



eQUEST ... the QUick Energy Simulation Tool

Imagine a building energy simulation tool comprehensive enough to be useful to ALL design team members, yet so intuitive ANY design team member could use it, in ANY or ALL design phases, including schematic design. We believe you'll find that eQUEST is well named because it provides something you've been looking for but until now have been unable to find ... a sophisticated, yet easy-to-use building energy use analysis tool. With eQUEST, you'll be able to provide professional-level results in an affordable level of effort.



**Evaluate today's newest building technologies ...
at the speed of tomorrow's design process**

eQUEST allows you to perform detailed analysis of today's state-of-the-art building design technologies using today's most sophisticated building energy use simulation techniques but without requiring extensive experience in the "art" of building performance modeling. This is accomplished by combining a *building creation wizard*, an *energy efficiency measure (EEM) wizard*, and a graphical results display module with a simulation "engine" derived from an advanced version of the DOE-2 building energy use simulation program.

Imagine being able to evaluate today's newest building technologies, at the speed of today's design process. Well... imagine no longer! See for yourself. eQUEST is available for you to download **FREE** from www.energydesignresources.com.



A trusted tool...

After two decades of continuous development and enhancement, DOE-2 is the most widely recognized and trusted building energy simulation program available today. eQUEST will guide you through the creation of a detailed DOE-2 building model, allow you to automatically perform parametric simulations of your design alternatives, and provide you with intuitive graphics that highlight the performance of your proposed design alternatives ... all within a fraction of the time previously required for professional-level analysis.

**The Building Creation Wizard gets you going so quickly,
it may seem like magic...**



Sophisticated energy use simulation programs have been in existence for more than two decades. Unfortunately, these programs have always required detailed knowledge of both the ART of building energy use analysis and the SCIENCE of the particular energy analysis program itself. The result has been that only specialists could reliably use the sophisticated simulation programs. The level of effort and associated expense generally meant that simulation analysis occurred only once during the design process, most frequently nearer the end of the process, when the most detailed inputs were available. Such a process was not only expensive... it did little to facilitate collaborative energy efficient design (i.e., involving several design team members) throughout the entire design process (i.e., from schematic through final design).

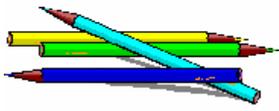
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The Building Creation Wizard acts as an expert modeling advisor...



eQUEST 3.0 helps to overcome past barriers to simulation by incorporating two building creation wizards: the Schematic Design Wizard (the "Schematic Wizard") and the Design Development Wizard (the "DD Wizard"), as well as an Energy Efficiency Measure wizard (the "EEM Wizard"). It's like having an expert advisor, operating between you and the DOE-2 energy simulation program. Either Wizard will guide you through a series of steps designed to allow you to fully describe the principal energy-related features of your design. The wizards then create a detailed description of the proposed design as required DOE-2. At each step of describing your building design, the wizards provide easy-to-understand choices of component and system options.

Schematic Design Wizard



Users may elect to begin the building simulation process by using the Schematic Wizard. The sequence of steps the wizard takes you through allows you to describe the building's architectural features and its heating, ventilating, and air-conditioning (HVAC) equipment. The steps are organized so that the most general project information is requested first (Figure 1), followed by more detailed architectural and HVAC information (Figures 2 and 3).

Figure 1
High-level eQUEST project information: building type (sets many subsequent defaults), weather location, heat/cool source (red fonts are user inputs, green fonts are wizard-provided defaults)

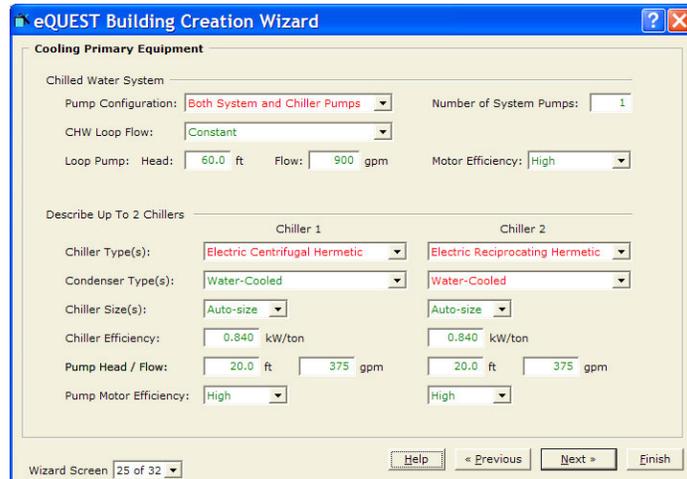
The screenshot shows the 'General Information' screen of the eQUEST Building Creation Wizard. It contains several input fields and dropdown menus. The 'Project Name' is '2-Story High School'. The 'Building Type' is 'School, Secondary (High School)'. The 'Energy Code Compliance Analysis' is set to 'none'. Under 'Building Location, Utilities and Rates', the 'Coverage' is 'California (Title 24)', 'Region' is 'Los Angeles Area (CZ06)', and 'City' is 'Los Angeles AP'. The 'Utility' section shows 'Electric' as 'SCE (CA)' and 'Rate' as 'TOU-8A (> 500 kW, < 2)'. The 'Gas' section shows 'SCG (CA)' and 'GN-10 (buildings with < 2)'. The 'Area and Floors' section shows 'Building Area' as '150,000 ft2', 'Number of Floors: Above Grade' as '2', and 'Below Grade' as '0'. The 'Cooling and Heating' section shows 'Cooling Equip' as 'Chilled Water Coils' and 'Heating Equip' as 'Hot Water Coils'. The 'Other Data' section shows 'Analysis Year' as '2002' and 'Daylighting Controls' as 'No'. At the bottom, there are 'Help', '< Previous', 'Next >', and 'Finish' buttons, and a 'Wizard Screen 1 of 32' indicator.

The screenshot shows the 'Building Footprint' screen of the eQUEST Building Creation Wizard. It features a diagram of an H-shaped building footprint with dimensions X1, X2, X3, Y1, Y2, and Y3. The 'Footprint Shape' is 'H-Shape' and the 'Zoning Pattern' is 'Perimeter / Core'. The 'Building Orientation' is 'Plan North: North'. The 'Footprint Dimensions' section lists: 'Perimeter Zone Depth: 30.0 ft', 'X1: 356.0 ft', 'Y1: 273.9 ft', 'X2: 109.5 ft', 'Y2: 82.2 ft', 'X3: 136.9 ft', and 'Y3: 109.5 ft'. The 'Area Per Floor, Based On' section shows 'Building Area / Number of Floors: 75,000 ft2' and 'Dimensions Specified Above: 75,000 ft2'. The 'Floor Heights' section shows 'Flr-To-Flr: 13.0 ft' and 'Flr-To-Ceiling: 9.0 ft'. At the bottom, there are 'Help', '< Previous', 'Next >', and 'Finish' buttons, and a 'Wizard Screen 3 of 32' indicator.

Figure 2
eQUEST building geometry information: use this screen to describe the building footprint and HVAC zoning. This can rely on automatic shapes or user-defined "custom" shapes (see Figure 9)

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Figure 3
eQUEST water-side information: use this screen to describe the central plant primary cooling equipment.



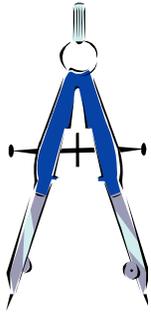
When to use the Schematic Design Wizard?

The Schematic Wizard is designed to support the earliest design phase, when information is most limited. Although time may also be limited, with even a little practice, you will find that you can explore the energy impacts of numerous design features in an hour or less. The Schematic Wizard is also well suited for smaller, simpler structures. Other features include the following:

- Building geometry can rely on predefined generic shapes, or custom user input via a drawing tablet, including importing & tracing DWG plan files.
- Currently, the Schematic Wizard is limited to one building shell and one footprint, i.e., only one structure with all floors in the structure sharing the same basic footprint shape and thermal zoning pattern.
- Up to two different types of HVAC systems can be described in any one Schematic Wizard project (e.g., built-up chilled water plus rooftop DX units). There are 60+ HVAC system types to choose from.
- The description of internal loads relies on generic, code-based activity area types having default lighting and equipment power densities.
- The user can choose between simple building schedule information using occupied vs. unoccupied times and allowing up to two seasons per year or detailed, hour-by-hour occupancy and equipment usage profiles with more flexible season definitions.
- Zone assignments for internal loads, schedule, and HVAC system types are simple and schematic in detail.
- Defaults, categorized by building type, are provided for ALL wizard inputs.

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Design Development Wizard (DD Wizard)



The Design Development Wizard (the "DD Wizard") is designed for later, more detailed design (i.e., during the Design Development phase), when more detailed information is available. It is also better suited for larger, more complicated structures, or for use with more detailed internal loads, schedules, and HVAC system assignment requirements. Users may begin their projects using the DD Wizard, or, if they began their building simulation project using the Schematic Wizard, they can elect at any time to continue their project analysis and development using the DD Wizard, e.g., as more detailed project information becomes available. Other features include the following:

- ^ The generic and custom drawing capabilities of the DD Wizard work the same as in the Schematic Wizard, however, in the DD Wizard, users can describe multiple building shell components, each with similar or very different geometry, shell properties, and HVAC zoning and/or systems.
- ^ Separate building shell components may be stacked (e.g., to form setback mid- or high-rise designs), or placed adjacent to one another (e.g., to form separate wings or a campus of separate structures).
- ^ The same 60+ HVAC system types are available for use in the DD Wizard, however, there is effectively no limit on the number of these different system types that can be used in a single project.
- ^ The description of internal loads can use generic, code-based activity area types (as in the Schematic Wizard), or users may provide much more detailed, even zone-by-zone, descriptions of internal loads and HVAC system assignments.
- ^ Building schedule information is in the form of hour-by-hour descriptions of building occupancy and equipment usage profiles.
- ^ Defaults, categorized by building type, are provided for ALL wizard inputs.

Not magic... just intelligent dynamic defaults



Both the Schematic and DD Wizards offer advice in the form of "intelligent defaults" for each choice. All wizard inputs have defaults (yes, ALL), however, the most important information is collected first, which is used to refine the defaults for later, more detailed inputs. The experience is intended to be like reading a good newspaper, i.e., the further you read into an article, the more detailed understanding you will gain, however, you can "get the gist" by covering only the first few paragraphs. Similarly, in eQUEST's wizards, it isn't necessary to complete every single step in either wizard. If you choose, you can "bail out" of the description process once you are satisfied with the level of detail you have provided. At that point, the wizard provides any missing information using eQUEST's hierarchical default process.

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The Energy-Efficiency Measures (EEM) Wizard helps you quickly, easily, and reliably explore the energy performance of your preferred design alternatives



The greatest value that energy simulation can provide to the building design professional is reliable guidance in determining the energy performance of design alternatives. After creating a new building description (i.e., using the Building Wizard), you can launch the EEM Wizard to quickly describe up to nine design alternatives to your "base" building description. You can then automatically simulate any or all of these alternative cases and view the simulation results as either individual or comparative graphs or in a detailed "parametric" tabular report. Using the EEM Wizard, designers can easily "weigh" the energy impacts and tradeoffs of their design options. Building energy performance simulation was never so quick, easy, and reliable.

Figure 4
eQUEST Energy-Efficiency Measures (EEM) Wizard: use this screen to describe energy-related features of design alternatives

EEM Run Name	Efficiency Measure	Apply Measure To	
1: Daylighting Controls	Daylighting	Baseline Run	Details...
2: Air-Side Economizer	Ventilation & Economizer	Daylighting Control	Details...
3: High Eff Chiller	Chiller Plant	Air-Side Economize	Details...
4: 2-Spd Tower Fan & Re	Chiller Plant	High Eff Chiller	Details...
5: VSD CHW Pumping	Chilled Water Loop	2-Spd Tower Fan &	Details...
6:	- select another -		

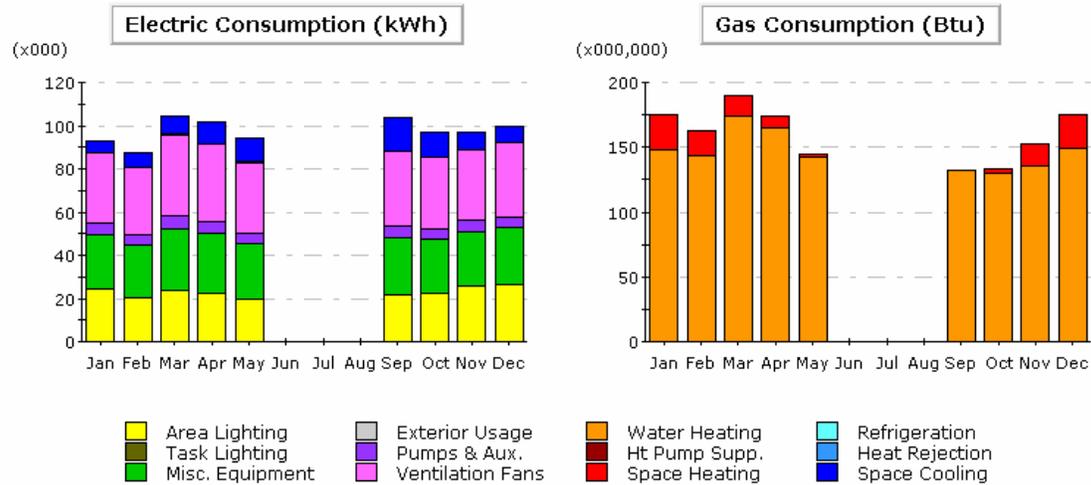
Intuitive Graphics Tell the Energy Story

Once a simulation has been completed, you visualize the results through a number of graphical formats. Overall building estimated energy use can be seen on an annual or monthly basis. Detailed performance of individual building components may also be examined. Figure 5, for example, shows the monthly electrical and gas consumption for a single building simulation and the fraction of that consumption attributed to each of the end-use categories. Figure 6, on the other hand, provides a pair of comparison graphics with associated tabular results that show the monthly electrical and gas consumption for each of five building EEM simulations.

A recently added feature now allows detailed "parametric" processing (Figures 15-17), in which you can define a series of detailed design alternatives and run them automatically. A new parametric tabular report details the annual use and savings (both incremental and cumulative), by end use (Figure 7) for both the EEM Wizard and detailed parametrics.

By performing multiple simulations on your building design alternatives you can take steps to optimize your design, with respect to energy consumption and operating cost, by viewing the alternative results in side-by-side graphics.

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Electric Consumption (kWh x000)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Space Cool	5.41	7.10	8.59	10.08	11.03	-	-	-	15.30	11.65	7.99	7.37	84.53
Heat Reject.	0.07	0.09	0.13	0.25	0.30	-	-	-	0.45	0.28	0.15	0.08	1.78
Refrigeration	-	-	-	-	-	-	-	-	-	-	-	-	-
Space Heat	-	-	-	-	-	-	-	-	-	-	-	-	-
HP Supp.	-	-	-	-	-	-	-	-	-	-	-	-	-
Hot Water	-	-	-	-	-	-	-	-	-	-	-	-	-
Vent. Fans	32.70	31.07	37.61	35.97	32.70	-	-	-	34.34	32.70	32.70	34.34	304.14
Pumps & Aux.	4.93	4.75	5.73	5.53	5.11	-	-	-	5.38	5.10	5.00	5.24	46.76
Ext. Usage	-	-	-	-	-	-	-	-	-	-	-	-	-
Misc. Equip.	25.22	23.96	29.01	27.75	25.22	-	-	-	26.49	25.22	25.22	26.49	234.59
Task Lights	-	-	-	-	-	-	-	-	-	-	-	-	-
Area Lights	24.58	20.62	23.53	22.25	19.94	-	-	-	21.78	22.11	25.79	26.20	206.80
Total	92.92	87.59	104.60	101.82	94.30	-	-	-	103.73	97.07	96.86	99.70	878.59

Gas Consumption (Btu x000,000)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Space Cool	-	-	-	-	-	-	-	-	-	-	-	-	-
Heat Reject.	-	-	-	-	-	-	-	-	-	-	-	-	-
Refrigeration	-	-	-	-	-	-	-	-	-	-	-	-	-
Space Heat	26.8	18.9	15.1	9.1	2.3	-	-	-	-	3.2	17.5	26.5	119.4
HP Supp.	-	-	-	-	-	-	-	-	-	-	-	-	-
Hot Water	147.9	143.6	174.2	164.6	142.9	-	-	-	132.7	129.6	135.5	149.1	1,320.1
Vent. Fans	-	-	-	-	-	-	-	-	-	-	-	-	-
Pumps & Aux.	-	-	-	-	-	-	-	-	-	-	-	-	-
Ext. Usage	-	-	-	-	-	-	-	-	-	-	-	-	-
Misc. Equip.	-	-	-	-	-	-	-	-	-	-	-	-	-
Task Lights	-	-	-	-	-	-	-	-	-	-	-	-	-
Area Lights	-	-	-	-	-	-	-	-	-	-	-	-	-
Total	174.7	162.5	189.3	173.7	145.2	-	-	-	132.7	132.8	153.0	175.7	1,439.5

Figure 5, monthly electrical and gas consumption, by end-use

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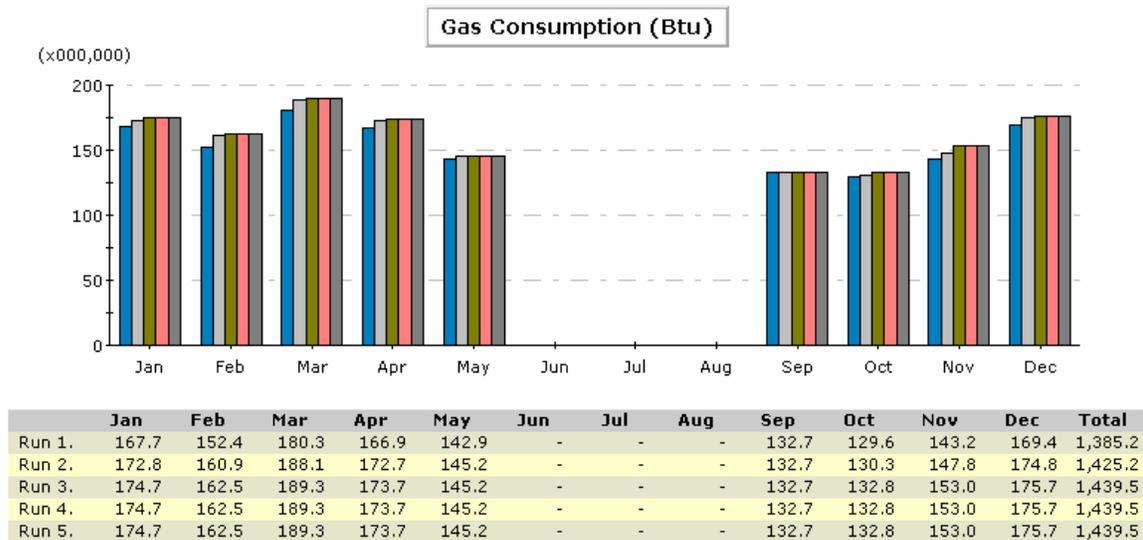
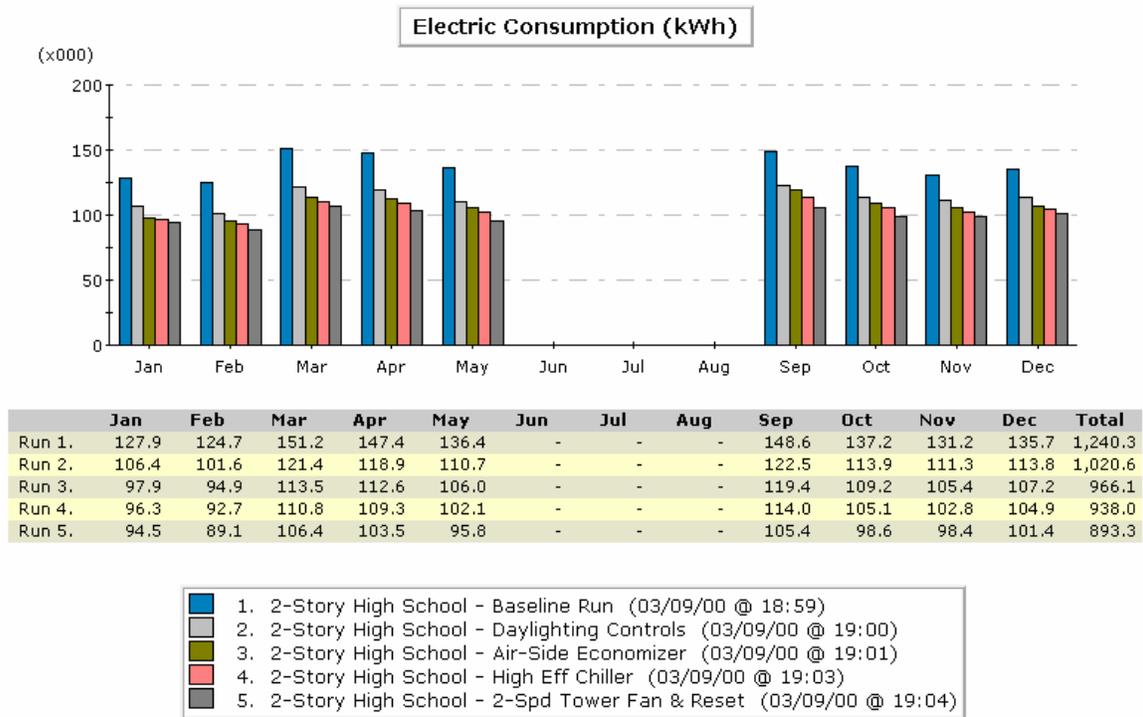


Figure 6, monthly electric and gas consumption for 5 simulations

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		Annual Site Energy				Annual Source Energy		Peak		Lighting	HVAC Energy		
		Elect kWh	Net Gas Therms	Total Mbtu	EUI kBtu/sf/yr	Elect kW	Cooling Tons	Electric MWh	Electric kWh	Net Gas Therms	Total Mbtu		
Annual Energy USE or DEMAND													
0	Min T24 Compliance	250,004	1,311	2,691	110	125	50	68	89,017	956	399		
1	00+Window Overhangs	236,519	2,059	2,628	107	108	35	68	75,532	1,705	428		
2	1+High Eff Lighting	219,579	2,358	2,484	101	99	33	52	74,285	2,003	454		
3	2+Side Daylighting	188,747	3,036	2,236	91	83	29	23	72,792	2,681	517		
4	3+High Eff Chiller	174,001	3,036	2,085	85	75	29	23	58,046	2,681	466		
5	4+VSD CHW Pumping	170,174	3,036	2,046	83	74	29	23	54,220	2,681	453		
6	5+Chiller Plant Opt Start	168,911	3,036	2,033	83	74	29	23	52,956	2,681	449		
Incremental SAVINGS (percentage savings shown in parentheses, negative entries indicate increased use or cost)													
1	00+Window Overhangs	13,485 (5%)	-749 (-57%)	63 (2%)	3 (2%)	18 (14%)	15 (30%)	0 (0%)	-3,485 (15%)	-749 (-78%)	-29 (-7%)		
2	1+High Eff Lighting	16,940 (7%)	-299 (-14%)	144 (5%)	6 (5%)	8 (8%)	2 (5%)	16 (23%)	1,246 (2%)	-299 (-18%)	-26 (-6%)		
3	2+Side Daylighting	8,832 (14%)	-678 (-29%)	248 (10%)	10 (10%)	16 (16%)	4 (13%)	29 (56%)	1,493 (2%)	-678 (-34%)	-63 (-14%)		
4	3+High Eff Chiller	14,746 (8%)	0 (0%)	151 (7%)	6 (7%)	8 (9%)	0 (0%)	0 (0%)	-4,746 (20%)	0 (0%)	50 (10%)		
5	4+VSD CHW Pumping	3,826 (2%)	0 (0%)	39 (2%)	2 (2%)	1 (2%)	0 (0%)	0 (0%)	3,826 (7%)	0 (0%)	13 (3%)		
6	5+Chiller Plant Opt Start	1,263 (1%)	0 (0%)	13 (1%)	1 (1%)	-0 (-0%)	0 (0%)	0 (0%)	1,263 (2%)	0 (0%)	4 (1%)		
Cumulative SAVINGS (relative to Base Case, i.e. Case 0, percentage savings shown in parentheses, negative entries indicate use or cost)													
1	00+Window Overhangs	13,485 (5%)	-749 (-57%)	63 (2%)	3 (2%)	18 (14%)	15 (30%)	0 (0%)	-3,485 (15%)	-749 (-78%)	-29 (-7%)		
2	1+High Eff Lighting	8,425 (12%)	1,047 (-80%)	207 (8%)	8 (8%)	26 (21%)	17 (33%)	16 (23%)	-4,731 (17%)	847 (-110%)	-54 (-14%)		
3	2+Side Daylighting	1,257 (25%)	725 (-132%)	455 (17%)	19 (17%)	42 (34%)	21 (42%)	45 (66%)	-6,224 (18%)	725 (-180%)	-117 (-29%)		
4	3+High Eff Chiller	6,003 (30%)	725 (-132%)	606 (23%)	25 (23%)	50 (40%)	21 (42%)	45 (66%)	8,970 (35%)	725 (-180%)	-67 (-17%)		
5	4+VSD CHW Pumping	9,829 (32%)	725 (-132%)	645 (24%)	26 (24%)	51 (41%)	21 (42%)	45 (66%)	14,797 (39%)	725 (-180%)	-54 (-13%)		
6	5+Chiller Plant Opt Start	11,093 (32%)	725 (-132%)	658 (24%)	27 (24%)	51 (41%)	21 (42%)	45 (66%)	16,060 (41%)	725 (-180%)	-49 (-12%)		

Figure 7, detailed annual energy use, incremental savings, and cumulative savings for 6 parametric simulations

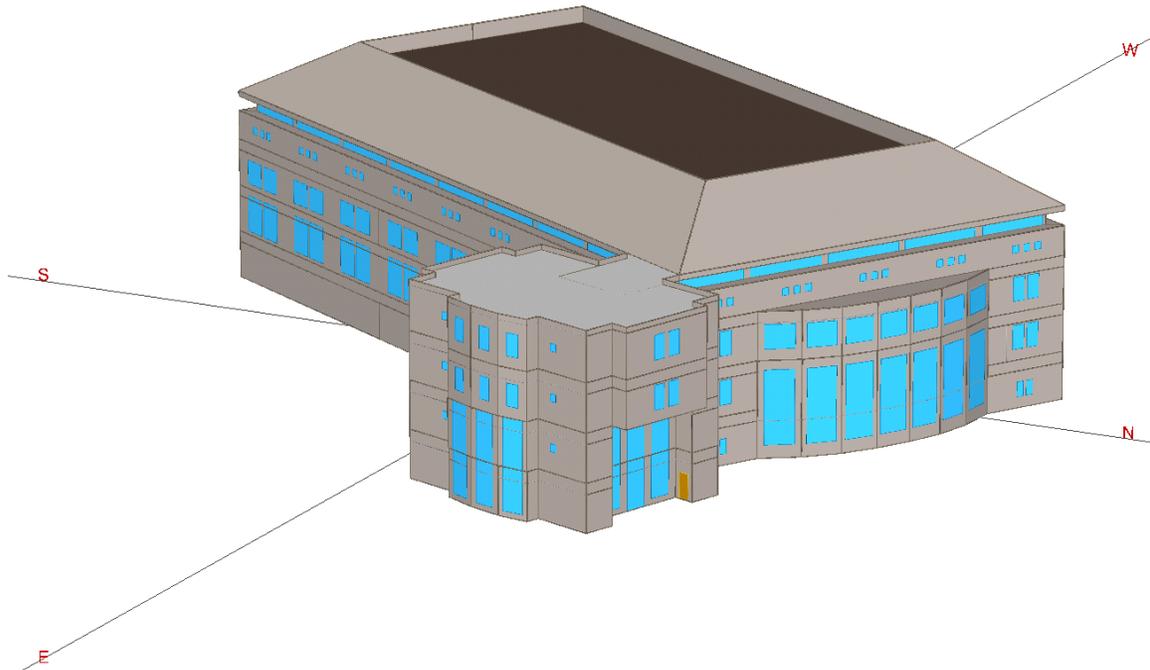


Figure 8, 3-D view of eQUEST model

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Provide as much detail as you like... or as little...

With eQUEST, you decide how much detail is appropriate. You can rely on predefined building shapes and automatic HVAC zoning or you can import DWG files and use them to create a project-specific footprint shapes and HVAC zoning.

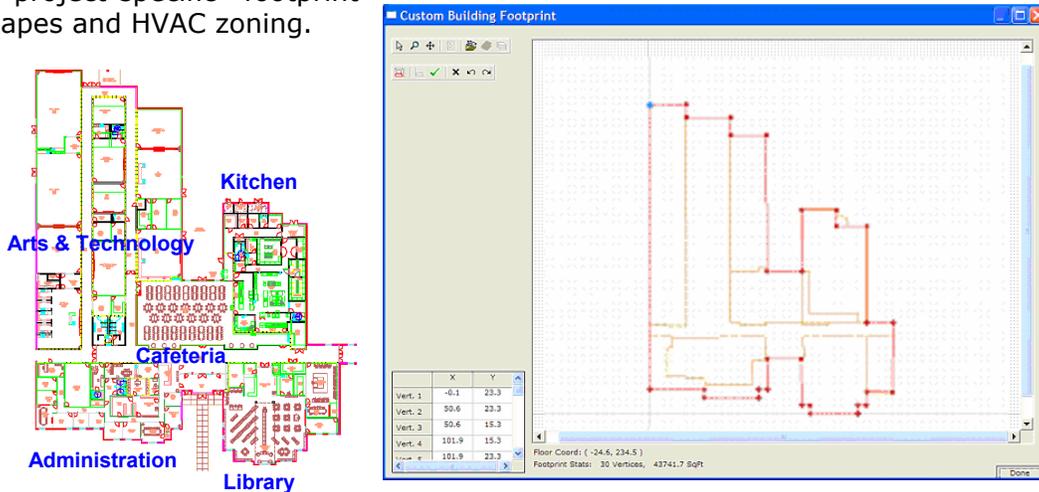


Figure 9, eQUEST custom drawing screen with DWG file imported

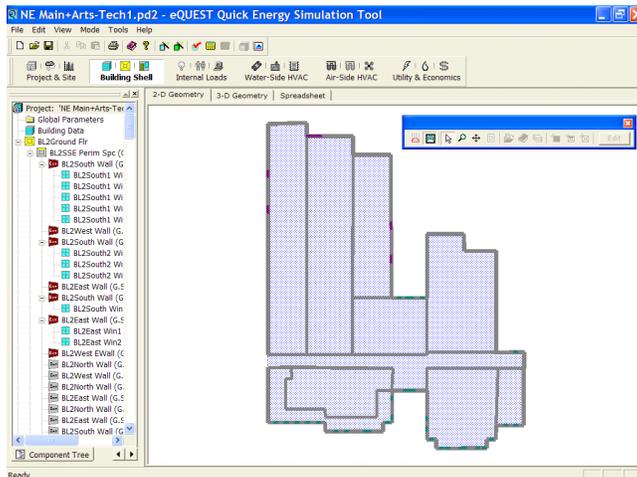
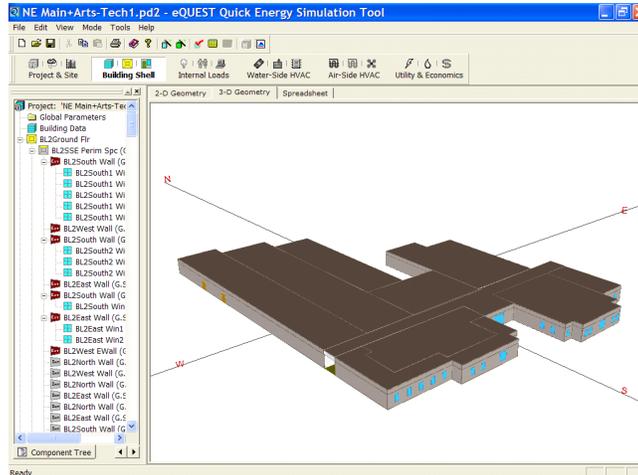


Figure 10

eQUEST building shell, 2-D geometry screen (from eQUEST's Detailed Interface), showing the completed building footprint and user-defined HVAC zoning. Components in the model are listed in the "tree" on the left side of the screen

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Figure 11
eQUEST building shell,
3-D geometry screen
(from eQUEST's
Detailed Interface).
Click on any object (i.e.,
from the component
tree or 2-D or 3-D
image) to see detailed
inputs.



Use the Design Development wizard to define multiple architectural shell and/or HVAC components, then assemble these into a completed project (Figure 12).

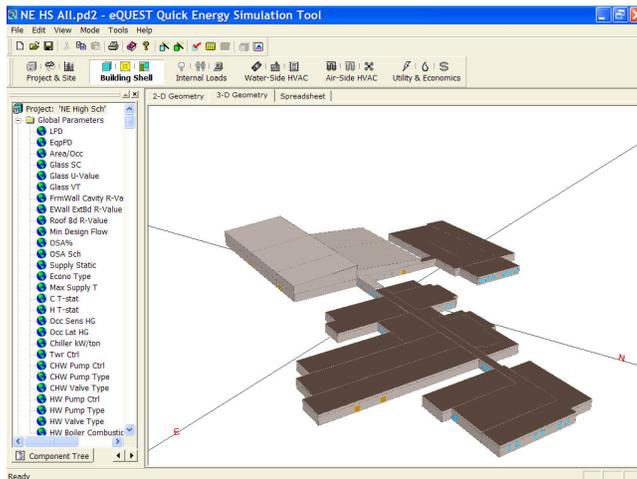
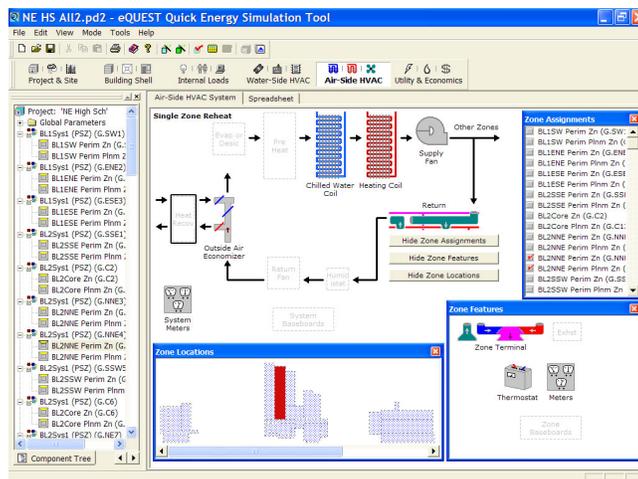


Figure 12
eQUEST building shell, 3-D
geometry screen (from
eQUEST's Detailed
Interface), showing a full
campus (the building in
Figures 9-11 is seen here
in the center of the
campus). This example
consists of four buildings.

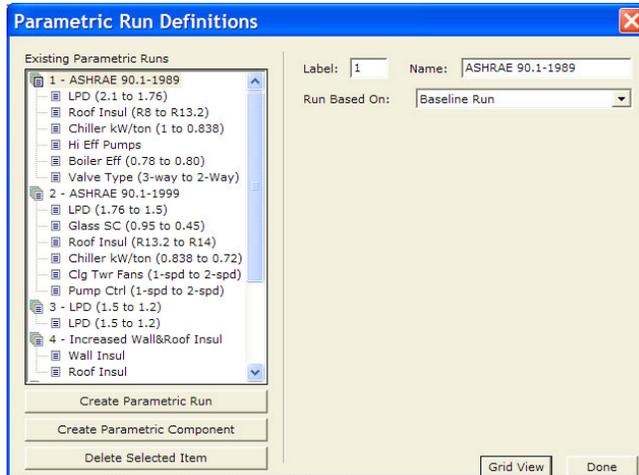
Use eQUEST's Detailed Interface to explore project architectural and HVAC components in detail. Graphical presentation of project components make navigation intuitive (Figure 13).

Figure 13
eQUEST air-side HVAC
screen, showing the
same building as in
Figure 12.



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Use the Parametric Run dialog in eQUEST's Detailed Interface to define detailed parametric runs to explore, in detail, the benefit of selected energy-efficient design features (Figures 15-17). Tabular results are automatically produced showing the incremental and cumulative benefits of your selected design features (Figure 7).



ed
efficiency design features.

Figure 16
Example component
list of eight
parametric runs

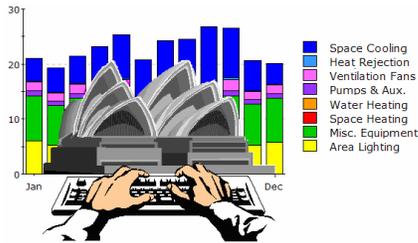
- 1 - ASHRAE 90.1-1989
 - LPD (2.1 to 1.76)
 - Roof Insul (R8 to R13.2)
 - Chiller kW/ton (1 to 0.838)
 - Hi Eff Pumps
 - Boiler Eff (0.78 to 0.80)
 - Valve Type (3-way to 2-Way)
- 2 - ASHRAE 90.1-1999
 - LPD (1.76 to 1.5)
 - Glass SC (0.95 to 0.45)
 - Roof Insul (R13.2 to R14)
 - Chiller kW/ton (0.838 to 0.72)
 - Clg Twr Fans (1-spd to 2-spd)
 - Pump Ctrl (1-spd to 2-spd)
- 3 - LPD (1.5 to 1.2)
 - LPD (1.5 to 1.2)
- 4 - Increased Wall&Roof Insul
 - Wall Insul
 - Roof Insul
- 5 - Reduced Static (2 to .75)
 - Reduced Static
- 6 - Hi Eff Chiller (.72 to .65)
 - Chiller kW/ton (.72 to .65)
- 7 - VSD CHW & HW Pumps
 - VSD Drives
- 8 - OSA ShutOff when UnOcc
 - OSA Sch

Component	Reference(s)	Baseline	ASHRAE 90...	ASHRAE 90.1-...	LPD (1.5 to 1.2)	Increased Wal...	Reduced Stat...	Hi Eff Chiller (...)	VSD CHW & ...	OSA ShutO...
PARAMETER	LPD	2.100000	1.760	1.760	1.760	1.760	1.760	1.760	1.760	1.760
PARAMETER	Roof Bd R-Value	8.000000	13.200	13.200	13.200	13.200	13.200	13.200	13.200	13.200
PARAMETER	Chiller kW/ton	1.000000	0.838	0.838	0.838	0.838	0.838	0.838	0.838	0.838
PARAMETER	HW Pump Type(1 of 2)	STANDARD	HI-EFF	HI-EFF	HI-EFF	HI-EFF	HI-EFF	HI-EFF	HI-EFF	HI-EFF
PARAMETER	HW Boiler Combustion Eff	0.780000	0.800	0.800	0.800	0.800	0.800	0.800	0.800	0.800
PARAMETER	CHW Valve Type(1 of 2)	THREE-WAY	TWO-WAY	TWO-WAY	TWO-WAY	TWO-WAY	TWO-WAY	TWO-WAY	TWO-WAY	TWO-WAY
PARAMETER	LPD	2.100000	1.500	1.500	1.500	1.500	1.500	1.500	1.500	1.500
PARAMETER	Glass SC	0.950000	0.450	0.450	0.450	0.450	0.450	0.450	0.450	0.450
PARAMETER	Roof Bd R-Value	8.000000	14.000	14.000	14.000	14.000	14.000	14.000	14.000	14.000
PARAMETER	Chiller kW/ton	1.000000	0.720	0.720	0.720	0.720	0.720	0.720	0.720	0.720
PARAMETER	Twr Ctrl	ONE-SPEED-FAN	ONE-SPEED-...	TWO-SPEED-FAN	TWO-SPEED-FAN	TWO-SPEED-FAN	TWO-SPEED-FAN	TWO-SPEED-F...	TWO-SPEED-...	TWO-SPEE...
PARAMETER	CHW Pump Ctrl(1 of 2)	ONE-SPEED-PUMP	ONE-SPEED-...	TWO-SPEED-P...	TWO-SPEED-P...	TWO-SPEED-P...	TWO-SPEED-P...	TWO-SPEED-P...	TWO-SPEED-...	TWO-SPEE...
PARAMETER	LPD	2.100000	1.200	1.200	1.200	1.200	1.200	1.200	1.200	1.200
PARAMETER	EWall ExtBd R-Value	0.100000	0.100000	0.100000	0.100000	4.300	4.300	4.300	4.300	4.300
PARAMETER	Roof Bd R-Value	8.000000	8.000000	8.000000	8.000000	21.000	21.000	21.000	21.000	21.000
PARAMETER	Supply Static	2.000000	2.000000	2.000000	2.000000	0.750	0.750	0.750	0.750	0.750
PARAMETER	Chiller kW/ton	1.000000	1.000000	1.000000	1.000000	0.650	0.650	0.650	0.650	0.650
PARAMETER	CHW Pump Ctrl(1 of 2)	ONE-SPEED-PUMP	ONE-SPEED-...	ONE-SPEED-P...	ONE-SPEED-P...	ONE-SPEED-P...	ONE-SPEED-P...	ONE-SPEED-P...	VAR-SPEED-P...	VAR-SPEED...
PARAMETER	OSA Sch	NoOccSens Sch	NoOccSens S...	NoOccSens Sch	NoOccSens Sch	NoOccSens Sch	NoOccSens Sch	NoOccSens Sch	NoOccSens Sch	OccSens Sch

Figure 17, side-by-side "Grid View" comparison of eQUEST parametric runs

eQUEST ... the Quick Energy Simulation Tool

What you've been looking for ... High-Powered Simulation at the Touch of a Button



When you exit the eQUEST wizard, you have a complete building description ready for simulation. eQUEST uses an enhanced, interactive, simulation engine... an advanced derivation of DOE-2, to perform an hourly simulation of the described building for a user-selected one-year time period. For each hour of the simulation, heating and/or cooling loads are

calculated based on contributions from walls, windows (including detailed shading), people, plug loads, and ventilation air and simulates the performance of fans, pumps, chillers, boilers, and all other energy-consuming building components as they respond to the building environment and controls. During the simulation, the energy use is tabulated for each of the end uses including lighting, general space equipment, heating, cooling, ventilation, and pumping.

The simulation "engine" within eQUEST is derived from the latest official version of DOE-2, however, eQUEST's engine extends and expands DOE-2's capabilities in several important ways, including: coupled air-side and water-side simulation, an all-new temperature/pressure/flow-based modular central plant simulation, more sophisticated (i.e., polygon-based) geometry, more dynamic/intelligent defaulting, and faster execution speed. Also, numerous long-standing shortcomings in DOE-2 that have contributed to its limited use by mainstream designers and buildings professionals have been improved. The full capabilities of this enhanced and improved DOE-2-derived engine have been integrated into eQUEST to provide you with detailed and accurate energy use estimates in remarkably little time.

Computer Requirements



To use eQUEST you need a PC with the following: Windows 95, 98, ME, NT, 2000, or XP (Windows 2000 or XP is recommended), having at least 64 Megabytes of RAM, 100 Megabytes of free hard drive space and a display capable of 800x600 resolution at 256 colors (or greater). You should also have internet access to allow the download of additional weather files and updates to new versions of eQUEST as they become available.

The QUEST Continues...



Version 3 of eQUEST provides a very capable tool for building energy use analysis, especially in the early conceptual design phase. Future enhancements to eQUEST are planned to permit even more comprehensive analysis...

1. Building energy code compliance checking (initially: California Title 24, later, ASHRAE 90-1)
2. HVAC-related enhancements that will make eQUEST a powerful and convenient HVAC design tool
3. Informative Q/A building model input and output reports to identify inconsistencies in the inputs and simulated results



Summary of eQUEST Features and Capabilities

eQUEST Availability, Cost, and Technical Support

eQUEST is provided **FREE** by courtesy of the State of California's *Energy Design Resources* program and is available for you to download from www.energydesignresources.com. Technical support is available via email at equst@doe2.com. For questions/problems regarding eQUEST's interface, contact Scott Criswell at scott.criswell@doe2.com. For questions/problems regarding eQUEST's simulation methodology or results, contact Marlin Addison at marlin.addison@doe2.com.

Number of Users

Approximately 7,000 copies of eQUEST have been downloaded from www.energydesignresources.com, however, it is difficult to estimate what portion of these downloads represent active users. Although the original target audience for eQUEST has been California, e-mail support inquiries have been received from all around the world.

General Issues

Simulation Engine:

eQUEST's engine is "DOE-2.2", an advanced derivation of DOE-2, initially developed jointly by Lawrence Berkeley National Laboratory and J.J. Hirsch and Associates, under funding from the U.S. Department of Energy and the Electric Power Research Institute. On-going development of DOE-2-based tools, like eQUEST, is continuing under both public and industry funding. The principal focus of these ongoing efforts has been to make detailed hour-by-hour simulation more reliable and affordable for a broader base of design and buildings professionals.

of unique simulation steps per year: 8760 (i.e., hourly) for up to one year maximum analysis period

of specific day types:

eQUEST's schematic design wizard — 3 for each of two seasons (6 total)
eQUEST's detailed interface — hundreds of day types in up to 52 seasons

Types of available weather files:

all common long-term average weather files, i.e., TMY, TMY2, TRY, CTZ, CTMY, WYEC, WYEC2. There are 667 of these long-term average weather files, representing approximately 300 North American locations. They are available for free download from www.doe2.com. eQUEST automatically downloads missing weather files via ftp, on-demand (prompts for permission). Many international weather files are also available, including via *meteoNorm*[™] (see http://www.meteotest.ch/en/mn_home?w=ber). Actual weather year data is also usable via the National Climatic Data Center (i.e., most popular NCDC weather file formats are supported, see <http://lwf.ncdc.noaa.gov/oa/ncdc.html>), as are WeatherMaker[™] TMY2 files (used to adjust dry-bulb and wet-bulb temperatures to produce site weather data, see <http://www.sbicouncil.org/enTen/weather.html>).

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Analysis methods

Heat Transmission through opaque exterior surfaces: two methods: “delayed” method via conduction transform functions (accounts for mass effects in delayed envelope heat transfer); “quick” method via steady-state $UA\Delta T$ calculations.

Heat Transmission through transparent surfaces: three methods are available: 1) shading coefficient method; 2) a predefined glass library (provides improved solar-optical transmission prediction at obtuse incident angles — user additions to library via *Windows 4.1*); 3) layer-by-layer method (permits detailed treatment of complex fenestration systems, including profile-angle-dependent slat-type shading devices, internal/external/integral — limited number of windows can be accommodated).

Interior sunlight/daylight modeling: DOE-2’s solar heat gain calculations do not provide detailed treatment of solar distribution on interior surfaces (i.e., does not project “sun patches” into a space’s interior), rather, relies on user-controlled assignment of the interior distribution of solar gain (e.g., assumes 60% of incoming solar is evenly distributed across the floor, 40% is evenly distributed across remaining interior surfaces). By contrast, DOE-2’s daylighting prediction does provide for detailed tracking of the “direct” daylight component (that portion of the daylight which arrives at the workplane without first bouncing off interior surfaces). The treatment of the “indirect” (the internally reflected) component uses the “split-flux” method which predicts average reflected daylight levels and neglects internal obstructions of complex fenestration/spatial configurations.

Space Loads: eQUEST relies on DOE-2’s standard and/or custom weighting factors methods.

Coil Loads: now coupled in DOE-2.2 with water-side calculations into the same time step.

Water-Side: in DOE-2.2, now based on temperature and flow and very modular (i.e., allows for flexible coupling or assignment of primary and secondary equipment).

Design-Day Weather data and schedules of operations: in DOE-2.2, up to three 24-hour design day weather profiles can be user input — none are automatically derived from the user-selected weather file. These 24-hour design weather sequences can be repeated for any number of days to include different solar angles. In eQUEST’s conceptual design wizard, design day conditions are automatically selected for any California climate zone locations, based on weather file selection (Title24 design day conditions).

The system types listed on the following page are available from eQUEST’s Conventional HVAC Systems

Types of HVAC systems that can be modeled:

The system types listed on the following page are available from eQUEST’s Building Creation Wizards (listed by cooling and heating source).

eQUEST ... the Quick Energy Simulation Tool

HVAC systems that can be modeled using eQUEST's Building Creation Wizards (shown by cooling/heating source)

Cooling Source	Heating Source	System Type
No Cooling	No Heating	- none -
No Cooling	No Heating	Unit Ventilator (no heating or cooling)
No Cooling	Furnace	Gas or Fuel Furnace with zone ventilation
No Cooling	Furnace	Gas or Fuel Furnace with NO zone ventilation
No Cooling	Elec Resist	Electric Furnace with zone ventilation
No Cooling	Elec Resist	Electric Furnace with NO zone ventilation
No Cooling	HW Coils	Hot Water Furnace with zone ventilation
No Cooling	HW Coils	Hot Water Furnace with NO zone ventilation
No Cooling	HW Coils	2-Pipe Fan Coils (heating only)
No Cooling	Baseboards	Electric Baseboards (only) with zone ventilation
No Cooling	Baseboards	Electric Baseboards (only) with NO zone ventilation
No Cooling	Baseboards	Hot Water Baseboards (only) with zone ventilation
No Cooling	Baseboards	Hot Water Baseboards (only) with NO zone ventilation
DX Coils	No Heating	Packaged Single Zone DX (no heating)
DX Coils	No Heating	Split System Single Zone DX (no heating)
DX Coils	No Heating	Packaged Terminal AC (no heating)
DX Coils	No Heating	Packaged VAV (no heating)
DX Coils	Furnace	Packaged Single Zone DX with Furnace
DX Coils	Furnace	Split System Single Zone DX with Furnace
DX Coils	Furnace	Packaged Multizone with Furnace
DX Coils	Elec Resist	Packaged Single Zone DX with Elec Resist Heat
DX Coils	Elec Resist	Split System Single Zone DX with Elec Resist Heat
DX Coils	Elec Resist	Packaged Terminal AC with Elec Resist Heat
DX Coils	Elec Resist	Packaged VAV with Elec Resist Reheat
DX Coils	Elec Resist	Packaged Multizone with Elec Resist Heat
DX Coils	DX Coils (HP)	Packaged Single Zone Heat Pump
DX Coils	DX Coils (HP)	Split System Single Zone Heat Pump
DX Coils	DX Coils (HP)	Packaged Terminal Heat Pump
DX Coils	DX Coils (HP)	Water-Source Heat Pump
DX Coils	HW Coils	Packaged VAV with Hot Water Reheat
CHW Coils	No Heating	Standard VAV (no reheat)
CHW Coils	No Heating	Parallel Fan-Powered VAV (no reheat)
CHW Coils	No Heating	Series Fan-Powered VAV (no reheat)
CHW Coils	No Heating	Single Zone Air Handler (cooling only)
CHW Coils	No Heating	2-Pipe Fan Coils (cooling only)
CHW Coils	No Heating	Multizone Air Handler (cooling only)
CHW Coils	No Heating	Single Fan Dual Duct (no heating)
CHW Coils	Elec Resist	Parallel Fan-Powered VAV (elec reheat)
CHW Coils	Elec Resist	Standard VAV (elec reheat)
CHW Coils	Elec Resist	Series Fan-Powered VAV (elec reheat)
CHW Coils	Elec Resist	Single Zone Air Handler (elec heat)
CHW Coils	Elec Resist	Reheat Fan System (elec reheat)
CHW Coils	Elec Resist	Multizone Air Handler (elec heat)
CHW Coils	Elec Resist	Dual Duct Air Handler (elec heat)
CHW Coils	HW Coils	Parallel Fan-Powered VAV (hot water reheat)
CHW Coils	HW Coils	Standard VAV (hot water reheat)
CHW Coils	HW Coils	Series Fan-Powered VAV (hot water reheat)
CHW Coils	HW Coils	Single Zone Air Handler (hot water heat)
CHW Coils	HW Coils	Reheat Fan System (hot water reheat)
CHW Coils	HW Coils	4-Pipe Fan Coils (hot water reheat)
CHW Coils	HW Coils	Multizone Air Handler (hot water heat)
CHW Coils	HW Coils	Dual Duct Air Handler (hot water heat)
Evap Cool	No Heating	Indirect/Direct Evaporative Cooler (no heat)
Evap Cool	No Heating	Direct Evaporative Cooler (no heat)
Evap Cool	Furnace	Indirect/Direct Evaporative Cooler (furnace heat)
Evap Cool	Furnace	Direct Evaporative Cooler (furnace heat)
Evap Cool	Elec Resist	Indirect/Direct Evaporative Cooler (electric heat)
Evap Cool	Elec Resist	Direct Evaporative Cooler (electric heat)

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Special HVAC Systems

Ground-Source Heat Pumps: these can be directly modeled using eQUEST's detailed interface, and includes a large variety of ground coupling configurations, e.g., vertical well, horizontal field, "slinky".

Dual-Fuel Cooling Plants: these can be directly modeled using eQUEST's detailed interface, including preferential loading of base equipment.

Primary/Secondary chilled water distribution systems: DOE-2.2's temperature and flow-based calculations make it much better suited than was DOE-2.1E for modeling primary/secondary distribution systems. Up to twenty secondary loops can be connected to a primary loop. Currently, primary equipment cannot be connected directly to secondary loops.

Variable Flow primary distribution systems: as above, DOE-2.2's temperature and flow-based calculations make it much better suited than was DOE-2.1E for modeling variable flow distribution systems.

Dual-Fan Dual-Duct VAV systems: dual-fan dual-duct and multi-zone systems are available in eQUEST.

Natural Ventilation: natural ventilation is available in eQUEST via the detailed interface, only for single duct DX systems. The calculation uses the Sherman-Grimsrud algorithm. Note that this does not include any mass transport (i.e., CFD), rather, it is an energy transfer algorithm only.

Custom Performance Curves: custom equipment performance curves can be modeled in eQUEST's detailed interface. The user can either specify coefficients or curve data points (up to third order polynomials). Currently, no graphics are provided to illustrate or check the curves.

Cogeneration: a wide variety of cogeneration schemes and equipment can be modeled using DOE-2.2 (accessed via eQUEST's detailed interface). These include Photovoltaics (see below) and sell back.

Thermal Energy Storage: eQUEST's TES model is best suited for empty tank chilled water tank systems. Ice TES can also be modeled. Stratified tank chilled water tank systems require significant user judgment.

Underfloor Air Distribution: Underfloor systems can be modeled reasonably well by advanced eQUEST users (i.e., requires significant user judgement and some advanced program features). To the extent that underfloor systems rely on displacement ventilation for their energy performance, eQUEST's DOE-2 loads calculations will be unable to predict the adequacy of the displacement ventilation scheme using first principles. Rather, significant user judgment will be required to model the more-or-less direct transfer of heat gain from lights, people, equipment, and solar to the unoccupied (stratified) or return air mass via convective plumes. Fortunately, the assumed split of heat gains between the occupied and unoccupied air mass can be "expressionized" in eQUEST, i.e., input using dynamic formulas rather than static numbers — this allows the user to conveniently bound the performance of the proposed underfloor displacement system by varying key system characteristics. While the thermal loss from the underfloor plenum can be approximated using DOE-2.2's duct loss modeling, the effect of any "coolth" charge to the underfloor mass is not accounted for. Contact the eQUEST developers for a paper describing the literature, data sources and suggested approach to modeling underfloor air distribution systems.

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New Special System Features

Photovoltaics: a PV algorithm has recently been added to DOE-2.2. Although no interface has been provided yet in eQUEST, the PV keywords are accessible via BDL/DOS.

Energy Recovery Ventilators: a wide variety of ERV configurations and options have recently been added to DOE-2.2. No interface has been provided yet in eQUEST. The ERV keywords are accessible via BDL/DOS.

Ice Rinks and Industrial Refrigeration Systems: the ability to model complex modular configurations for refrigeration systems and ice rinks has recently been added to DOE-2.2. No interface has been provided yet in eQUEST for the new refrigeration-related keywords. These keywords are accessible via BDL/DOS.

Notable DOE-2 HVAC Omissions

Solar Thermal: currently, there is no capability to model solar thermal systems in eQUEST or DOE-2.2.

Vertical Self-Contained Fan-Powered VAV: currently, there is no capability to model fan-powered VAV systems having DX cooling coils in eQUEST or DOE-2.2. Funding is in place to model this system. Completion of this addition is expected by the end of 2001.

Steam Loops: DOE-2 has never been able to directly model steam distribution systems. HW distribution systems are used to approximate steam systems.

Plate-and-frame economizers: DOE-2 has never included the ability to model plate-and-frame type water-side economizers, either series or parallel configurations.

Two or more HVAC systems serving the same zone: DOE-2 has never been able to model the use of two or more systems to provide cooling or heating service to the same zone. The only exception is baseboard heating combined with ambient heating (e.g., reheat coils).

Comfort-controlled radiant cooling or heating systems: DOE-2 has never been able to model radiant systems other than those whose control is via a standard dry-bulb thermostat.

Water-Use and Emissions: DOE-2.2 does not currently include either water use calculations or emissions calculations. Emissions calculations are anticipated in the near future.

Controls

DOE-2 has always assumed "perfect" control where capacity and operations permit. This makes it difficult to approximate the behavior of typical "real world" control, e.g., poorly maintained or calibrated controls, sticking valves or linkages, failed actuators, etc. Indirectly, DOE-2's "perfect" control tends to be a better approximation of PID/DDC control than pneumatic controls.

Daylighting Controls: three types of daylighting controllers are provided in both eQUEST's wizard and detailed interface: stepped, dimming, dimming/off.

Demand Limiting: demand limiting capabilities are available via eQUEST's detailed interface. Given the coupling between the air-side and water-side calculations in DOE-2.2, the affect of air-side resets are passed on to chilled water resets and the affect on space temperature is determined.

eQUEST ... the Quick Energy Simulation Tool

Controls (continued)

Window Shades: manually or automatically operated window shades can be modeled from eQUEST's detailed interface. Triggers include transmitted solar and estimated visual discomfort glare.

Night Venting: night venting can be modeled directly from eQUEST's detailed interface.

One-Hour time step: The fixed one-hour time step that has always been built into DOE-2 makes it difficult to model many control system effects.

Optimum Start / Morning Warm-up: Optimum start is provided directly in eQUEST's detailed interface, however, DOE-2's fixed one-hour time step makes this a rather "blunt" instrument to predict the benefit of optimum start. Morning warm-up outside air strategies can be well modeled from eQUEST's detailed interface. This can also be well integrated with economizer actions.

Utility Rates

DOE-2 has long been able to model a wide variety of utility rates. Rate features that can be easily accommodated include: inclined or declining block rates, hours use (variable block) rates, time-of-use rates, ratchets, rate limiters, customer service/meter charges, taxes/surcharges, and fuel adjustments. Rate qualifiers can also be modeled which can select among several available rates, the one that applies, based on peak kW or energy. It should be comparatively rare that a DOE-2.2 user would encounter a rate feature that cannot adequately be modeled. Typically, this tends to be specialized "IF then" tests built into a rate, e.g., off-peak kW is free unless the on-peak kW is less than 25% of the off-peak kW, in which case some charge applies per off-peak kW. NOTE: currently eQUEST only comes with California utility rates predefined. Users can add their own custom rates, however, this is not a simple undertaking (i.e., requires a user to prepare a text file containing DOE-2 BDL commands describing the custom utility rate — user documentation is provided).

Energy Code Compliance

Funding has been allocated to add California Title 24 compliance analysis to eQUEST. Work on this is nearing completion. Once completed, this will permit eQUEST users to certify their building designs for Title 24 compliance. eQUEST will produce the necessary submission forms. Additionally, eQUEST will be able to automatically complete compliance runs as part of general parametric energy analyses, e.g., *Savings By Design* analysis. eQUEST implements its compliance capabilities via external rule sets, driven by a rule processor. It is expected that this capability will be extended to include other codes, such as ASHRAE 90.1.

Interoperability

eQUEST has recently added DWG import capabilities. This provides users with the ability to import DWG files, then use them as a guide to "trace" the shape of the building footprint and zoning in a drawing module.