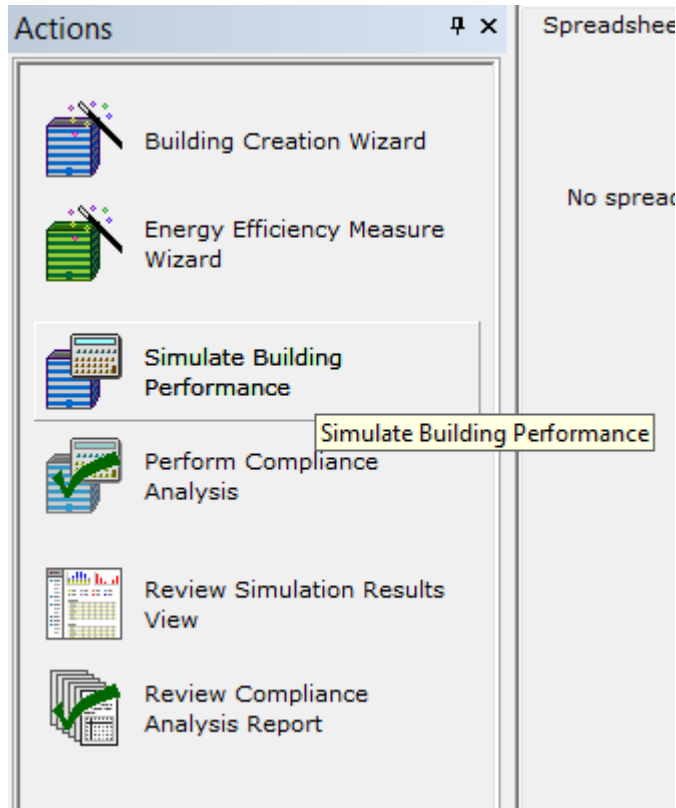
  

	Demand Blocks	Blk Size	\$ / kW
1	kW Block	99,999	0.000

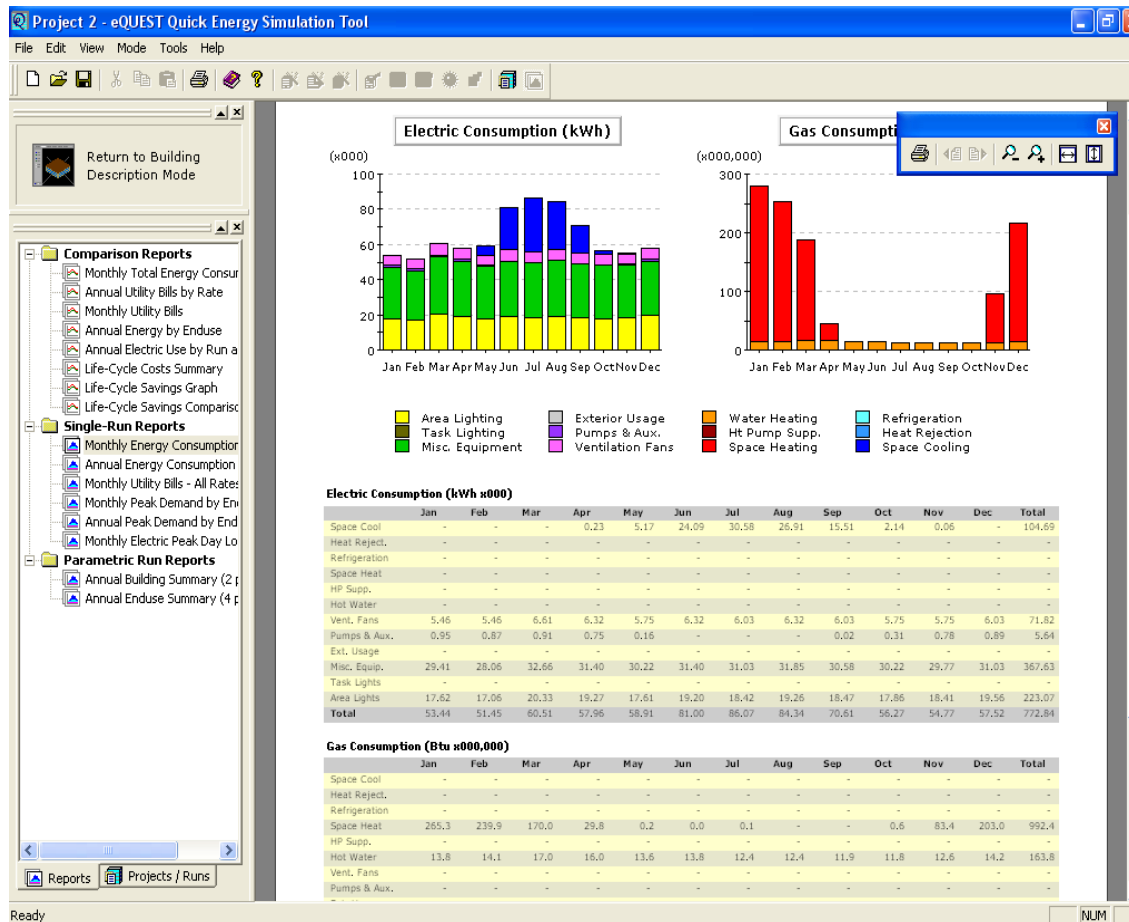
Wizard Screen

Help    Previous Screen    Next Screen    Finish

# Running the simulation

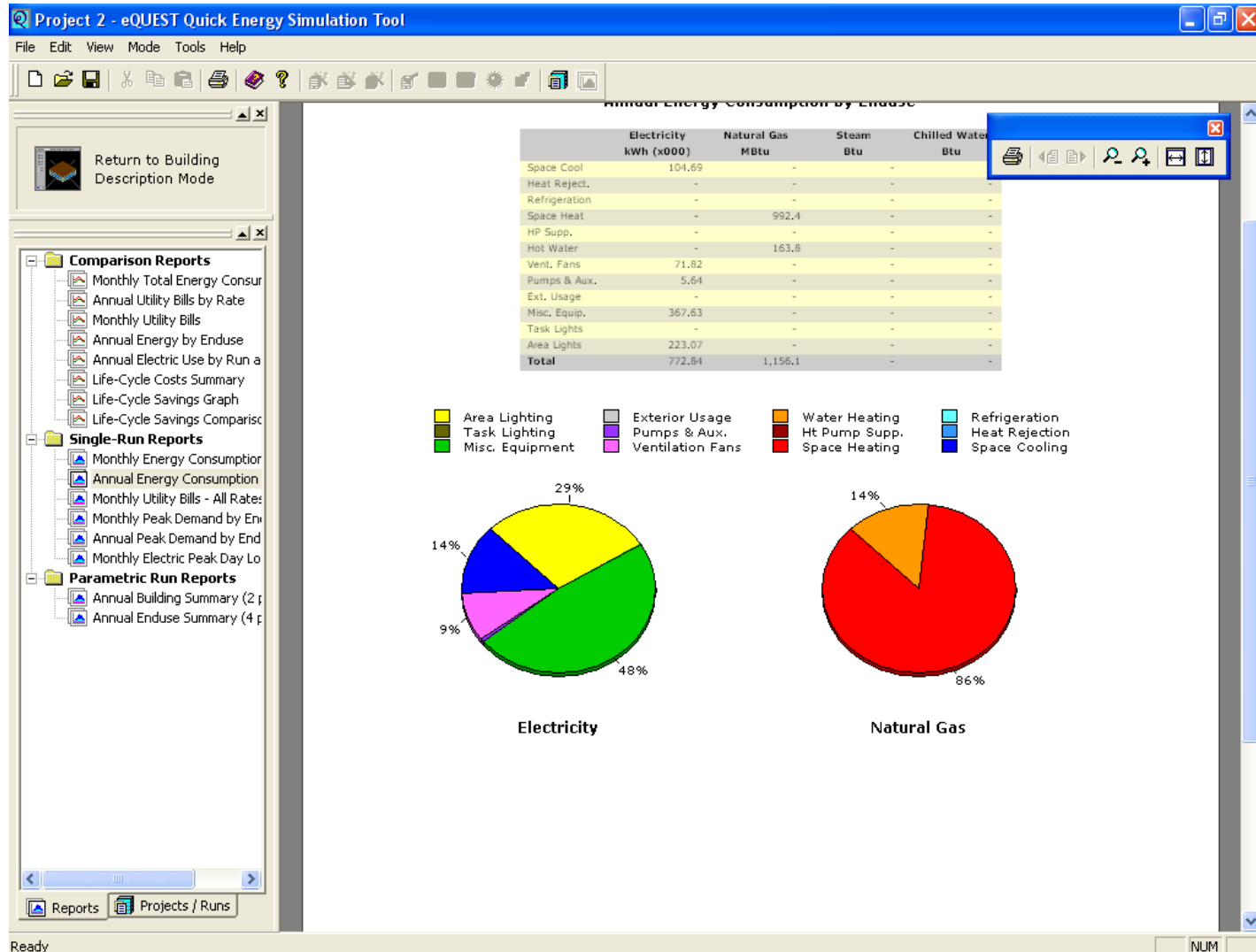


# Graphical output reports



- Can use to calibrate models

# Graphical output reports (2)

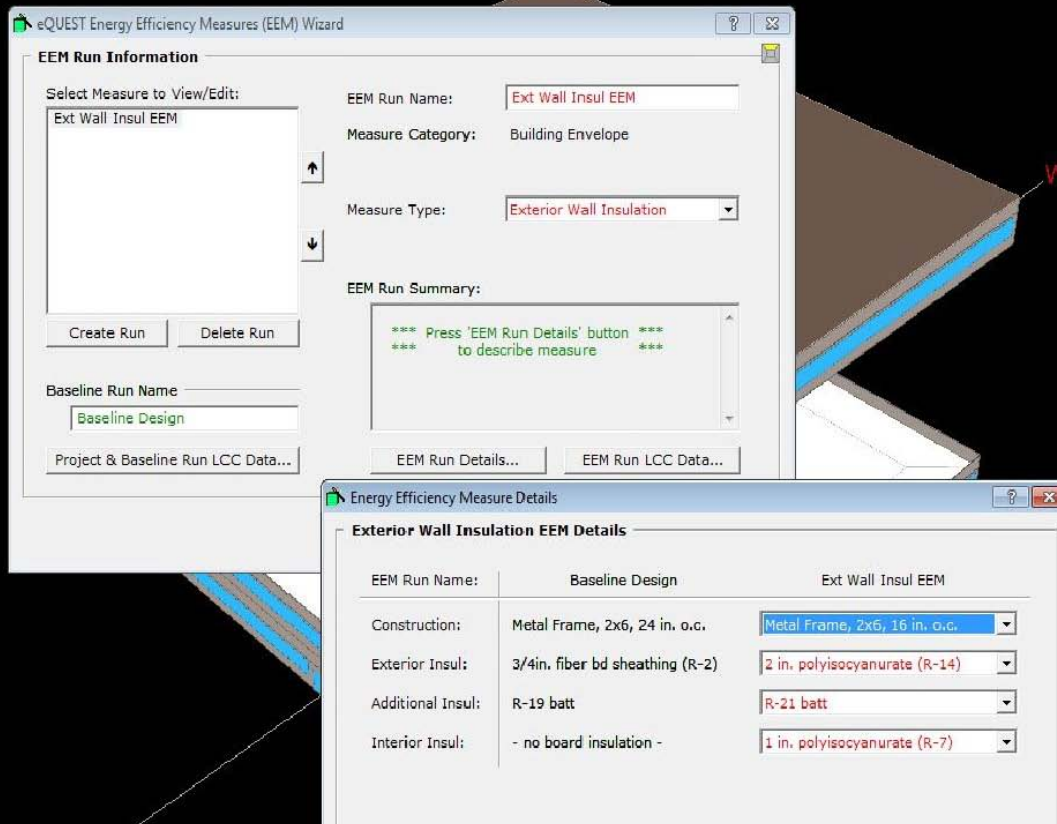


# The EEM wizard

- Energy efficiency measure (EEM) wizard
  - Sets up parametric runs for EEM options, e.g.
    - Roof insulation
    - Side or top daylighting
    - High performance glazing
    - High efficiency lighting
    - Fan VSDs
    - High efficiency water-cooled chillers
    - High efficiency packaged VAV systems
  - Whole building EEM feature allows changing any input in the wizard



# Wall construction EEM



# HVAC EEM

The image shows two overlapping software windows from the eQUEST Energy Efficiency Measures (EEM) Wizard. The background window is the 'EEM Run Information' dialog, and the foreground window is the 'Energy Efficiency Measure Details' dialog.

**EEM Run Information**

- Select Measure to View/Edit:
  - Ext Wall Insul EEM
  - Vent & Economizer EEM
- EEM Run Name: Vent & Economizer EEM
- Measure Category: HVAC System
- Measure Type: Ventilation & Economizer
- Apply Measure To: - baseline run -
- EEM Run Summary:
  - \*\*\* Press 'EEM Run De
  - \*\*\* to describe m
- Buttons: Create Run, Delete Run, Project & Baseline Run LCC Data..., EEM Run Details...
- Baseline Run Name: Baseline Design

**Energy Efficiency Measure Details**

**Ventilation & Economizer EEM Details**

**Baseline Design**

- HVAC System(s): 1: Standard VAV, HW Reheat
- Outside Air Mult: 1.00

**Economizer(s)**

- Type: Drybulb Temperature
- High Limit: 70.0 °F

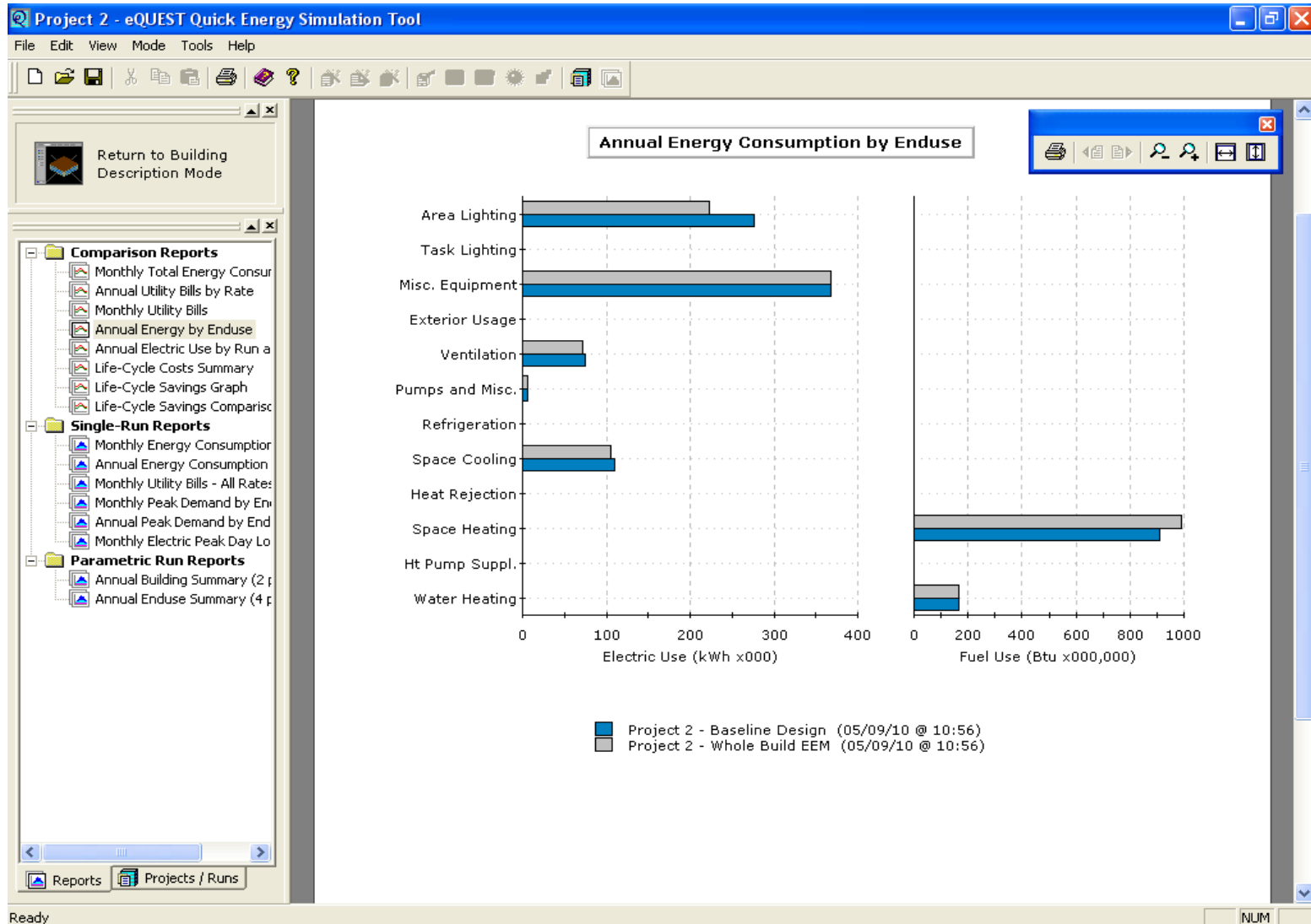
**Vent & Economizer EEM**

- HVAC System(s): 1: Standard VAV, HW Reheat
- Outside Air Mult: 1.00
- Economizer(s)
  - Type: Dual Enthalpy
  - High Limit: 75.0 °F

Help ? Done ✖



# EEM graphical reports (2)



# Getting deeper into eQUEST

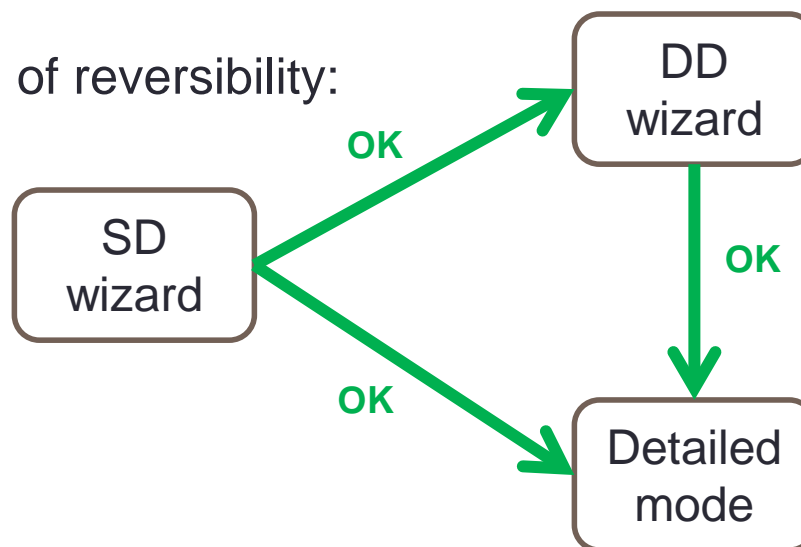
- Outline:
  - Summary of modes
  - Transitioning between modes
  - The DD wizard
  - Detailed mode
  - Where to go for help
  - Output files
  - Checking your work
  - Parametric runs
  - Hourly reports
  - User expressions
  - Custom performance curves
  - Modeling examples: cogen, heat recovery, equipment controls, infiltration

# More detailed eQUEST modes

SD Wizard  
DD Wizard  
Detailed mode  
INP file edits

↓ More detailed

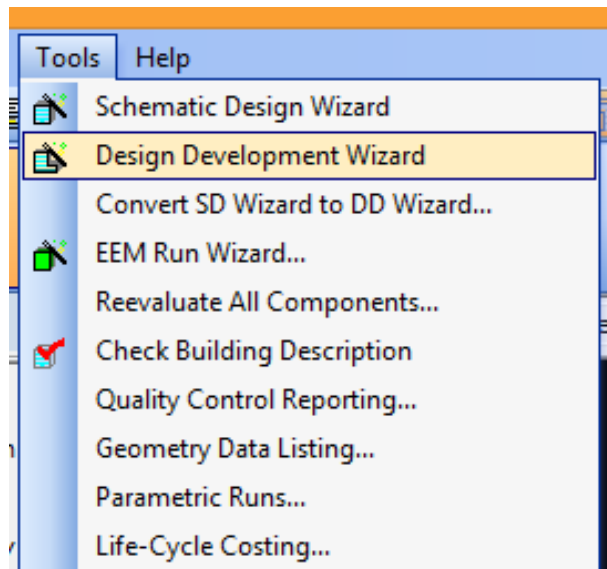
- Reminder on direction of reversibility:



- Edits made in a more detailed mode will be lost if you return to a simpler mode
- eQUEST will warn you if this is about to happen

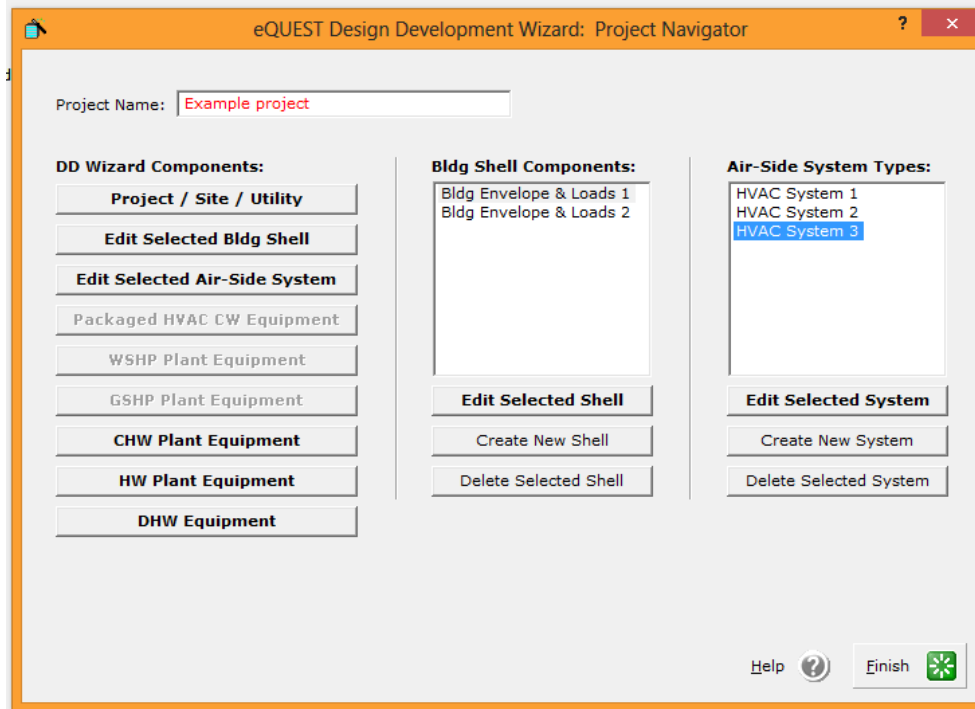
# The DD wizard

- Almost same set of screens as SD wizard
- Switch into DD from SD mode via Tools menu
- (or just start with DD wizard)



# DD wizard differences

- “Navigator” screen



- Multiple shells with different zoning and shapes
- More than 2 HVAC systems



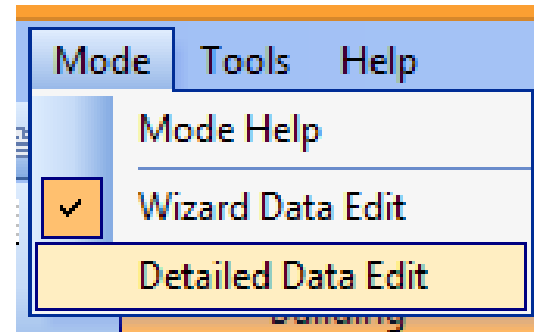
# Detailed mode: more control

- Where the pros go
- More model visibility
  - Tabs, dialog boxes, component trees, spreadsheet mode, summary reports
- More control over inputs and components
  - Create, copy, link, rename, delete components
  - Zone and system reassignment
  - User defined expressions and defaults
  - Custom curves
  - Global parameters
  - Detailed parametric runs
- More (and more flexible) system options, e.g.
  - 100% outside air systems
  - Exhaust heat recovery
  - Cogen
  - Equipment scheduling and control sequences

# Detailed mode

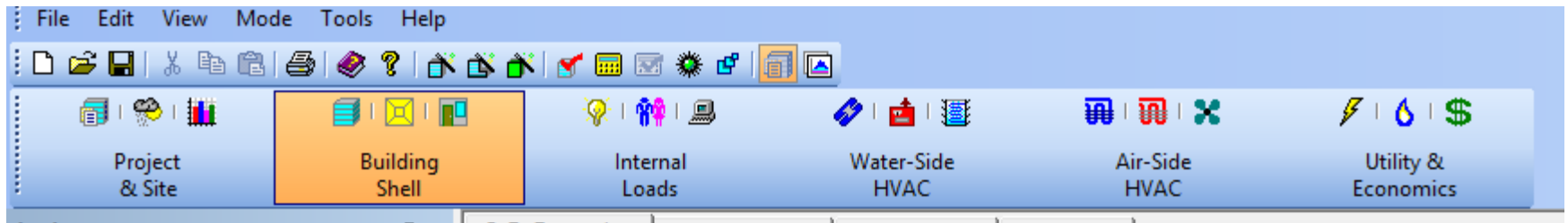
- Detailed mode viewer is where the wizards exit
- Can view tabs without moving to detailed mode
- Good way to check on what wizard has created
- To make edits, switch into detailed mode:

- Suggested workflow:
  - Set up basic models in SD and DD
  - Add details in detailed mode



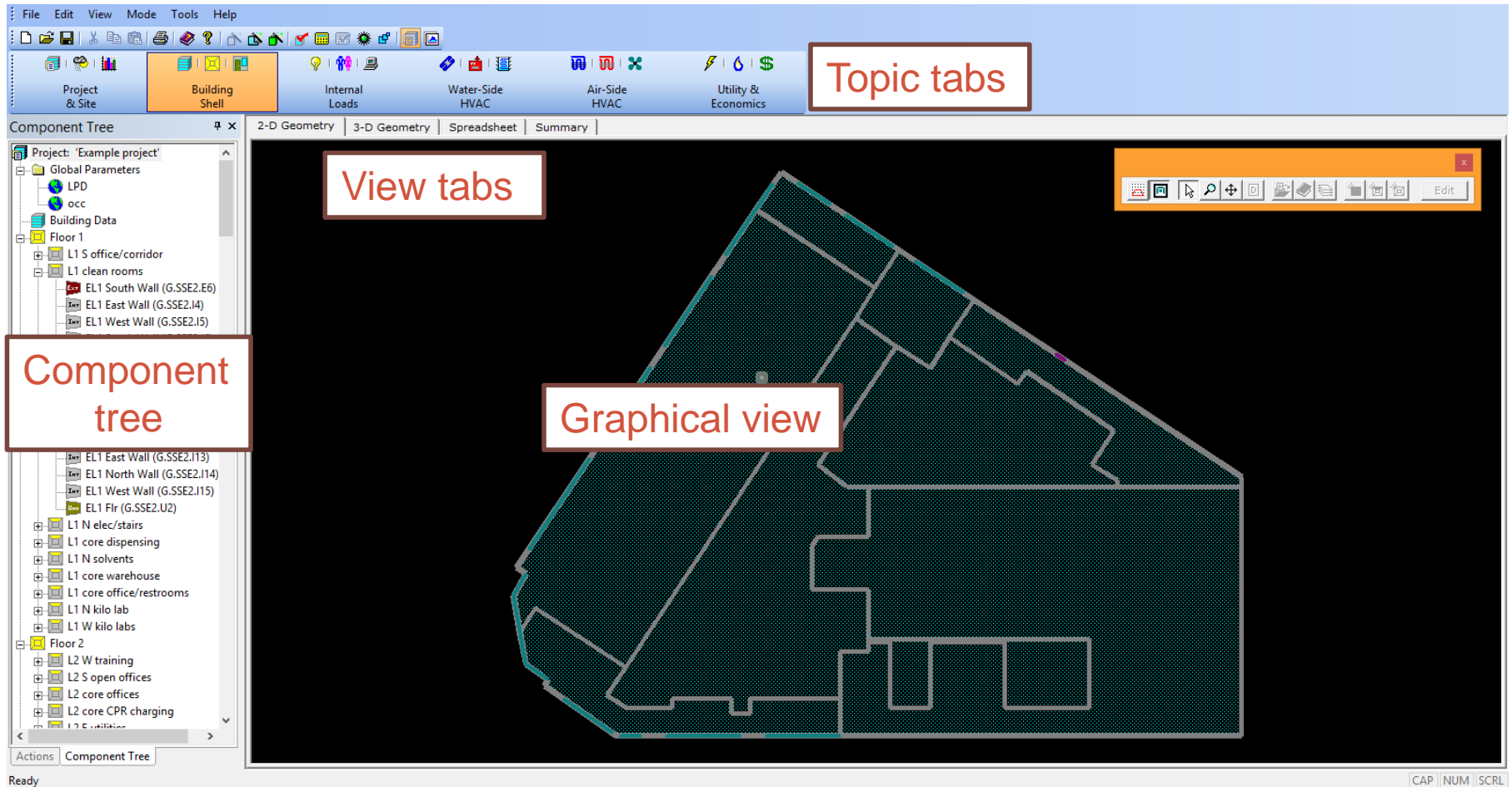
# Detailed mode navigation

- Six navigation tabs:



- On each tab (as applicable):
  - Component tree
  - Dialog box for each component
  - Graphical view
  - Spreadsheet view
  - Summary reports

# Detailed mode navigation (cont)



# Detailed mode navigation (cont)

Currently Active Space: **L1 S office/corridor** Zone Type: Conditioned

Basic Specs | Equipment | Infiltration | Daylighting | Contents | Lighting

Space Name: **L1 S office/corridor**

Parent Floor: **Floor 1**

Zone Type: **Conditioned**

Description:

Multipliers: Space: **1** Floor: **1**

Sunspace: **No** Temp.: **70.0** °F

Location & Geometry

Location: **V10 of Floor Polygon**

Shape: **Use a POLYGON**

Polygon: **EL1 Space Polygon 1**

X: **14.00** ft Fir-to-Clg Ht: **22.0** ft

Y: **2.00** ft Width: **n/a** ft

Z: **0.00** ft Depth: **n/a** ft

Azimuth: **78.69** deg Area: **1,446.1** ft<sup>2</sup>

Volume: **31,813** ft<sup>3</sup>

Occupancy

Schedule: **Occup Sch**

Area/Person: **200** ft<sup>2</sup>

Number of People: **7**

Total Heat Gain: **450** Btu/h-person

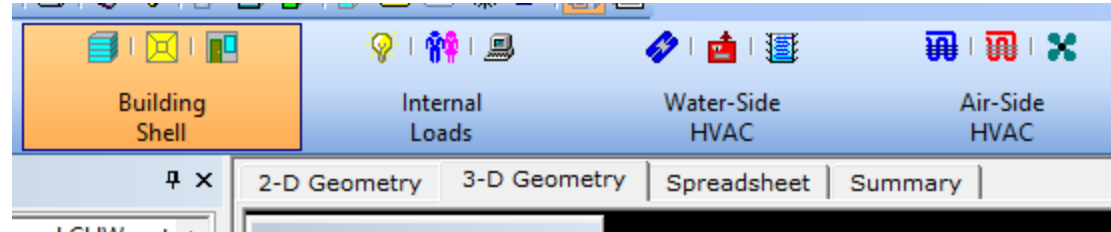
Sensible Heat Gain: **251** Btu/h-person

Latent Heat Gain: **230** Btu/h-person

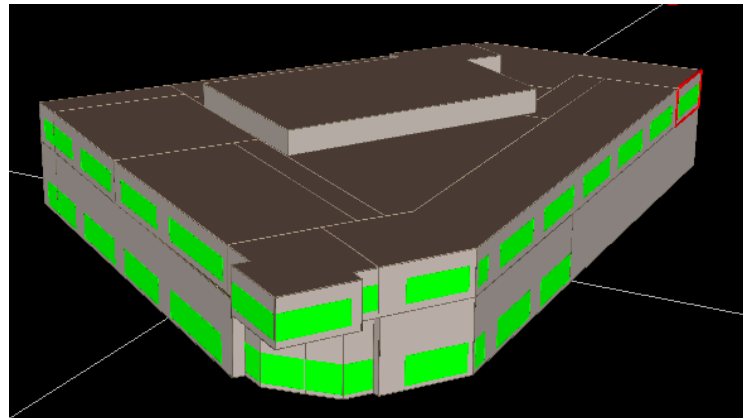
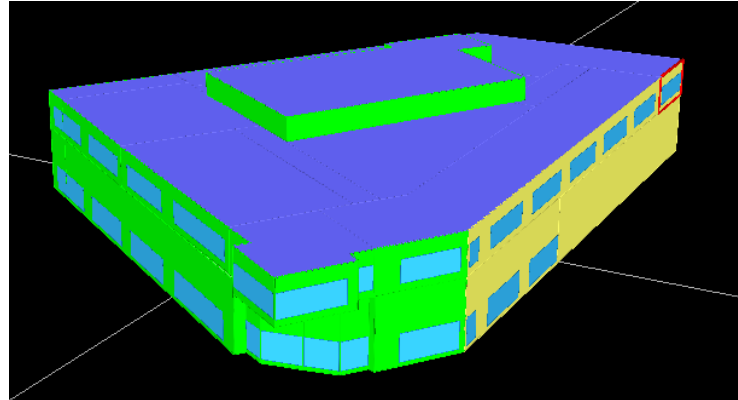
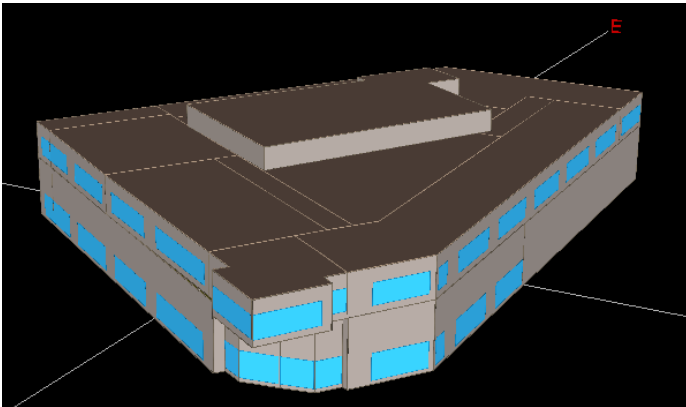
Done

Component dialog box

# 3D view



- Check geometry
- Check construction assignments



# Spreadsheet view

2-D Geometry | 3-D Geometry | Spreadsheet | Summary

Display Mode:

	Space Name	Parent Floor	Activity Desc.	Equipment Schedule 1	Equip W / Area 1 (W/ft2)	Equip kW 1 (kW)	Equip Sensible 1 (ratio)	Equip Latent 1 (ratio)	Equipment Schedule 2
1	L1 S office/corridor	Floor 1		Office Equip Sch	0.500		1.00	0.00	- undefined -
2	L1 clean rooms	Floor 1		Lab Equip Sch	4.000		1.00	0.00	- undefined -
3	L1 N elec/stairs	Floor 1		Office Equip Sch	0.500		1.00	0.00	- undefined -
4	L1 core dispensing	Floor 1		Lab Equip Sch	4.000		1.00	0.00	- undefined -
5	L1 N solvents	Floor 1		Office Equip Sch	0.500		1.00	0.00	- undefined -
6	L1 core warehouse	Floor 1		Office Equip Sch	0.500		1.00	0.00	- undefined -
7	L1 core office/restrooms	Floor 1		Office Equip Sch	0.500		1.00	0.00	- undefined -
8	L1 N kilo lab	Floor 1		Lab Equip Sch	4.000		1.00	0.00	- undefined -
9	L1 W kilo labs	Floor 1		Lab Equip Sch	4.000		1.00	0.00	- undefined -
10	L2 W training	Floor 2		Office Equip Sch	0.500		1.00	0.00	- undefined -
11	L2 S open offices	Floor 2		Office Equip Sch	0.500		1.00	0.00	- undefined -
12	L2 core offices	Floor 2		Office Equip Sch	0.500		1.00	0.00	- undefined -
13	L2 core CPR charging	Floor 2		Lab Equip Sch	4.000		1.00	0.00	- undefined -
14	L2 E utilities	Floor 2		Office Equip Sch	0.500		1.00	0.00	- undefined -
15	L2 N elec/stairs	Floor 2		Office Equip Sch	0.500		1.00	0.00	- undefined -
16	L2 core labs	Floor 2		Lab Equip Sch	4.000		1.00	0.00	- undefined -
17	L2 N future kilo lab	Floor 2		Lab Equip Sch	4.000		1.00	0.00	- undefined -
18	L2 W kilo labs	Floor 2		Lab Equip Sch	4.000		1.00	0.00	- undefined -
19	L2 W RSL labs	Floor 2		Lab Equip Sch	4.000		1.00	0.00	- undefined -
20	L2 core corr	Floor 2		Office Equip Sch	0.500		1.00	0.00	- undefined -
21	L2 core store/mech/toil	Floor 2		Office Equip Sch	0.500		1.00	0.00	- undefined -
22	Penthouse	Penthouse Floor		Office Equip Sch	0.500		1.00	0.00	- undefined -

# Internal loads tab

- View and edit occupancy lighting, daylighting, equipment loads

	Space Name	Floor	Conditioned	Sur
1	L1 S office/corridor			No
2	L1 clean rooms			No
3	L1 N elec/stairs			No
4	L1 core dispensing	Floor 1	Conditioned	No
5	L1 N solvents	Floor 1	Conditioned	No



# Water-side HVAC tab

The screenshot displays the 'Water-Side HVAC' tab in a software application. The interface includes a menu bar (File, Edit, View, Mode, Tools, Help), a toolbar, and a ribbon with tabs for Project & Site, Building Shell, Internal Loads, Water-Side HVAC (selected), Air-Side HVAC, and Utility & Economics. A Component Tree on the left lists project components, including Global Parameters, LPD, occ, CHW Loop, Chiller 1, Air-Side System(s), Thermal Zone(s), HW Loop, HW Pumps (B-1, B-2), and Performance Curves. The Performance Curves list includes MS EIR(CHWT,OAT) -fake 42F, MS EIR(PLR), MS Cap(CHWT,OAT) -fake 42F, Pump-Head-fFlow, Coil-bypass-factor-fPLR, HW-Coil-Cap-fFluidFlow, CHW-Coil-Cap-fEWB&EWT, CHW-Coil-Cap-fAirFlow, CHW-Coil-Cap-fFluidFlow, HW-Coil-Cap-fdT, HW-Coil-Cap-fAirFlow, and Electric Motors. The main graphical view shows a CHW Loop with a Chiller 1 and Multiple Coils. A red box highlights the 'Performance Curves (custom and default)' section of the Component Tree.

Performance Curves (custom and default)

Graphical view

CHW Loop

HW Loop

# Air-side HVAC tab

The screenshot displays the 'Air-Side HVAC' tab in a software application. The interface includes a menu bar (File, Edit, View, Mode, Tools, Help), a toolbar, and a ribbon with tabs for Project & Site, Building Shell, Internal Loads, Water-Side HVAC, Air-Side HVAC (selected), and Utility & Economics. A Component Tree on the left shows a project named 'Example project' with various zones and systems. The main workspace is divided into several panels:

- System Diagram:** A schematic of a Variable Air Volume (VAV) system. It shows air flow from a Return Fan through a Humidistat, then through a Chilled Water Coil and a Heating Coil, before reaching a Supply Fan. Other components include Evap or Desic, Pre Heat, Heat Recovery, and OA Econ. A central box labeled 'System diagram' is overlaid on this panel.
- Zone Assignments:** A list of zones with checkboxes indicating their assignment to the system. The list includes: L1 clean rooms Zn, L2 core CPR charging Zn, L1 core dispensing Zn, L1 N kilo lab Zn, L1 W kilo labs Zn, L2 N future kilo lab Zn, L2 W kilo labs Zn, L1 S office/corridor Zn, L1 N elec/stairs Zn, L1 N solvents Zn, and L1 core warehouse Zn. Buttons for 'Hide Zone Assignments', 'Hide Zone Features', and 'Hide Zone Locations' are visible below the list.
- Zone Features:** A panel showing features for a selected zone, including 'Zone Terminal', 'Exhst', 'Thermostat', 'Meters', and 'Zone Baseboards'.
- Locations:** A 2D floor plan showing the layout of the building. A red box highlights a specific zone, with a central box labeled 'Zone locations' overlaid on it.

Additional panels and components include:

- Performance Curves (custom and default):** A list of performance curves such as MS EIR(CHWT, OAT) -fake 42F, MS EIR(PLR), MS Cap(CHWT, OAT) -fake 42F, Pump-Head-fFlow, and Pump-Power-fFlow.
- System Meters:** A panel for monitoring system performance.
- System Baseboards:** A panel for configuring baseboard heating/cooling.

Air-side systems and zones served

Performance Curves (custom and default)

System diagram

Zone locations

# Summary reports view

- Air-side and water-side tabs
- Useful reports (after model has been run)

File Edit View Mode Tools Help

Project & Site Building Shell Internal Loads Water-Side HVAC **Air-Side HVAC** Utility & Economics

Component Tree

Project: 'Example project'

- Global Parameters
  - LPD
  - occ
- AC-1
  - L1 clean rooms Zn
  - L2 core CPR charging Zn
  - L1 core dispensing Zn
- AC-2
  - L1 N kilo lab Zn
  - L1 W kilo labs Zn
  - L2 N future kilo lab Zn
  - L2 W kilo labs Zn
- AC-3
  - L1 S office/corridor Zn
  - L1 N elec/stairs Zn
  - L1 N solvents Zn
  - L1 core warehouse Zn
  - L1 core office/restrooms Zn
  - L2 W training Zn
  - L2 S open offices Zn
  - L2 core offices Zn
  - L2 E utilities Zn
  - L2 N elec/stairs Zn
  - L2 core labs Zn
  - L2 W RSL labs Zn

Air-Side HVAC System | Spreadsheet | Summary

System & Zone Name	System Type Principal Zone Activity	Type*	Area sqft	Design Flow		Design Ventilation				Design Capacity				Hrs Outside Thr/Range			
				Supply cfm	Supply cfm/sf	Min Flow	OSA cfm	OSA %	OSA cfm/sf	OSA cfm/per	Cool tons	Cool sf/ton	Cool cfm/ton	Cool Btuh/sf	Heat Btuh/sf	Cool Hrs	Heat Hrs
<b>AC-3</b>	Variable Air Volume	D	38,439	33,000	0.91	48%	14,402	44%	0.395	63.0	128	290	282	41.4	39.4	0	0
... L1 S office/corridor Zn		C	1,446	820	0.57	94%	357	44%	0.247	14.3	3	483	283	25.9	40.9	0	0
... L1 N elec/stairs Zn		C	1,426	1,100	0.77	36%	479	44%	0.336	67.2	4	341	283	35.2	38.0	0	0
... L1 N solvents Zn		C	756	1,512	2.00	50%	658	44%	0.871	174.2	6	131	283	91.3	56.6	0	0
... L1 core warehouse Zn		C	3,048	400	0.13	50%	174	44%	0.057	11.4	2	2,002	283	6.0	25.3	0	0
... L1 core office/restrooms Zn		C	4,857	2,000	0.41	85%	871	44%	0.179	35.9	8	638	283	18.8	34.8	0	0
... L2 W training Zn		C	1,066	2,000	1.88	20%	871	44%	0.817	163.4	8	140	283	85.7	54.5	0	0
... L2 S open offices Zn		C	5,167	6,490	1.28	28%	2,828	44%	0.547	109.4	25	209	283	57.4	44.1	0	0
... L2 core offices Zn		C	616	370	0.60	54%	161	44%	0.262	52.3	1	438	283	27.4	33.9	0	0
... L2 E utilities Zn		C	3,537	2,000	0.57	50%	871	44%	0.246	49.2	8	465	283	25.8	32.5	0	0
... L2 N elec/stairs Zn		C	1,952	2,245	1.15	33%	978	44%	0.501	100.2	9	229	283	52.5	42.3	0	0
... L2 core labs Zn		C	2,750	5,499	2.00	50%	2,395	44%	0.871	174.2	21	131	283	91.3	56.6	0	0
... L2 W RSL labs Zn		C	3,019	6,038	2.00	50%	2,829	44%	0.871	174.2	23	131	283	91.3	56.6	0	0
... L2 core office/corr Zn		C	670	600	0.90	100%	261	44%	0.390	78.0	2	293	283	40.9	53.1	0	0
... L2 core store/mech/toil Zn		C	6,130	2,000	0.33	40%	871	44%	0.142	28.4	8	805	283	14.9	27.5	0	0
... Penthouse Zn		U	5,725	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Sum of Zones	..	..	..	33,074	..	..	..	..	..	..	128	..	..	..	..	0%	0%
Sum of Zones / System Total	..	..	..	..	100%	..	..	..	..	..	100%	..	..	..	..	..	..

\* Return Types: .. 'P' = Plenum Return .. 'D' = Ducted Return .. 'd' = Direct return .. (Plenum Zones are not shown on this report)  
 \* Zone Types: .. 'C' = Conditioned Zone .. 'U' = Unconditioned Zone .. 'S' = Slave Zone .. (conditioned but no t-stat)

# Utility & Economics tab

File Edit View Mode Tools Help

Project & Site Building Shell Internal Loads Water-Side HVAC Air-Side HVAC Utility & Economics

Component Tree

Project: 'Example project'

- Global Parameters
  - LPD
  - occ
- Utility Rates
  - NStar G-3 2013
  - National Grid G-43 2012
- Block Charges
  - NStar summer peak
  - NStar summer off-peak
  - NStar winter peak
  - NStar winter off-peak
  - NGrid G-43 winter
  - NGrid G-43 summer
- Fuel Meters
  - FM1
- Steam Meters
- CHW Meters
- Baseline Data
- Photovoltaic Modules
- Electric Generators
- Central Plant Component Costs
- Other Building Component Costs
- Annual Schedules
  - Occup Sch
  - Lighting Sch
  - Office Equip Sch
  - DHW Eqp NRes Sch
  - ZG0-S1 (PSZ) P-Inf Sch
  - ZG0-S1 (PSZ) C-Inf Sch
  - Op all-time Eqp Sch

Spreadsheet | Summary

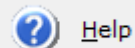
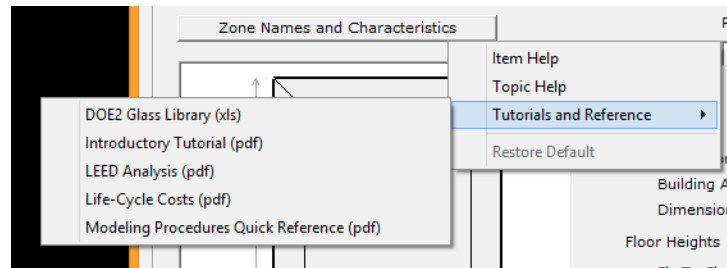
Display Mode: Utility Rate - General

	Utility Rate Name	Utility Rate Type	Monthly Charge (Jan)	Monthly Charge (Feb)	Monthly Charge (Mar)	Monthly Charge (Apr)	Monthly Charge (May)	Monthly Charge (Jun)	Monthly Charge (Jul)	Monthly Charge (Aug)	Monthly Charge (Sep)	Monthly Charge (Oct)	Monthly Charge (Nov)	Monthly Charge (Dec)	Last Billing Day (Jan)	Last Billing Day (Feb)
1	NStar G-3 2013	Electricity	237.07	237.07	237.07	237.07	237.07	237.07	237.07	237.07	237.07	237.07	237.07	237.07	31	28
2	National Grid G-43 2012	Natural Gas	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	31	28

Rate structure

# Where to go for help

- In wizard modes:
  - Right click on an input field to get to tutorials



Help

Help button on wizard tabs goes to built-in help

## Quick Start

### Things to Know Before Getting Started

**Whole building analysis.** eQUEST is a whole building performance analysis tool for building designers, operators, utility & regulatory personnel. Whole building analysis recognizes that a building's energy performance is a function of the performance of interacting systems, e.g., envelope, HVAC, and DHW. Therefore, any analysis of these building systems must consider the interaction in a manner that is both comprehensive and affordable in terms of time, simulation runtime, results troubleshooting, etc.

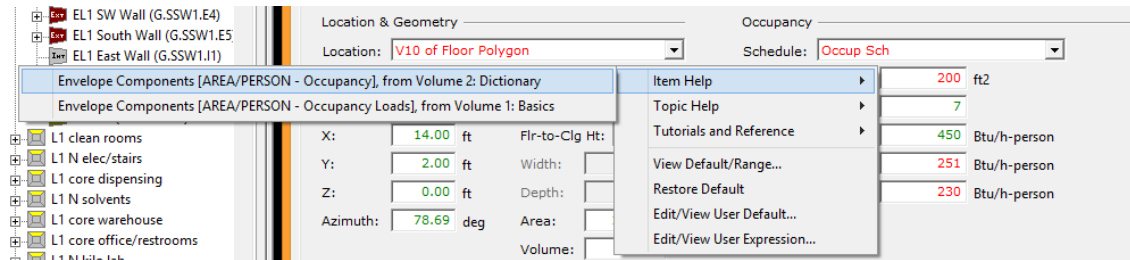
**What Comes in the 'Package'?** There are three main components: 1) the *Wizards* (both for building creation and analysis), 2) the *Detailed Interface* (including Results Reporting), and 3) the *Help*.

**Wizards.** eQUEST's *Wizards* are intended to streamline the process of preparing building models for simulation. Unlike conventional simulation tools, eQUEST's wizards are designed to answer the questions of the user. Combining limited user input with default values, eQUEST's *Wizards* can be used either for preliminary screening analysis or to speed the preparation of models to be used for more detailed analysis. There are three *Wizards*, the *Schematic Design Wizard*, the *Design Development Wizard* ('DD Wizard'), and the *Energy Measures Wizard* ('EEM Wizard'). The *SD Wizard* is used to create building models. The *EEM Wizard* is used to create building design alternatives. This tutorial provides an overview of the *Wizards*.

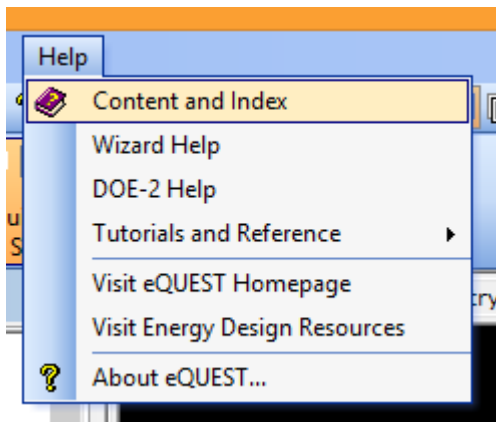
There are two main differences between the *SD Wizard* and the *DD Wizard*: 1) The *SD Wizard* can only create a single building model. The *DD Wizard* refers to any area of the building that shares the same footprint, shape, HVAC zoning, ceiling height, envelope, and services. The *DD wizard* can be used to create multiple building models. 2) The *SD Wizard* can create up to two building models (from which one or more HVAC models). The *DD Wizard* can be used to create multiple building models and provides more flexibility in assigning templates. For these two reasons, the *DD Wizard* is more suitable to start their eQUEST project in either wizard. Some projects can be converted to the *DD Wizard* projects at any time, but projects cannot be converted to a *SD Wizard* project.

# Help in detailed mode

- Right mouse click on any input field



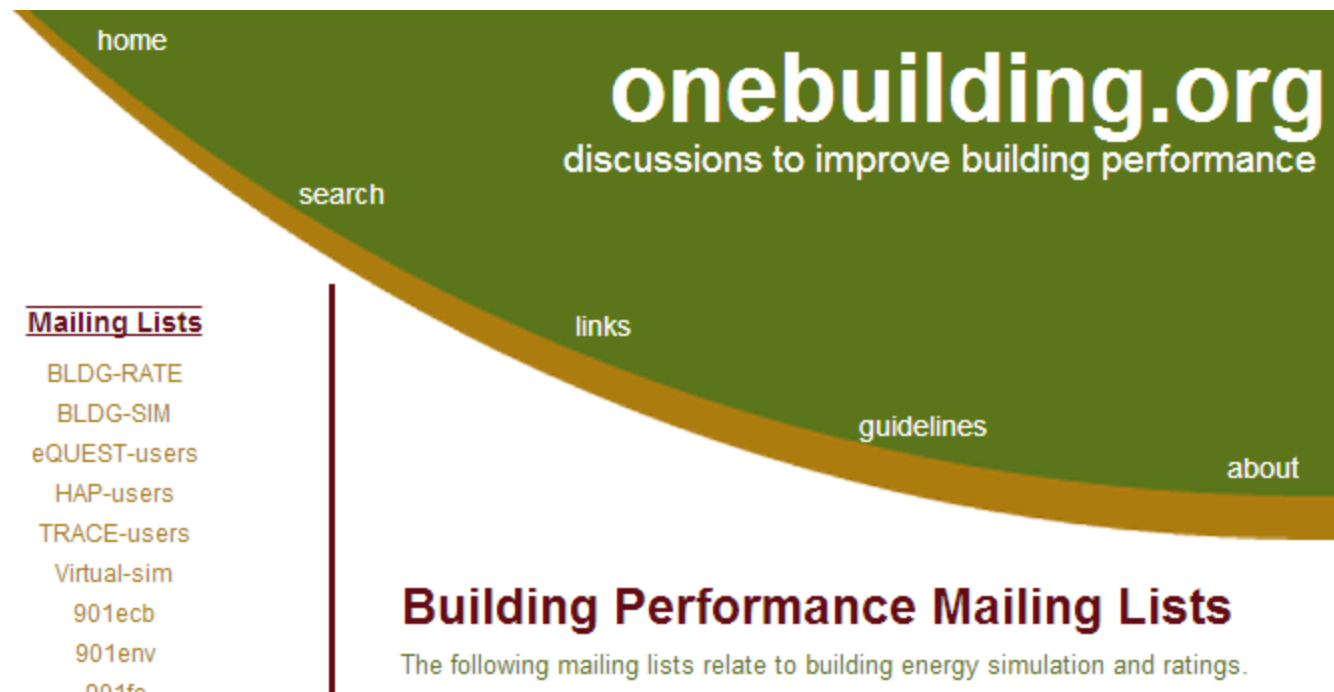
- Help menu



- Help file is usually correct

# Help from elsewhere

- eQUEST files and documentation at doe2.com
- eQUEST users and BLDG-SIM email lists
  - Sign up at [www.onebuilding.org](http://www.onebuilding.org)
- Or call us



The image shows a screenshot of the onebuilding.org website. The header is green with the text "home" in the top left, "search" in the middle left, "onebuilding.org" in large white font in the center right, and "discussions to improve building performance" below it. A curved navigation bar at the bottom contains "links", "guidelines", and "about". A sidebar on the left is titled "Mailing Lists" and lists several categories: BLDG-RATE, BLDG-SIM, eQUEST-users, HAP-users, TRACE-users, Virtual-sim, 901ecb, 901env, and 001fo. Below the sidebar, the text "Building Performance Mailing Lists" is displayed in bold, followed by the sentence "The following mailing lists relate to building energy simulation and ratings."

home

search

**onebuilding.org**  
discussions to improve building performance

links

guidelines

about

**Mailing Lists**

BLDG-RATE  
BLDG-SIM  
eQUEST-users  
HAP-users  
TRACE-users  
Virtual-sim  
901ecb  
901env  
001fo

**Building Performance Mailing Lists**

The following mailing lists relate to building energy simulation and ratings.

# Parametric runs

- Accessed via detailed mode
- Much more control than EEM wizard
- Requires familiarity with BDL keywords
- A few limitations, e.g.
  - Cannot enter new equipment (but can enter equipment in base model with zero capacity, then change capacity in parametric run)



# Parametric runs

The screenshot displays the eQUEST software interface for a project named 'Large Office 2'. The main window shows a 'Powered Induction Unit' diagram with various HVAC components. A 'Parametric Run Definitions' dialog box is open, allowing the user to define a new parametric run. The dialog includes a list of existing parametric runs, a form for defining a new run, and a table for data modifications.

**Parametric Run Definitions Dialog:**

- Name:** HR Effectiveness
- Type:** BDL Command
- Component Type:** HVAC System
- Sort Component Type:**
- References:**  Flr1 Sys,  Flr2 Sys,  Flr3 Sys,  Flr4 Sys,  RTU-3-Dining
- Data Modifications:**

Category	Keyword	Value	Units
Energy Recovery Ventilators - He...	ERV-SENSIBLE-EFF	0.7000	ratio
Energy Recovery Ventilators - He...	ERV-LATENT-EFF	0.7000	ratio

Buttons: Create Parametric Run, Create Parametric Component, Delete Selected Item, Select All, Clear All, Display DOE-2 BDL Keyword, Grid View, Done.

**Component Tree (Left):**

- Global Parameters
- Glass 1
- Glass 2
- Glass 3
- Office 1
- Office 2
- Office 3
- Office 4
- Office 5
- Office 6
- Office 7
- Office 8
- Office 9
- Office 10
- Office 11
- Office 12
- Office 13
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- Office 100

**Zone Assignments (Right):**

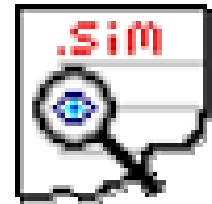
- EL1 South Perim Zn (G.W10)
- EL1 East Perim Zn (G.E13)
- EL1 SSW Perim Zn (G.S14)
- EL1 East Perim Zn (G.E15)
- EL1 NNE Perim Zn (G.N16)
- EL1 East Perim Zn (G.E17)
- EL1 North Perim Zn (G.N18)
- EL1 NW Perim Zn (G.NW19)
- EL1 West Perim Zn (G.W20)
- EL1 North Perim Zn (G.N21)

**Zone Baseboards (Bottom Right):**

- Exhst
- Meters
- Zone Baseboards

# Detailed output reports

- As well as colorful plots and tables, eQUEST also outputs the SIM file
- The SIM file contains:
  - Everything the graphical reports contain, plus
  - Detailed reports on loads, systems, and economics
- eQUEST comes with SIM file viewing software (D2SimViewer)
- SIM files can also be opened with any text editor



# The SIM file

Project 2 - Baseline Design - D2SimViewer

File Edit View Window Help

Report: BEPU Building Utility Performance Component: Hourly Results

Project 2 DOE-2.2-48r 4/10/2014 14:24:11 BDL RUN 3

REPORT- BEPU Building Utility Performance WEATHER FILE- Boston MA TMY2

	LIGHTS	TASK LIGHTS	MISC EQUIP	SPACE HEATING	SPACE COOLING	HEAT REJECT	PUMPS & AUX	VENT FANS	REFRIG DISPLAY	HT PUMP SUPPLEM	DOMEST HOT WTR	EXT USAGE	TOTAL
EM1 ELECTRICITY													
KWH	90465.	0.	46271.	0.	16432.	0.	2168.	21515.	0.	0.	0.	0.	176851.
FM1 NATURAL-GAS													
THERM	0.	0.	0.	2872.	0.	0.	0.	0.	0.	0.	340.	0.	3212.
TOTAL ELECTRICITY	176851. KWH			7.074 KWH /SQFT-YR GROSS-AREA			7.074 KWH /SQFT-YR NET-AREA						
TOTAL NATURAL-GAS	3212. THERM			0.128 THERM /SQFT-YR GROSS-AREA			0.128 THERM /SQFT-YR NET-AREA						
PERCENT OF HOURS ANY SYSTEM ZONE OUTSIDE OF THROTTLING RANGE = 0.76													
PERCENT OF HOURS ANY PLANT LOAD NOT SATISFIED = 0.00													
HOURS ANY ZONE ABOVE COOLING THROTTLING RANGE = 11													
HOURS ANY ZONE BELOW HEATING THROTTLING RANGE = 10													
NOTE: ENERGY IS APPORTIONED HOURLY TO ALL END-USE CATEGORIES.													
Project 2 DOE-2.2-48r 4/10/2014 14:24:11 BDL RUN 3													
REPORT- PS-H Loads and Energy Usage for DHW Plant 1 Loop (1) WEATHER FILE- Boston MA TMY2													

# Key SIM file reports

- Warnings and errors: ATTN
- Energy consumption summary: BEPU
- Utility rates: ES-E
- Loads: LV-B, LV-D
- Plant equipment usage: PS-C
- Plant equipment design: PV-A
- System loads: SS-A, SS-B, SS-R
- Airside system design: SV-A



# Example SIM report: PS-C

- Start to ask questions about output:

Report: PS-C Equipment Loads and Energy Use | Component: | Hourly Res

DOE-2.2-48r 4/10/2014 12:03:03 BDL RUN 1

REPORT- PS-C Equipment Loads and Energy Use WEATHER FILE- Boston MA TMY2

MON	SUM	COOL LOAD (MBTU) (KBTU/HR)	HEAT LOAD (MBTU) (KBTU/HR)	ELEC USE (KWH) (KW)	FUEL USE (MBTU) (KBTU/HR)	Number of hours within each PART LOAD range										TOTAL RUN HOURS	
						00	10	20	30	40	50	60	70	80	90		100
	PEAK					10	20	30	40	50	60	70	80	90	100	+	
-----																	
B-1																	
	SUM	-11346.9	8135.9	14191.1	LOAD	0	326	1083	1772	1389	630	888	713	631	531	797	8760
	PEAK	8252.7	2.3	2462.4	ELEC	8760	0	0	0	0	0	0	0	0	0	0	8760
	MON/DAY	1/13	1/13	1/13	FUEL	0	259	1092	1825	1409	636	895	706	623	518	797	8760
B-2																	
	SUM	-525.3	323.2	660.6	LOAD	0	0	0	0	0	24	248	54	17	0	0	343
	PEAK	-1937.2	1.2	2413.8	ELEC	343	0	0	0	0	0	0	0	0	0	0	343
	MON/DAY	12/24	12/24	12/24	FUEL	0	0	0	0	0	4	273	50	16	0	0	343
Chiller 1																	
	SUM	9196.1	0.0	756120.7	LOAD	4482	1035	989	895	848	439	72	0	0	0	0	8760
	PEAK	3057.1	0.0	222.4	ELEC	4273	1215	1077	873	790	371	152	9	0	0	0	8760
	MON/DAY	7/24	0/0	6/3													
HW Pumps																	
	SUM			65386.1	FLOW	0	0	6761	1311	567	106	15	0	0	0	0	8760
	PEAK			10.3	RPM	0	0	0	0	0	0	0	0	0	0	8760	8760
	MON/DAY			12/24	ELEC	0	0	0	0	0	6698	1707	341	14	0	0	8760
CHW Pumps																	
	SUM			73054.6	FLOW	0	5670	847	614	700	916	13	0	0	0	0	8760
	PEAK			16.6	RPM	0	0	0	0	0	0	0	8201	559	0	0	8760
	MON/DAY			7/24	ELEC	0	0	6501	1011	1183	65	0	0	0	0	0	8760

Annotations in the image:

- Boiler annual efficiency?** (Circled: -11346.9)
- Boiler loading?** (Circled: 14191.1)
- Chiller annual efficiency?** (Circled: 9196.1)
- Chiller run hours?** (Circled: 8760)
- Pump flow?** (Circled: 6761, 1311, 567, 106, 15)
- Pump power?** (Circled: 5670, 847, 614, 700, 916)

# Model checking

- Today's most important topic
- Garbage in garbage out is a real problem in energy modeling
- Surprising results are usually wrong
  
- Always perform a general sanity check on models
- More detailed checks required for important aspects and for energy efficiency measures

# A quick general check

## "10 Minute" DOE2 Output QC Checklist

Report	Check	Comments
BEPU	Percent of hours outside throttling range	Eq. size, control (see SS-R, SS-F, and SS-O)
BEPU	Percent of hours loads not satisfied	Equip sizing, control (see PS-C, and PS-H)
BEPS	Energy use & cost intensity	Btu/sqft/year from BEPS, (\$/sqft/year from ES-D)
BEPU	Energy use by category	Compare relative magnitudes
PS-E	kW and kWh by end-use (annual & monthly)	to check W/sqft, get conditioned area from LS-C
PS-D	Peak loads on loops	compare peak load (PS-D) with equip size (PV-A)
PS-C	Peak load & equipment sizes	compare peak load (PS-C) with equip size (PV-A)
PS-C	Calculate overall equipment efficiencies	Load met / energy used (see SS-P for unitary eq.)
PS-C	Equipment part-load ranges (annual)	for monthly - see PS-H, for unitary equip - see SS-P
PS-C	Total equipment operating hours	for monthly - see PS-H, for unitary equip - see SS-P
PS-A	Monthly pattern of heating and cooling loads	confirm realistic pattern (compare also SS-D & LS-D)
SS-N	Hours at Relative Humidity Levels	check RH levels by time of day
SS-J	System load and size checks	sqft/ton, cfm/sqft, min osa/per, cool/heat pk (Btuh/sf)
* any *	Proper weather file used	reported at top right corner of most reports

- From the makers of eQUEST
- Any checklist should also include ATTN report



# More detailed checking:

- Also from the makers of eQUEST

## "30 Minute" DOE2 Output QC Checklist

Report	Check	Comments
④ LV-A	Proper weather file used	also reported at top right corner of most reports
LV-B	Lighting density in each space	0.6 - 2.5 W/sf, confirm no lights in plenums
LV-C	Average space height for each space	DOE2 bases this on volume/area
LV-D	Total (opaque + glass) wall area by orientation	approx equal areas for opposite orientations
LS-B	Peak space load per sqft for each space	perimeter: $\sim 25 \text{ Btu/sf} \cdot \text{win}/\text{flr ratio} \cdot \text{SC} + \text{Internal}$
LS-C	Peak space load per sqft (building total)	$\% \text{ core} \cdot \text{core Btu/sf} + \% \text{ perim} \cdot \text{perim Btu/sf}$
LS-C	Outdoor temperatures coincident with peak	these are used in outdoor air design load calcs.
LS-C	Building net area (modeled area)	compare to known gross building area
LS-D	Peak lighting + plug load density	compare to inputs for lights & plugs (see also PS-F)
④ LS-D	Monthly pattern of heating and cooling loads	confirm realistic pattern (see also SS-D & PS-A)
SV-A	Amount of outside air (if not scheduled)	check or reasonable values
SV-A	Sensible heat ratio	check or reasonable values
SS-D	Peak cooling load, square feet per ton	compare with PS-D and/or PS-C (if built-up equip)
④ SS-D	Monthly pattern of heating and cooling loads	confirm realistic pattern (see also LS-D & PS-A)
SS-E	Cooling/heating/simultaneous hrs & availability	ensure realistic hours (check for too much simultaneous)
SS-A	For unitary DX, monthly pattern of loads	unitary loads are not totaled in SS-D
④ SS-P	Average EER for unitary DX	cooling load / (compressor+fán kWh)
④ SS-J	System load and size checks	sqft/ton, cfm/sqft, min osa/per, cool/heat pk (Btu/sf)
④ SS-K	Avg temperature, cooling and heating hours	Compare to t-stat set points (includes unconditioned!)
④ SS-O	Hours under cooled/heated by time-of-day	Compare to t-stat set points & throttling range
④ SS-F	Hours under cooled/heated by zone	Excessive hours indicate faulty control
④ SS-R	Hours under cooled/heated by system	Excessive hours indicate faulty control
SS-N	Hours at relative humidity levels	check RH levels by time of day
PV-A	Equipment sizes	compare with peak loads on PS-C and PS-D
④ PS-A	Monthly pattern of heating and cooling loads	confirm realistic pattern (compare SS-D & LS-D)
④ PS-C	Calculate overall equipment efficiencies	Load met / energy used (see SS-P for unitary eq.)
④ PS-C	Equipment part-load ranges (annual)	for monthly - see PS-H, for unitary equip - see SS-P
④ PS-C	Total equipment operating hours	for monthly - see PS-H, for unitary equip - see SS-P
④ PS-E	kW and kWh by end-use (annual & monthly)	to check W/sqft, get conditioned area from LS-C
④ PS-H	Average operating ratios	Equip sizing & load management check
PS-H	Peak load & equipment sizes	peak load & equipment size, 300 to 700 sqft/ton
④ BEPU	Percent of hours outside throttling range	Eq. size, control, schedules (see SS-R, SS-F, SS-O)
① *	Percent of hours loads not satisfied	Equip sizing, control & schedules (see PS-C, PS-H)
④ BEPU	Energy use by category	Compare relative magnitudes
④ *	Energy use & cost intensity	Btu/sqft/year from BEPU, (\$/sqft/year from ES-D)

④ primary check item

④ secondary check item (related to a primary check)



# Model checking example: high-efficiency lighting measure

- ECM: Lighting power density reduction
  - Code baseline 1.2 W/sf
  - Proposed case 0.8 W/sf
  - i.e. 33% reduction in LPD
- Modeled using parametric run
- Check either via graphical or SIM reports

# High efficiency lighting check (2)

- Check electric end use savings:

Annual Electric Energy by Enduse (pg 1 of 4)

		Ambient Lghts	Task Lghts	Misc Enuin	Space Heating	Space Cooling	Heat Reiert	Pumps & Aux	Vent Fans	Dom Ht Wtr
<b>Annual Energy USE (kWh)</b>										
0	Base Design	286,359	0	224,320	2,731	224,149	0	105,613	199,650	0
1	0+High-eff lighting	190,906	0	224,320	2,933	218,374	0	105,487	197,981	0
<b>Incremental SAVINGS (MWh)</b>		(values are relative to previous measure (% savings are relative to base case use), negative entries indicate increased use)								
1	0+High-eff lighting	95.45 (33%)	--	0.00 (0%)	-0.20 (-7%)	5.77 (3%)	--	0.13 (0%)	1.67 (1%)	--

Lighting savings should be 33%

Cooling and fan savings usually positive

- Check gas end use savings:

		Misc Enuin	Space Heating	Space Cooling	Heat Reiert	Pumps & Aux	Vent Fans	Ht Pump Sunn	Dom Ht Wtr	Ex L
<b>Annual Energy USE (MBtu)</b>										
0	Base Design	0.0	3,573.6	0.0	0.0	0.0	0.0	0.0	0.0	
1	0+High-eff lighting	0.0	3,853.0	0.0	0.0	0.0	0.0	0.0	0.0	
<b>Incremental SAVINGS (MBtu)</b>		(values are relative to previous measure (% savings are relative to base case use), negative entries indicate increased use)								
1	0+High-eff lighting	--	-279.43 (-8%)	--	--	--	--	--	--	--

Usually heating penalty

# Checking example 2: reduced VAV box minimum setpoints

- Changed minimum flow ratio from 50% to 20%
- Best checked using SIM files:

Base case:

REPORT- SS-R Zone Performance Summary for AC-2 WEATHER FILE- Boston MA TMY2

ZONE	ZONE OF MAXIMUM HTG DMND (HOURS)	ZONE OF MAXIMUM CLG DMND (HOURS)	ZONE UNDER HEATED (HOURS)	ZONE UNDER COOLED (HOURS)	Number of hours within each PART LOAD range										TOTAL RUN HOURS		
					00	10	20	30	40	50	60	70	80	90		100	
					10	20	30	40	50	60	70	80	90	100		+	
lab 1 Zn		0	0	0	2	0	0	0	0	0	1873	2473	1518	1536	1353	2	8760
lab 2 Zn		0	0	0	0	0	0	0	0	0	8756	0	0	0	0	0	8760
lab 3 Zn		0	0	0	0	0	0	0	0	0	8274	311	140	15	0	0	8760
lab 4 Zn		0	0	0	0	0	0	0	0	0	8709	51	0	0	0	0	8760
TOTAL		0	0	0	2												

Proposed case:

REPORT- SS-R Zone Performance Summary for AC-2 WEATHER FILE- Boston MA TMY2

ZONE	ZONE OF MAXIMUM HTG DMND (HOURS)	ZONE OF MAXIMUM CLG DMND (HOURS)	ZONE UNDER HEATED (HOURS)	ZONE UNDER COOLED (HOURS)	Number of hours within each PART LOAD range										TOTAL RUN HOURS				
					00	10	20	30	40	50	60	70	80	90		100			
					10	20	30	40	50	60	70	80	90	100		+			
lab 1 Zn		0	0	0	16	0	0	0	0	0	89	838	2131	1772	1365	1386	1226	3	8760
lab 2 Zn		0	0	0	0	0	0	7904	547	228	31	0	0	0	0	0	0	8760	
lab 3 Zn		0	0	0	0	0	0	6338	1260	617	317	175	47	6	0	0	0	8760	
lab 4 Zn		0	0	0	0	0	0	0	0	0	8708	52	0	0	0	0	0	8760	
TOTAL		0	0	0	16														

Why?

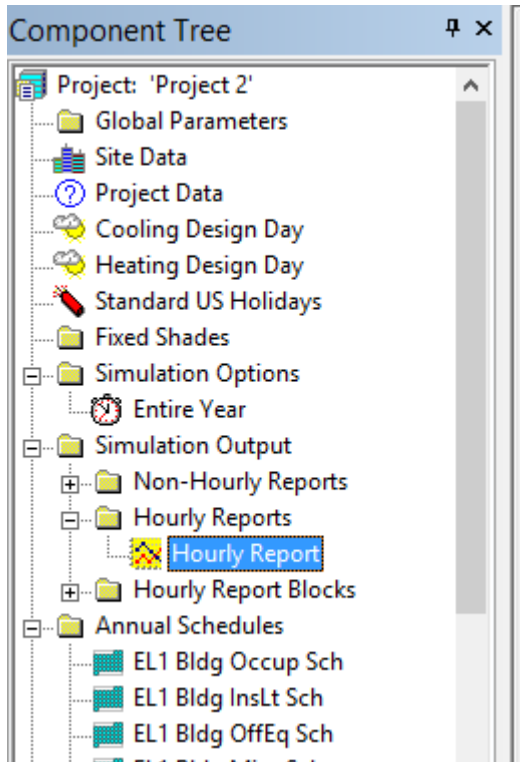
# Diagnosing some common problems

- Excessive hours outside throttling range
  - Check SS-R reports for problem zones
  - Check reheat and or baseboard heat assigned
  - Check zone cfm
- Pumps & Aux usage too high
  - Check PV-A report for pump sizing
  - Check PS-C report for pump operating hours and part load operation
    - Change loop controls
    - Change pump speed control
- Excessive winter cooling or summer heating
  - Check to see if airside economizer is set up
  - Check minimum flow ratio for VAV system
  - Check space thermostat schedules
- Excessive cooling or heating energy use
  - Check on weather file
  - Check PS-C for average equipment performance
    - Resize equipment
    - Change loop controls
    - Overwrite default equipment performance

# Hourly reports

- Output hourly values of almost any data point used or calculated by eQUEST
- View and analyze in Excel
- Useful for:
  - Detailed model checking, especially non-standard systems
  - Checking peak demand reductions
  - Detailed calibration (e.g. to electric interval data)

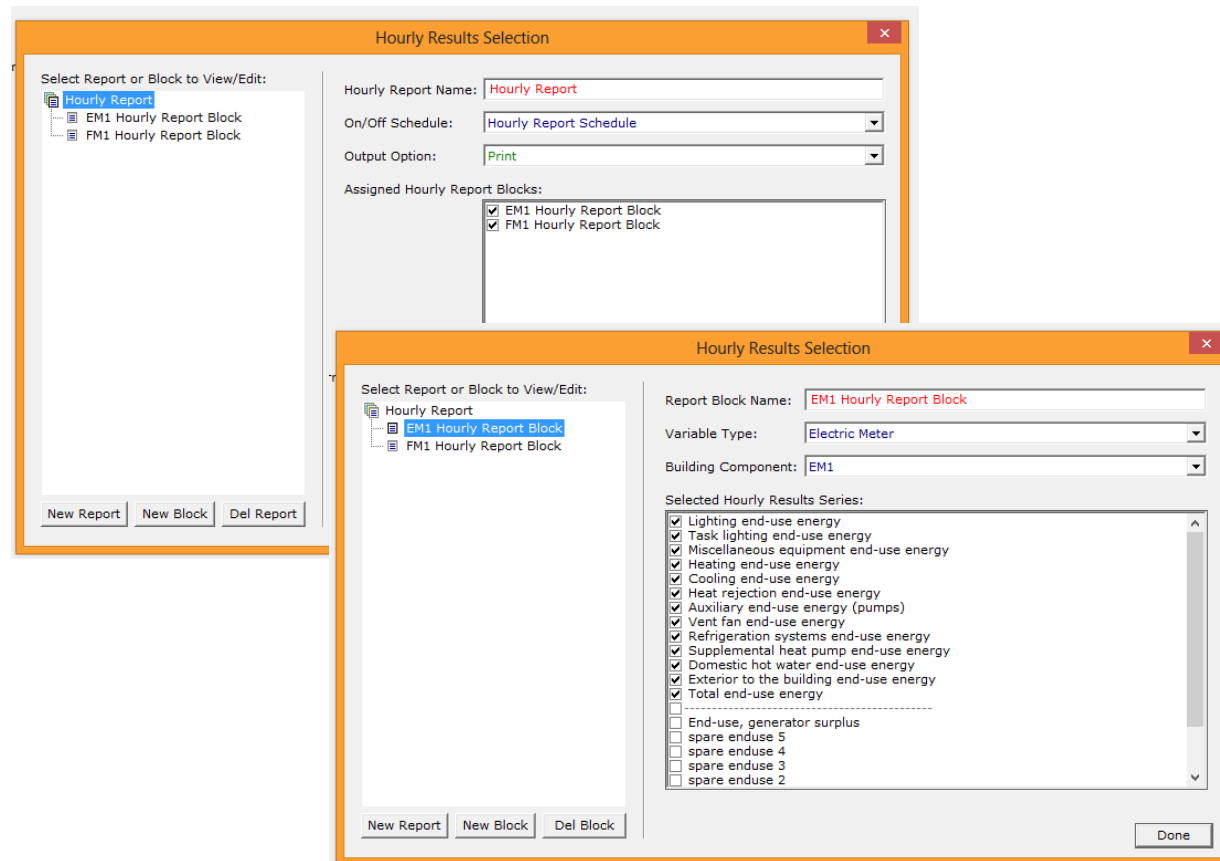
# Setting up hourly reports



- Hourly reports accessed from Project & Site tab
- DD wizard creates default hourly report of hourly electric and gas end use consumption
- Easy to create others
  - Hundreds of options

# Setting up hourly reports (2)

- “Report blocks” must be assigned to each hourly report
- For each block, select points of interest from list



# Accessing hourly report data

- Best way is via SIM file:

Button opens hourly reports in Excel

The screenshot shows the D2SimViewer software interface. The title bar reads "Project 2 - Baseline Design - D2SimViewer". The menu bar includes "File", "Edit", "View", "Window", and "Help". Below the menu bar is a toolbar with icons for file operations and a search function. The main window displays a report titled "REPORT- BEPU Building Utility Performance". The report header includes "Project 2", "DOE-2.2-48r", "4/10/2014", "12:12:32", "BDL RUN 3", and "WEATHER FILE- CZ06RV2 WYEC2". The report content is a table with columns for various energy categories and a total column. The table data is as follows:

	LIGHTS	TASK LIGHTS	MISC EQUIP	SPACE HEATING	SPACE COOLING	HEAT REJECT	PUMPS & AUX	VENT FANS	REFRIG DISPLAY	HT PUMP SUPPLEM	DOMEST HOT WTR	EXT USAGE	TOTAL
EM1 ELECTRICITY													
KWH	90465.	0.	46271.	0.	21158.	0.	320.	21178.	0.	0.	0.	0.	179392.
EM1 NATURAL-GAS													
THERM	0.	0.	0.	9.	0.	0.	0.	0.	0.	0.	298.	0.	307.

Summary statistics at the bottom of the report:

- TOTAL ELECTRICITY 179392. KWH
- TOTAL NATURAL-GAS 307. THERM
- 7.176 KWH /SQFT-YR GROSS-AREA
- 0.012 THERM /SQFT-YR GROSS-AREA
- 7.176 KWH /SQFT-YR NET-AREA
- 0.012 THERM /SQFT-YR NET-AREA

Operational metrics:

- PERCENT OF HOURS ANY SYSTEM ZONE OUTSIDE OF THROTTLING RANGE = 0.04
- PERCENT OF HOURS ANY PLANT LOAD NOT SATISFIED = 0.00
- HOURS ANY ZONE ABOVE COOLING THROTTLING RANGE = 1
- HOURS ANY ZONE BELOW HEATING THROTTLING RANGE = 0

NOTE: ENERGY IS APPORTIONED HOURLY TO ALL END-USE CATEGORIES.

The bottom of the report shows "Project 2", "DOE-2.2-48r", "4/10/2014", "12:12:32", "BDL RUN 3", and "WEATHER FILE- CZ06RV2 WYEC2". The status bar at the bottom left says "Ready" and the bottom right says "Page 454 of 1563". A green circle highlights the "Hourly Results" button in the top right corner of the report window.





# User expressions

- Useful for adding comments or references
- Can refer to other components from within model (e.g. area of space, global parameters)
- BDL expressions based on Fortran 77 (e.g. \*\* means ^)

The image shows a software interface with a context menu, a data table, and a dialog box. The context menu is open over a table with the following data:

Area/Person:	Value	Unit
	100	ft2
	14	
	450	Btu/h-person
	251	Btu/h-person
	230	Btu/h-person

The dialog box, titled "User Input Expression", is open and shows the following text in the input field:

```
1+3+21 $ people from 3 spaces
```

The text "1+3+21" is highlighted in blue, and "\$ people from 3 spaces" is highlighted in magenta. The dialog box also has buttons for "Install Expression From User Default", "Install Expression From DOE-2 Default", "OK", and "Cancel".

1. Right click on box

2. Enter expression

3. Magenta text indicates success

# The meaning of colors

- Green: eQUEST default
- Red: user value
- Magenta: user expression
- Blue: user default

	Zone Name	Parent System	Flow/Area (cfm/ft2)	Assigned Flow (cfm)	Air Changes / hour	Min Flow Ratio (ratio)	Min F (cf)
1	L1 clean rooms Zn	AC-1	0.50			0.90	
2	L2 core CPR charging Zn	AC-1	0.50			0.90	
3	L1 core dispensing Zn	AC-1	0.50			0.90	
4	L1 N kilo lab Zn	AC-2	0.50	2,013.59	n/a	0.33	
5	L1 W kilo labs Zn	AC-2	0.50	20,830.03	n/a	0.33	
6	L2 N future kilo lab Zn	AC-2	0.50	1,876.34	n/a	0.33	
7	L2 W kilo labs Zn	AC-2	0.50	8,241.60	n/a	0.33	
8	L1 S office/corridor Zn	AC-3	0.50	820.00	n/a	0.94	
9	L1 N elec/stairs Zn	AC-3	0.50	1,100.00	n/a	0.36	
10	L1 N solvents Zn	AC-3	0.50	1,511.79	n/a	0.50	
11	L1 core warehouse Zn	AC-3	0.50	400.00	n/a	0.50	
12	L1 core office/restrooms	AC-3	0.50	2,000.00	n/a	0.85	
13	L2 W training Zn	AC-3	0.50	2,000.00	n/a	0.20	
14	L2 S open offices Zn	AC-3	0.50	6,490.00	n/a	0.28	
15	L2 core offices Zn	AC-3	0.50	370.00	n/a	0.54	
16	L2 E utilities Zn	AC-3	0.50	2,000.00	n/a	0.50	
17	L2 N elec/stairs Zn	AC-3	0.50	2,245.00	n/a	0.33	
18	L2 core labs Zn	AC-3	0.50	5,499.00	n/a	0.50	
19	L2 W RSL labs Zn	AC-3	0.50	6,038.28	n/a	0.50	
20	L2 core corr Zn	AC-3	0.50	600.00	n/a	1.00	

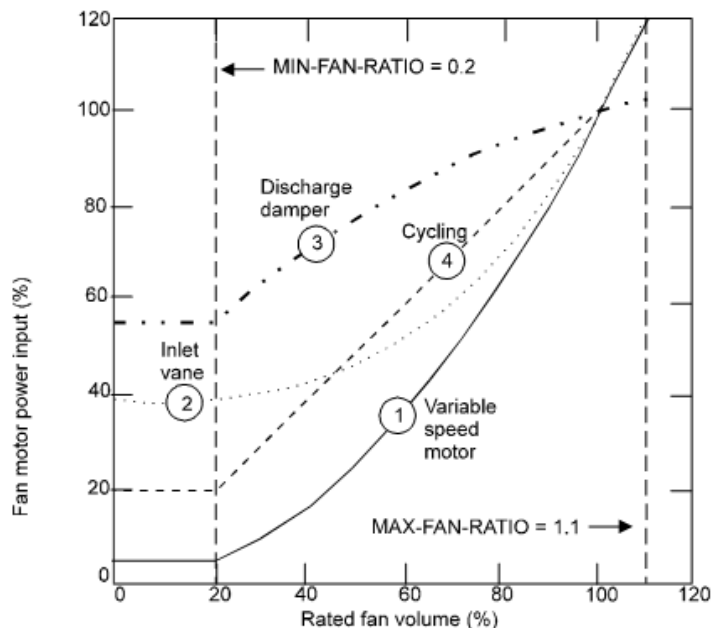


# Custom curves

- Go beyond eQUEST's default assumptions about equipment performance
- Most common reasons to do this:
  - Chiller performance curves (savings associated with a particular model of chiller; performance data obtained from vendor)
  - Fan curves (e.g. to model static pressure reset controls or Appendix G fan curve)
- Raw data or curve coefficient input
- eQUEST derives curve coefficients from raw data inputs

# Custom curve example: Fan curves

- eQUEST has a number of built-in fan control options:



The screenshot shows the 'Air-Side HVAC System Parameters' window. The 'Fan Control' dropdown menu is open, displaying the following options:

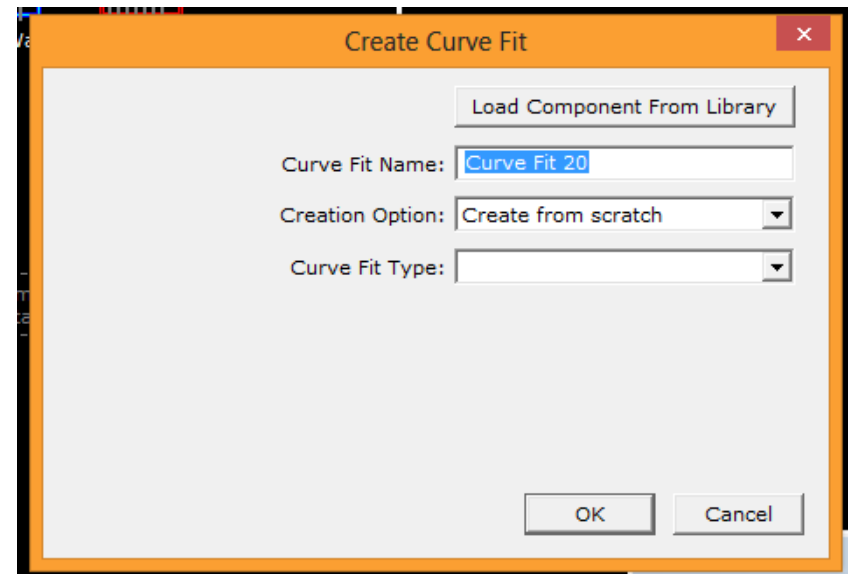
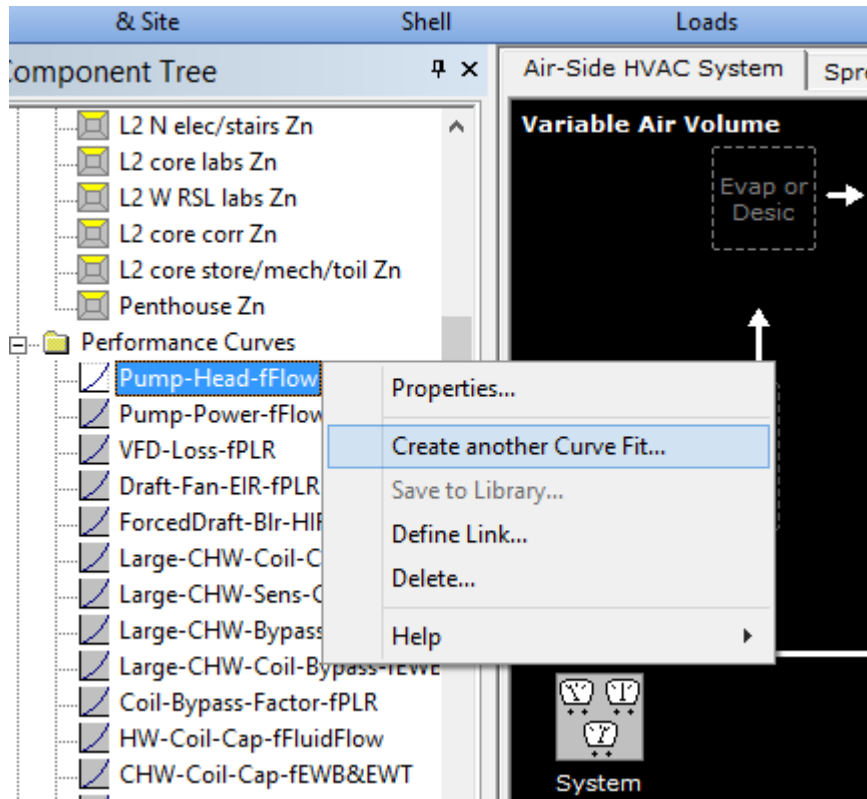
- Variable Speed
- undefined -
- Variable Speed
- Inlet
- Discharge
- Cycling
- Two Speed
- Constant Volume
- Fan EIR FPLR
- Default Fan Control

A red arrow points from the 'Variable Speed' option in the dropdown to the 'Fan Control' dropdown in the main interface.

- Each option corresponds to a fan performance curve: %kW(% volume)

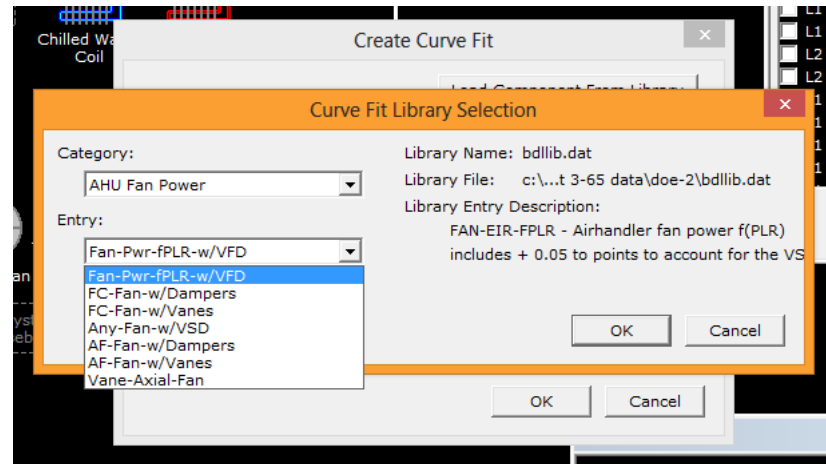
# Fan curves (2)

- Alternatively, a custom fan curve can be defined

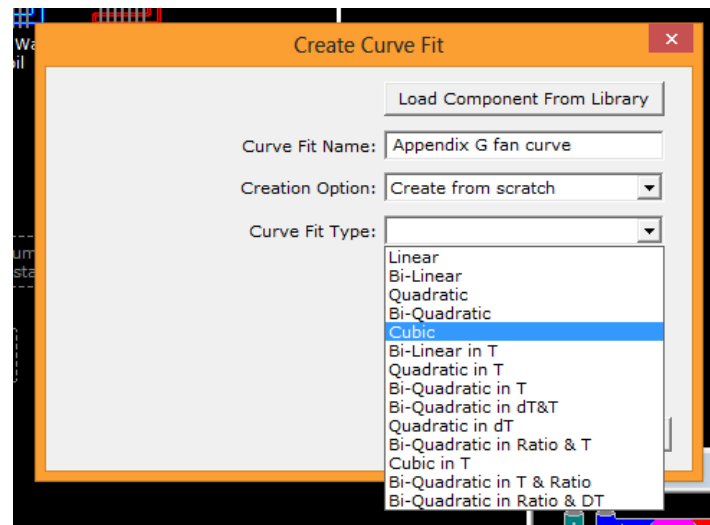


# Fan curves (3)

- Library curves:
  - Some additional curves available here



- Or custom curve:
  - Start from scratch





# Fan curves (4)

- Appendix G VAV fan power curve  
( $x = \% \text{ airflow}$ )
- $\%kW(x) = 0.0013 + 0.147 x + 0.9506 x^2 - 0.0998 x^3$
- Choose “curve coefficients” and “cubic” input
- Choose “Fan EIR FPLR” for Fan Control and select new curve

Required Curve Fit Data for 'Appendix G fan curve'

Coefficient 1:	0.01300000
Coefficient 2:	0.14700000
Coefficient 3:	0.95060003
Coefficient 4:	-0.0998

Done Cancel

Fan Control and Placement

Fan Schedules	Fan Control	Fan Placement
Cooling: On all time Fan Sch	Fan EIR FPLR	Draw Through
Unused: n/a	n/a	n/a
Return: - undefined -	Variable Speed	Common
Exhaust: - undefined -		

Required HVAC System Data for 'AC-1'

Cooling Fan EIR f(PLR):

- library -
- Large-CHW-Bypass-fAirFlow
- Coil-Bypass-Factor-fPLR
- HW-Coil-Cap-fFluidFlow
- CHW-Coil-Cap-fAirFlow
- CHW-Coil-Cap-fFluidFlow
- Pump-Head-fFlow
- HW-Coil-Cap-fAirFlow
- Pump-Power-fFlow
- Draft-Fan-EIR-fPLR
- VFD-Loss-fPLR
- ForcedDraft-Blr-HIR-fPLR
- Appendix G fan curve

# Advanced modeling topics

- A few examples of features accessible only via detailed mode
- As time permits:
  - Exhaust air heat recovery
  - Cogen systems
  - Equipment controls and load management
  - Infiltration

# Exhaust air heat recovery

Air-Side HVAC System | Spreadsheet | Summary

**Variable Air Volume**

Evap or Desic → Pre Heat → Chilled Water Coil → Heating Coil → Supply Fan → Other Zones

Heat Recovery Economizer → Outside Air → Humidistat → Return

System

Hide Zone Assignments  
Hide Zone Features  
Hide Zone Locations

Air-Side HVAC System Parameters

Currently Active System: Sys1 (VAVS) (G) System Type: Variable Air Volume

Basics | Fans | Outdoor Air | Cooling | Heating | Preconditioner | Meters | Refrigeration

Outside Air and Economizer | Heat Recovery 1 | Heat Recovery 2 | Natural Ventilation

**Basic Specifications**

ERV Device Installed: Yes  
ERV Device Type: Enthalpy Wheel  
Design Outdoor Airflow: cfm  
Design Exhaust Airflow: cfm  
OSA Increase for Purge: n/a ratio

**HX Performance**

HX Configuration: Counter Flow

	Sensible	Latent	
Effectiveness:	0.7000	0.7000	ratio
HX Air Film Resist:	0.7000	0.7000	ratio
Air Film Resist Exp:	0.5000	0.4000	ratio

**Control Sequences**

Operation: When Fans On  
Schedule: n/a  
Operating Mode: n/a  
Make-up Air Temp Ctrl: Mixed Air Reset  
Capacity Control: Modulate HX  
Outsd / Exhst Air Delta T: n/a °F (delta)  
Outsd / Exhst Air Delta Enth: n/a Btu/lb  
Make-up Air Heat/Cool Setpt: n/a n/a °F

# Electric generators

Internal Loads | Water-Side HVAC | Air-Side HVAC | **Utility & Economics**

Spreadsheet | Summary |

Display Mode: Basic Specifications

	Electric Generator Name	Generator Type	Fuel Meter	Electric Meter	Surplus Meter	# of Inverters	Capacity (kW)	Minimum Ratio	Maximum Ratio	Start-up Time (h)	Mechanical Eff. (ratio)	Heat Input Ratio	Elec Input Ratio	Auxiliary Power (kW)	Auxiliary Schedule	Auxiliary Mode	Auxiliary Meter
1	Electric Generator 1	Engine Generator	FM1	EM1	- undefined -	n/a	250,000	0.10	1.05	0.08	n/a	2.86	n/a	n/a	n/a	n/a	n/a

**Electric Generator Properties**

Currently Active Electric Generator: **Electric Generator 1** Type: Engine Generator

Basic Specifications | Performance Curves | Loop Attachments | PV Array | Miscellaneous

Electric Generator Name: **Electric Generator 1**  
 Type: **Engine Generator**

Meter Assignments

Fuel Meter: **FM1**  
 Electric Meter: **EM1**  
 Surplus Meter: **- undefined -**

Equipment Capacity

Capacity: **250.0 kW**  
 Minimum Ratio: **0.10 ratio**  
 Maximum Ratio: **1.05 ratio**

Equipment Efficiency

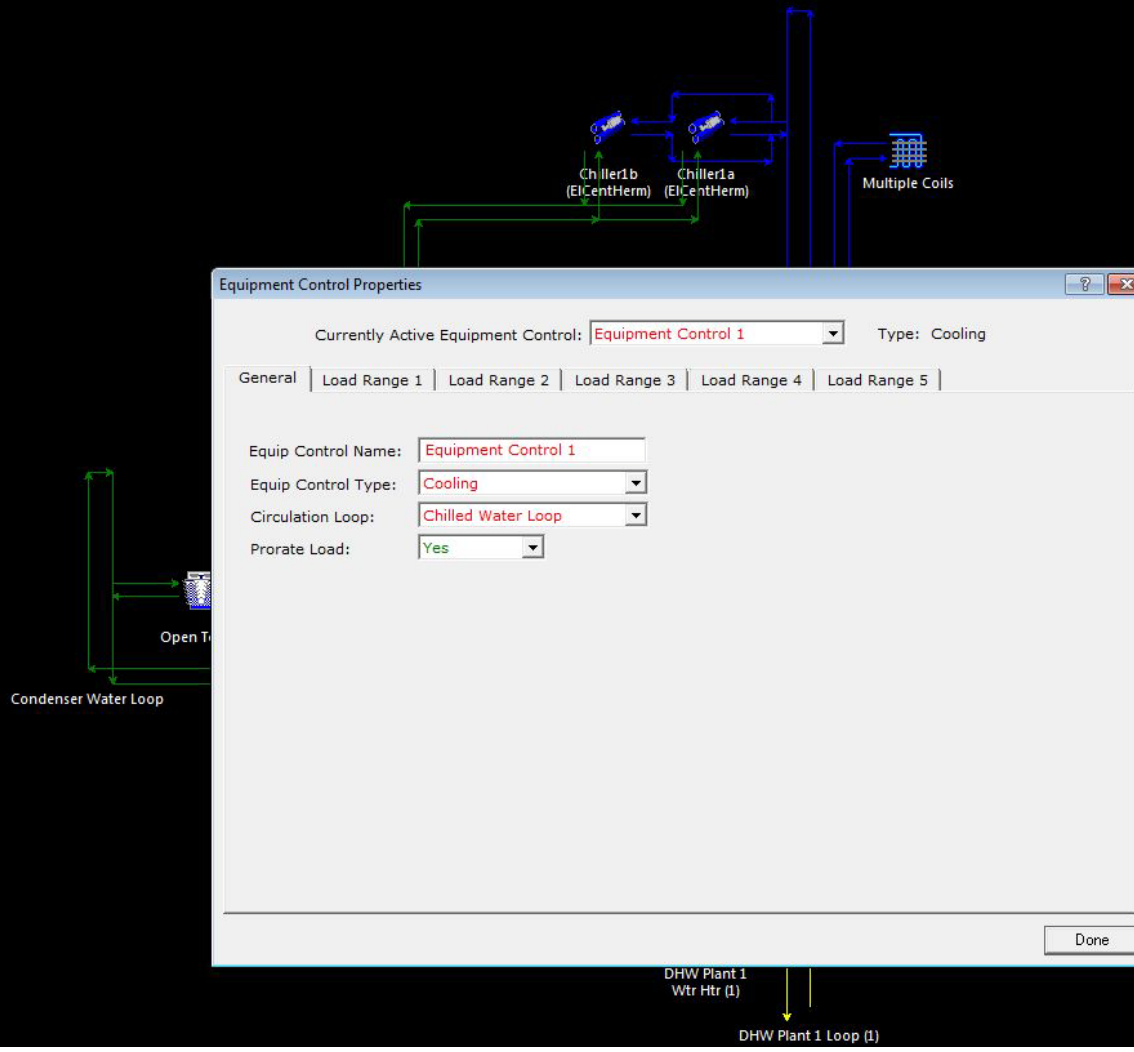
Mechanical Efficiency: **n/a ratio**  
 Heat Input Ratio: **2.86 ratio**

Availability

Start-up Time: **0.08 h**

Done

# Equipment controls



# Equipment controls (2)

Currently Active Equipment Control: **Equipment Control 1** Type: Cooling

General | Load Range 1 | Load Range 2 | Load Range 3 | Load Range 4 | Load Range 5

Loads Through:  MBtu/h

	Chiller Name	Seq	Max Load
1	Chiller1a (ElCentHerm)	1	999.00
2	Chiller1b (ElCentHerm)	1	999.00
3	- undefined -	3	999.00
4	- undefined -	4	999.00
5	- undefined -	5	999.00
6	- undefined -	6	999.00
7	- undefined -	7	999.00
8	- undefined -	8	999.00
9	- undefined -	9	999.00
10	- undefined -	10	999.00

Storage Sequence:  Max Load:  MBtu/h

Meter Sequence:  Max Load:  MBtu/h

[Examine Load Management](#)

[Done](#)

# Load management controls

The screenshot displays a software interface for managing HVAC systems. In the background, a schematic shows two chillers, Chiller1a and Chiller1b, connected to a Multiple Coils unit. The foreground features two dialog boxes:

**Equipment Control Properties**

Currently Active Equipment Control: **Equipment Control 1**

General | Load Range 1 | Load Range 2 | Load Range 3

Loads Through: **10.0** MBtu/h

	Chiller Name	Seq	Max Load
1	Chiller1a (ElCentHerm)	1	999.00
2	Chiller1b (ElCentHerm)	1	999.00
3	- undefined -	3	999.00
4	- undefined -	4	999.00
5	- undefined -	5	999.00
6	- undefined -	6	999.00
7	- undefined -	7	999.00
8	- undefined -	8	999.00
9	- undefined -	9	999.00
10	- undefined -	10	999.00

Storage: Sequence:  Max Load: **999.0** MBtu/h

Meter: Sequence:  Max Load:

**Load Management Properties**

Currently Active Load Management: **Load Management 1** Type: Outside-Air Temperature

General | Managemnt Seq 1 | Managemnt Seq 2 | Managemnt Seq 3 | Managemnt Seq 4 | Managemnt Seq 5

Max OSA Temp: **70.0** °F Loops forced ON or OFF by a schedule flag or maximum temperature condition specified for this Control Range

Priority: **1.0**

Equipment Control Sequences		Loops 'ON'		Loops 'OFF'	
1	Equipment Control 1	1	Chilled Water Loop	1	- undefined -
2	- undefined -	2	- undefined -	2	n/a
3	n/a	3	n/a	3	n/a
4	n/a	4	n/a	4	n/a
5	n/a	5	n/a	5	n/a
6	n/a	6	n/a	6	n/a
7	n/a	7	n/a	7	n/a
8	n/a	8	n/a	8	n/a
9	n/a	9	n/a	9	n/a
10	n/a	10	n/a	10	n/a
11	n/a	11	n/a	11	n/a

Examine Equipment Control

Done

# Infiltration

- Air change method
  - Air change/hr – adjusted for wind speed
  - cfm/sf – not adjusted for wind speed
- Crack method
  - Crack width of each element must be specified
    - Accounts for wind and stack effects
  - Residential
    - Accounts for wind and outdoor/indoor delta T
  - Sherman-Grimsrud
    - Personal favorite for simple buildings
    - Accounts for wind and outdoor/indoor delta T
- Natural ventilation optional for residential systems



# Infiltration (help file)

DOE-2

Locate Previous Next Back Forward Print Options

Contents Index Search

Type in the word(s) to search for:  
superheater

List Topics Display

Select topic: Found: 0

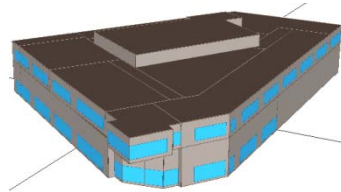
INF-METHOD	Associated SPACE Keywords	Wind Speed Correction? 1	Inside-Outside Temp Difference Correction?
AIR-CHANGE	AIR-CHANGES/HR INF-FLOW/AREA INF-SCHEDULE	AIR-CHANGES/HR - Yes INF-FLOW/AREA - No	No
RESIDENTIAL	RES-INF-COEF INF-SCHEDULE	Yes	Yes
S-G	FRAC-LEAK-AREA HOR-LEAK-FRAC NEUTRAL-LEVEL INF-SCHEDULE	Yes <sup>2</sup>	Yes
CRACK	INF-COEF (for EXTERIOR-WALL, WINDOW and DOOR) INF-SCHEDULE	Yes	No
ASHRAE- ENHANCED	FLOW-COEF STACK-COEF WIND-COEF SHELTER-FACTOR PRESSURE-EXP INF-SCHEDULE	Yes	Yes

<sup>1</sup>Infiltration methods with wind speed correction depend also on the following SITE-PARAMETER keywords, which affect local wind speed: TERRAIN-PAR1, TERRAIN-PAR2, WS-TERRAIN-PAR1, WS-TERRAIN-PAR2 and WS-HEIGHT.

<sup>2</sup>In addition to the above SITE-PARAMETER keywords, SHIELDING-COEF is also used in the S-G method to modify the the local wind speed, but does not modify the wind speed in any of the other infiltration methods.

Search previous results  
 Match similar words  
 Search titles only

# Thanks for listening



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