

# Codes and Simulations

Course No. ENRG 59

# Outline

- A. Introduction
  - a) How this class is related to California's Energy Efficiency Plan and energy audits.
- B. Building Energy Efficiency Standards -Title 24 section 6
  - a) We will review the history, versions, and how it is implemented.
- C. Energy Appliance Efficiency Code-Title 20
- D. California Green Building Standards Code
- E. Building Information Modeling Programs
  - a) History and programs used for modeling buildings.
  - b) eQUEST- using and modeling with this software.

# A. Introduction

## 1. California's “Long Term Energy Efficiency Plan”

- Released by the CPUC September 2008
- Added “Promote energy efficiency”- As one of the 6 tasks of the California Energy Commission
  - Responsible for Energy codes such as Title 24
- All California new residential construction zero net energy (ZNE) by 2020
- Low income homes energy efficient by 2020
- All California new commercial construction zero net energy (ZNE) by 2030

# A. Introduction

## 2. Relationship between energy auditing and energy codes

- Description of codes in general
- General History of the California Building Energy Efficiency Standards
- Impacts of California Energy Code on construction projects.

# A. Introduction

## California Code of Regulations-28 Titles

### Title 20- Public Utilities and Energy

- Part of Chapter 4 is the Energy Appliance Efficiency Code
- Defines appliances and list acceptable energy use and features for those sold in California
- Describes specific test methods to be used for energy use

Guide:

[http://www.documents.dgs.ca.gov/bsc/Title\\_24/T24TrainingGuide.pdf](http://www.documents.dgs.ca.gov/bsc/Title_24/T24TrainingGuide.pdf)

### Title 24-California Building Standards Code

- Includes 12 parts related to building
  - Part 6 is the Energy Code
  - Part 11 is the California Green Building Standards Code (CALGreen)

# A. Introduction

## History of California Building Energy Efficiency Standards

- 1975 California legislature passed the Warren Alquist Act
  - Created “California Energy Commission”
    - » Forecast future energy needs
    - » Promote energy efficiency through appliance and building standards
    - » Support renewable technologies
    - » Create and maintain the California Energy Code –Title 24 Section 6
- This paved the way for the energy code which is updated every three years.

# A. Introduction

## Impact on Construction Projects

Cities and Counties are required to enforce CCR.

- When construction permits are applied for the plans are checked to verify that the project meets the current codes. In addition plans are checked in the field during the project construction.
- The codes require more energy efficiency with each version
- Contractors and designers are pushed to provide more efficient projects.

# A. Introduction

## 3. Use of Building Energy Modeling Programs (BEMS) in energy auditing

- Easy way to predict energy usage of a building and optimize energy consuming aspects
- Required to meet some regulations in Title 24
- Title 24 is also called The Energy Efficiency Standards for Residential and Nonresidential Buildings



## History and context

- Title 24 section 6 first implemented 1978, updated every 3 years
- 2013 version effective Jan 1, 2014
- Building areas covered
  - Building envelope, including insulation, windows, roofing
  - Lighting
  - HVAC equipment standards, duct leakage, etc.

## Versions and Accomplishments

### Title 24 sec 6 implementation

Applies to residential, commercial, and industrial buildings (this class focuses only on commercial buildings)

Sets energy budget for new buildings, and for additions and alterations.

Budget is in units of energy (kBtu/sf/yr)

Budget varies by climate zone

Mandatory measures and energy budget.

Prescriptive-checklist approach

Performance-modeling approach

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Relevant code when permit is pulled

## Compliance with Title 24

### Submit documentation

- Prescriptive (list of minimum requirements)
- Computer simulation showing performance exceeds identical building with prescriptive measures.

### Acceptance Tests

Responsible party ensures “acceptance tests” are passed and any necessary corrections made.

Submit certificate of acceptance

Building inspectors are enforcers

# A. Introduction

## C. Energy Appliance Efficiency Code (Title 20)

### – History and context

- Warren-Alquist Act of 1974 instructed the CEC to promulgate efficiency standards
- First standards went into effect in 1977, most recent 2013.
- Regulated by the Residential Buildings and Appliances Unit
- Title 20 Sections 1601 through 1608 of California Code of regulations
- Database of Energy Efficient Appliances
- Goal is to reduce California's energy consumption

# Energy Appliance Efficiency Code (Title 20)

## – Versions and Accomplishments

- Large impact on residential pool pumps.
- Many states have adopted California's tests and covered products.



# Energy Appliance Efficiency Code (Title 20)

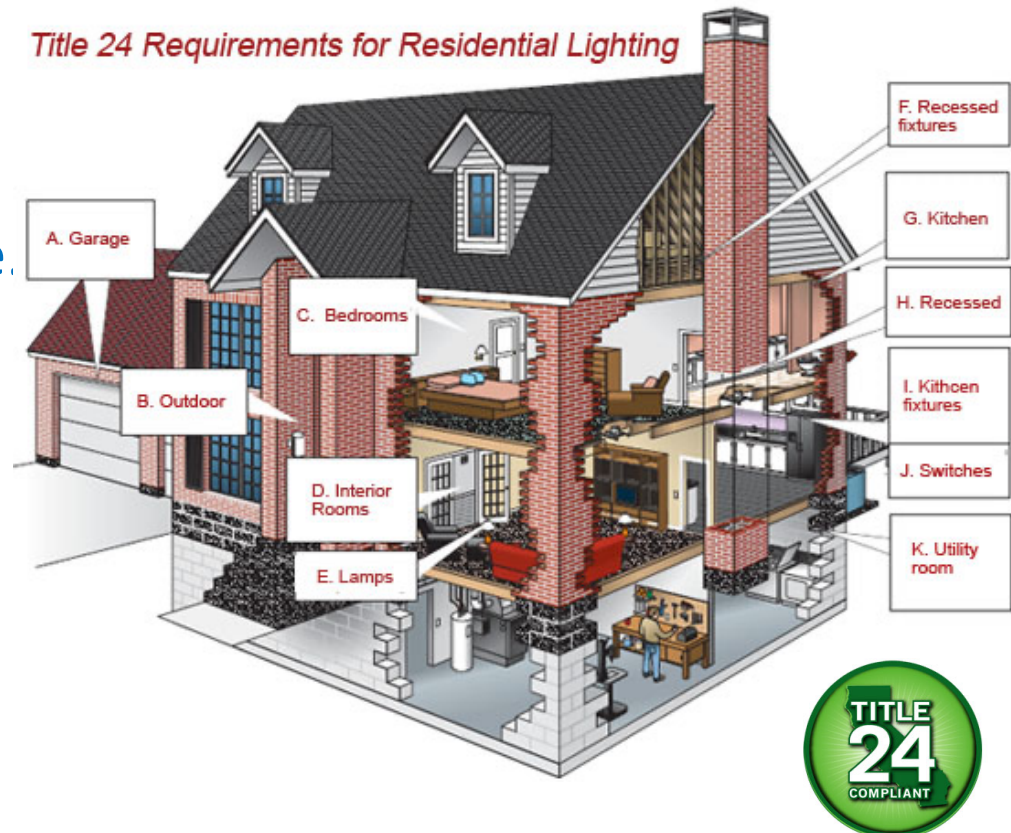
## – Title 20 implementation

- Overlap with Title 24: some appliances installed in new building construction covered under Title 24 Part 6.
- Covers appliances sold in California with a few exceptions. Includes lights.
- Covers twenty-three categories of equipment.
  - Requires that equipment meet state and federal standards for energy and water efficiency.
  - Requires testing, certification, and labeling.
  - All appliances are added to online database. The database can be used to search and compare models.

# Energy Appliance Efficiency Code (Title 20)

## – Title 20 compliance

- Self policing
- Beginning to develop fines for non-compliance.



# California Green Building Standards Code (CALGreen) Title 24 section 11

## — History

- First statewide mandatory green building code.
- First published with the 2008 California building Code
- Request from Governor Schwarzenegger that green code be investigated.



# California Green Building Standards Code (CALGreen) Title 24 section 11

## – Goals

- Improve public health, safety and welfare.
- Encourage sustainable construction practices.
  - Planning and design
  - Energy Efficiency
  - Water efficiency and conservation
  - Material conservation and resource efficiency
  - Environmental quality

# California Green Building Standards Code (CALGreen) Title 24 section 11

## – Versions and Accomplishments

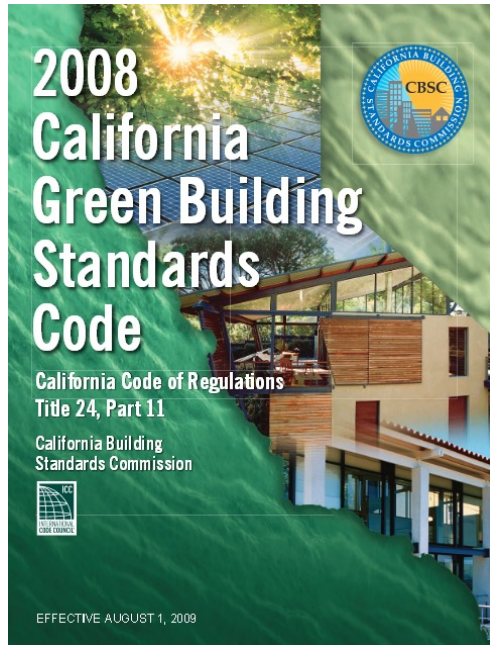
- 2008 version was voluntary
- 2010 version became mandatory
- 2013 version out now. Will become effective January 1, 2014.

# California Green Building Standards Code (CALGreen) Title 24 section 11

## – Title 24 section 11 implementation

- Residential is regulated by California Department of Housing and Community Development
- Non-residential is regulated by the Building Standards Commission
- Applies to new buildings only.
- Provides a set of Mandatory Provisions that are required for all new construction
  - Basic Quality construction practices
  - Green practices not addressed in the building code
  - Duplication of requirements found elsewhere in the code
  - Additive to other code requirements
- Includes two voluntary tiers that may be adopted via local amendment.

# California Green Building Standards Code (CALGreen) Title 24 section 11



[Link to Regulations:](http://www.documents.dgs.ca.gov/bsc/2009/part11_2008_calgreen_code.pdf)

[http://www.documents.dgs.ca.gov/bsc/2009/part11\\_2008\\_calgreen\\_code.pdf](http://www.documents.dgs.ca.gov/bsc/2009/part11_2008_calgreen_code.pdf)

# E. Building Information Modeling Programs

What:

Software programs that use a model to predict what will happen in the real world. Typically using 3D rather than the traditional 2D drawings.

Types of predictions that can be made:

Energy consumption and peak demand

Economics (construction costs or life cycle costs)

Indoor Air Quality

Solar energy potential

Ventilation/Airflow

Water Conservation

# E. Building Information Modeling Programs

## History:

1974: Charles Eastman, architect from Berkeley developed a model called Building Descriptive System (BDS). His goals were to make design more efficient and create models that can be updated with changes rather than hardcopy drawings.

1977: Eastman and additional team members from Carnegie Mellon University developed Graphical Language for Interactive Design (GLIDE)

1980's and 90's: Several other programs were developed by governmental groups and Universities in the US and in Europe. Namely two programmers from Hungary. CAEADS, GLIDE-II, ArchiCAD, Pro/ENGINEER, Revit, Ecotect, Energy Plus.

1995: International Foundation Class (IFC) developed to help ease collaboration so that models can be moved across platforms.

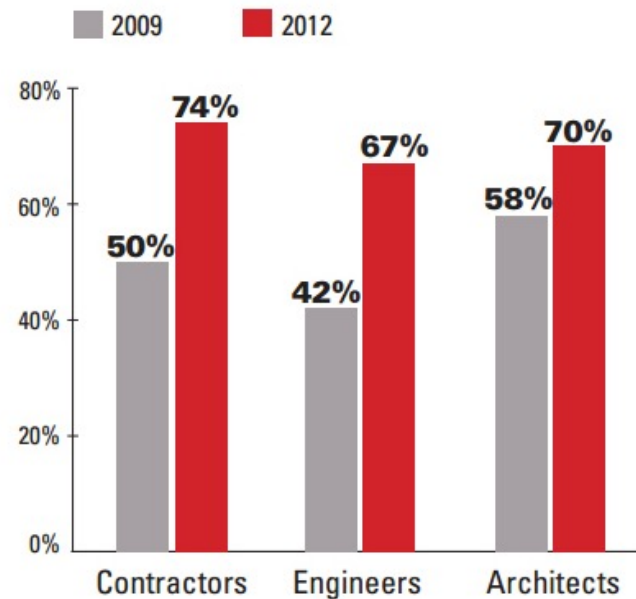
# E. Building Information Modeling Programs

***The percentage of companies using BIM jumped from 28% in 2007, to 49% in 2009, and to 71% in 2012.***

***For the first time ever, more contractors are using BIM than architects.***

Source: *The Business Value of BIM in North America: Multi-Year Trend Analysis and User Ratings SmartMarket Report*, McGraw-Hill Construction, 2012.

BIM Adoption by Player (2009–2012)



# E. Building Information Modeling Programs

BIM's today:

The Department of Energy (DOE) has an extensive website dedicated to Building Energy Software. It lists 400 plus programs for evaluating energy and other building aspects.

Typical components of most programs:

1. 3D Model
  1. Virtual equivalent of actual building. "As simple as possible but no simpler"- Albert Einstein.
  2. Create realistic visualizations and compare alternatives
2. Change Management
  1. Changes are floor plan, section, model are recorded and transferred to other aspects of program
3. Building Simulation
  1. Structure, mechanical equipment lighting, envelope can all be simulated
4. Ongoing changes to building
  1. Modifications in the future can be modeled to assess changes and continue to predict behavior of building.

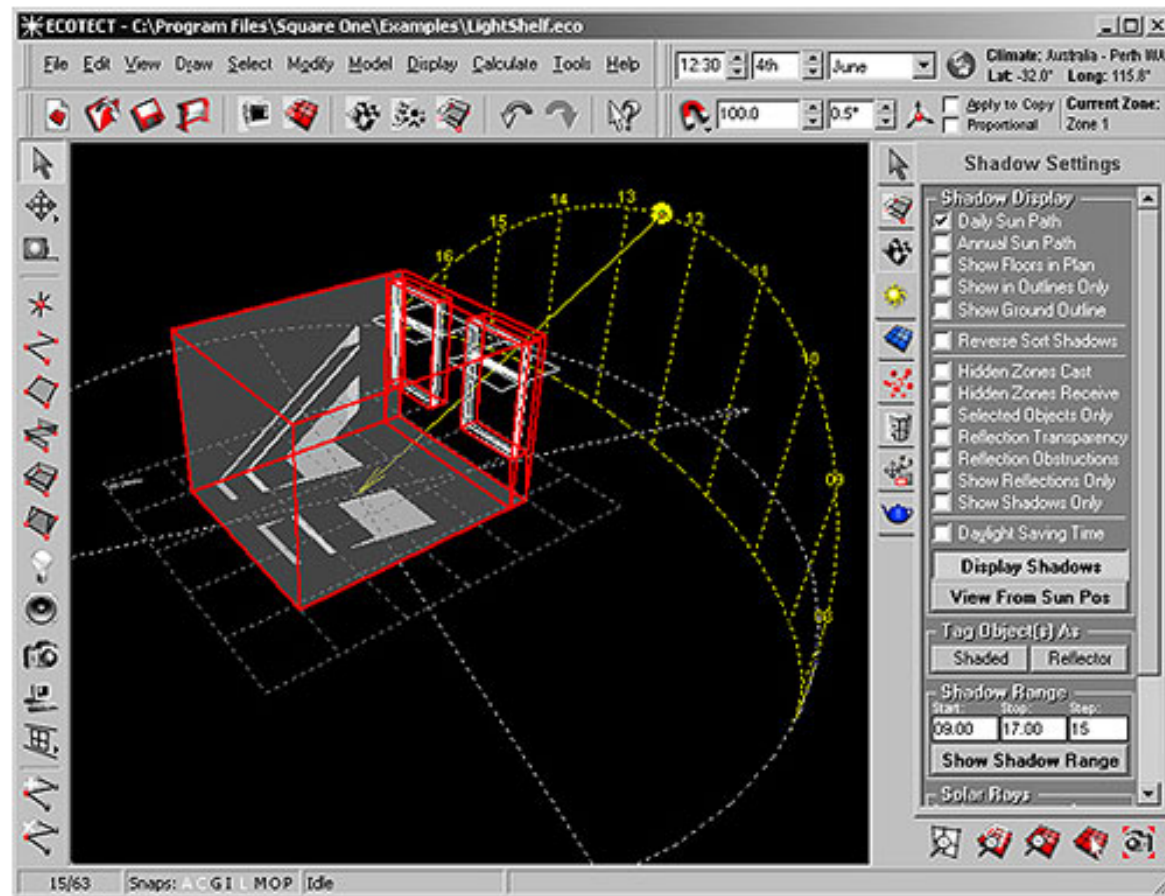


# E. Building Information Modeling Programs

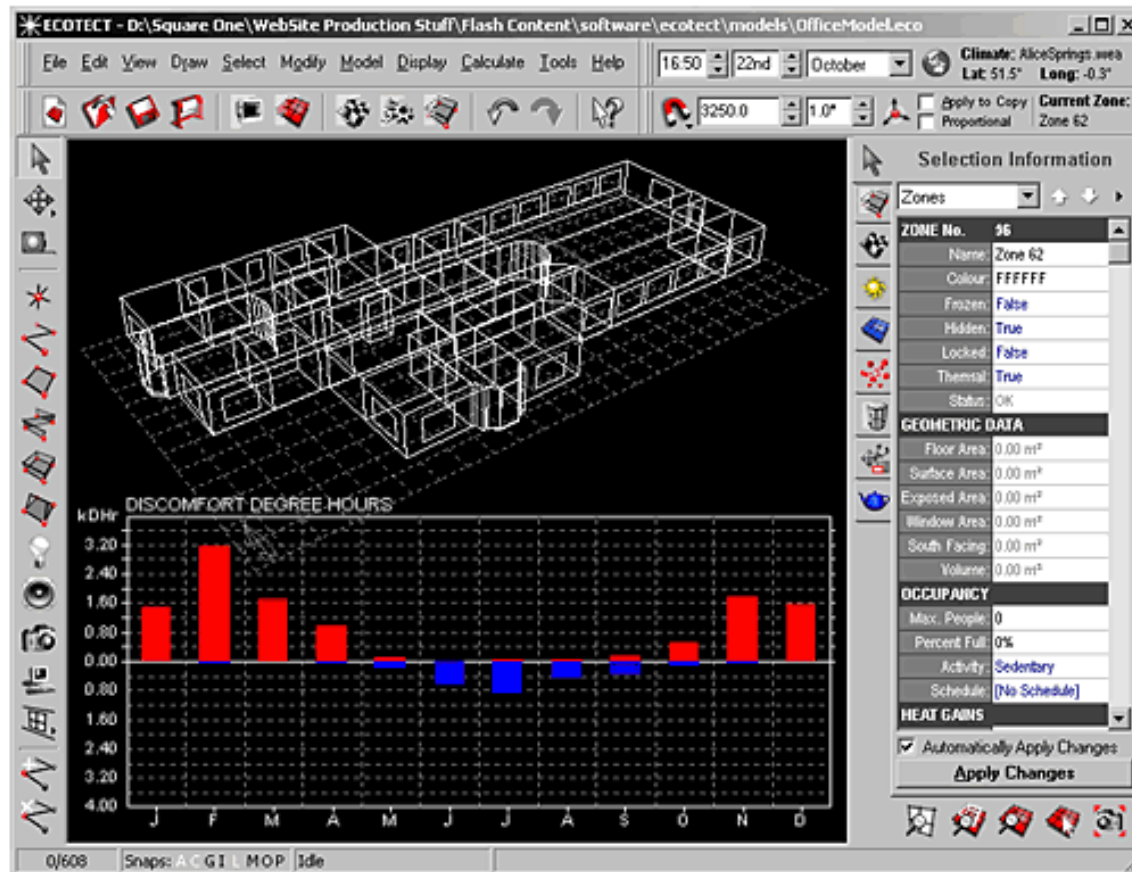
Ecotect:

1. Purchased by AutoDesk in 2008. AutoDesk is the maker of AutoCAD. They have been instrumental in the development of BIM through development and acquisitions.
2. Models are created through menu options called wizards that guide the model development.
3. Student version is available free of cost.
4. Strengths:
  1. Users can play with design ideas at the conceptual stages.
  2. Guides users as more detailed design information becomes available
5. Weaknesses:
  1. Use needs to be aware of different modeling requirements otherwise the outputs may be misleading.

# E. Building Information Modeling Programs



# E. Building Information Modeling Programs



# E. Building Information Modeling Programs

## EnergyPro:

1. Developed by EnergySoft in Novato, CA
2. California focused, incorporates Title 24 regulations.
3. Can be used for LEED or ASHRAE 90.1 certification.
4. Uses DOE-2 energy analysis.
5. Can output California Energy Commission Forms.
6. Cost is \$300 to \$3300. Individual modules can be purchased to make it cheaper.
7. Strengths:
  1. Uses wizards to help create models.
  2. Incorporates debugging tools
8. Weaknesses:
  1. Does not model cogeneration, day lighting, or off site steam production.

# E. Building Information Modeling Programs

## DOE-2:

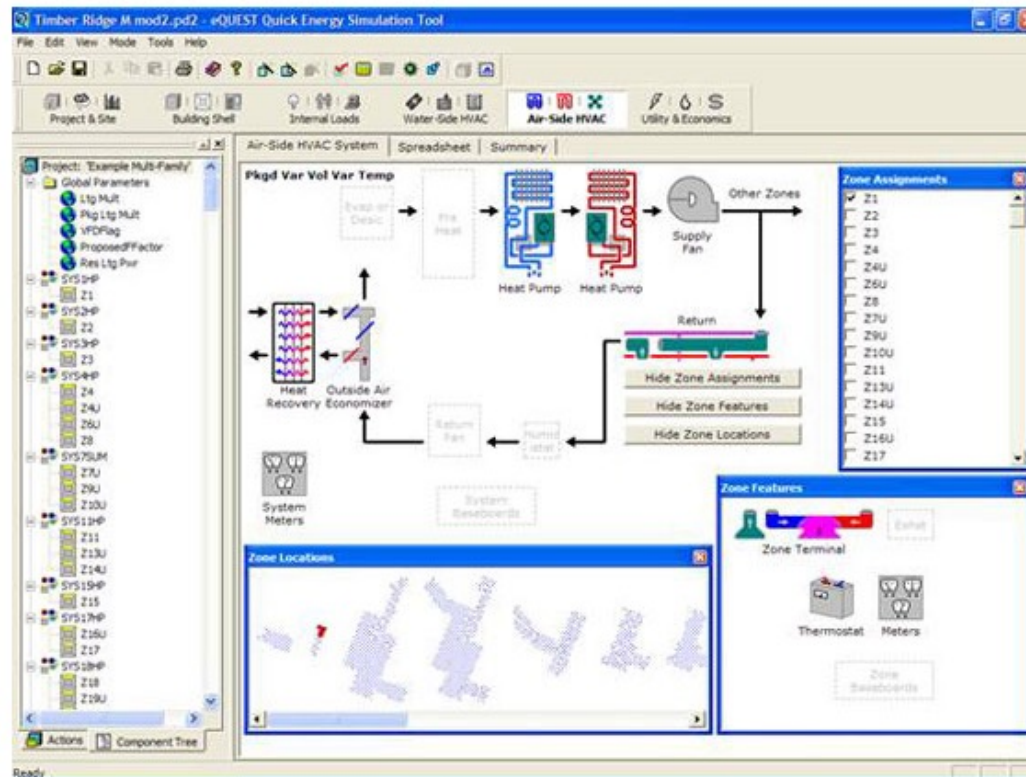
1. Developed by Lawrence Berkeley National Laboratory (LBNL).
2. Analysis program that has a DOS interface. Requires extensive experience. Other programs such as eQUEST provide a Windows interface.
3. Available for free.
4. Strengths:
  1. Detailed analysis
  2. Recognized as industry standard
5. Weaknesses:
  1. Requires high level of user knowledge.

# E. Building Information Modeling Programs

## eQUEST:

1. Developed by James Hirsch and Associates in California
2. California focused, incorporates Title 24 regulations.
3. Can be used for LEED or ASHRAE 90.1 certification.
4. Uses DOE-2.2 simulation engine for energy analysis.
5. Can output California Title 24 analysis reports.
6. Available for free.
7. Strengths:
  1. Wizards to help create models and measures.
  2. Automated T24 compliance.
  3. Evaluates whole building performance throughout the design process.
8. Weaknesses:
  1. Limited capability for ground coupling and infiltration/natural ventilation.
  2. Day lighting can only be applied to convex spaces.
  3. Custom functions in DOE 2.1E have not been made available in DOE 2.2 or eQUEST.

# E. Building Information Modeling Programs



# E. Building Information Modeling Programs

## Basics of eQUEST:

1. Uses Wizards to help guide the modeling process
  1. Schematic design Wizard
    1. Used for simple building that have a single building shell (one building, all floors identical, no separate wings, three floors max)
  2. Design Development Wizard
    1. Used for buildings that have multiple shells.
    2. Allows air s-side HVAC system templates.
  3. Energy Efficiency Measures Wizard
    1. Analyzes various options to determine energy usage differences
    2. Provides a quick analysis
2. Detailed Interface
  1. The detailed interface is a second way to develop or improve models with more detail. It can be used to add refinements to models made with wizards.
  2. Allows analysis of energy efficiency measures



# E. Building Information Modeling Programs

Using eQUEST:

1. Refer to the eQUEST Introductory Tutorial

1. Review “Quick Start” and Install eQUEST.
2. Review Simulation Basics
3. Follow the tutorials.
  1. Schematic Design Wizard
  2. Design Development Wizard
  3. EEM Wizard

2. Additional resource-SED slideshow-75 page intro to eQUEST.

3. Class tutorial

<http://www.learm.illinois.edu/up466/transportation/lab-5-demo/part-ii-equest/11-equest-tutorial.html>

# E. Building Information Modeling Programs

Using eQUEST:

1. Skylight tutorial SMUD
2. IDL :4 Modules.
  1. <http://www.idlbozeman.com/equest/>
3. Colorado Lab session

<http://civil.colorado.edu/classes/cven5080/EQuest-Lab-09-6.pdf>

4. User guide –Drexel U.

[https://docs.google.com/file/d/0B69AvRYJR07tTmtot2o4bHRvUGM/edit?usp=drive\\_web](https://docs.google.com/file/d/0B69AvRYJR07tTmtot2o4bHRvUGM/edit?usp=drive_web)

5. Energy modeling for LEED

<http://energymodelingprocess.files.wordpress.com/2012/03/energy-modeling-for-leed.pdf>

# BEST Center Curricula, Resources & Recordings

## Academic Programs

Georgia Piedmont Technical College - Building Automation Systems

Milwaukee Area Technical College - Sustainable Facilities Operations

Laney College - Commercial HVAC Systems

City College San Francisco - Commercial Building Energy Analysis & Audits

## Professional Development Materials, Presentations & Videos

National Institutes

Building Automation Systems Instructor Workshops

Webinars (e.g., BEST Talks)

## Faculty Profile Videos

## Reports & Case Studies

## Marketing Resources

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