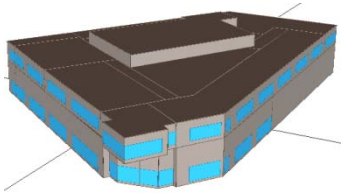
An introduction to eQUEST



For
The Massachusetts Energy Efficiency Partnership

By
Andelman and Lelek Engineering, Inc.

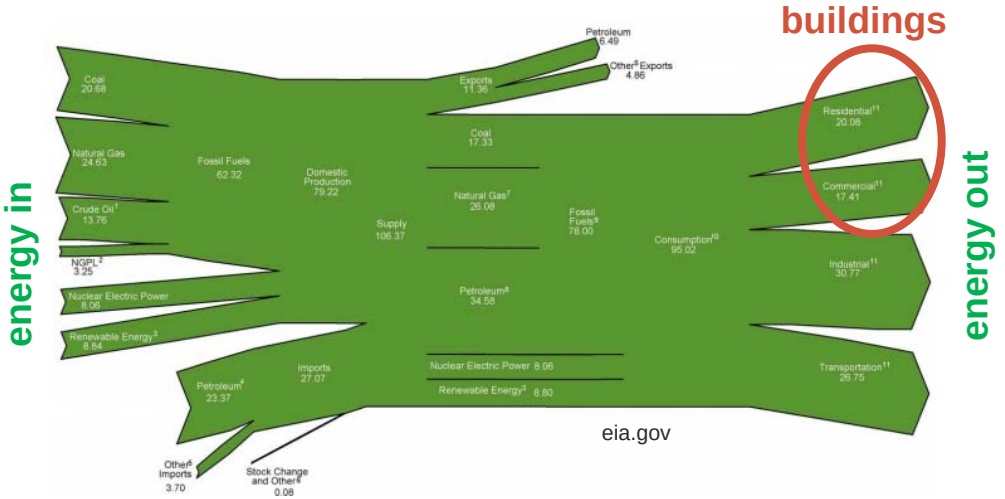
29 April 2014

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_2)
  - 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



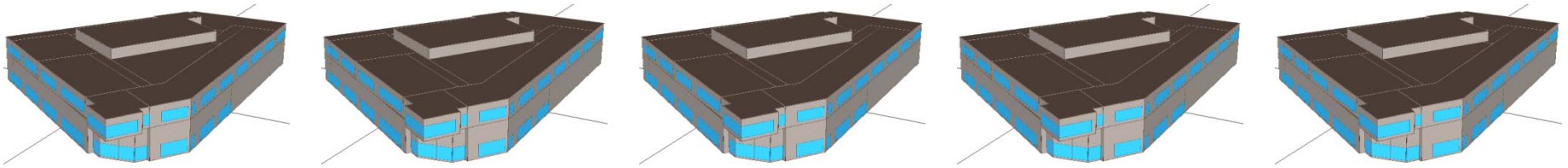
What is building energy modeling?

- 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

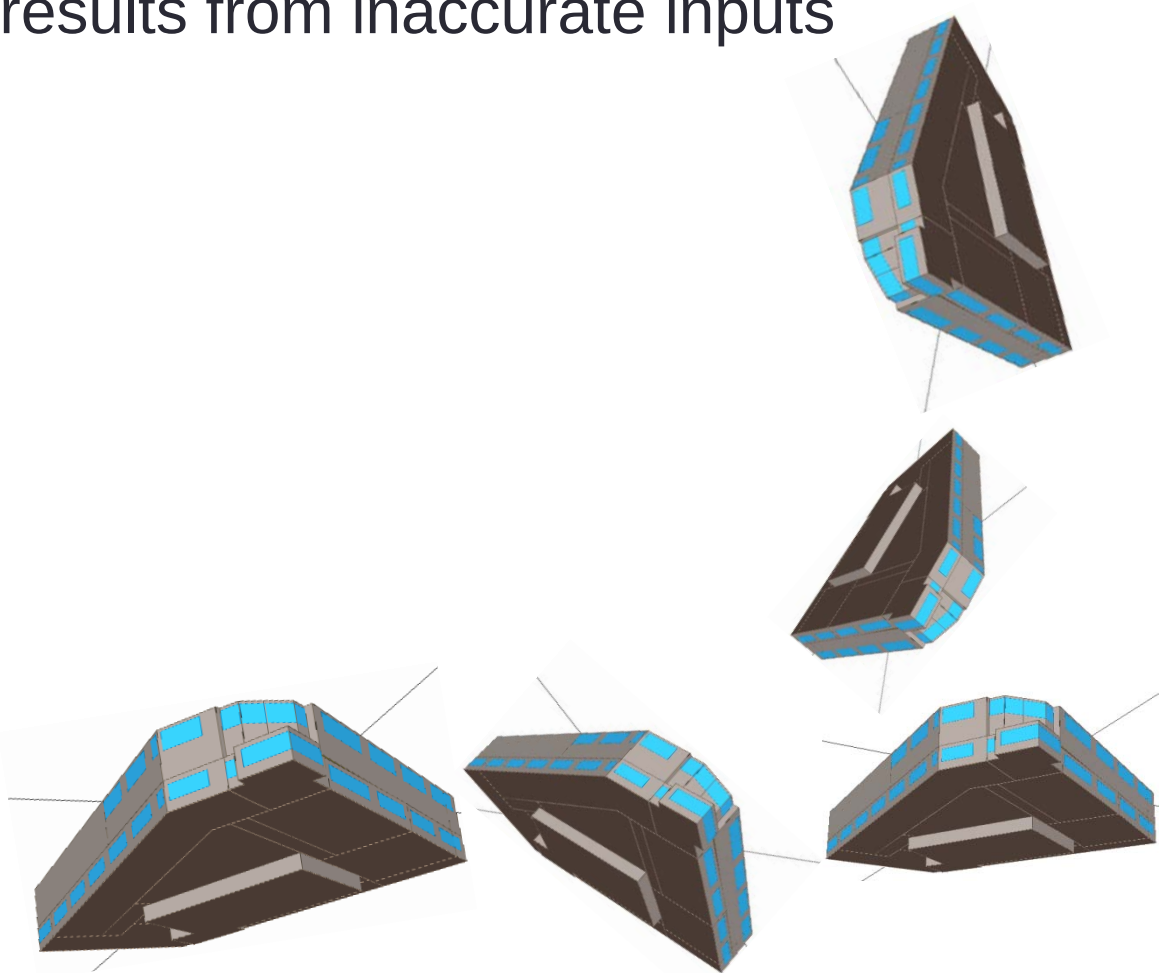
What energy modeling can do

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



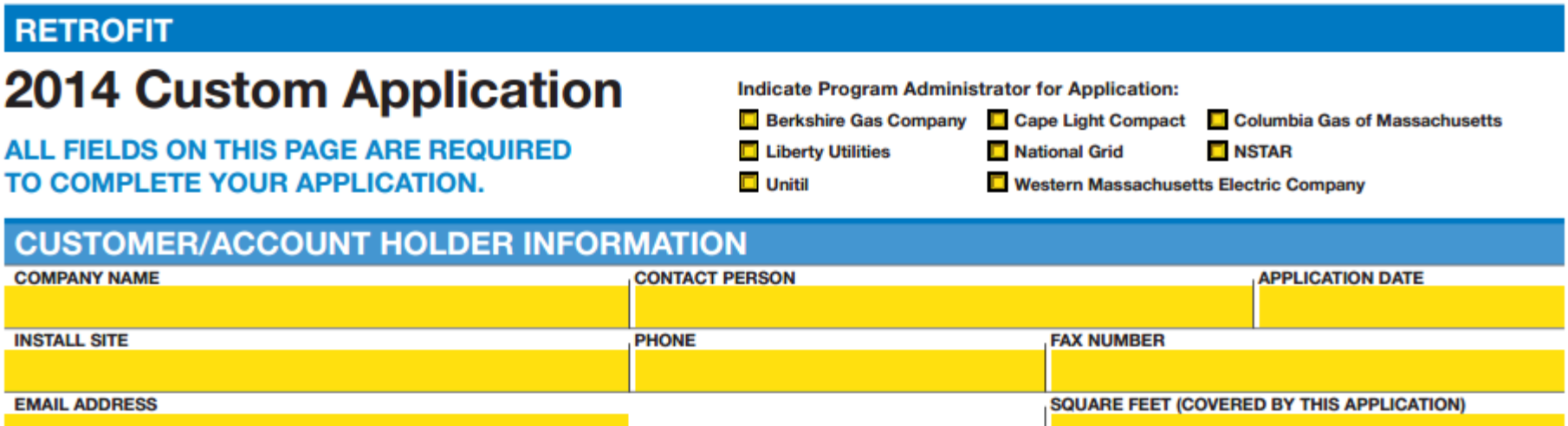
What energy modeling can’t do

- 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:

Berkshire Gas Company | Cape Light Compact | Columbia Gas of Massachusetts
Liberty Utilities | National Grid | NSTAR
Unitil | Western Massachusetts Electric Company

CUSTOMER/ACCOUNT HOLDER INFORMATION

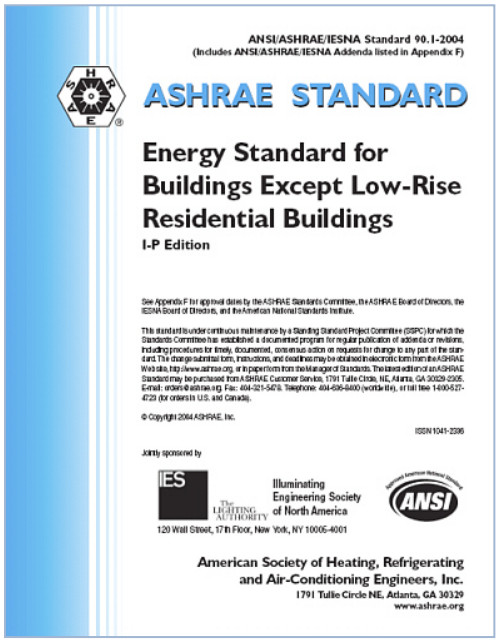
COMPANY NAME | CONTACT PERSON | APPLICATION DATE

INSTALL SITE | PHONE | FAX NUMBER

EMAIL ADDRESS | SQUARE FEET (COVERED BY THIS APPLICATION)

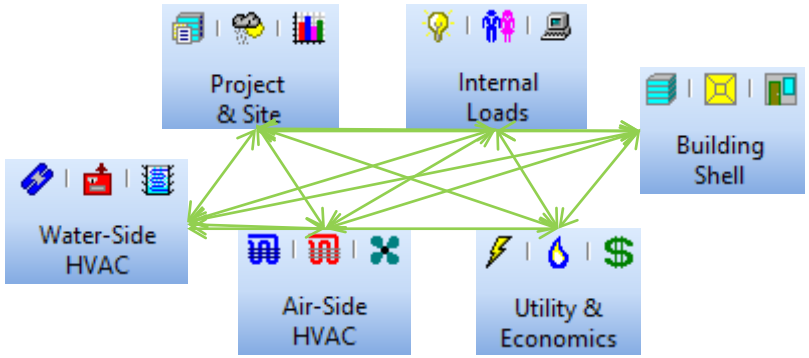
2) Code compliance analysis

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



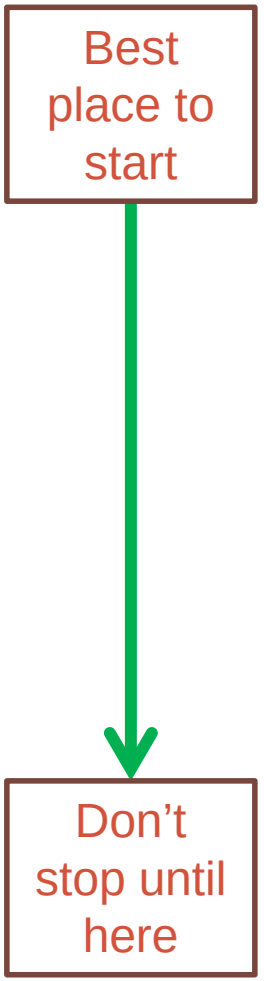
3) Whole building design

- 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



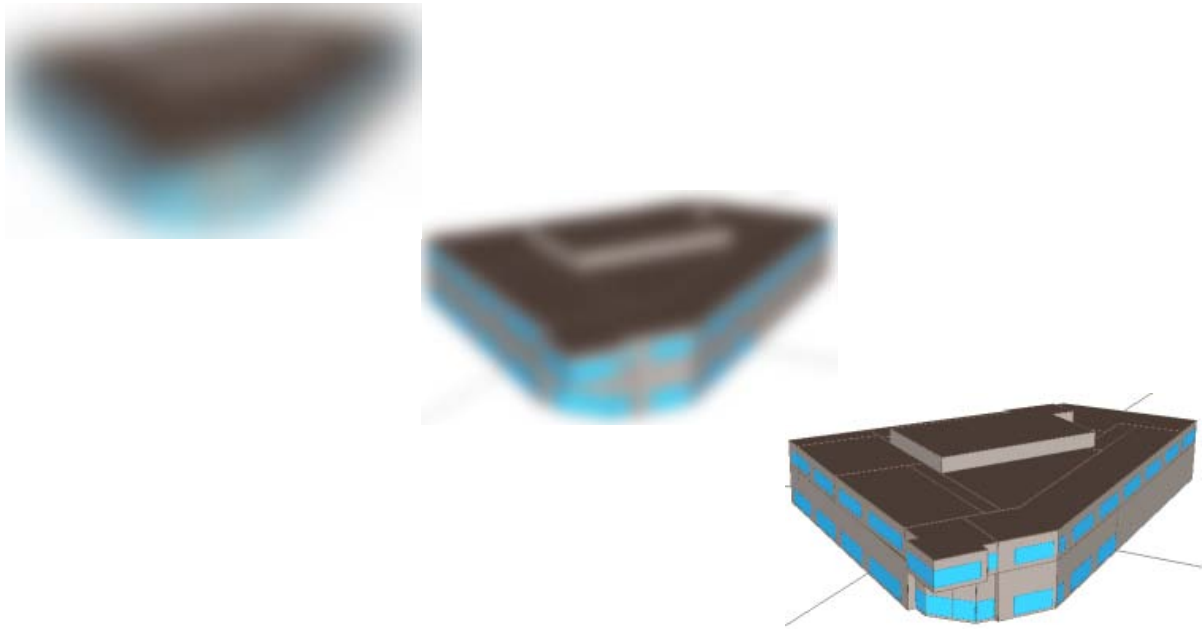
Energy modeling and the design process

- 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



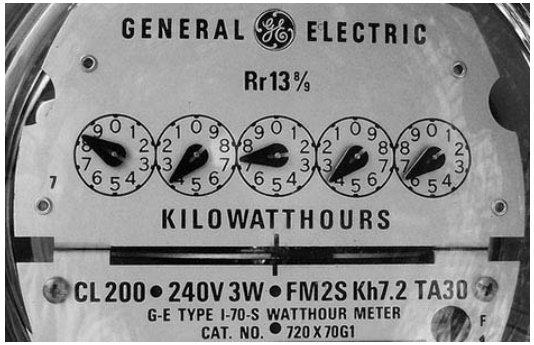
Energy modeling and the design process (2)

- 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

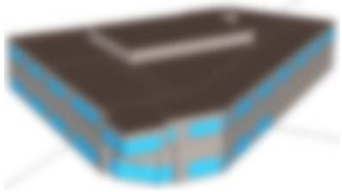


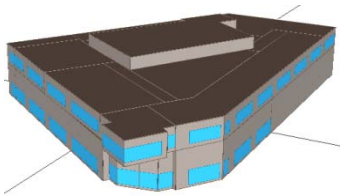
The energy modeling process

- 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

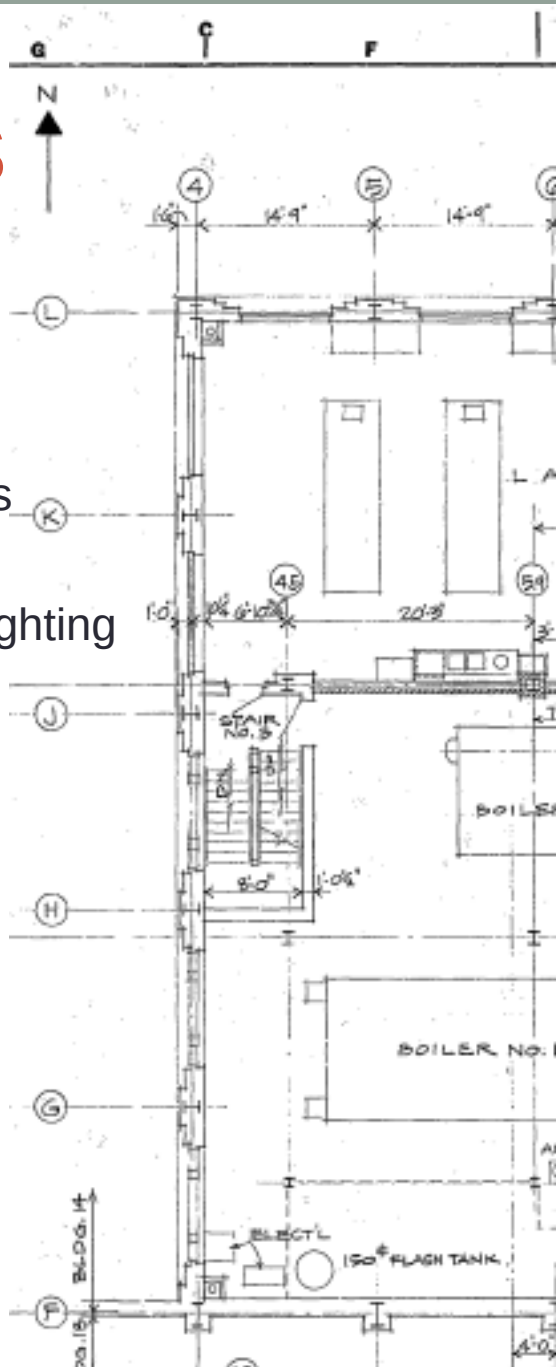
- Prioritize - keep in mind purpose of analysis
- Save detailing for critical elements
- Use custom performance curves only for critical or non-standard equipment





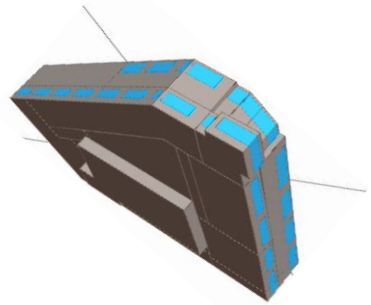
Modeling data requirements

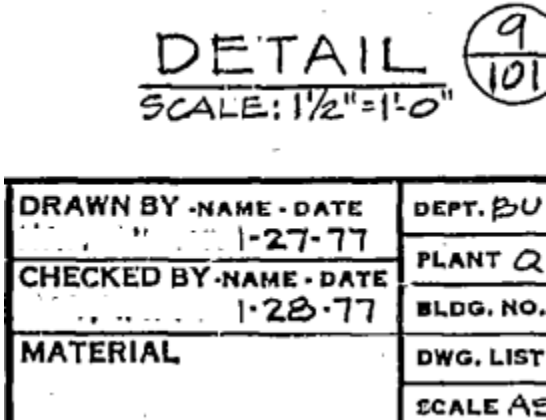
- Architectural
  - Plans, wall sections, building elevations, window specs
- Mechanical
  - HVAC plans, schedules, specifications, control sequences
- Electrical
  - Lighting plans, lighting take-off, occupancy sensors, daylighting
- Internal Loads
  - Peak occupancy, lighting, equipment loads
- Operations
  - 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





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

Table 8 ***HVAC Equipment***	BLAST	BSim	DeST	DOE-2.1E	ECOTECT	Ener-Win	Energy Express	Energy-10	EnergyPlus	eQUEST	ESP-r	HAP	HEED	IDA ICE	IES <VE>	PowerDomus	SUNREL	Tas	TRACE	TRNSYS
Coils											I[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	P	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[163]								X		X			X		X				X
▪ DX coil																				O[158]
o Bypass factor cooling empirical	X								X			X			X[164]					
o Multispeed cooling empirical	X								X						[164]					
o Heating empirical	X								X						[164]					
o Coil frost control									X	X	X	X			[164]				X	
▪ Water-to-air heat pump[165]	X		X	X			P		I	X		X			X			X	X	X

Intro to DOE2.2

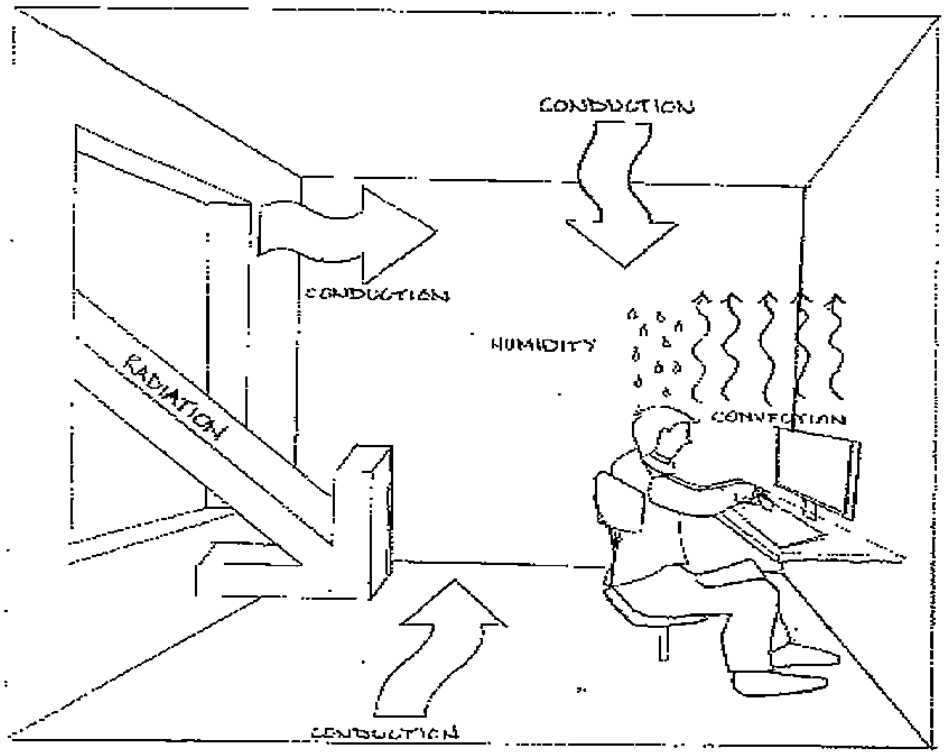
- Building energy simulation engine used by eQUEST
- History
  - Started in the 1970s
  - Continually tested and revised to allow for new developments in industry
- Capabilities
  - Calculates hour-by-hour building energy consumption over an entire year
  - Accounts for hourly schedules, building shell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



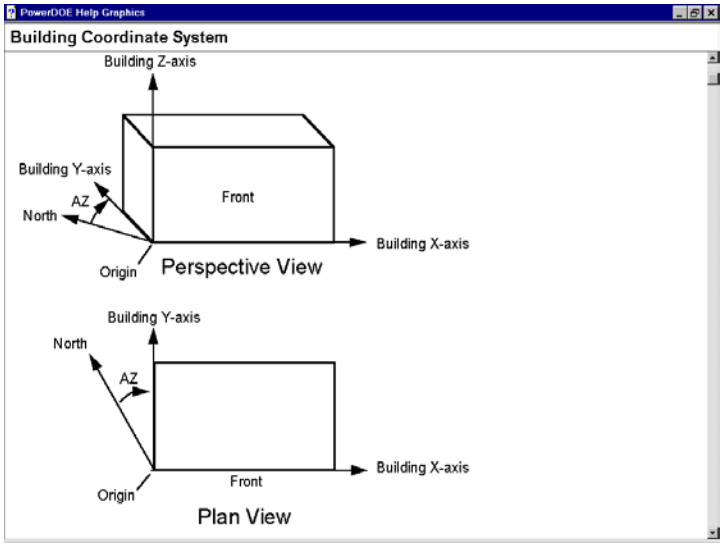
BDL

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

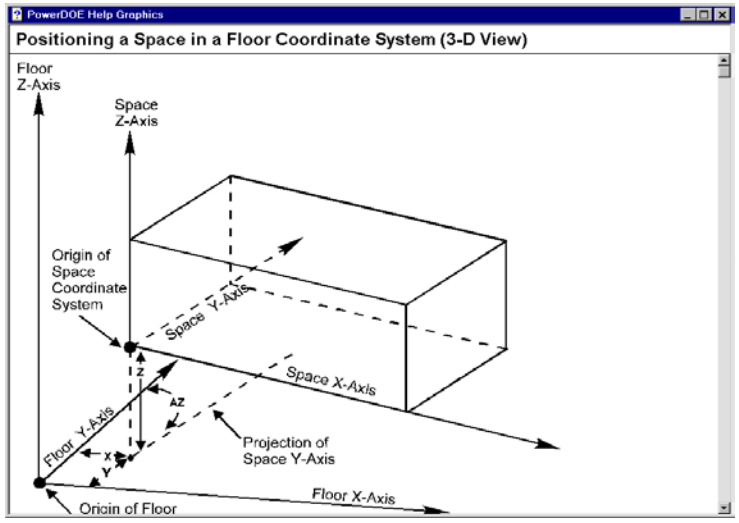
```
SET-DEFAULT FOR SPACE
   PEOPLE-SCHEDULE  = "equip-sch"
   LIGHTING-SCHEDUL = ( "equip-sch" )
   EQUIP-SCHEDULE   = ( "equip-sch" )
   LIGHTING-W/AREA  = ( 1.5 )
   EQUIPMENT-W/AREA = ( 30 )
   AREA/PERSON      = 400
   ..
"First Floor" = FLOOR
   SHAPE            = BOX
   FLOOR-HEIGHT     = 15
   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
```

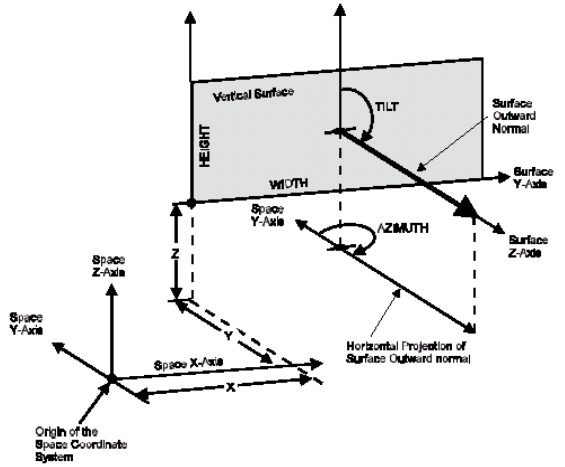
BDL Geometry

- 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
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   AREA/PERSON      = 400
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   SHAPE            = BOX
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   ..
"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
```
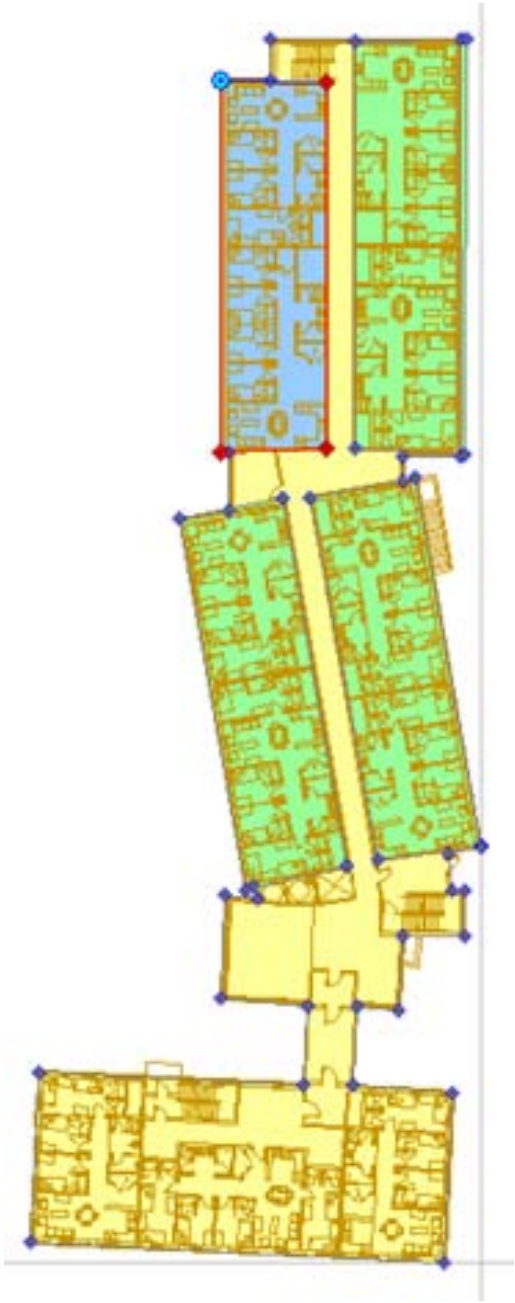

text to visual



eQUEST overview

- QUick Energy Simulation Tool
- 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

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)

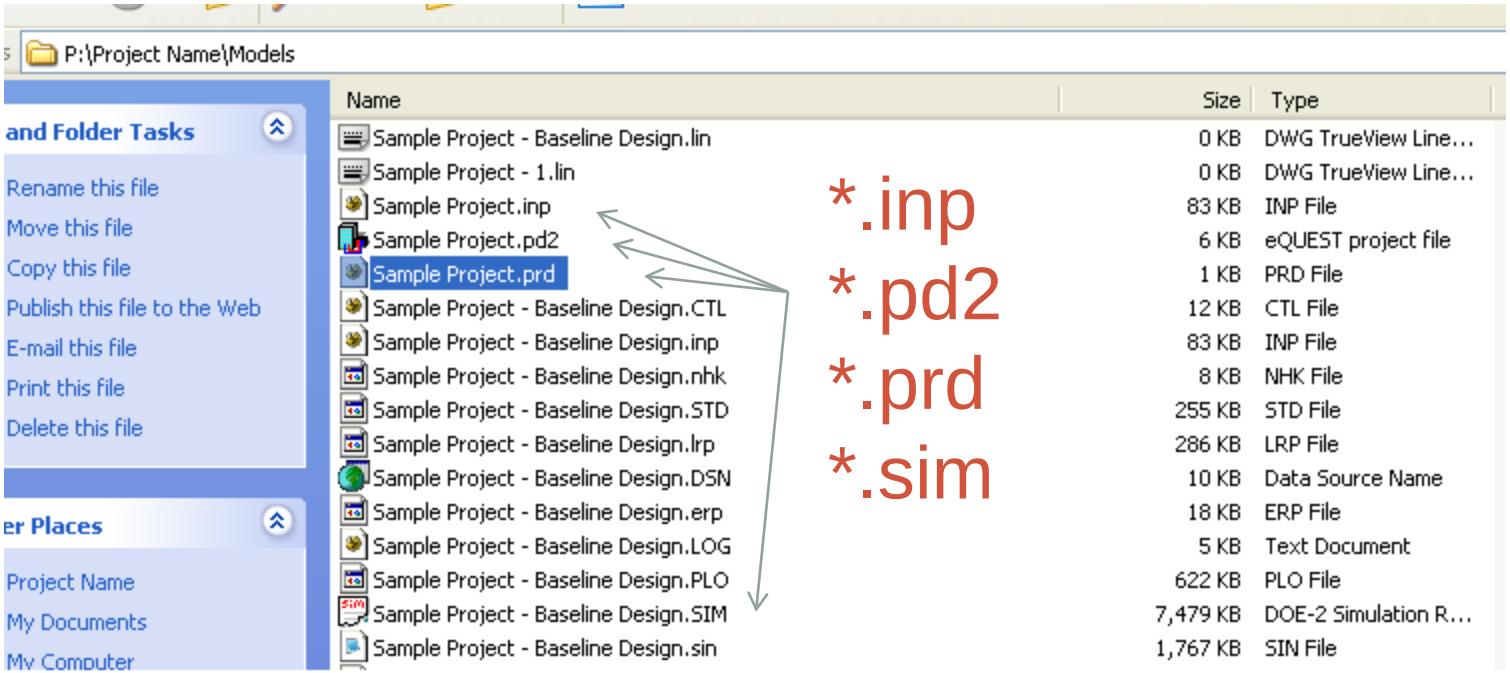
- Primary/secondary hydronic loops
- Variable flow hydronic loops
- Custom performance curves
- Cogeneration
- Thermal energy storage
- Photovoltaics
- Energy recovery ventilators
- Ice rinks
- Many more

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:



- 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

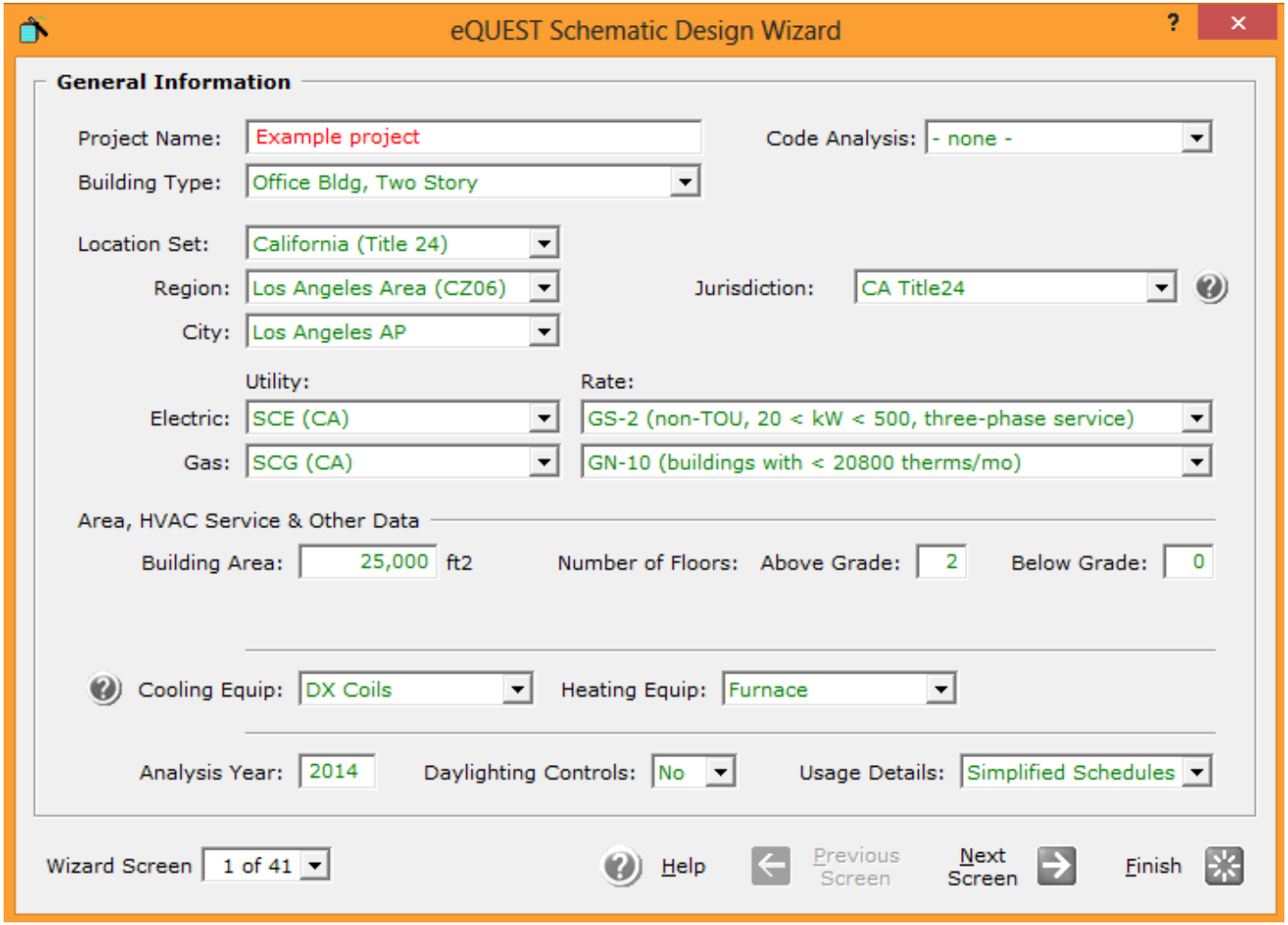
- Examples include:
  - Typical Meteorological Year (TMY, TMY2, TMY3) **(FREE)**
  - Weather Year for Energy Calculations (WYEC, WYEC2)
  - International Weather for Energy Calculations (IWEC, IWEC2)
  - Actual meteorological year (AMY) – good for calibration
- TMY data (available in BIN format from doe2.com):
  - 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



Thermal zoning

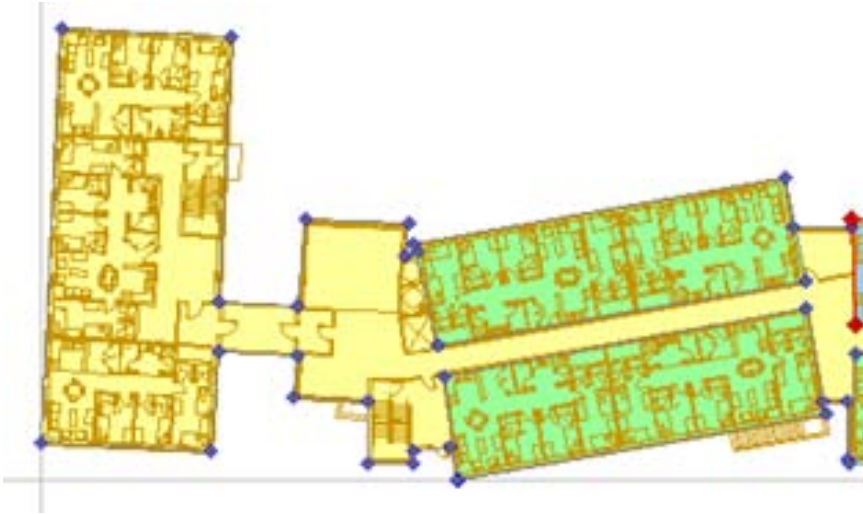
- Everything should be made as simple as possible but not simpler – Albert Einstein

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

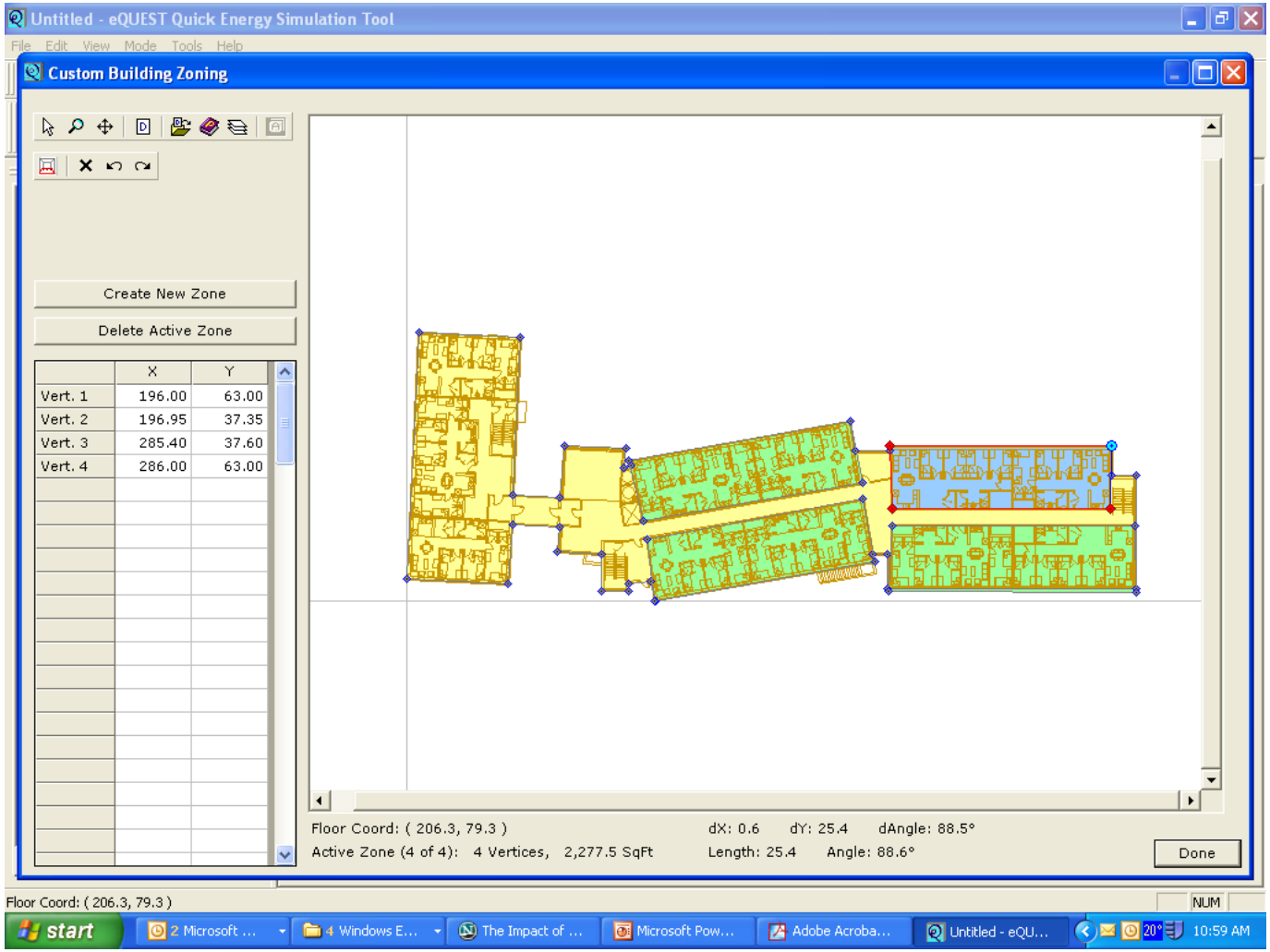
Custom zoning in eQUEST

- 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

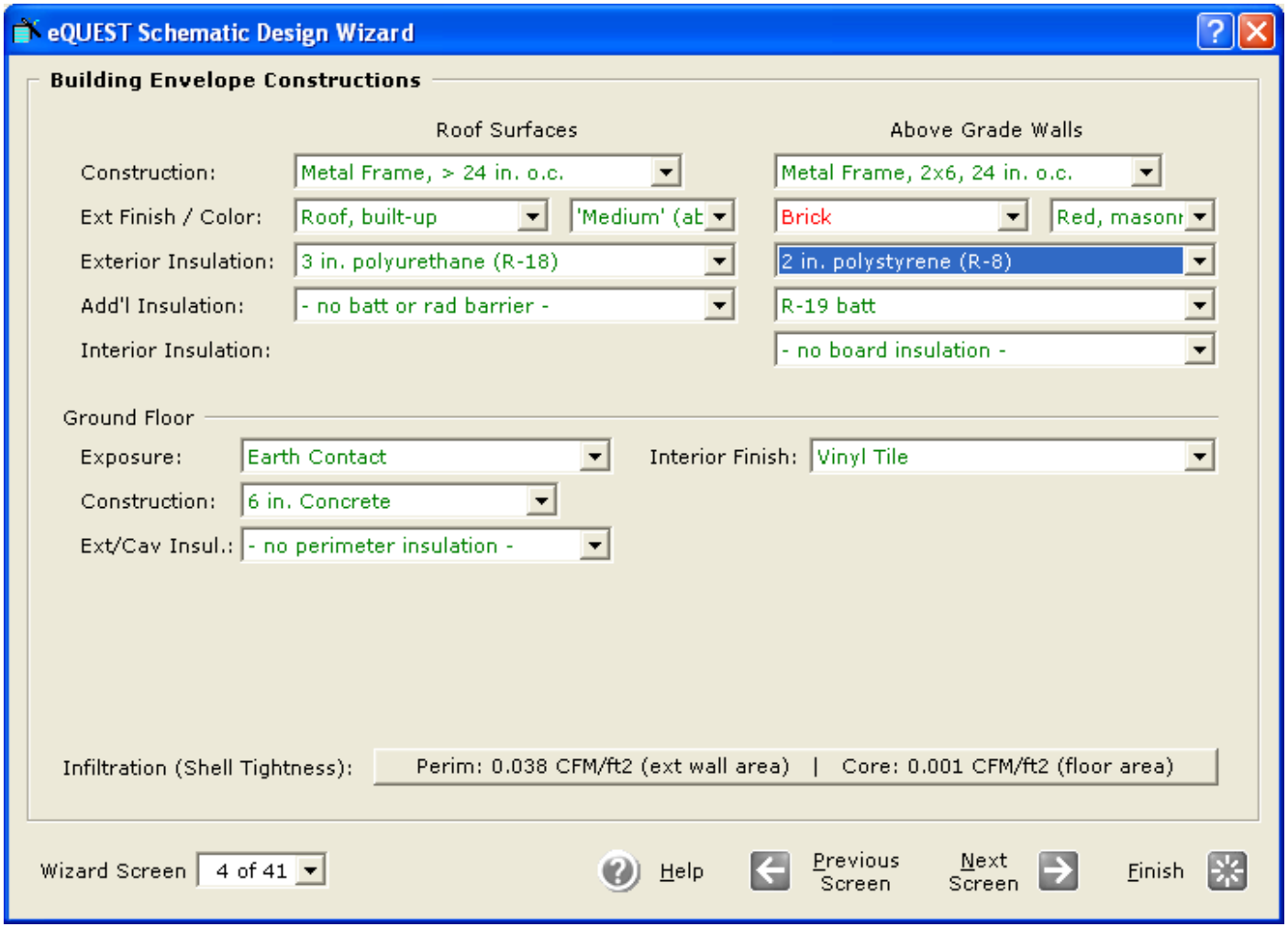
Custom zoning (2)



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)

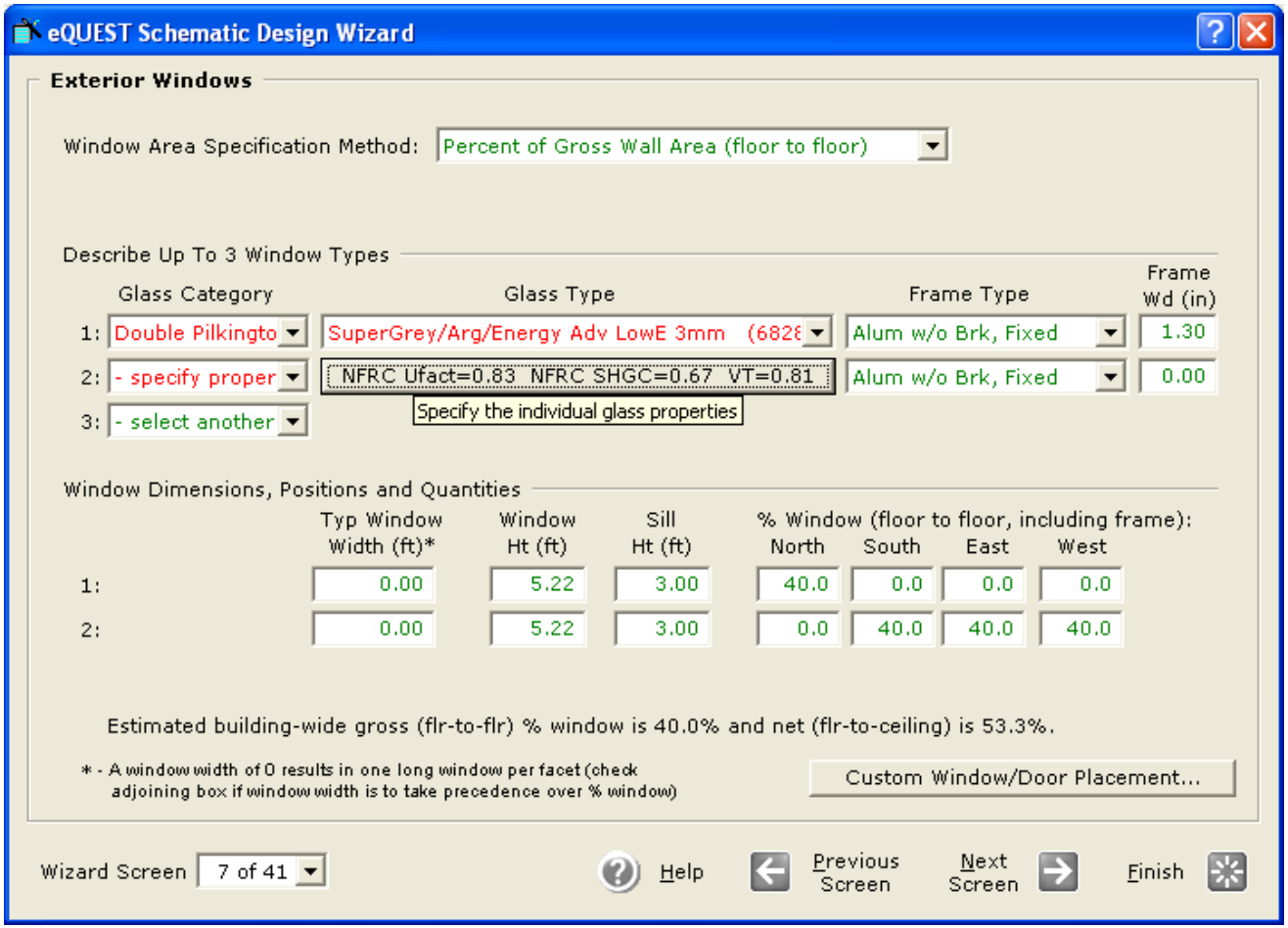


Windows

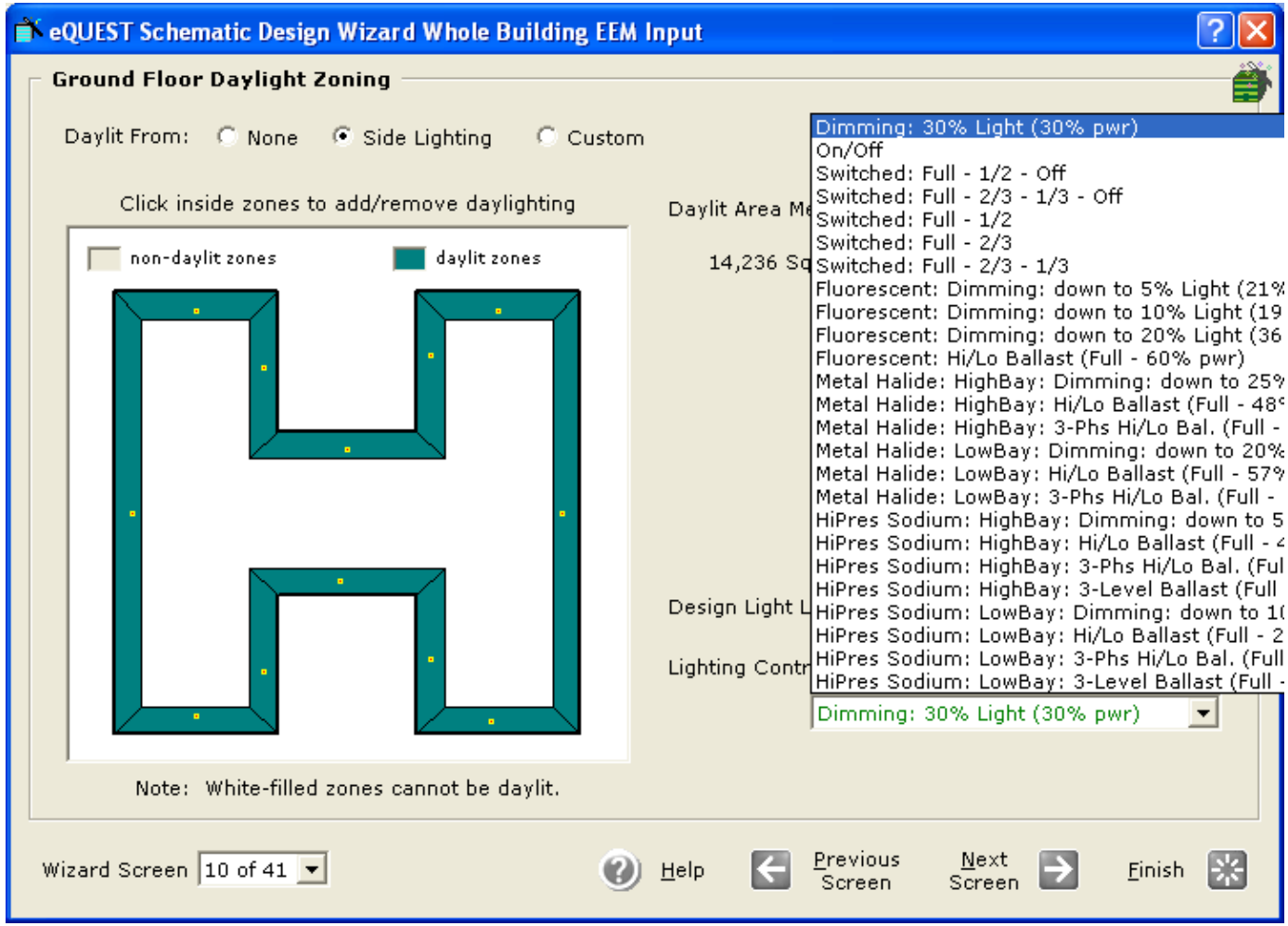
- Window types:
  - Simple (“specify properties”)
    - Enter shading coefficient and U-value
  - Library (choose a glass category)
    - Optical properties vary with sun angle
  - Custom
    - LBNL Window 4 or 5 output can be imported directly into eQUEST

- 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: Percent of Gross Wall Area (floor to floor)
Describe Up To 3 Window Types
Glass Category
Glass Type
Frame Type
Frame Wd (in)
1: Double Pilkingto
SuperGrey/Arg/Energy Adv LowE 3mm (682
Alum w/o Brk, Fixed
1.30
2: - specify proper
NFRC Ufact=0.83 NFRC SHGC=0.67 VT=0.81
Alum w/o Brk, Fixed
0.00
3: - select another
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: 0.00 5.22 3.00 40.0 0.0 0.0 0.0
2: 0.00 5.22 3.00 0.0 40.0 40.0 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)
Custom Window/Door Placement...
Wizard Screen 7 of 41
Help
Previous Screen
Next Screen
Finish

Daylight harvesting

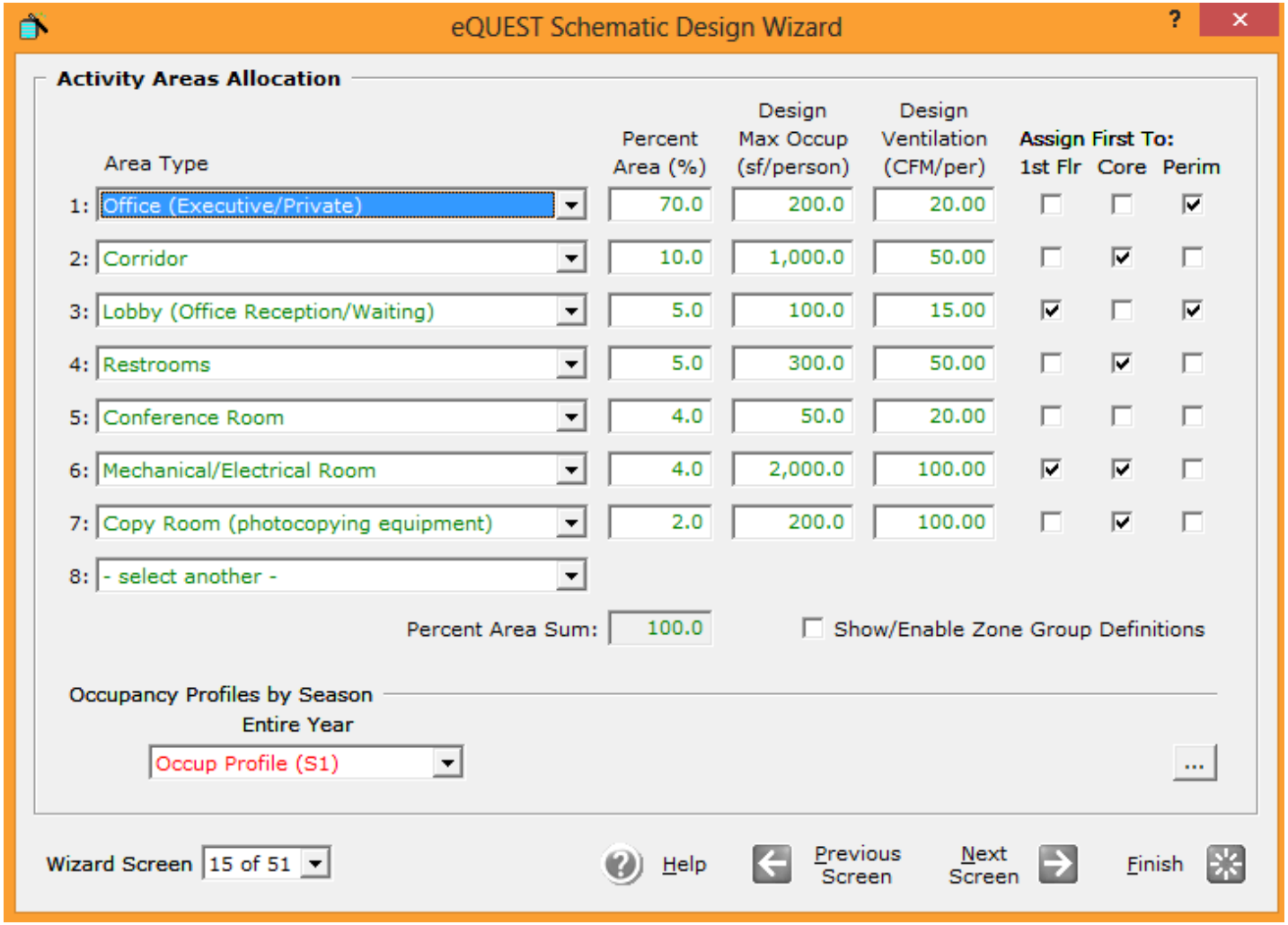


Schedules in eQUEST

- 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

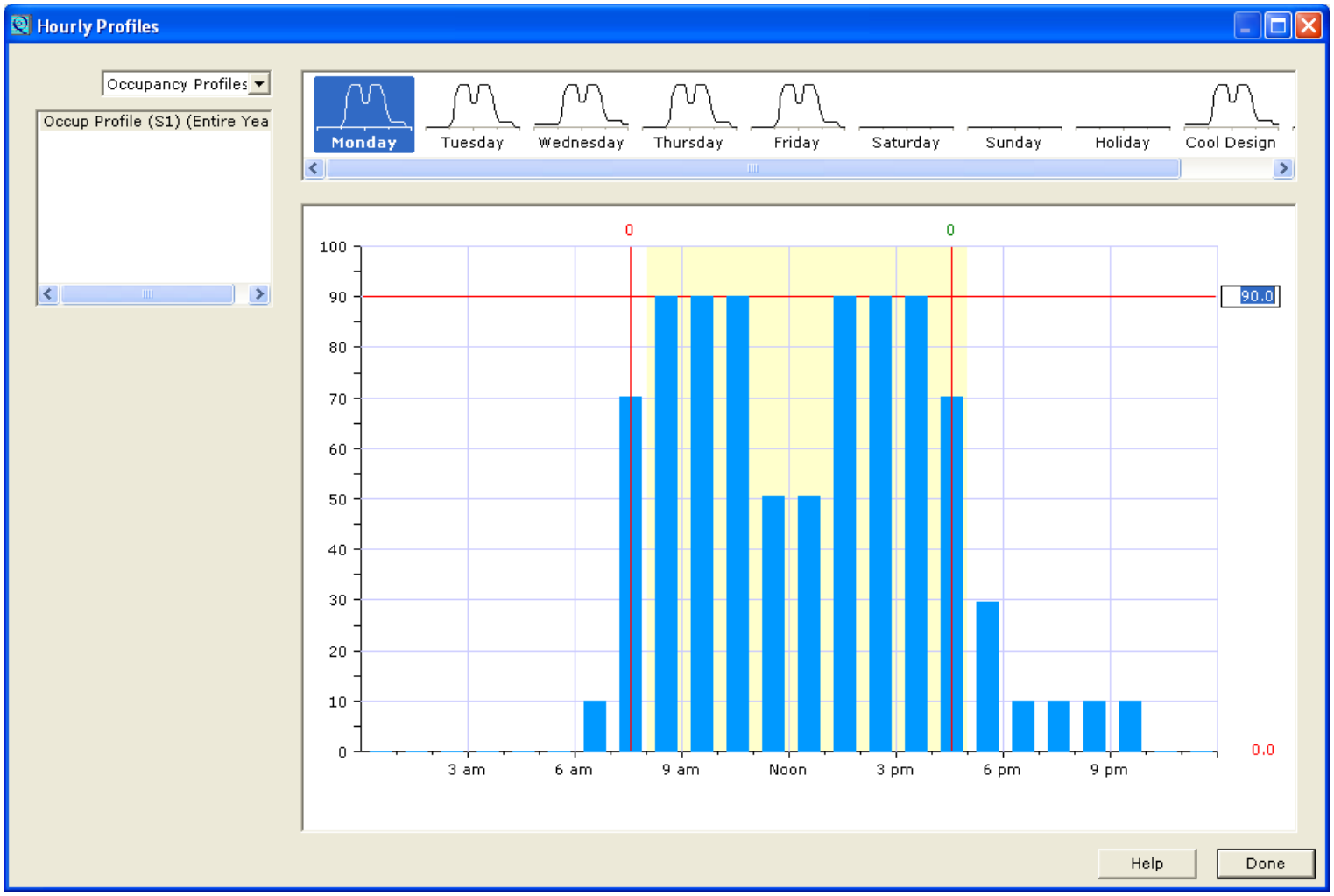
Activity areas



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

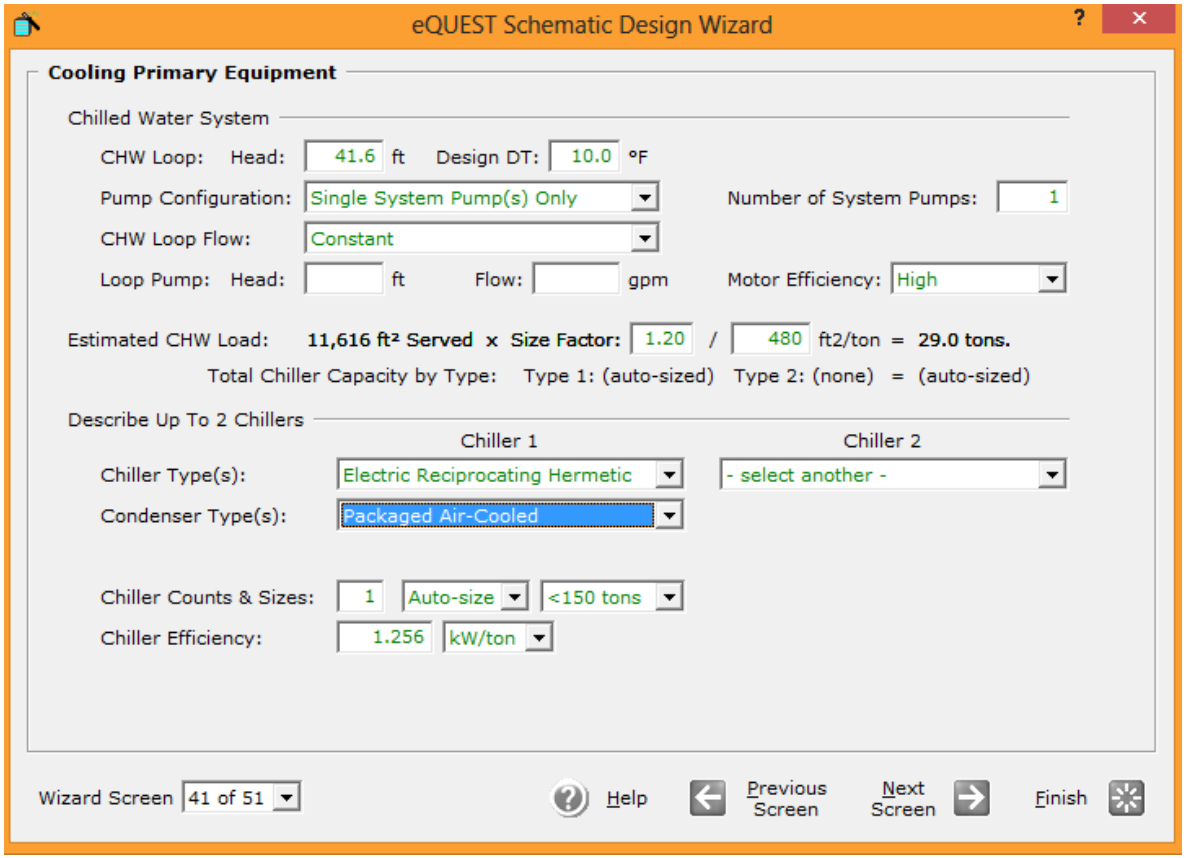
- Zonal system types:
  - Fan coil
  - PTAC
  - Heat pump
- Zonal system characteristics:
  - One system assignment can be used for whole building
  - Can cycle individual fans when no heating or cooling demand
  - Cannot implement airside economizer (except for fan coil units)
  - Check fan power –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



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

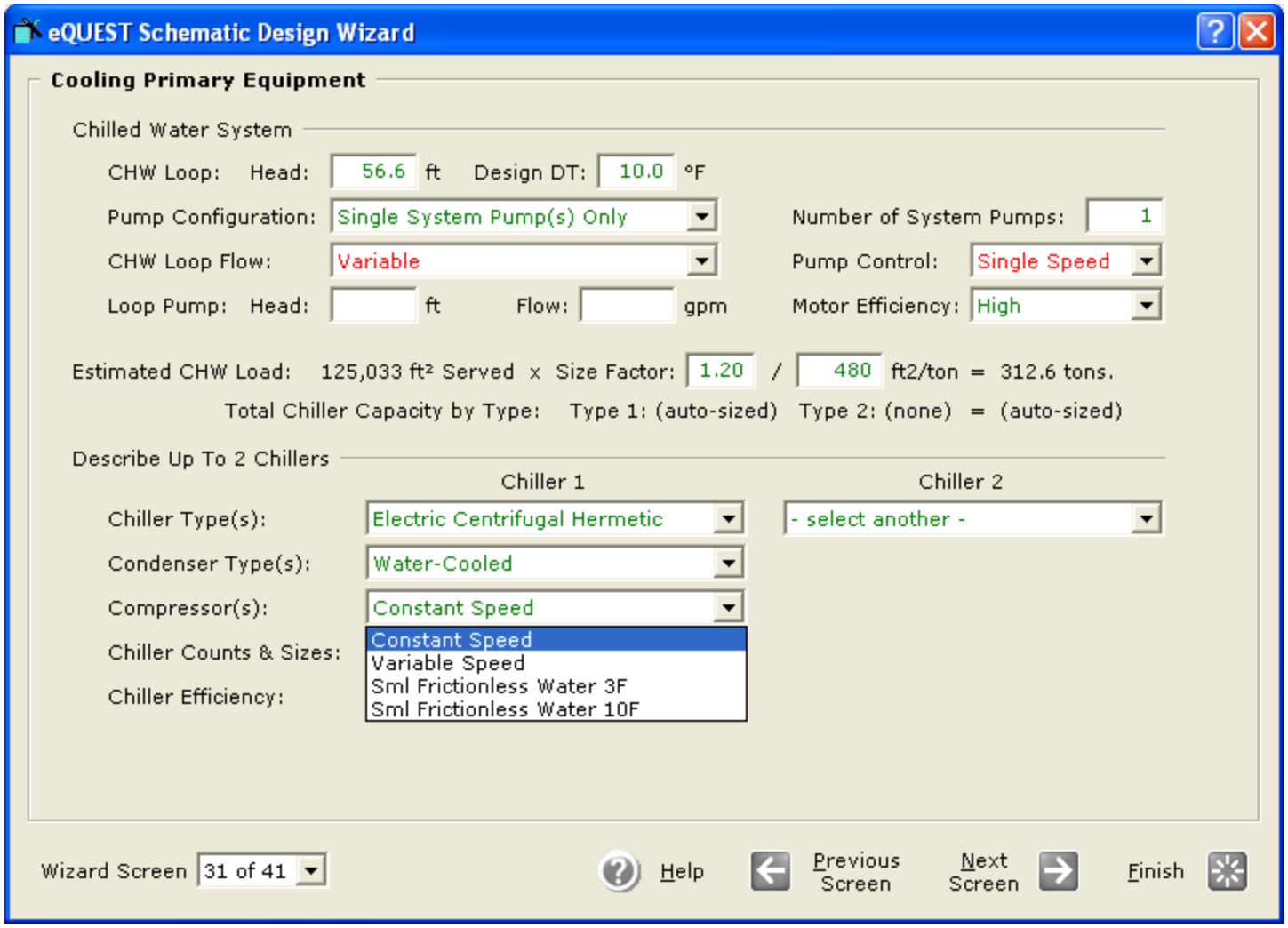
Plant equipment

- 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

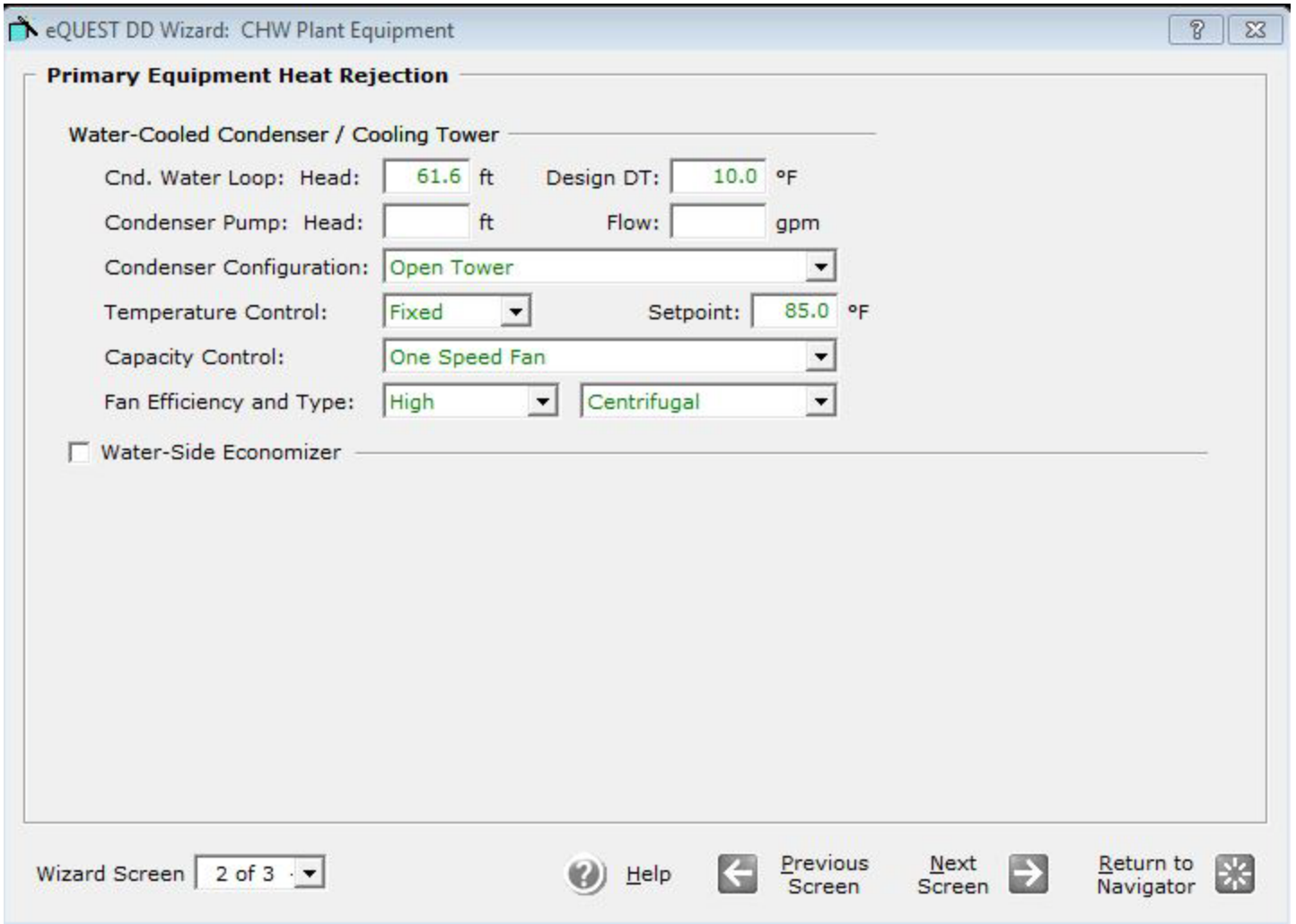
Chillers


eQUEST Schematic Design Wizard
Cooling Primary Equipment
Chilled Water System
CHW Loop: Head: 56.6 ft Design DT: 10.0 °F
Pump Configuration: Single System Pump(s) Only
Number of System Pumps: 1
CHW Loop Flow: Variable
Pump Control: Single Speed
Loop Pump: Head: ft Flow: gpm
Motor Efficiency: High
Estimated CHW Load: 125,033 ft² Served x Size Factor: 1.20 / 480 ft2/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): Electric Centrifugal Hermetic
- select another -
Condenser Type(s): Water-Cooled
Compressor(s): Constant Speed
Chiller Counts & Sizes:
Chiller Efficiency:
Constant Speed
Variable Speed
Sml Frictionless Water 3F
Sml Frictionless Water 10F
Wizard Screen 31 of 41
Help
Previous Screen
Next Screen
Finish

Heat rejection

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

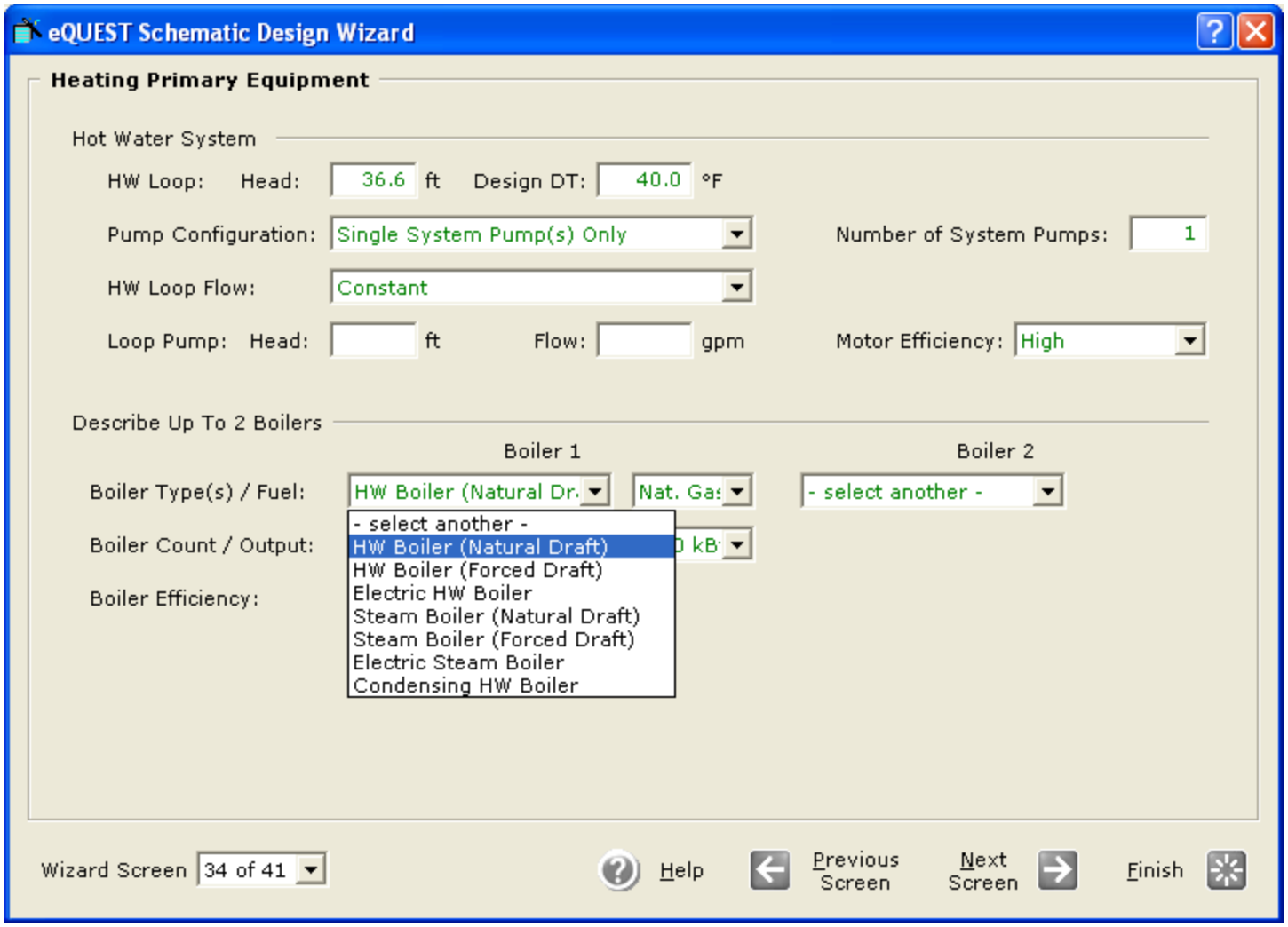
Heat rejection



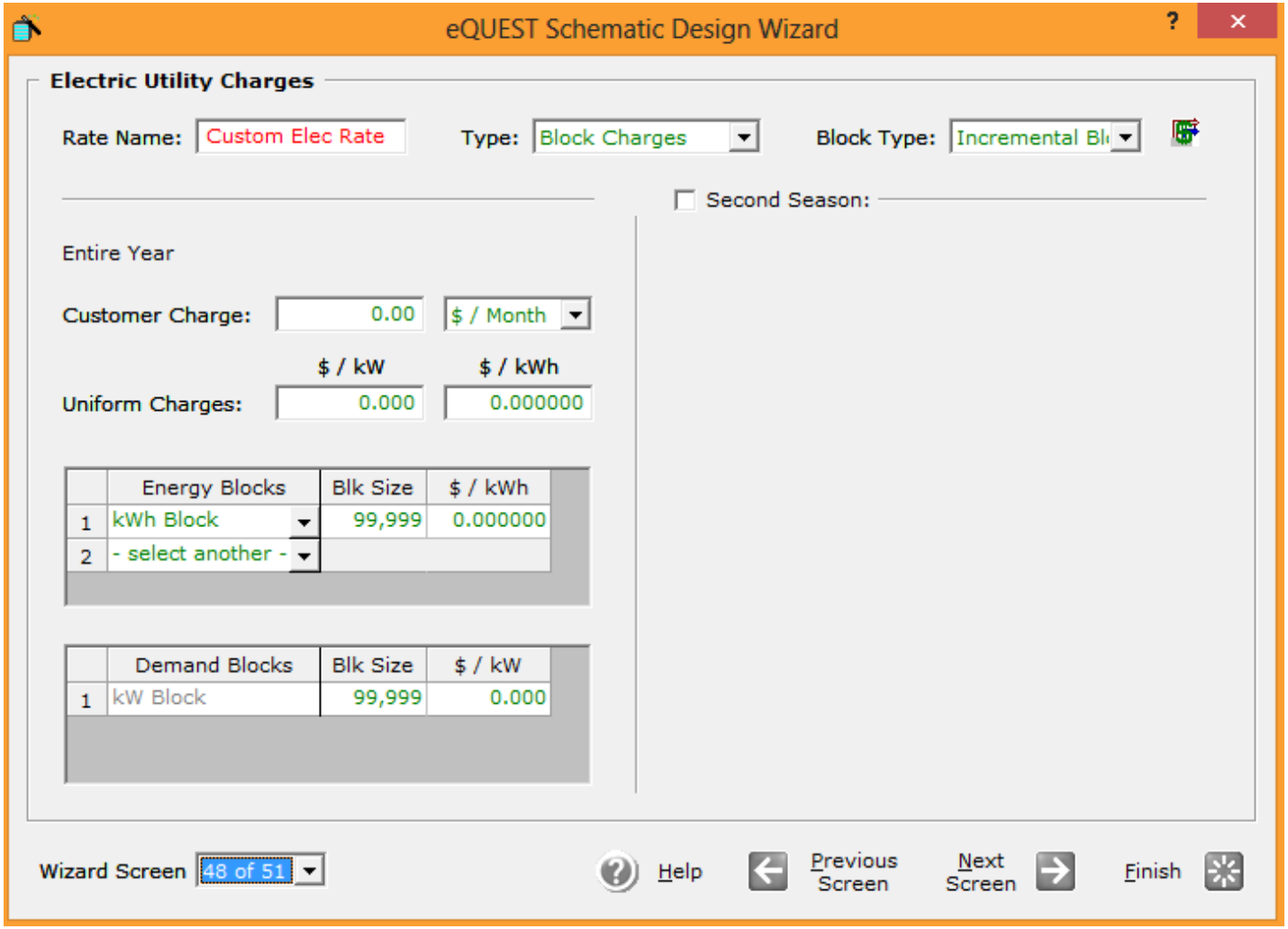
Boilers

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

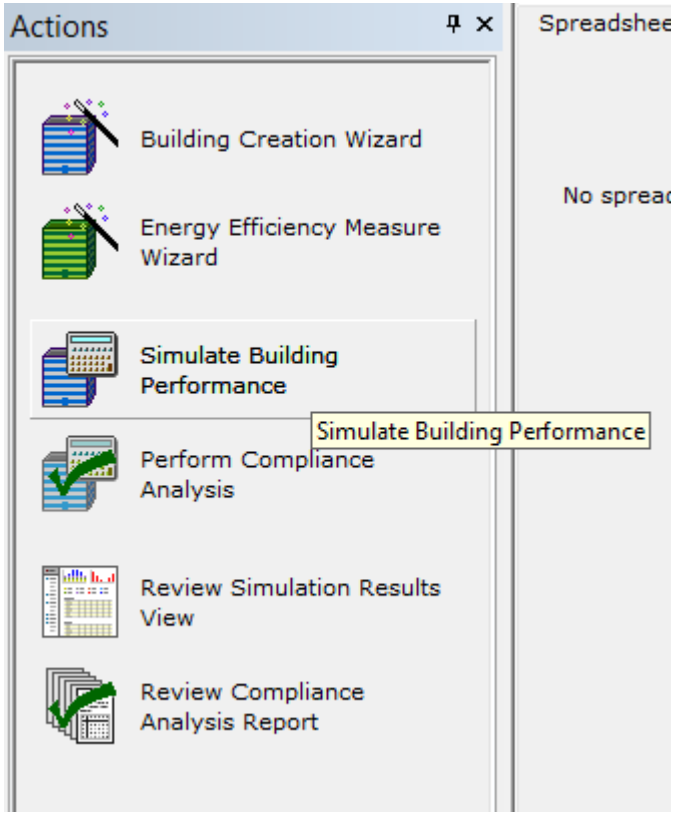
Boilers

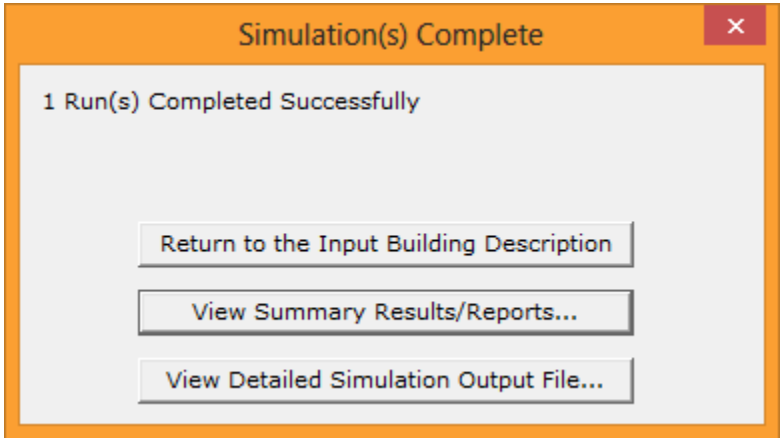

eQUEST Schematic Design Wizard
Heating Primary Equipment
Hot Water System
HW Loop: Head: 36.6 ft Design DT: 40.0 °F
Pump Configuration: Single System Pump(s) Only
Number of System Pumps: 1
HW Loop Flow: Constant
Loop Pump: Head: ft Flow: gpm
Motor Efficiency: High
Describe Up To 2 Boilers
Boiler 1
Boiler 2
Boiler Type(s) / Fuel:
HW Boiler (Natural Dr.
Nat. Ga:
- select another -
Boiler Count / Output:
Boiler Efficiency:
- 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 34 of 41
Help
Previous Screen
Next Screen
Finish

Utility rates

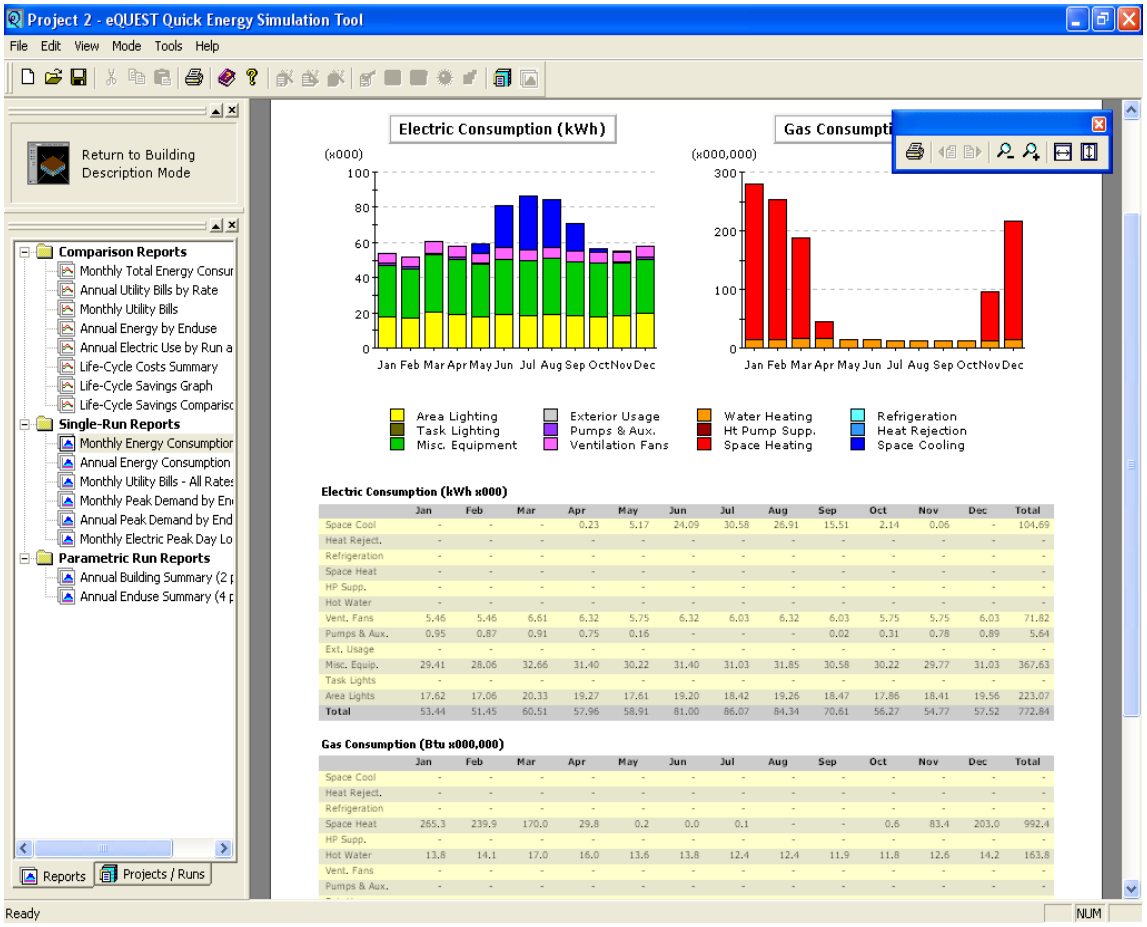


Running the simulation



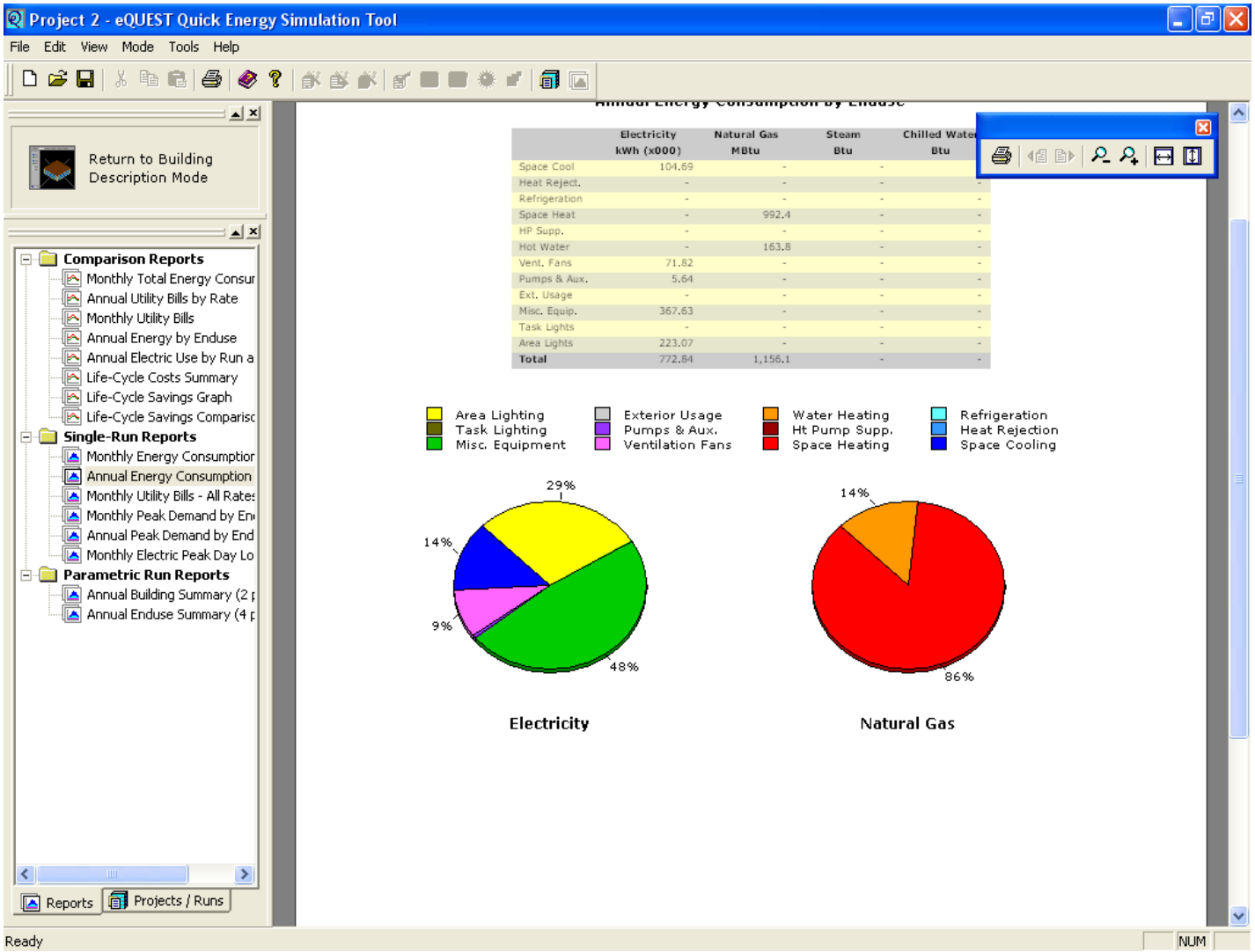


Graphical output reports



- Can use to calibrate models

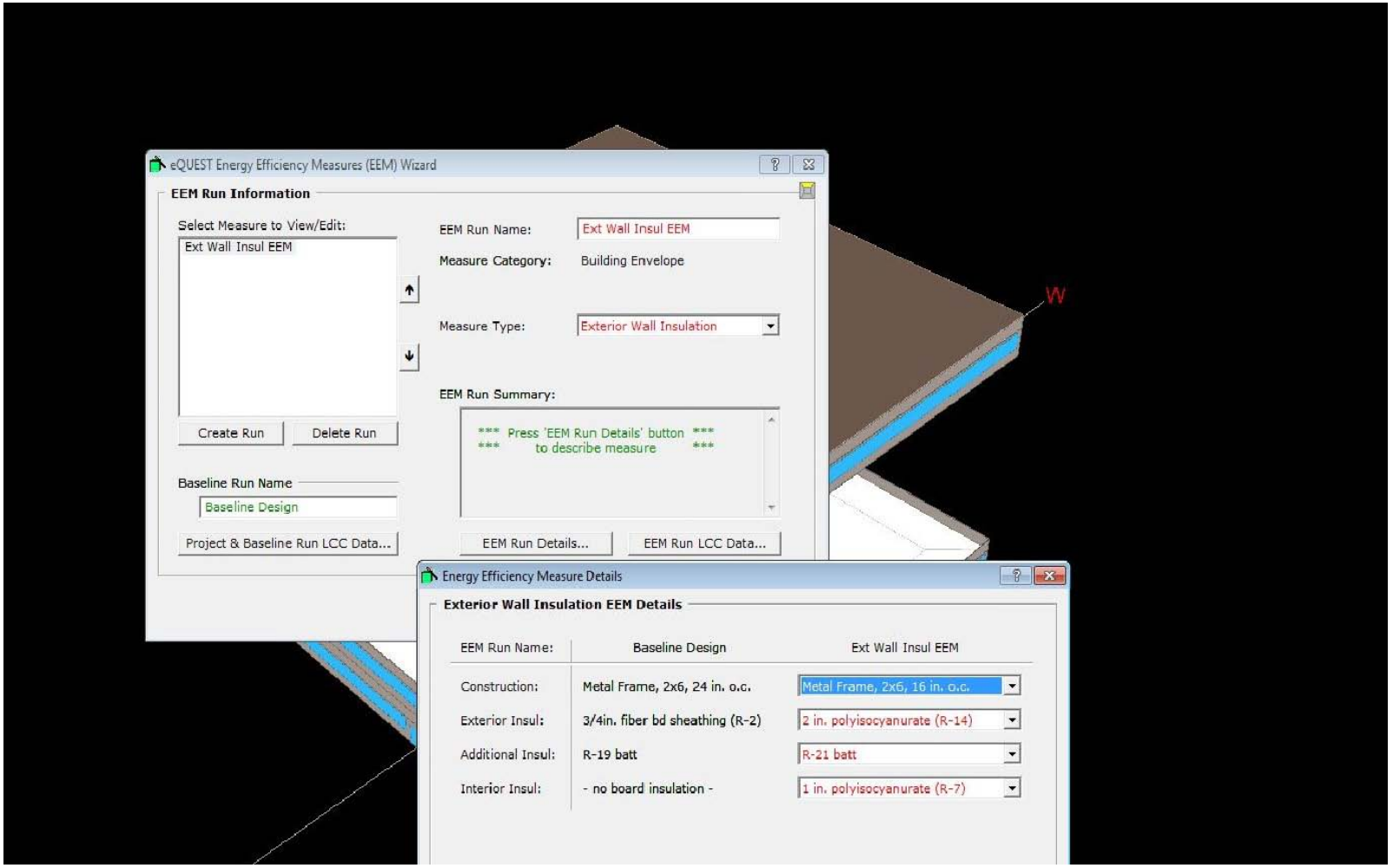
Graphical output reports (2)



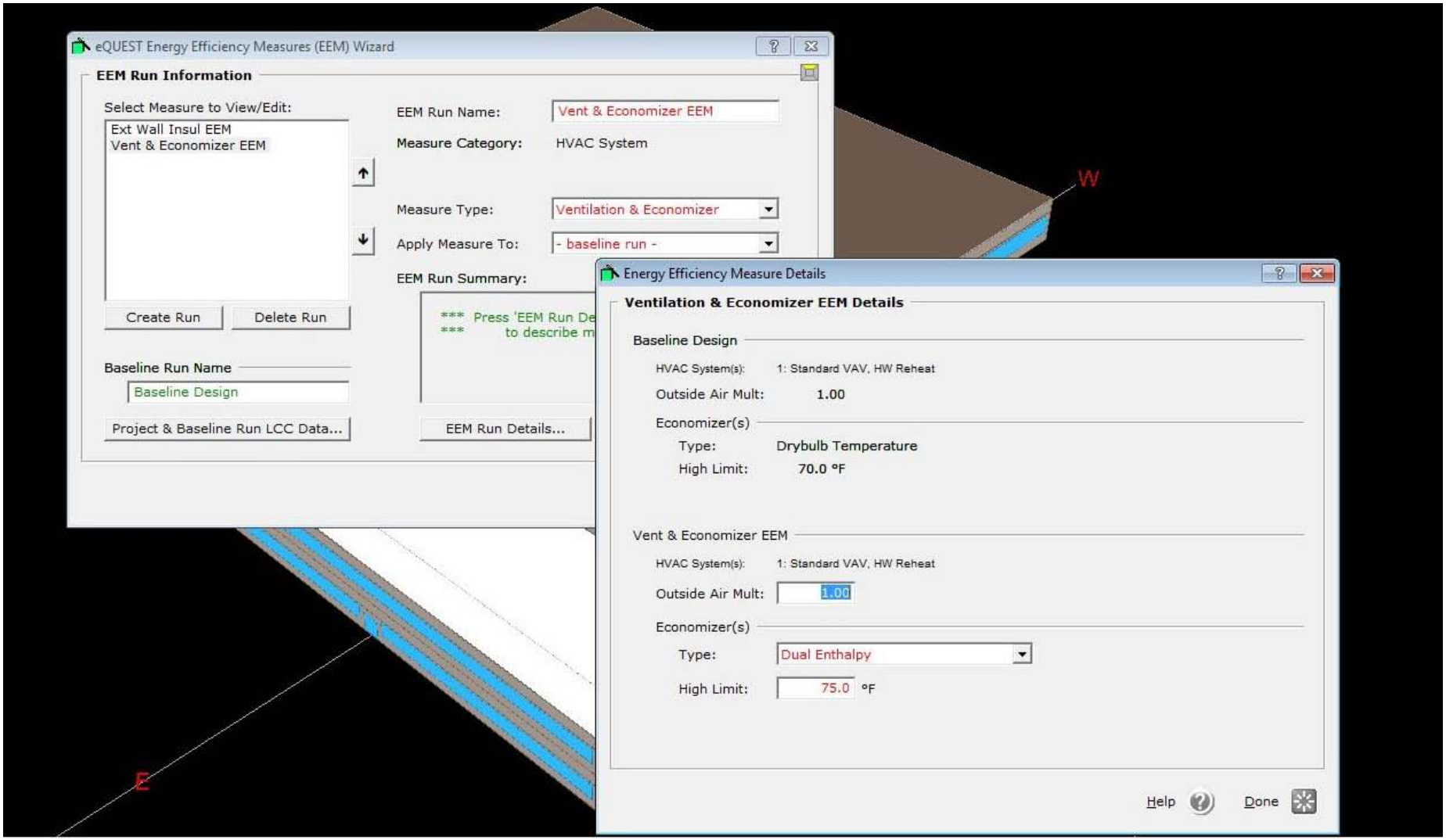
The EEM wizard

- 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

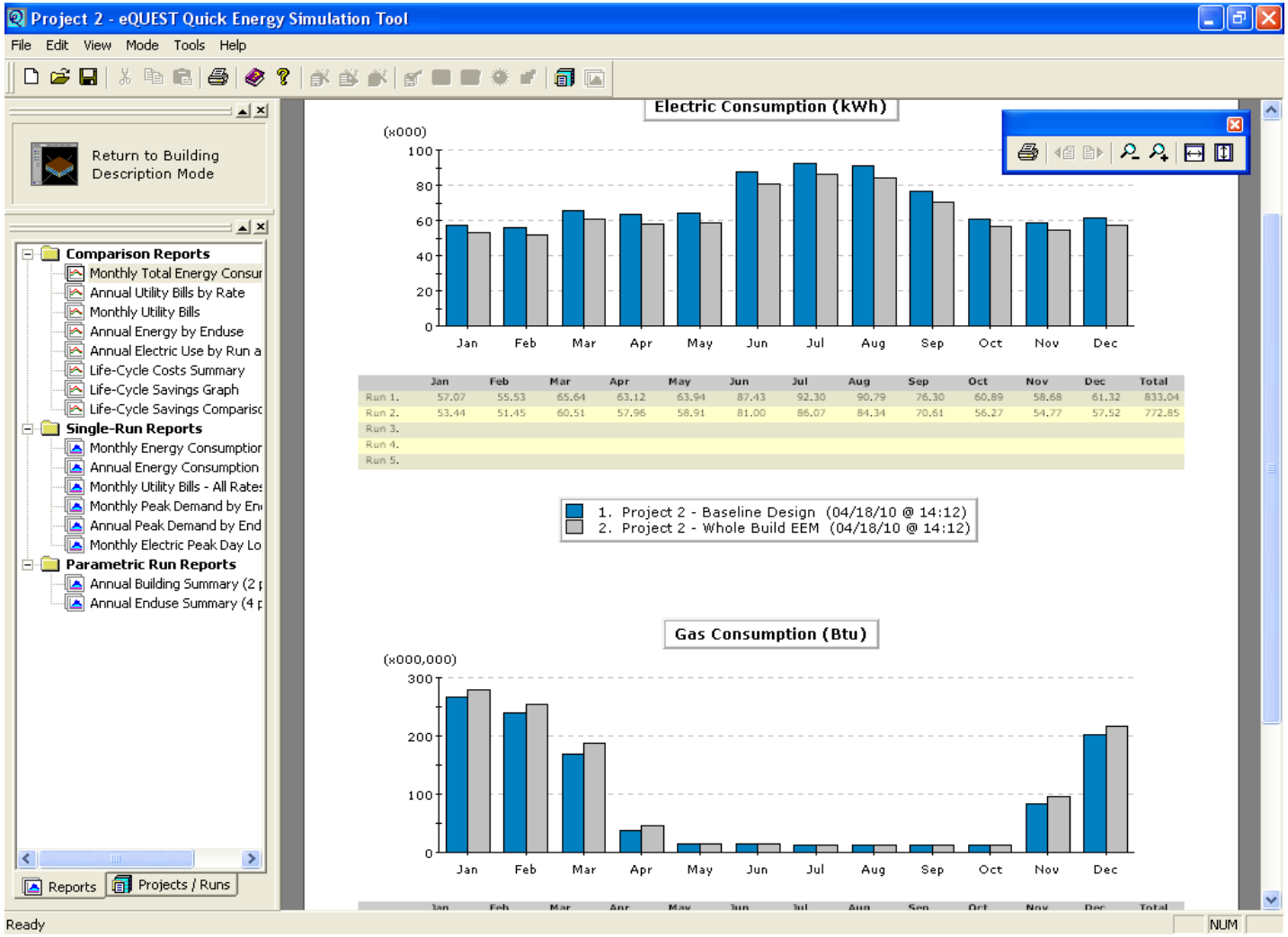
Wall construction EEM



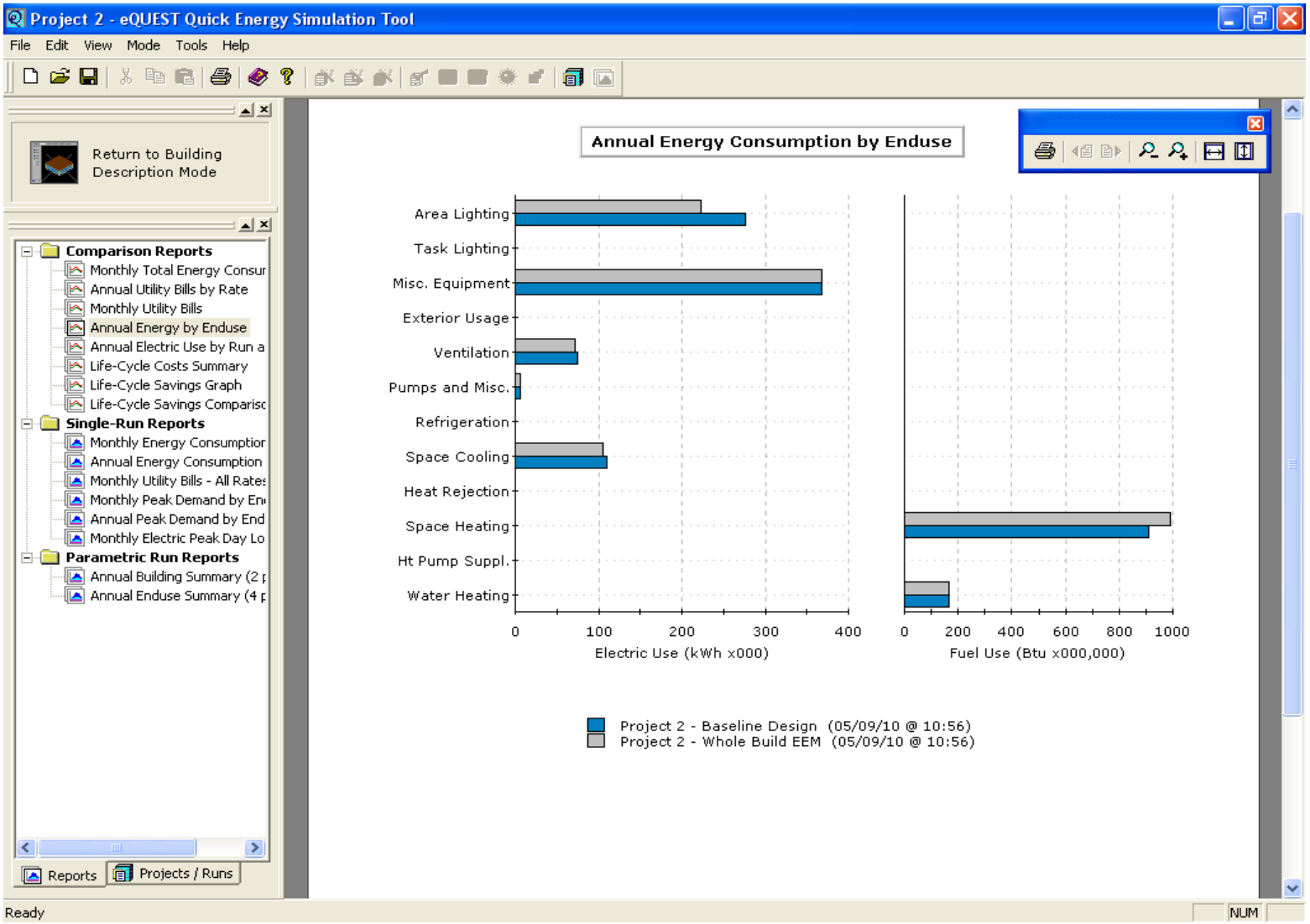
HVAC EEM


eQUEST Energy Efficiency Measures (EEM) Wizard
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:
Create Run
Delete Run
Baseline Run Name
Baseline Design
Project & Baseline Run LCC Data...
EEM Run Details...
W
E
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



EEM graphical reports (2)



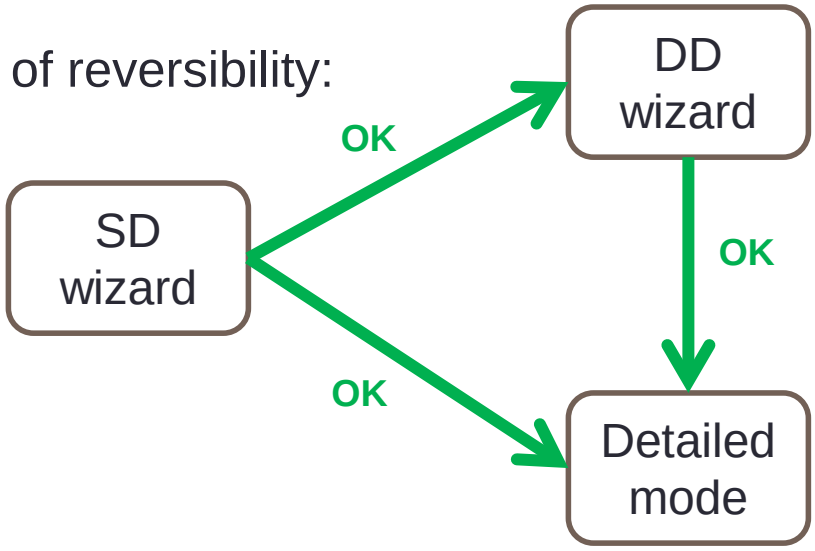
Getting deeper into eQUEST

- 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

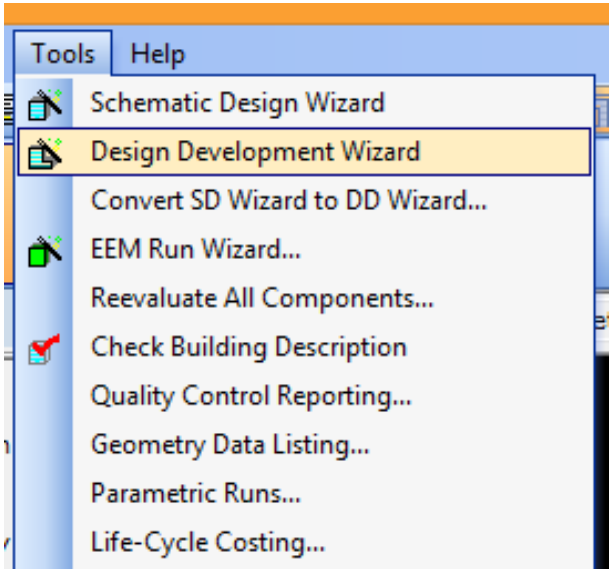
- Reminder on direction of reversibility:

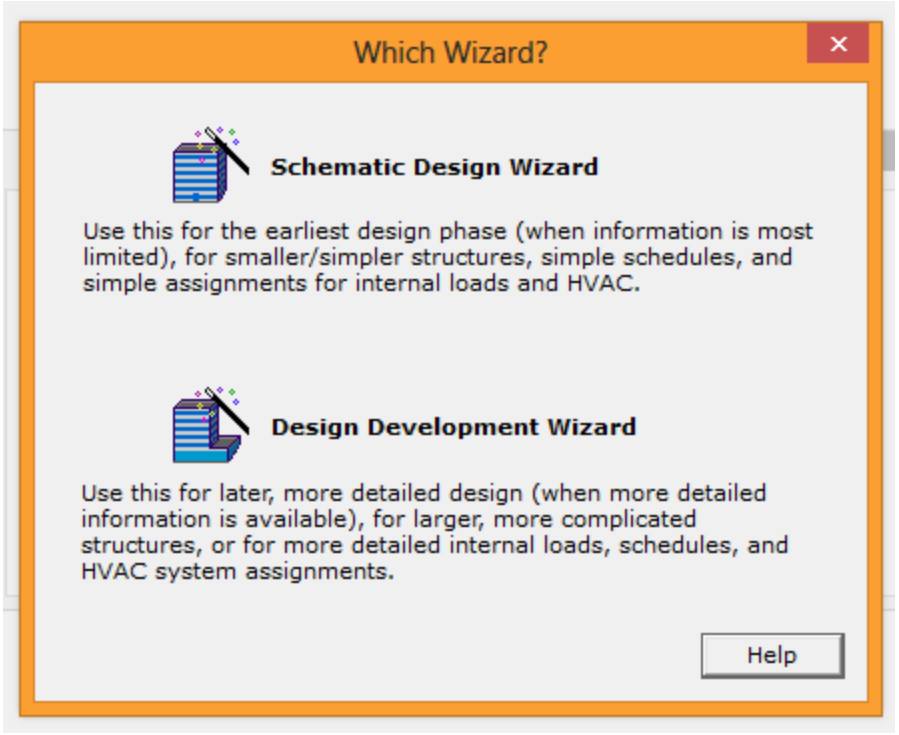


- Edits made in a more detailed mode will be lost if you return to a simpler mode
- eQUEST will warn you if this is about to happen

The DD wizard

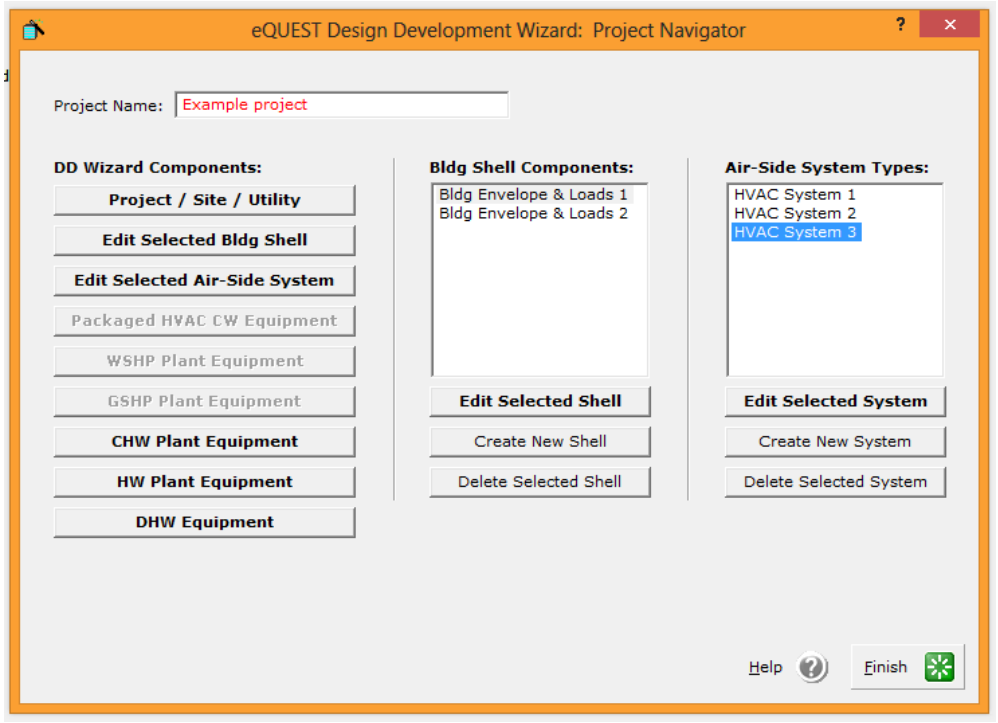
- Almost same set of screens as SD wizard
- Switch into DD from SD mode via Tools menu
- (or just start with DD wizard)





DD wizard differences

- “Navigator” screen



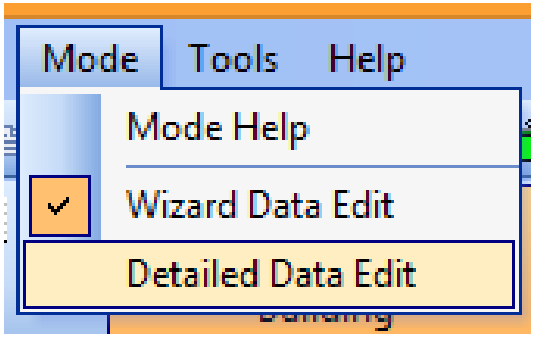
- Multiple shells with different zoning and shapes
- More than 2 HVAC systems

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

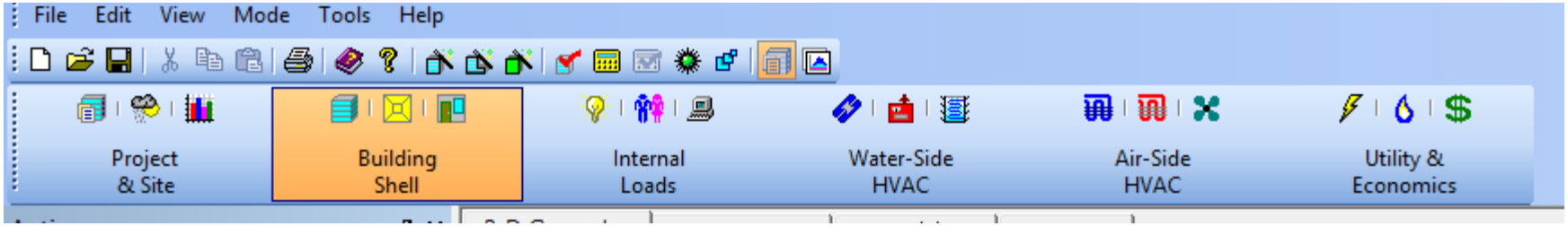
- Detailed mode viewer is where the wizards exit
- Can view tabs without moving to detailed mode
- Good way to check on what wizard has created
- To make edits, switch into detailed mode:



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

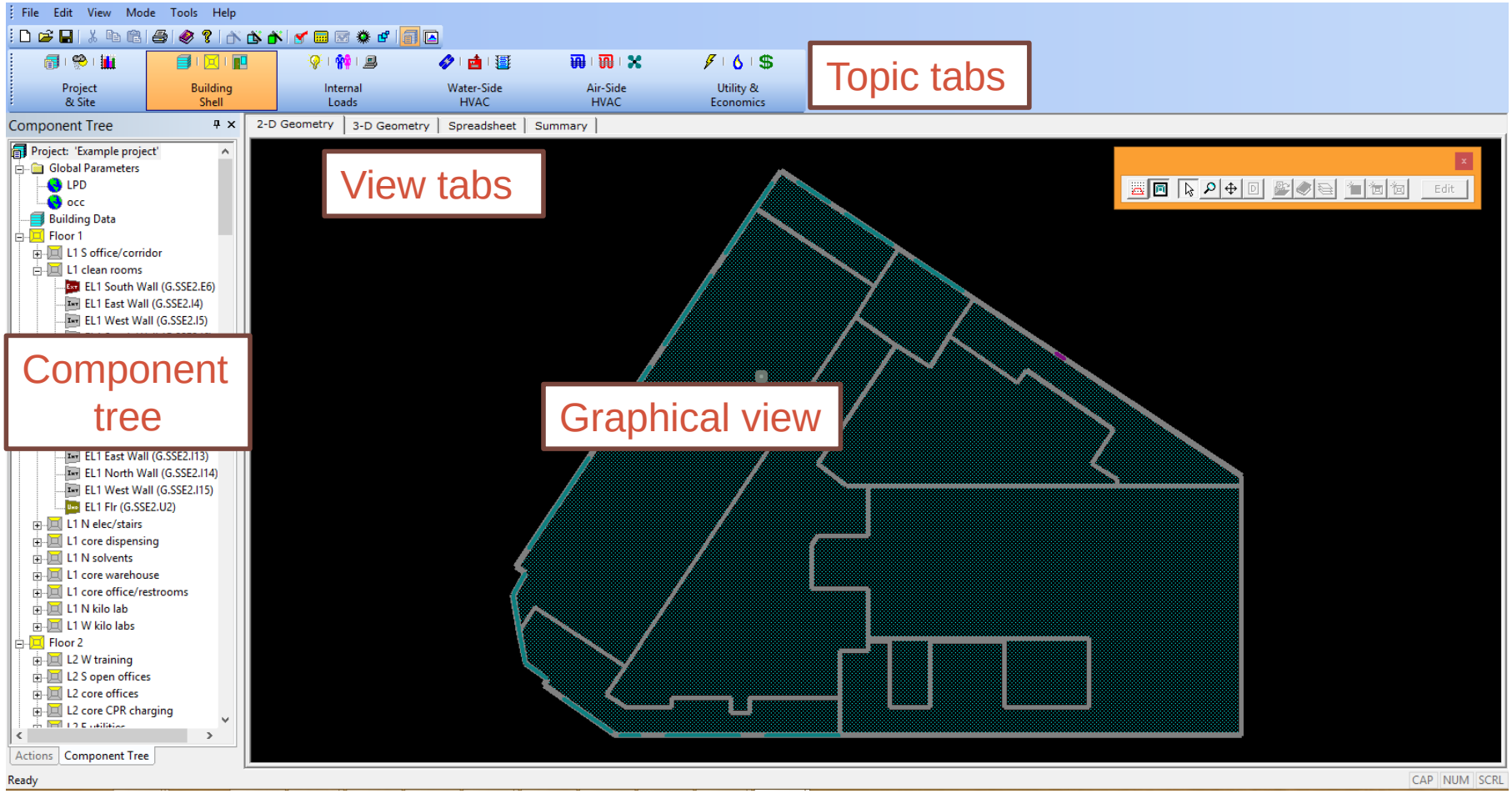
Detailed mode navigation

- Six navigation tabs:

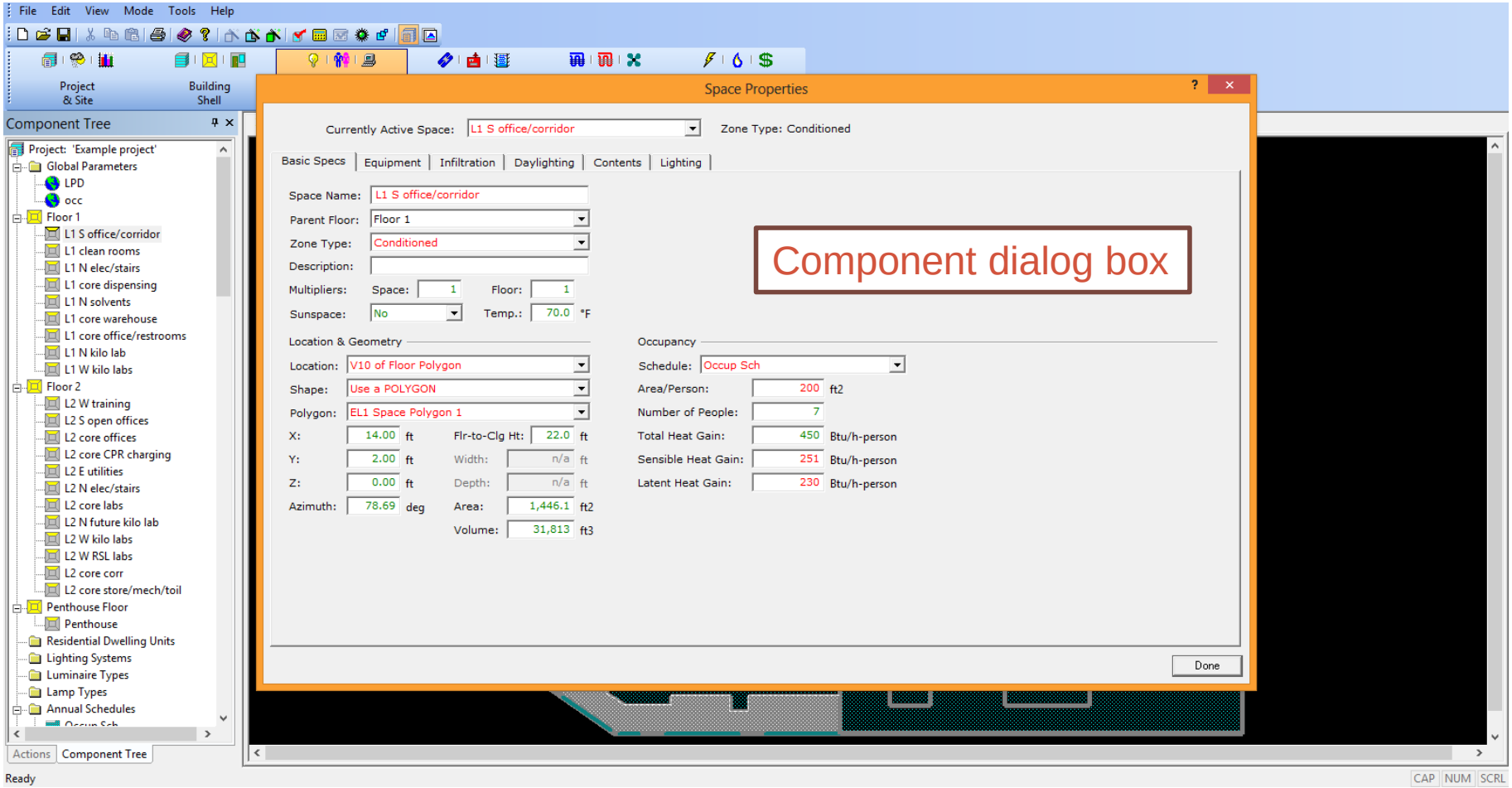


- On each tab (as applicable):
  - Component tree
  - Dialog box for each component
  - Graphical view
  - Spreadsheet view
  - Summary reports

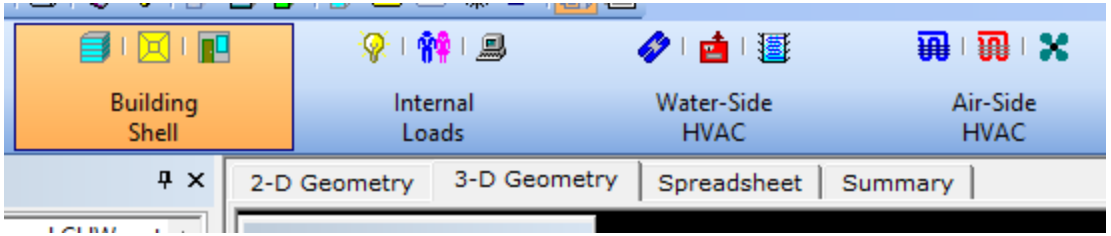
Detailed mode navigation (cont)



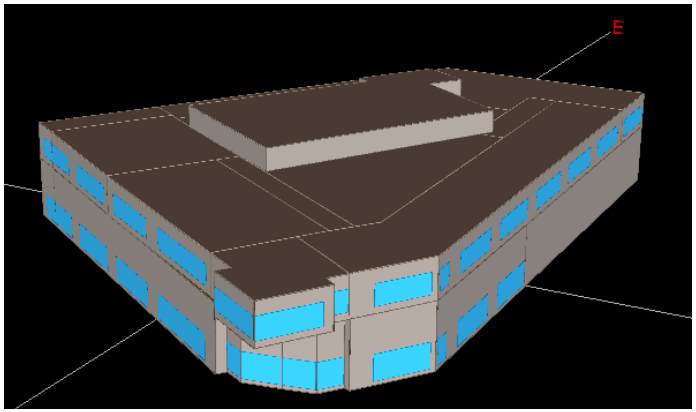
Detailed mode navigation (cont)

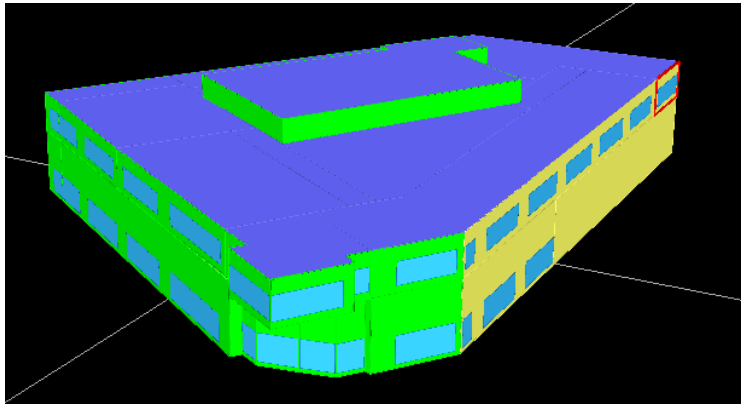


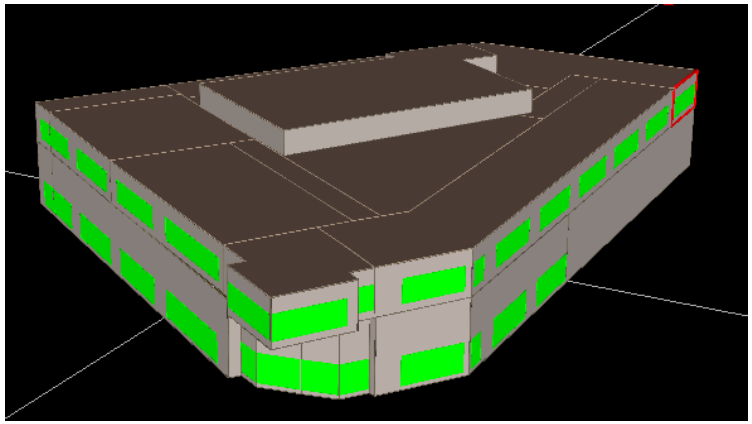
3D view



- Check geometry
- Check construction assignments







Spreadsheet view

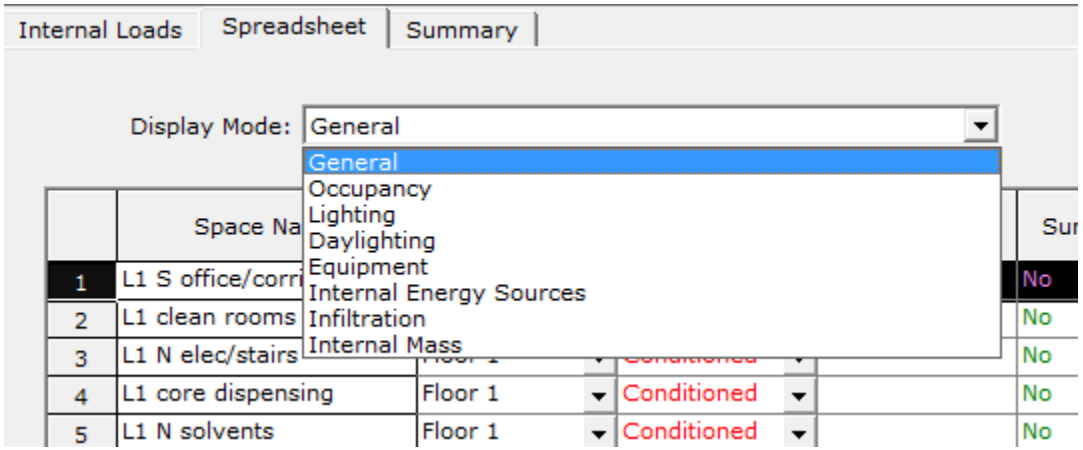
2-D Geometry | 3-D Geometry | Spreadsheet | Summary

Display Mode: Equipment

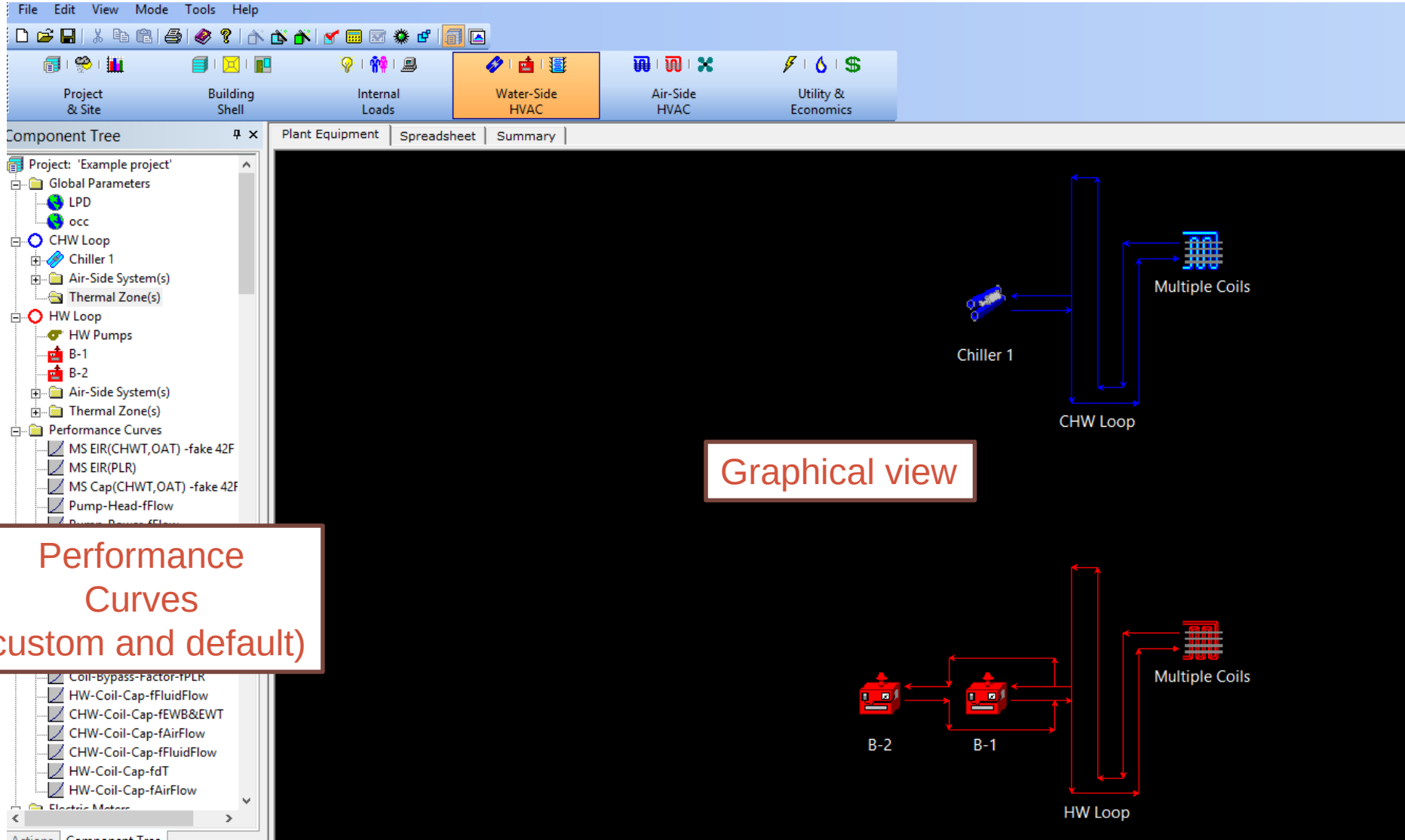
	Space Name	Parent Floor	Activity Desc.	Equipment Schedule 1	Equip W / Area 1 (W/ft2)	Equip kW 1 (kW)	Equip Sensible 1 (ratio)	Equip Latent 1 (ratio)	Equipment Schedule 2
1	L1 S office/corridor	Floor 1		Office Equip Sch	0.500		1.00	0.00	- undefined -
2	L1 clean rooms	Floor 1		Lab Equip Sch	4.000		1.00	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



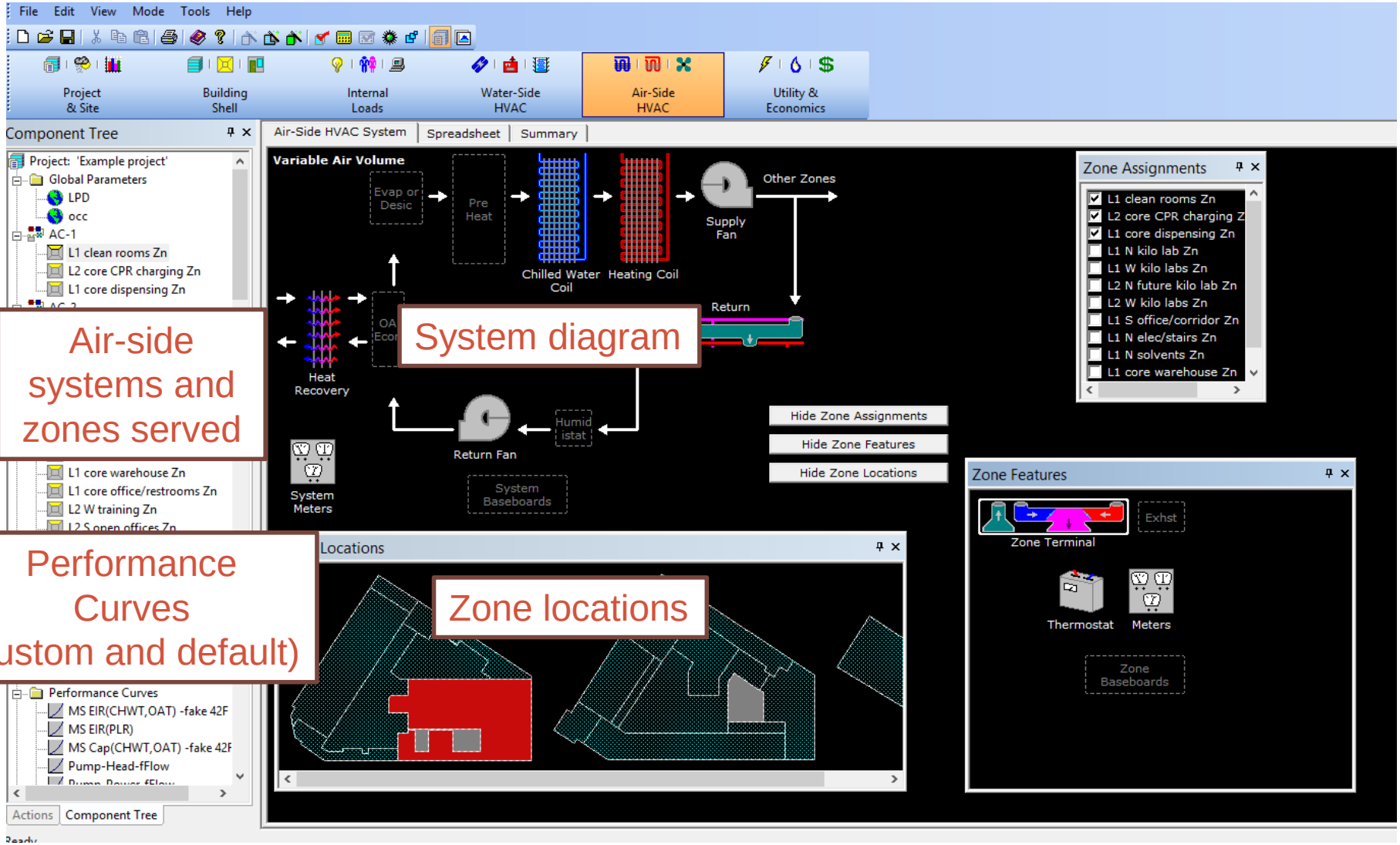
Water-side HVAC tab



Graphical view

Performance Curves (custom and default)

Air-side HVAC tab



Air-side systems and zones served

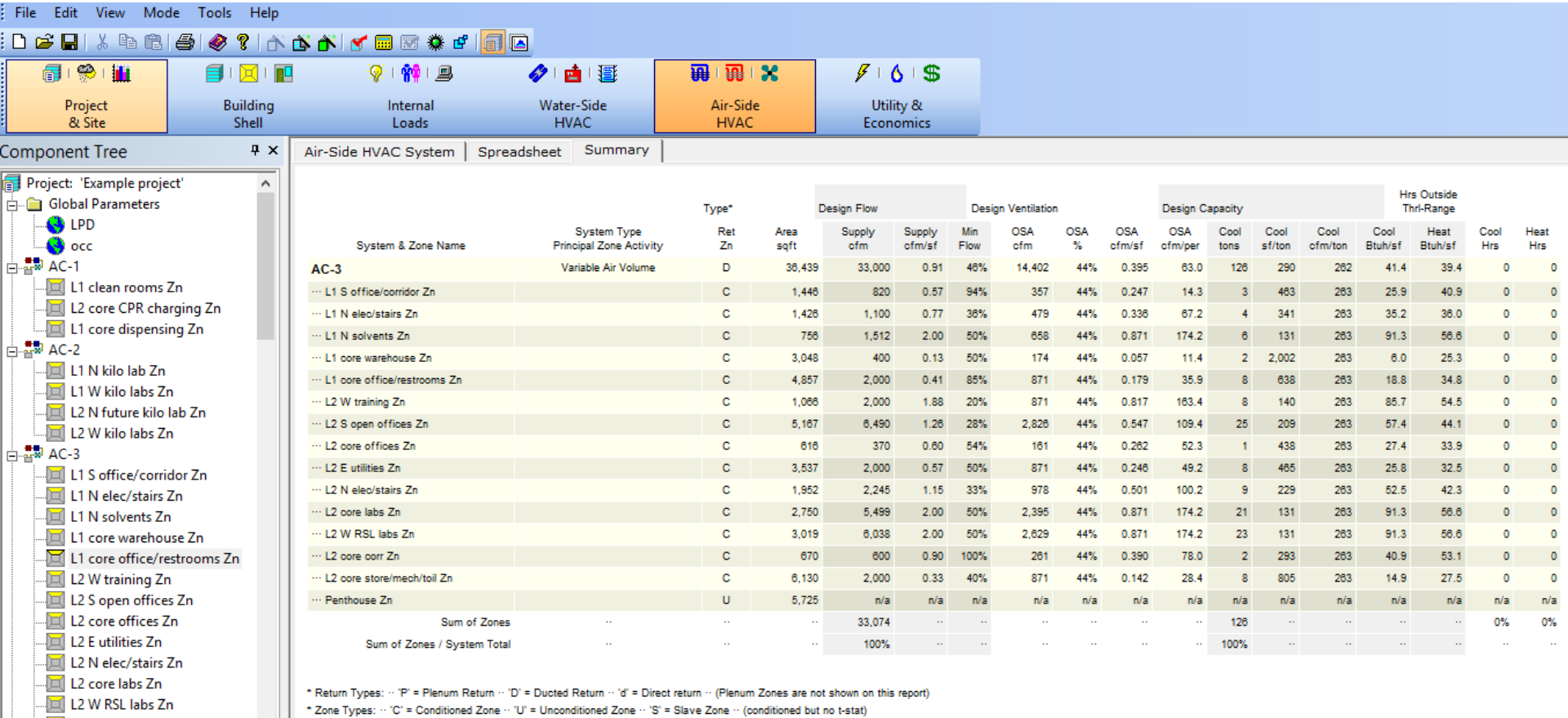
System diagram

Performance Curves (custom and default)

Zone locations

Summary reports view

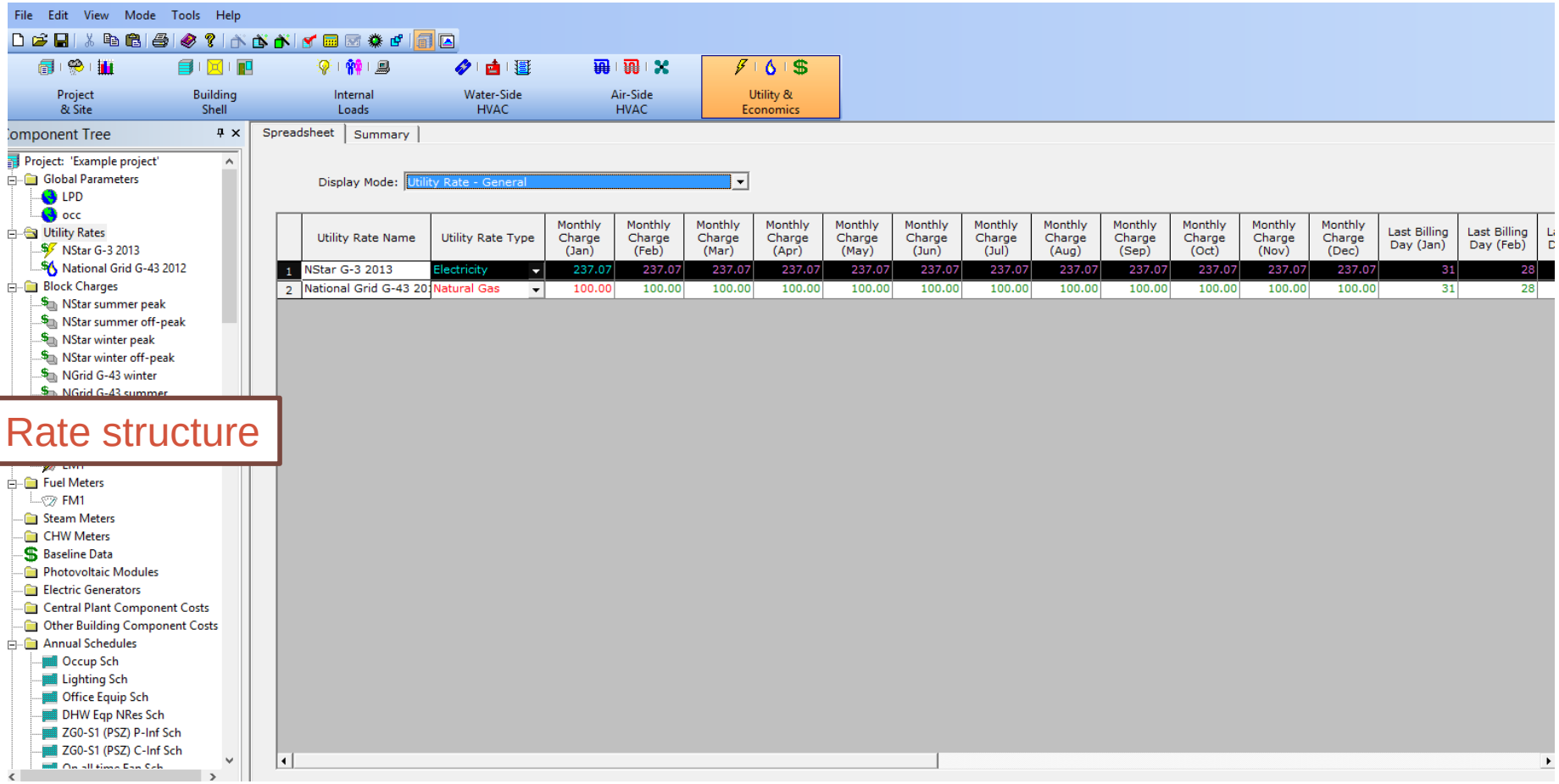
- Air-side and water-side tabs
- Useful reports (after model has been run)



System & Zone Name	System Type Principal Zone Activity	Type* Ret Zn	Area sqft	Design Flow Supply cfm	Supply cfm/sf	Min Flow	Design Ventilation OSA cfm	OSA %	OSA cfm/sf	OSA cfm/per	Design Capacity Cool tons	Cool sf/ton	Cool cfm/ton	Cool Btuh/sf	Heat Btuh/sf	Hrs Outside Thrl-Range Cool Hrs	Heat Hrs
AC-3	Variable Air Volume	D	36,439	33,000	0.91	46%	14,402	44%	0.395	63.0	126	290	262	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	463	263	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	263	35.2	36.0	0	0
··· L1 N solvents Zn		C	756	1,512	2.00	50%	658	44%	0.871	174.2	6	131	263	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	263	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	263	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	263	85.7	54.5	0	0
··· L2 S open offices Zn		C	5,167	6,490	1.26	28%	2,826	44%	0.547	109.4	25	209	263	57.4	44.1	0	0
··· L2 core offices Zn		C	616	370	0.60	54%	161	44%	0.262	52.3	1	438	263	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	263	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	263	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	263	91.3	56.6	0	0
··· L2 W RSL labs Zn		C	3,019	6,038	2.00	50%	2,629	44%	0.871	174.2	23	131	263	91.3	56.6	0	0
··· L2 core corr Zn		C	670	600	0.90	100%	261	44%	0.390	78.0	2	293	263	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	263	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	..	..	..	..	..	..	126	..	..	..	..	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)

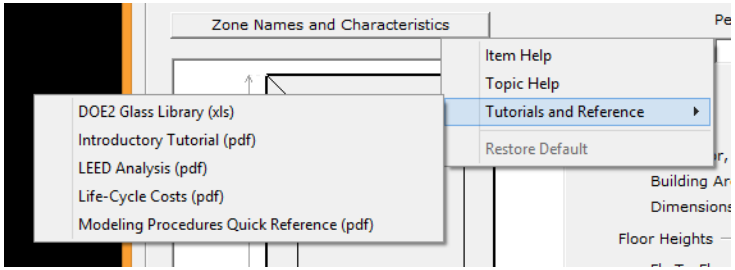
Utility & Economics tab

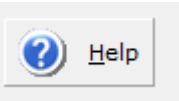


Rate structure

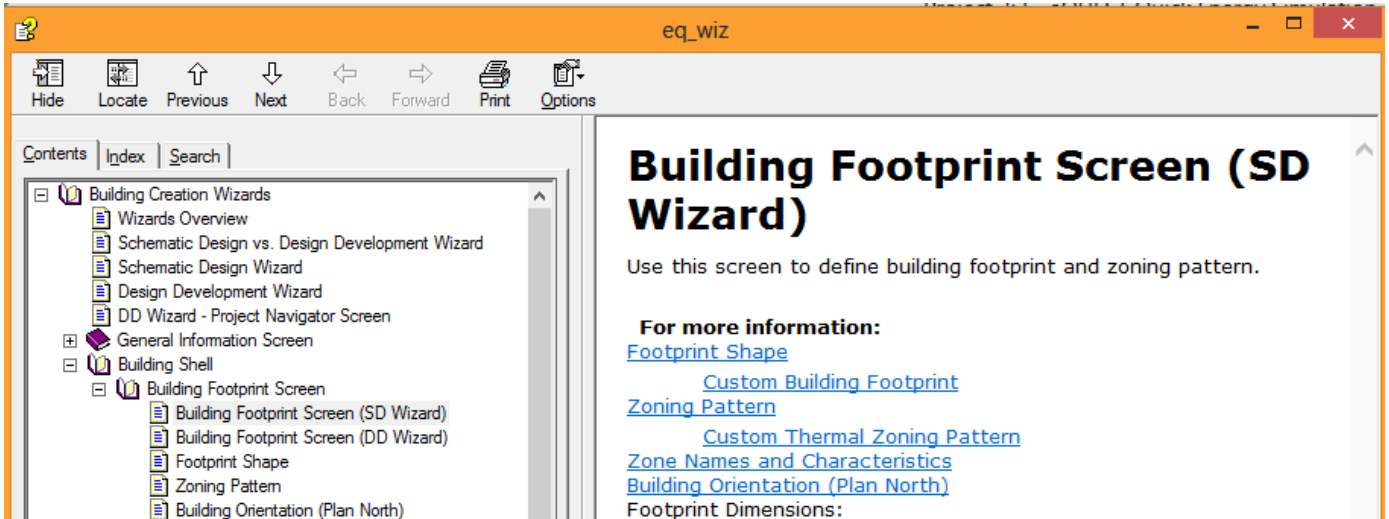
Where to go for help

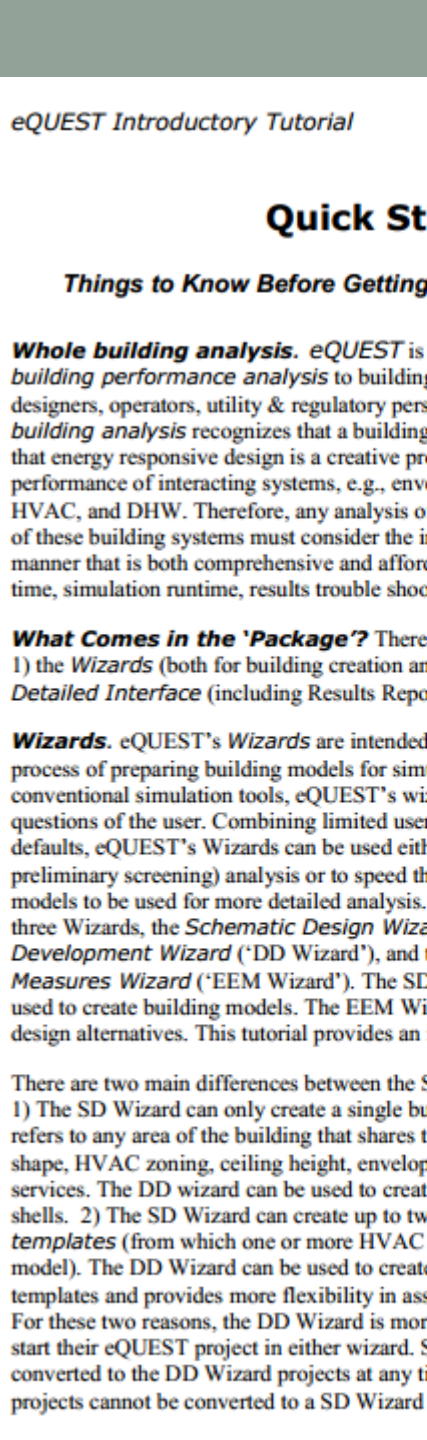
- In wizard modes:
  - Right click on an input field to get to tutorials





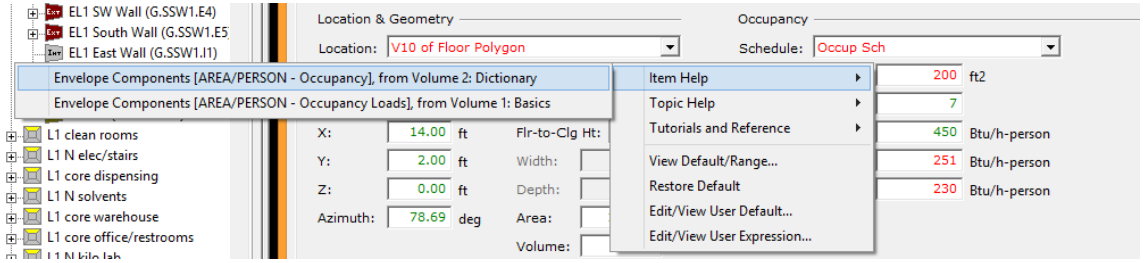
Help button on wizard tabs goes to built-in help



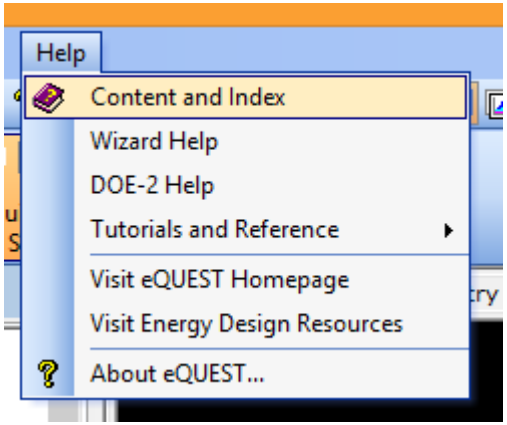


Help in detailed mode

- Right mouse click on any input field



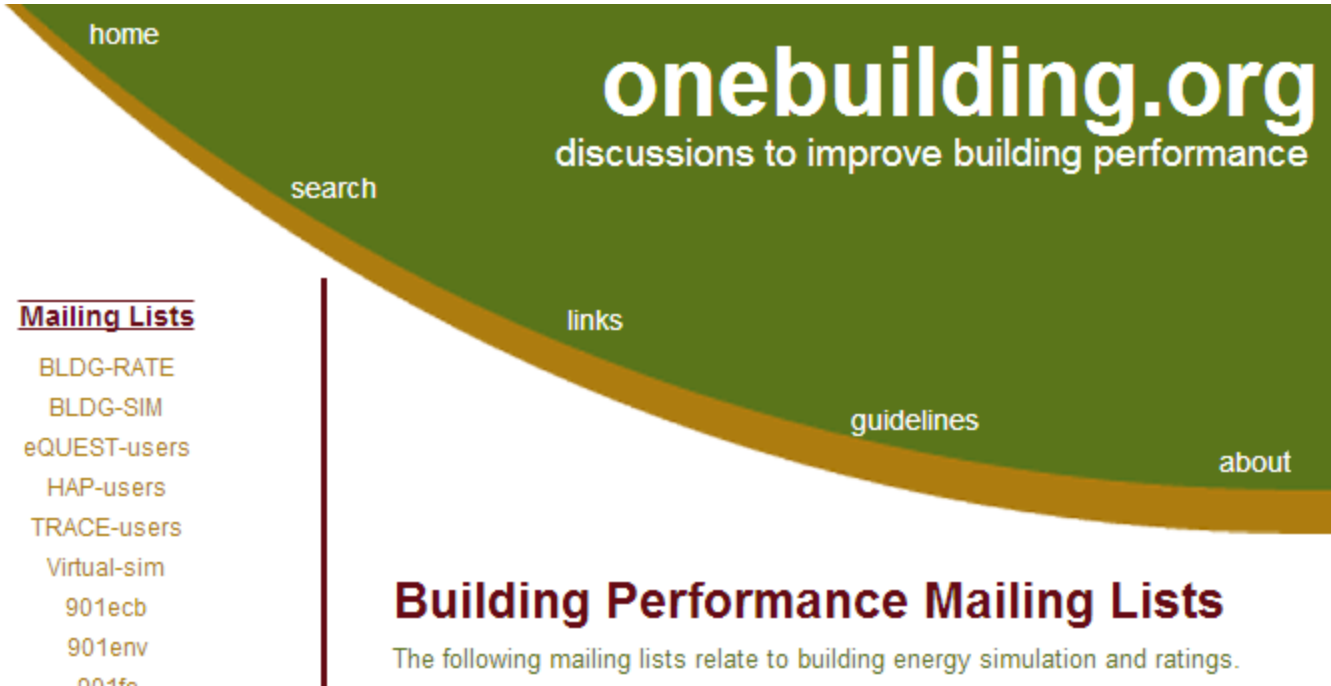
- Help menu



- Help file is usually correct

Help from elsewhere

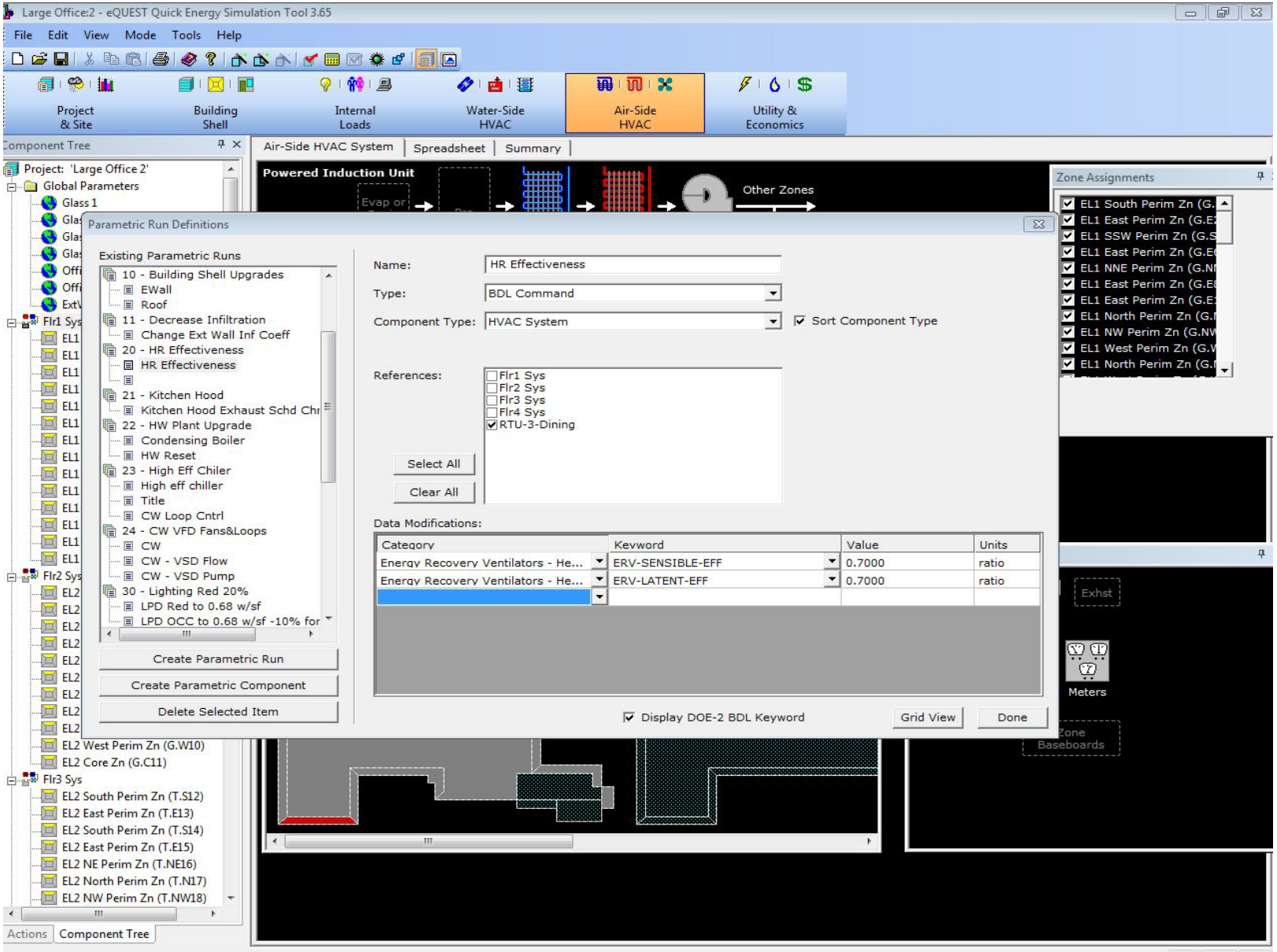
- eQUEST files and documentation at doe2.com
- eQUEST users and BLDG-SIM email lists
  - Sign up at www.onebuilding.org
- Or call us



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)

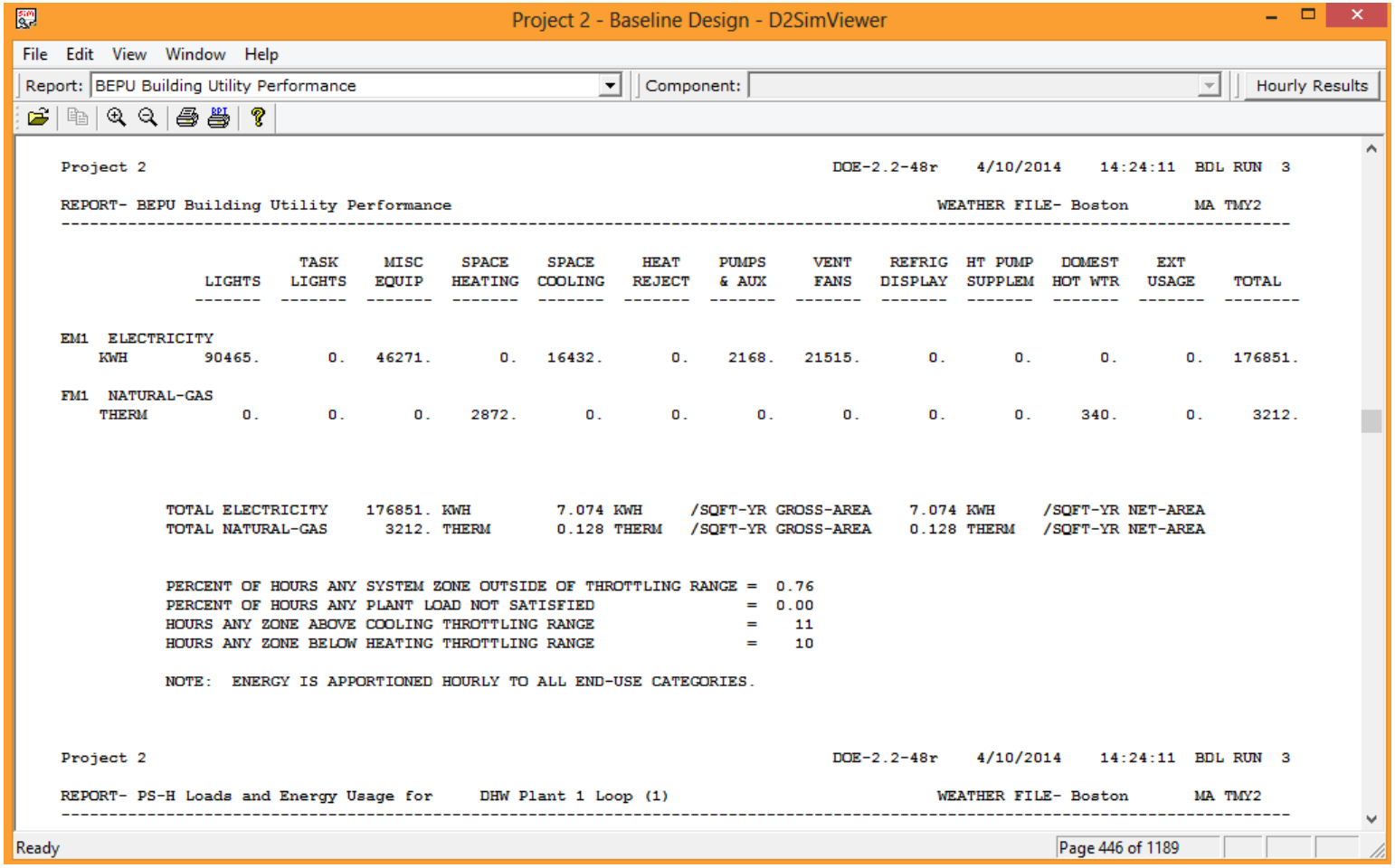
Parametric runs



Detailed output reports

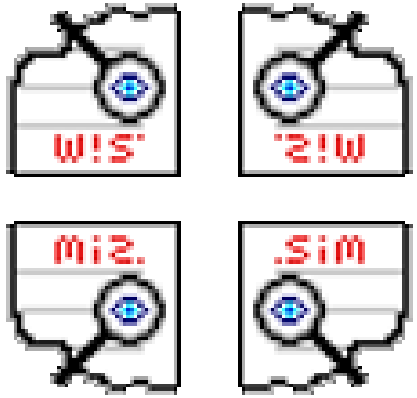
- As well as colorful plots and tables, eQUEST also outputs the SIM file
- The SIM file contains:
  - Everything the graphical reports contain, plus
  - Detailed reports on loads, systems, and economics
- eQUEST comes with SIM file viewing software (D2SimViewer)
- SIM files can also be opened with any 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
Ready
Page 446 of 1189

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		COOL LOAD (MBTU) (KBTU/HR)	HEAT LOAD (MBTU) (KBTU/HR)	ELEC USE (KWH) (KW)	FUEL USE (MBTU) (KBTU/HR)		00 10	10 20	20 30	30 40	40 50	50 60	60 70	70 80	80 90	90 100	100 +	TOTAL RUN HOURS
B-1																		
	SUM		-11346.9	8135.9	14191.[illegible]	LOAD	0	326	1083	1772	1389	630	888	713	631	531	797	8760
	PEAK		[illegible]	2.3	[illegible]	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	[illegible]	0.0	[illegible]		ELEC	4273	1215	1077	873	790	371	152	9	0	0	0	[illegible]
	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

Boiler annual efficiency?

Boiler loading?

Chiller annual efficiency?

Chiller run hours?

Pump flow?

Pump power?

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
⓿ 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: ~25 Btu/sf*win/flr ratio*SC+Internal
LS-C	Peak space load per sqft (building total)	% core*core Btuh/sf + % perim*perim Btuh/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)
❺ 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)
❺ 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 simulataneous)
SS-A	For unitary DX, monthly pattern of loads	unitary loads are not totaled in SS-D
❺ SS-P	Average EER for unitary DX	cooling load / (compressor+fan kWh)
⓳ SS-J	System load and size checks	sqft/ton, cfm/sqft, min osa/per, cool/heat pk (Btuh/sf)
❶ SS-K	Avg temperature, cooling and heating hours	Compare to t-stat set points (includes unconditioned!)
❶ SS-O	Hours under cooled/heated by time-of-day	Compare to t-stat set points & throttling range
❶ SS-F	Hours under cooled/heated by zone	Excessive hours indicate faulty control
❶ 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
⑧ PS-A	Monthly pattern of heating and cooling loads	confirm realistic pattern (compare SS-D & LS-D)
⑤ PS-C	Calculate overall equipment efficiencies	Load met / energy used (see SS-P for unitary eq.)
⑥ PS-C	Equipment part-load ranges (annual)	for monthly - see PS-H, for unitary equip - see SS-P
⑦ 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
③ 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
①BEPU	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)
②BEPU	Energy use by category	Compare relative magnitudes
② "	Energy use & cost intensity	Btu/sqft/year from BEPU, ($/sqft/year from ES-D)

①primary check item

❶secondary 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 Lights	Task Lights	Misc Equip	Space Heating	Space Cooling	Heat Reject	Pumps & Aux	Vent Fans	Dom Ht Wtr
Annual Energy USE (kWh)										
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
Incremental SAVINGS (MWh)		(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:

Usually heating penalty

		Misc Equip	Space Heating	Space Cooling	Heat Reject	Pumps & Aux	Vent Fans	Ht Pump Supp	Dom Ht Wtr
Annual Energy USE (MBtu)									
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
Incremental SAVINGS (MBtu)		(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%)	--	--	--	--	--	--

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 00-10	10-20	20-30	30-40	40-50	50-60	60-70	70-80	80-90	90-100	100+	TOTAL RUN HOURS
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	4	0	0	0	0	8760
lab 3 Zn	0	0	0	0	0	0	0	0	0	8274	371	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 00-10	10-20	20-30	30-40	40-50	50-60	60-70	70-80	80-90	90-100	100+	TOTAL RUN HOURS
lab 1 Zn	0	0	0	16	0	0	0	89	838	2131	1772	1365	1386	1226	3	8760
lab 2 Zn	0	0	0	0	0	0	7904	507	228	31	0	0	0	0	0	8760
lab 3 Zn	0	0	0	0	0	0	6338	1260	617	317	175	47	6	0	0	8760
lab 4 Zn	0	0	0	0	0	0	0	0	0	8708	52	0	0	0	0	8760
TOTAL	0	0	0	16												

Why?

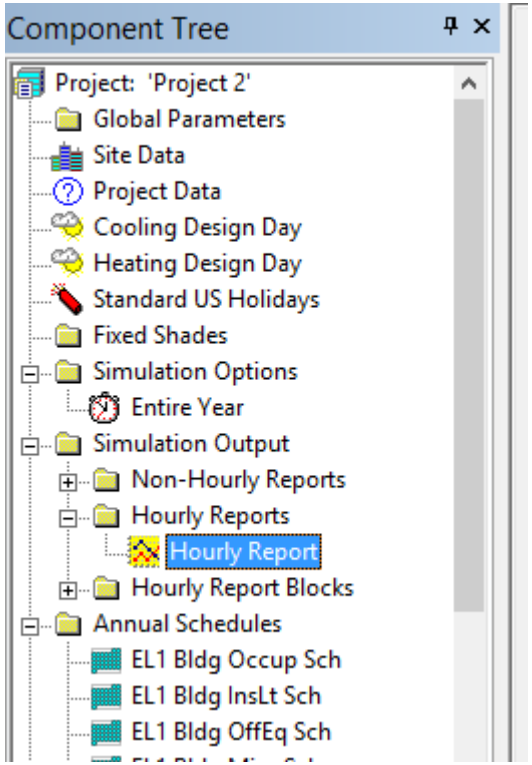
Diagnosing some common problems

- 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)

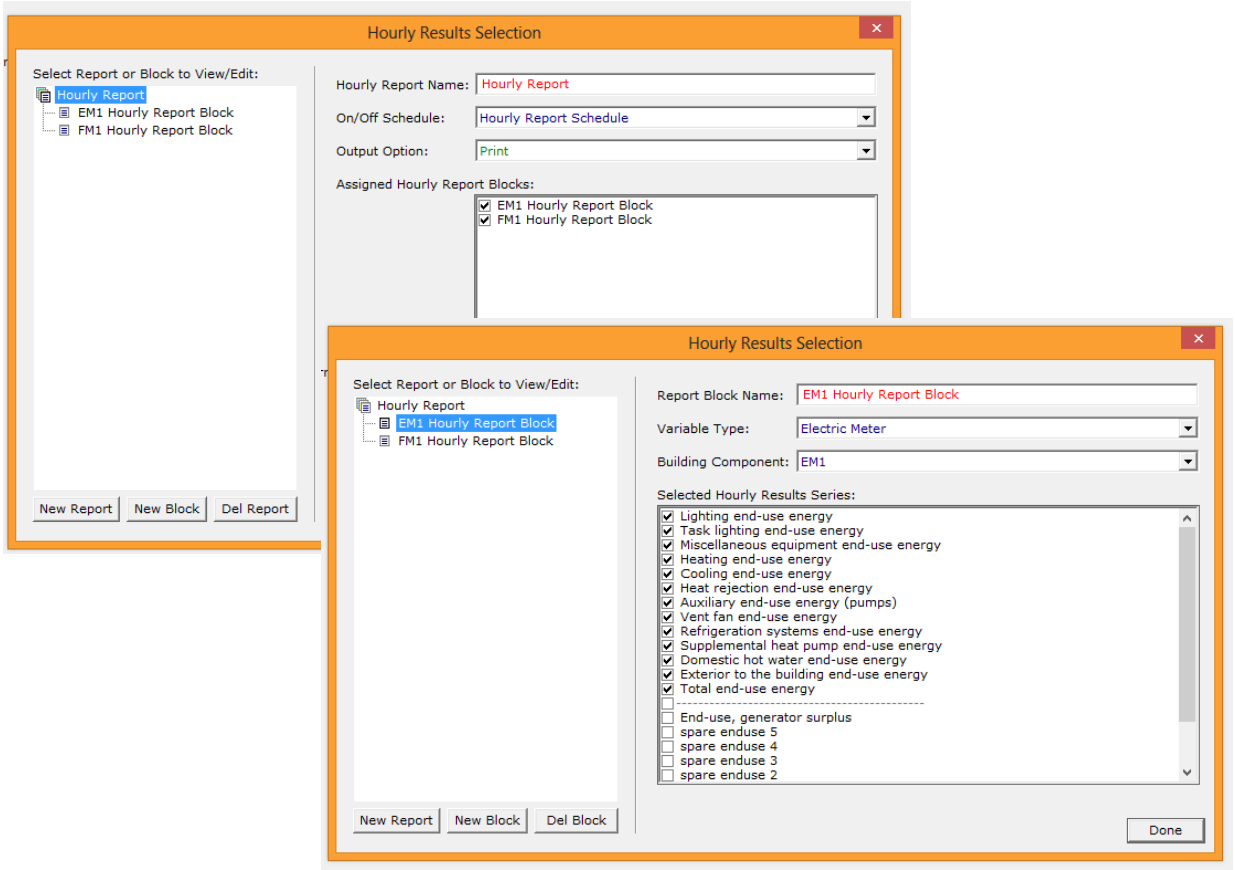
Setting up hourly reports



- 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)

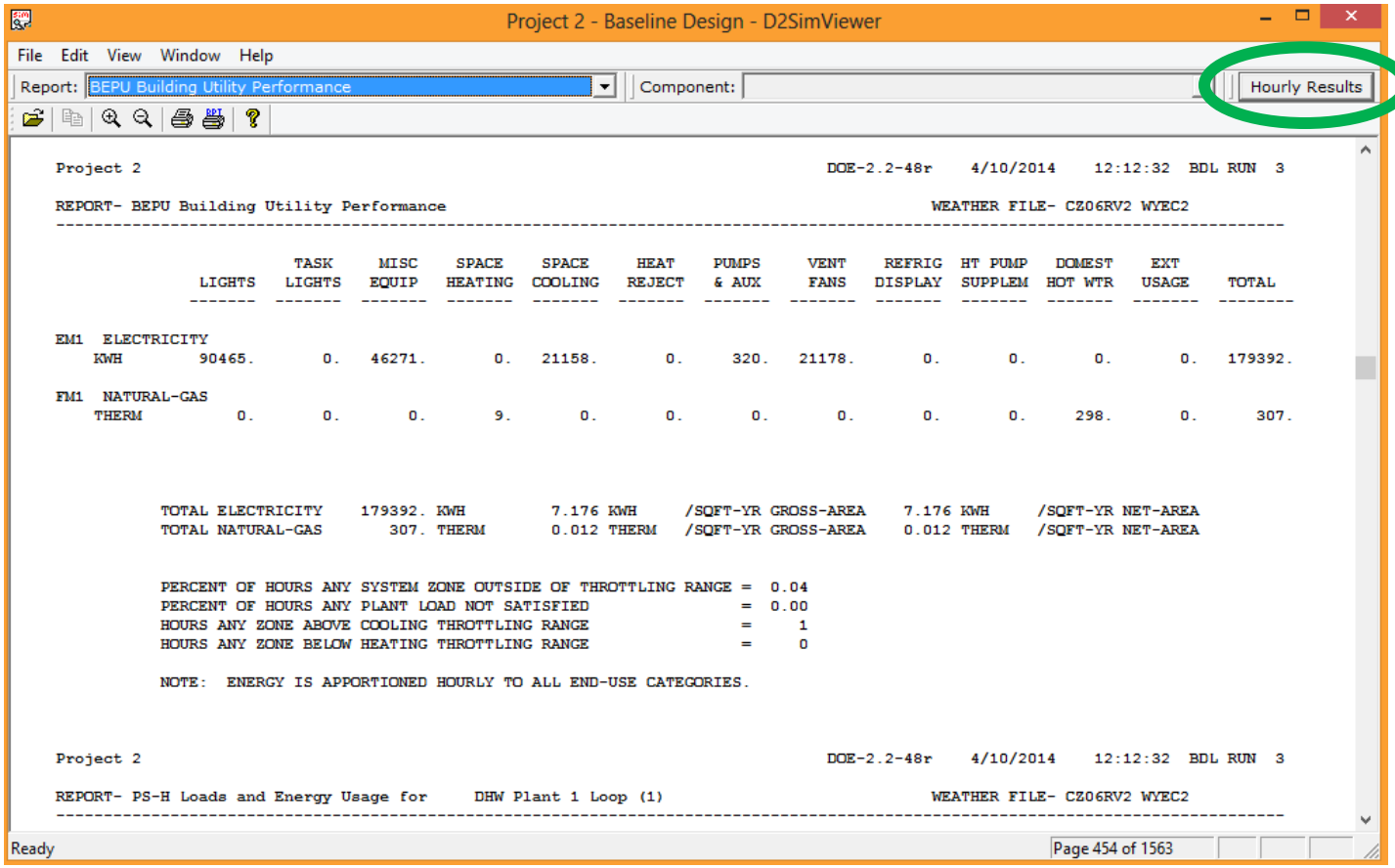
- “Report blocks” must be assigned to each hourly report
- For each block, select points of interest from list



Accessing hourly report data

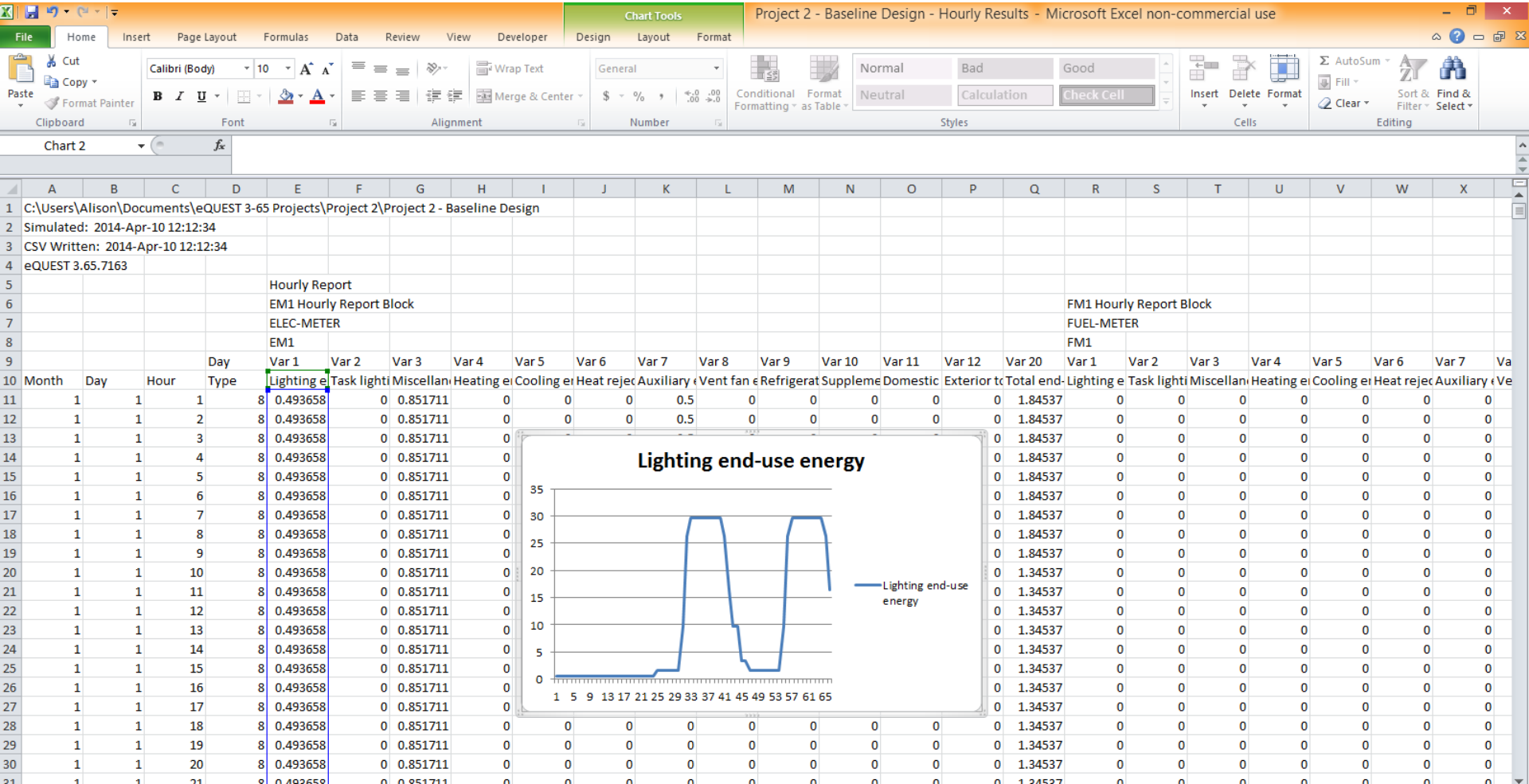
- Best way is via SIM file:

Button opens hourly reports in Excel



Hourly report data in Excel

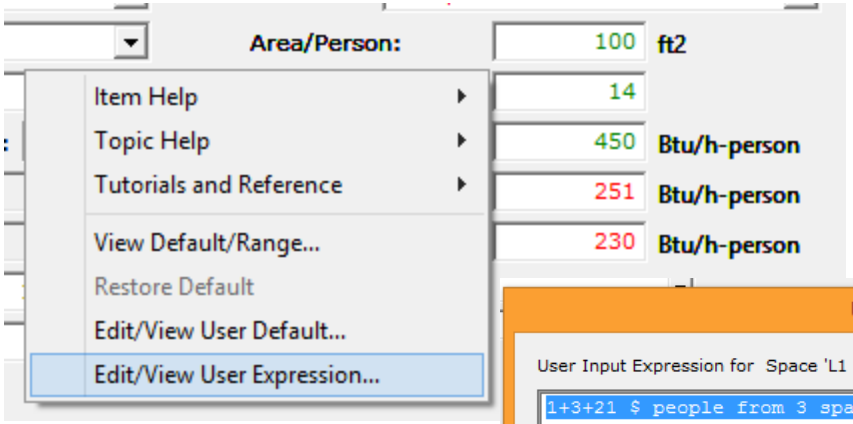
- Analyze and use data as desired



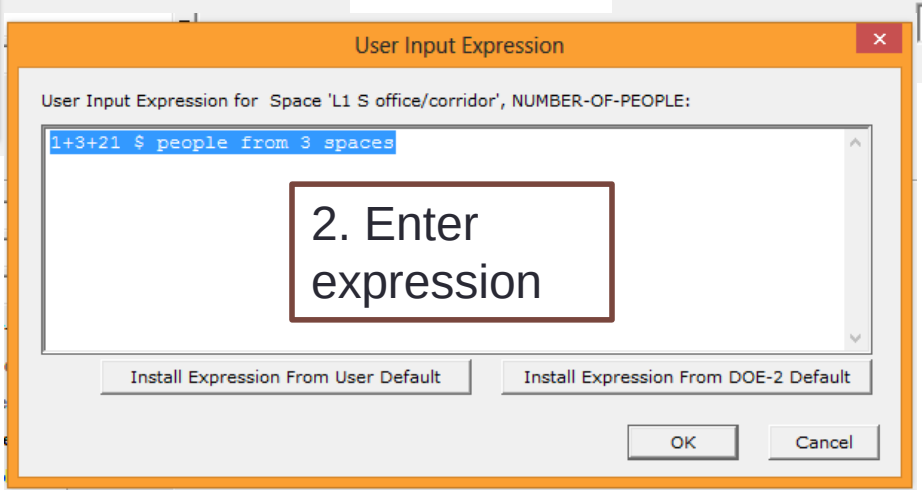
	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X
1	C:\Users\Alison\Documents\eQUEST 3-65 Projects\Project 2\Project 2 - Baseline Design																							
2	Simulated: 2014-Apr-10 12:12:34																							
3	CSV Written: 2014-Apr-10 12:12:34																							
4	eQUEST 3.65.7163																							
5					Hourly Report																			
6					EM1 Hourly Report Block													FM1 Hourly Report Block						
7					ELEC-METER													FUEL-METER						
8					EM1													FM1						
9				Day	Var 1	Var 2	Var 3	Var 4	Var 5	Var 6	Var 7	Var 8	Var 9	Var 10	Var 11	Var 12	Var 20	Var 1	Var 2	Var 3	Var 4	Var 5	Var 6	Var 7	Va
10	Month	Day	Hour	Type	Lighting e	Task lighti	Miscellan	Heating e	Cooling e	Heat rejec	Auxiliary	Vent fan e	Refrigerat	Suppleme	Domestic	Exterior t	Total end-	Lighting e	Task lighti	Miscellan	Heating e	Cooling e	Heat rejec	Auxiliary	Ve
11	1	1	1	8	0.493658	0	0.851711	0	0	0	0.5	0	0	0	0	0	1.84537	0	0	0	0	0	0	0	
12	1	1	2	8	0.493658	0	0.851711	0	0	0	0.5	0	0	0	0	0	1.84537	0	0	0	0	0	0	0	
13	1	1	3	8	0.493658	0	0.851711	0									1.84537	0	0	0	0	0	0	0	
14	1	1	4	8	0.493658	0	0.851711	0									1.84537	0	0	0	0	0	0	0	
15	1	1	5	8	0.493658	0	0.851711	0									1.84537	0	0	0	0	0	0	0	
16	1	1	6	8	0.493658	0	0.851711	0									1.84537	0	0	0	0	0	0	0	
17	1	1	7	8	0.493658	0	0.851711	0									1.84537	0	0	0	0	0	0	0	
18	1	1	8	8	0.493658	0	0.851711	0									1.84537	0	0	0	0	0	0	0	
19	1	1	9	8	0.493658	0	0.851711	0									1.84537	0	0	0	0	0	0	0	
20	1	1	10	8	0.493658	0	0.851711	0									1.34537	0	0	0	0	0	0	0	
21	1	1	11	8	0.493658	0	0.851711	0									1.34537	0	0	0	0	0	0	0	
22	1	1	12	8	0.493658	0	0.851711	0									1.34537	0	0	0	0	0	0	0	
23	1	1	13	8	0.493658	0	0.851711	0									1.34537	0	0	0	0	0	0	0	
24	1	1	14	8	0.493658	0	0.851711	0									1.34537	0	0	0	0	0	0	0	
25	1	1	15	8	0.493658	0	0.851711	0									1.34537	0	0	0	0	0	0	0	
26	1	1	16	8	0.493658	0	0.851711	0									1.34537	0	0	0	0	0	0	0	
27	1	1	17	8	0.493658	0	0.851711	0									1.34537	0	0	0	0	0	0	0	
28	1	1	18	8	0.493658	0	0.851711	0	0	0	0	0	0	0	0	0	1.34537	0	0	0	0	0	0	0	
29	1	1	19	8	0.493658	0	0.851711	0	0	0	0	0	0	0	0	0	1.34537	0	0	0	0	0	0	0	
30	1	1	20	8	0.493658	0	0.851711	0	0	0	0	0	0	0	0	0	1.34537	0	0	0	0	0	0	0	

User expressions

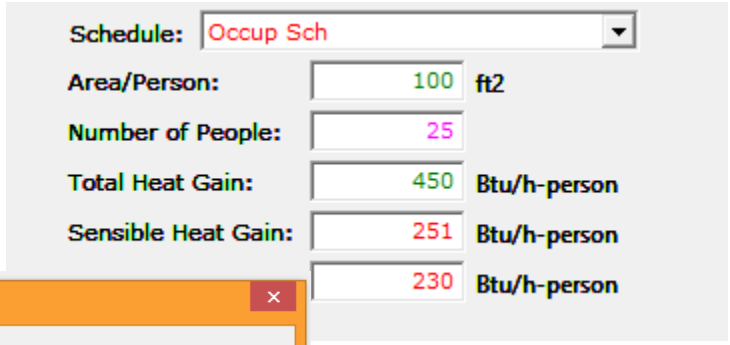
- Useful for adding comments or references
- Can refer to other components from within model (e.g. area of space, global parameters)
- BDL expressions based on Fortran 77 (e.g. ** means ^)



1. Right click on box



2. Enter expression



3. Magenta text indicates success

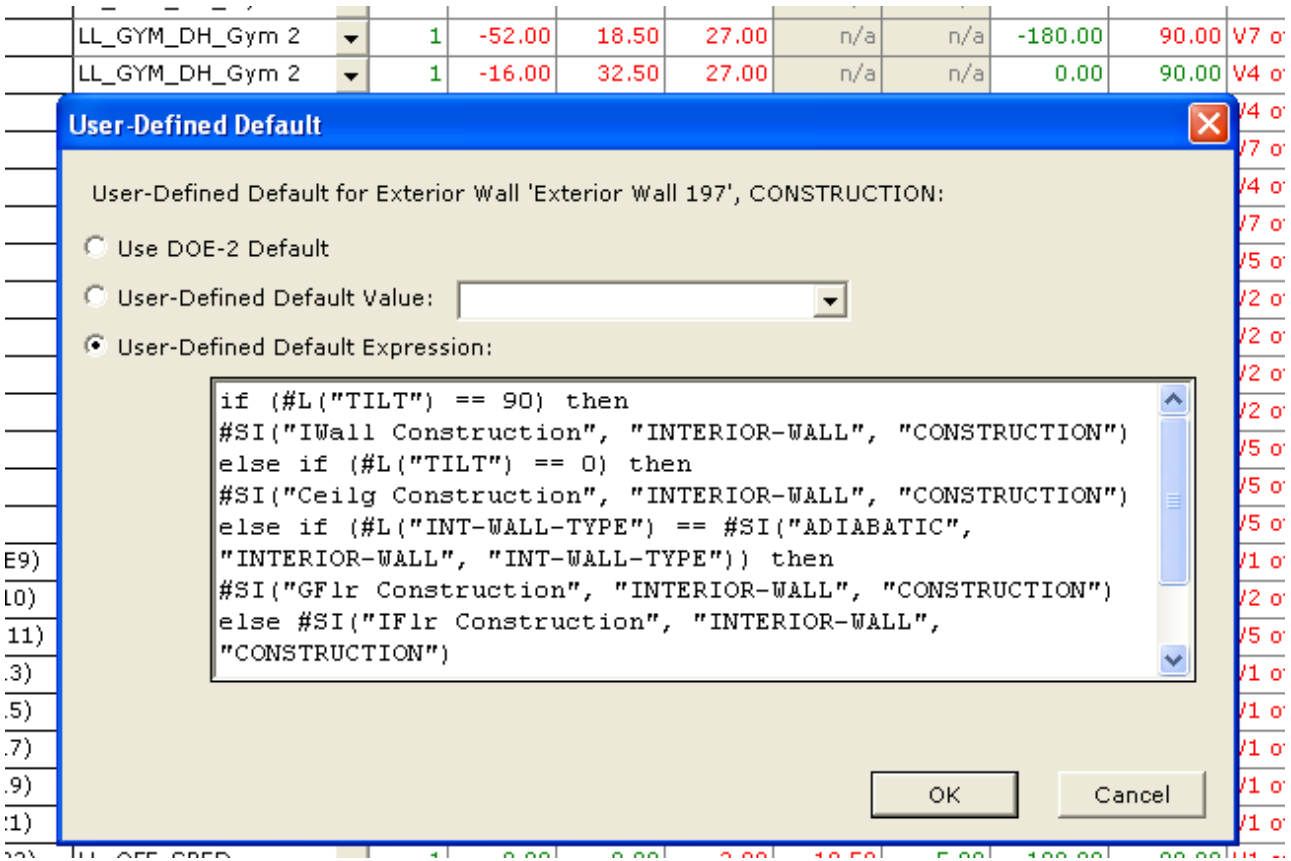
The meaning of colors

- 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 Z	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	

More complicated expressions

- Use BDL expressions to refer to other model components

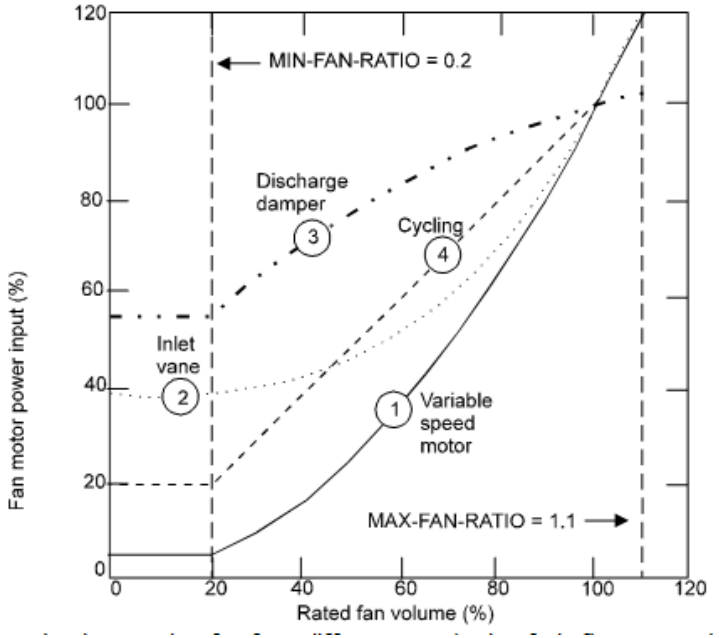


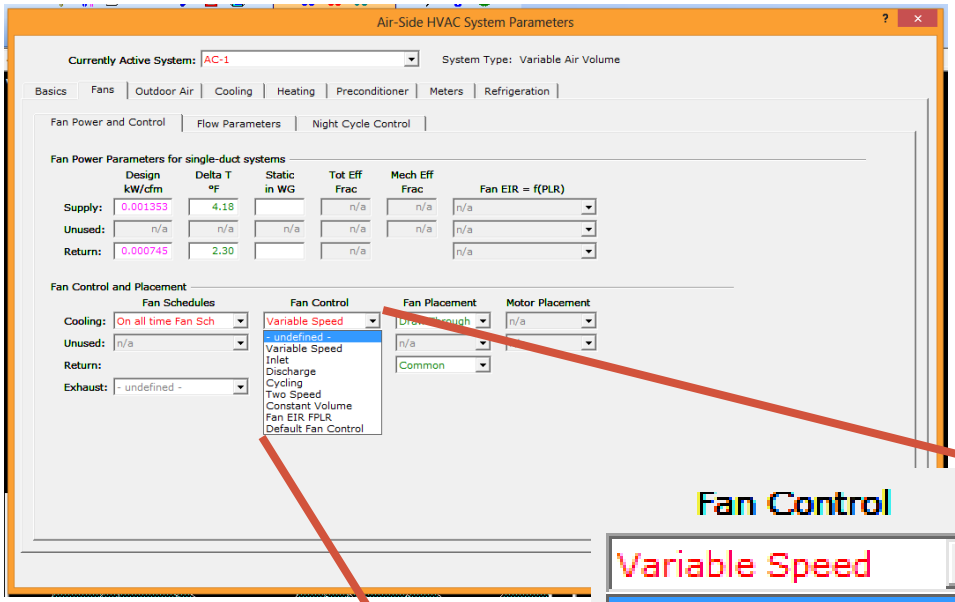
Custom curves

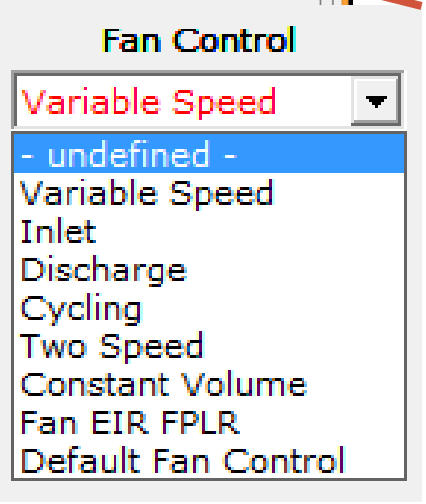
- Go beyond eQUEST's default assumptions about equipment performance
- Most common reasons to do this:
  - Chiller performance curves (savings associated with a particular model of chiller; performance data obtained from vendor)
  - Fan curves (e.g. to model static pressure reset controls or Appendix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



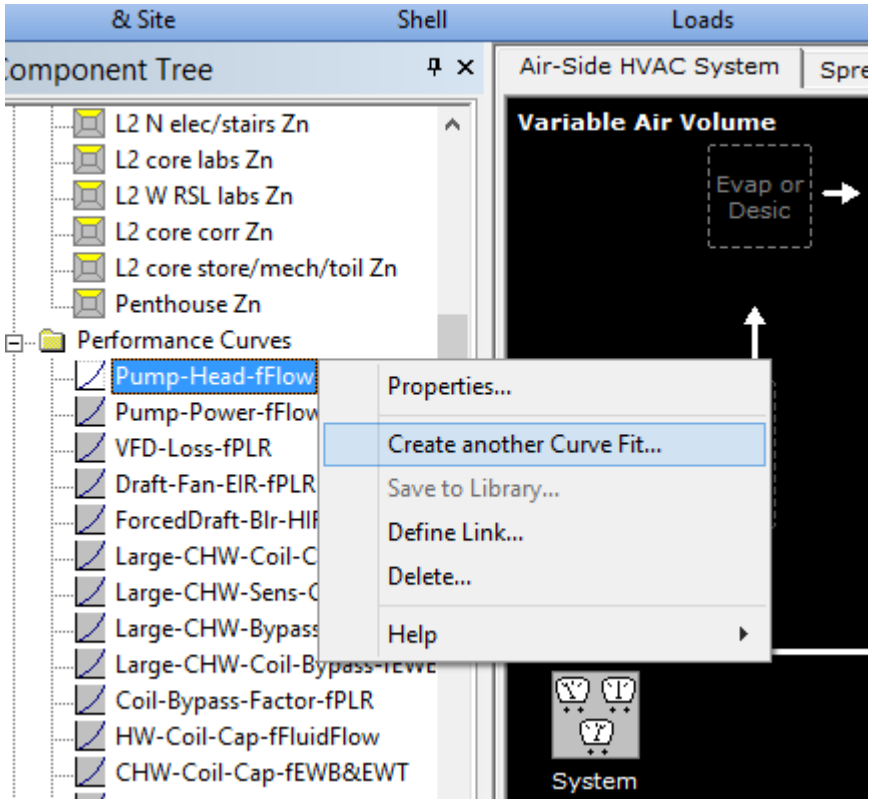


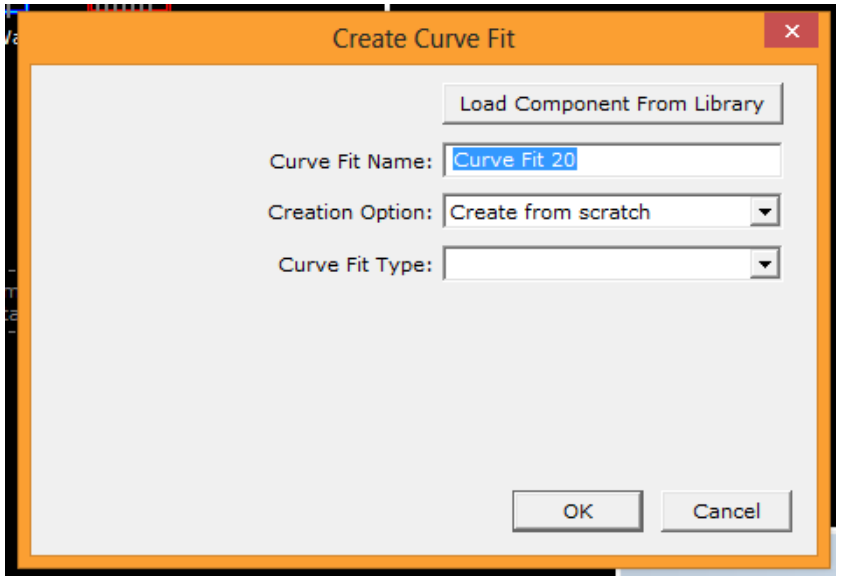


- Each option corresponds to a fan performance curve: %kW(% volume)

Fan curves (2)

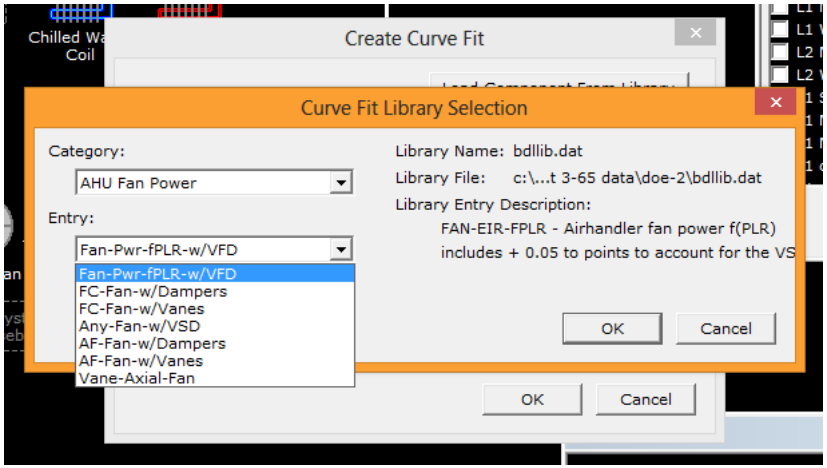
- Alternatively, a custom fan curve can be defined



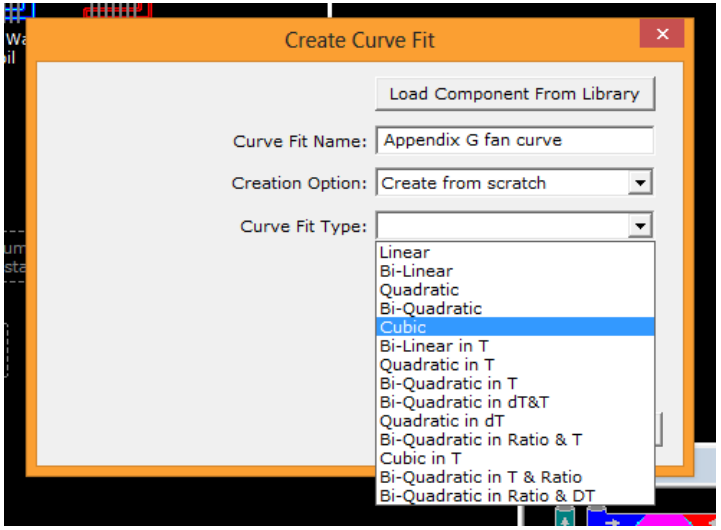


Fan curves (3)

- Library curves:
  - Some additional curves available here

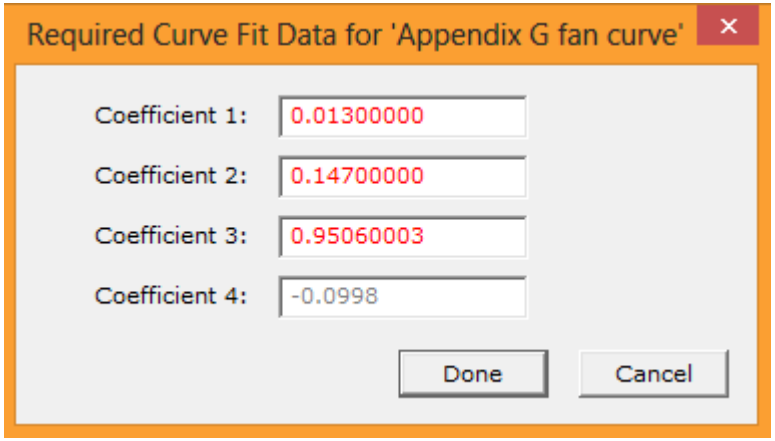


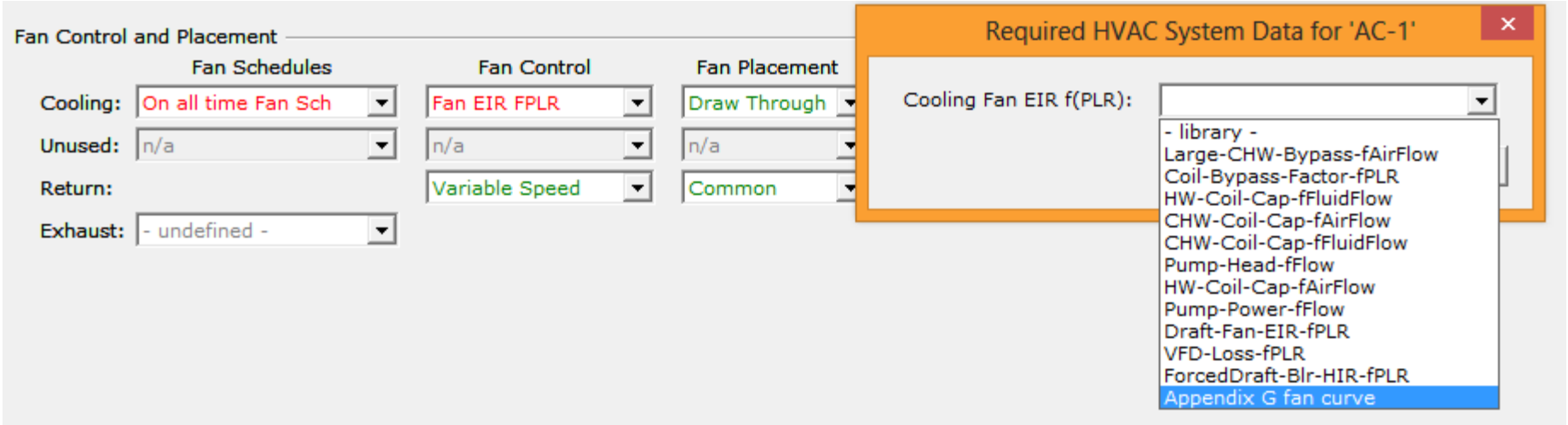
- Or custom curve:
  - Start from scratch



Fan curves (4)

- Appendix G VAV fan power curve
  (x = % 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

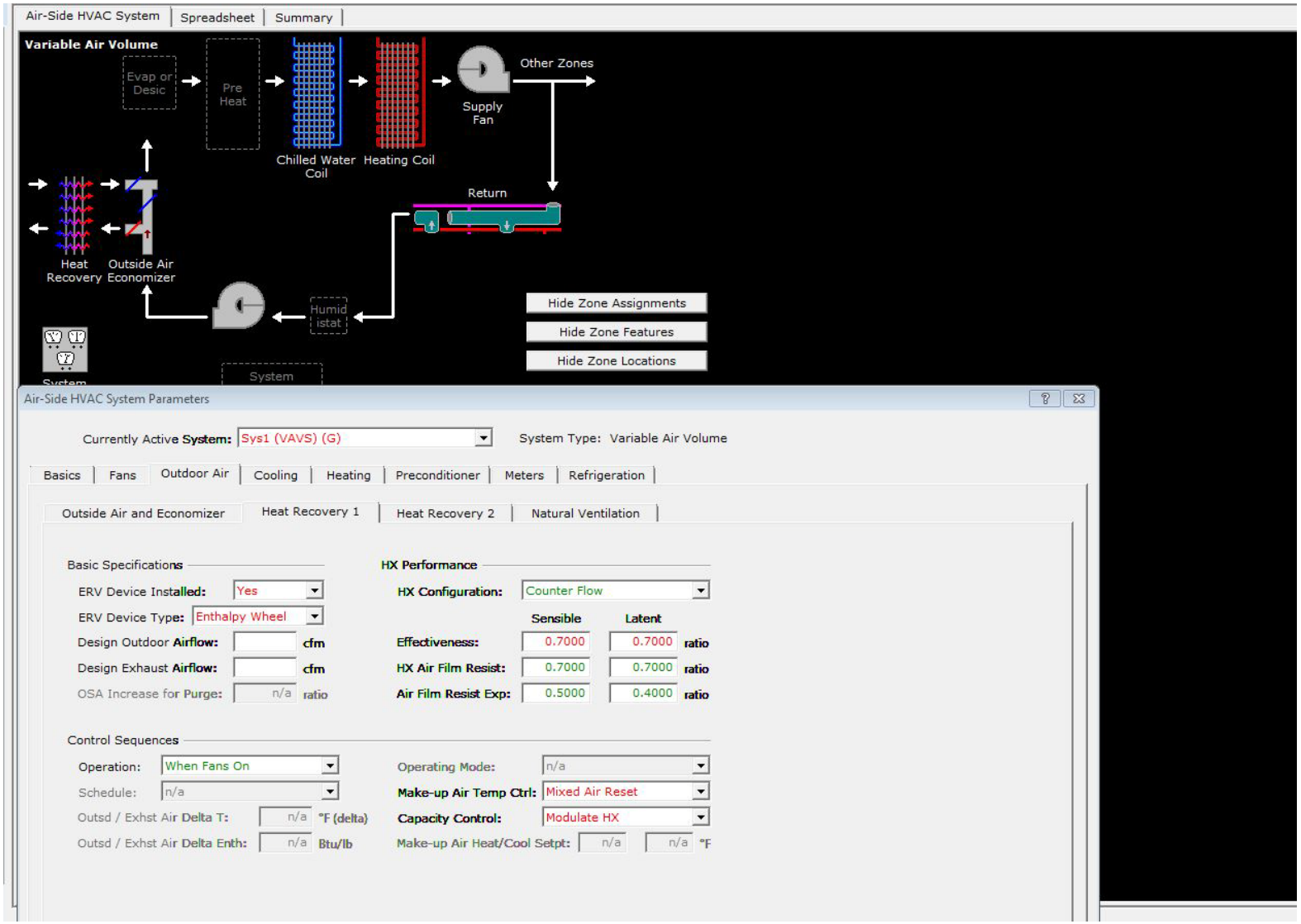




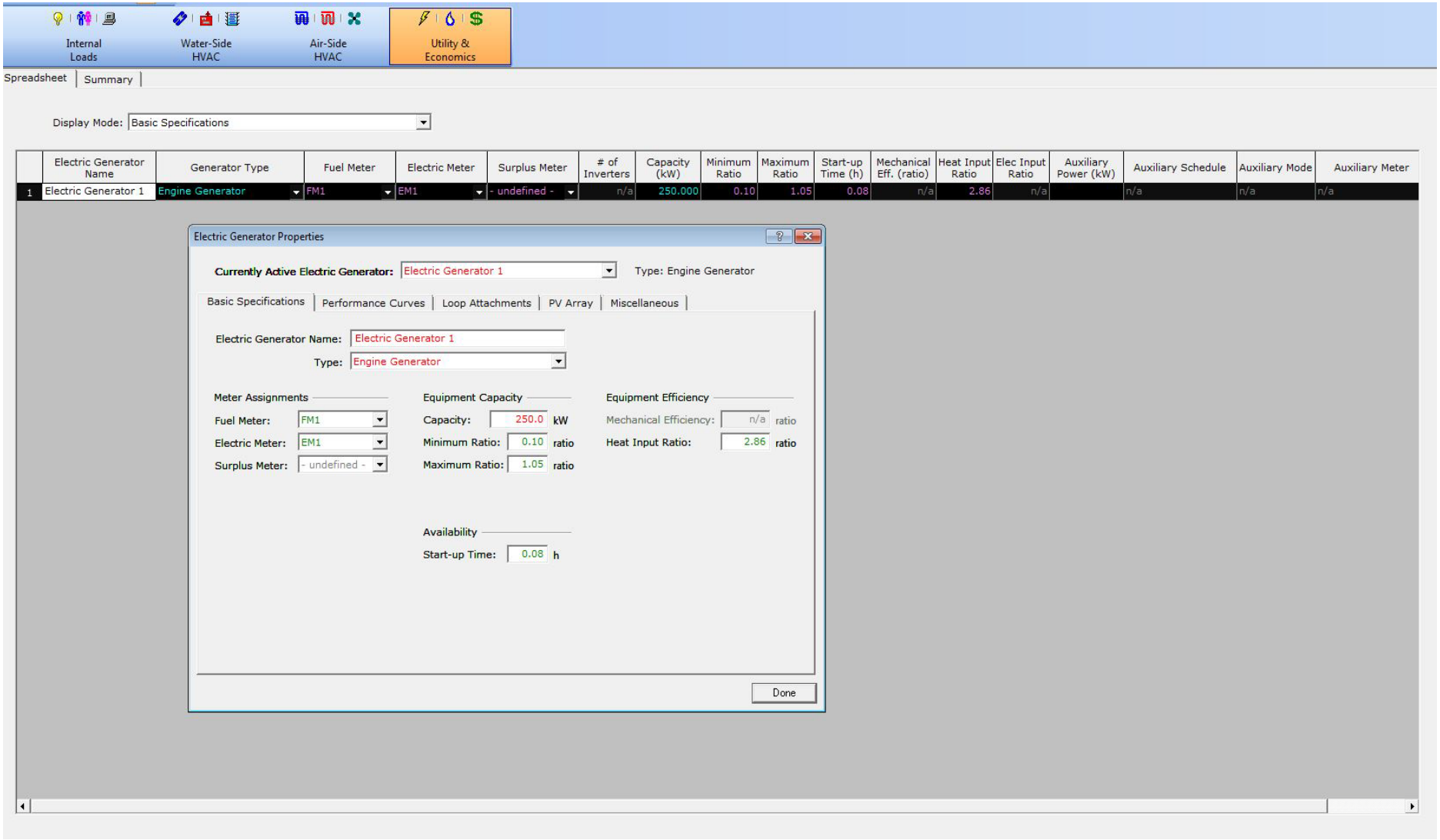
Advanced modeling topics

- 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

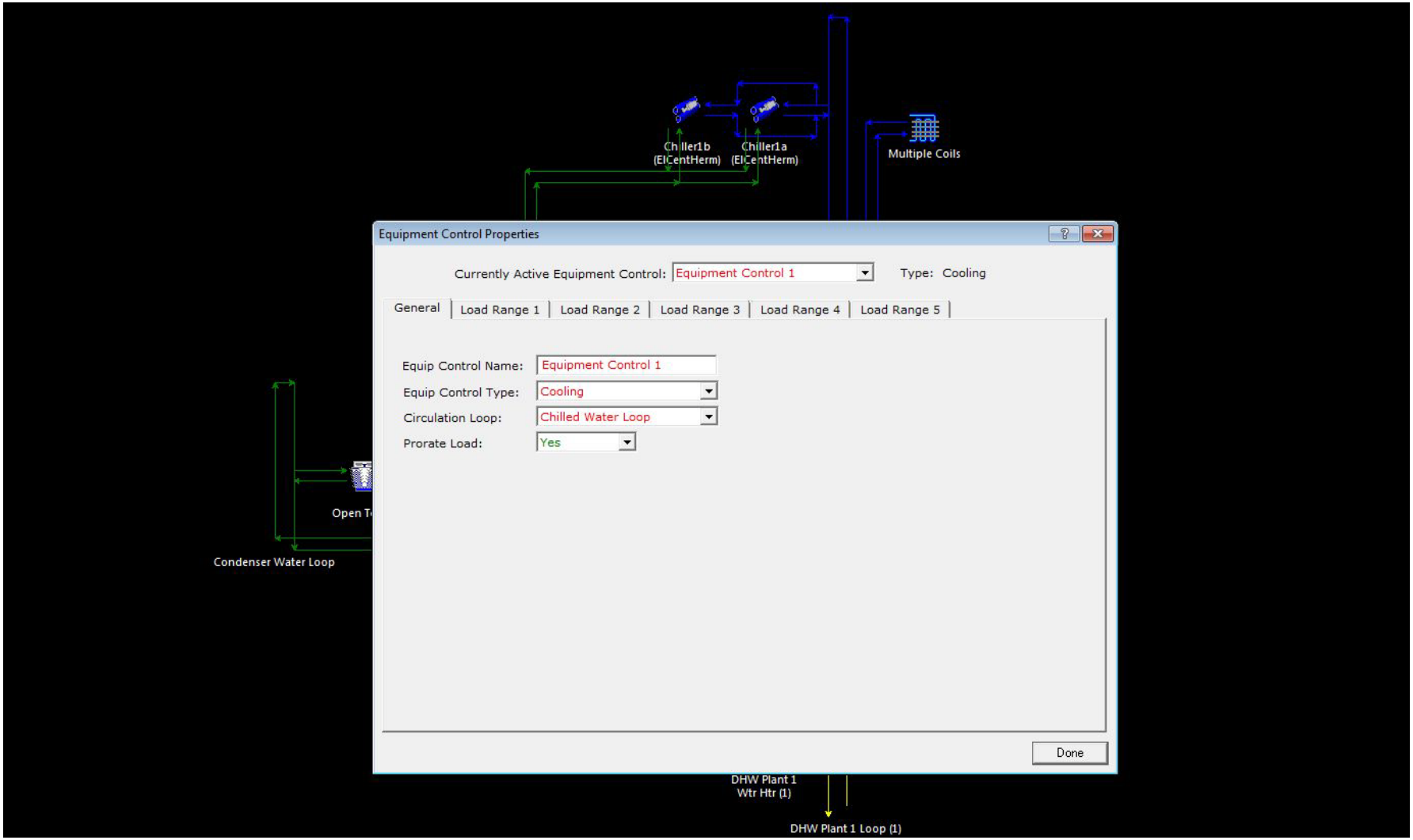
Exhaust air heat recovery



Electric generators

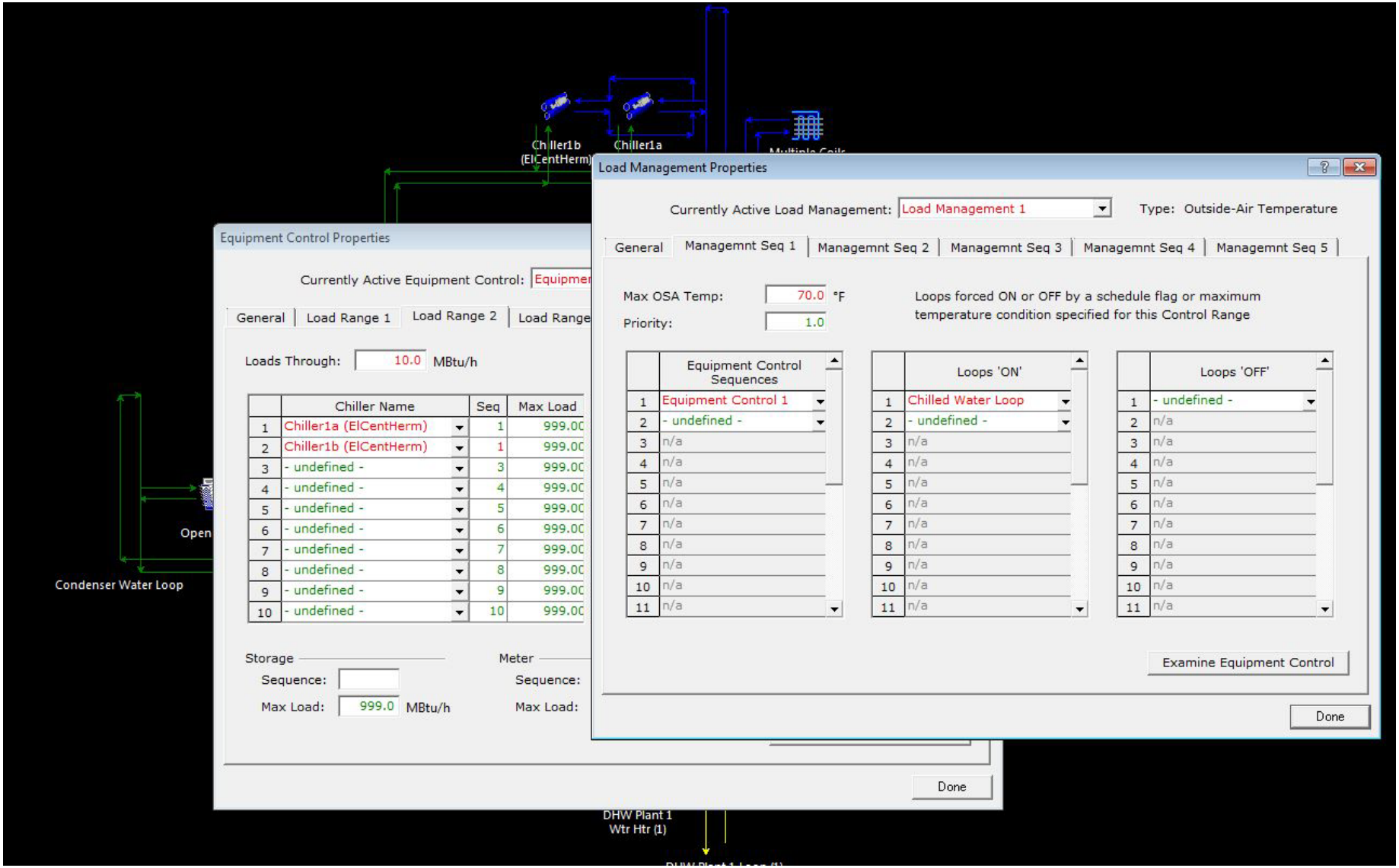


Equipment controls



Equipment controls (2)

Load management controls



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)

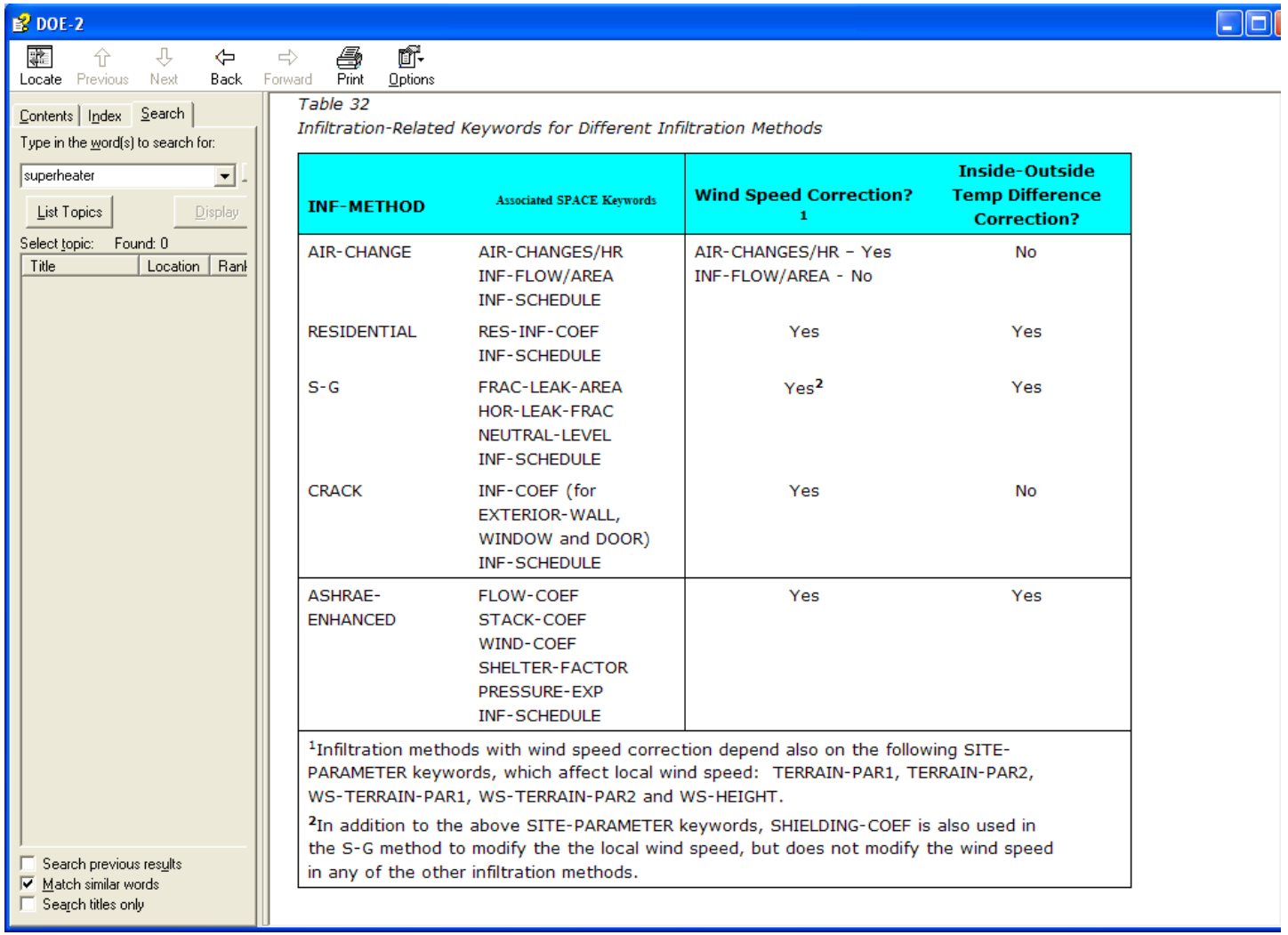


Table 32

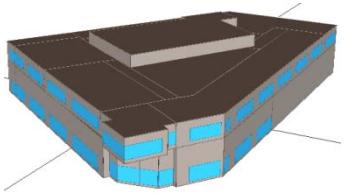
Infiltration-Related Keywords for Different Infiltration Methods

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[2]	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

[1]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.

[2]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.

Thanks for listening



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