ENRG 59 - Simulation Methods and Code Compliance

COURSE DESCRIPTION: California's energy and sustainability codes represent cost-effective levels of building performance and are a critical reference for energy auditors. This course explores the Building Energy Code (Title 24, section 6), Appliance Code (Title 20), and the Green Building Code (Title 24, section 11). The class will include modules on simulation tools that can be used for code compliance, analysis of the potential impact for specific EE and DR measures, verification of energy savings efforts. Simulation programs to be addressed include eQUEST, EnergyPro and Ecotect. Students will model specific EE measures or whole facilities with these programs as part of in-class exercises and homework assignments.

36 Lecture Hours

LEARNING OUTCOMES:

Upon completion of this course a student will be able to:

- Describe the history of commercial energy efficiency regulation in California and related codes
- Describe the components of the Building Energy Efficiency Standards (Title 24, Section 6), the Appliance Code (Title 20), and the Green Building Code (Title 24, Part 11), and the building simulation requirements of each
- Compare various Building Energy Modeling Systems (BEMS), including Energy Pro, eQUEST, and Ecotect
- Create a building model using a BEMS such as eQUEST, and employ that model to measure and evaluate various energy efficiency and demand response measures

COURSE TOPICS:

I. Introduction
    A. California's "Long Term Energy Efficiency Plan" goals
        1. Promote energy efficiency- One of the 6 tasks of the California Energy Commission
        2. All California new residential construction zero net energy (ZNE) by 2020
        3. Low income homes energy efficient by 2020
        4. All California new commercial construction zero net energy (ZNE) by 2030
    B. Relation of energy auditing and energy codes
        1. Description of codes in general and how they affect construction projects
        2. General History of the California Building Energy Efficiency Standards
        3. Impacts of California Energy Code on construction projects
    C. Use of Building Energy Modeling Programs (BEMS) in energy auditing
        1. Easy way to predict energy usage of a building and optimize energy consuming aspects
        2. Required to meet some regulations in Title 24
II. Building Energy Efficiency Standards (Title 24 sec 6)
    A. History and context
        1. Title 24 implemented 1978, updated every 3 years
        2. 2013 version effective Jan 1, 2014
        3. Building areas covered
            a. Building envelope, including insulation, windows, roofing
            b. Lighting
            c. HVAC equipment standards, duct leakage, etc.
    B. Versions and Accomplishments
    C. Title 24 sec 6 implementation
        1. Applies to residential, commercial, & industrial buildings (this class focuses only on commercial buildings)
        2. Sets energy budget for new buildings, and for additions and alterations
            a. Budget is in units of energy (kBtu/sf/yr)
            b. Budget varies by climate zone
            c. Mandatory measures and energy budget
                1.) Prescriptive-checklist approach
                2.) Performance-modeling approach

3. Relevant code when permit is pulled
   D. Compliance with Title 24
     1. Submit documentation
       a. Prescriptive (list of minimum requirements)
       b. Computer simulation showing performance exceeds identical building with prescriptive measures
     2. Acceptance Tests
       a. Responsible party ensures "acceptance tests" are passed and any necessary corrections made
       b. Submit certificate of acceptance
     3. Building inspectors are enforcers

III. Energy Appliance Efficiency Code (Title 20)
   A. History and context
     1. Warren-Alquist Act of 1974 instructed the CEC to promulgate efficiency standards
     2. First standards went into effect in 1977, most recent 2013
     3. Regulated by the Residential Buildings and Appliances Unit
     4. Title 20 Sections 1601 through 1608 of California Code of regulations
     5. Database of Energy Efficient Appliances
     6. Goal is to reduce California's energy consumption
   B. Versions and Accomplishments
     1. Large impact on residential pool pumps
     2. Many states have adopted California's tests and covered products
   C. Title 20 implementation
     1. Overlap with Title 24: some appliances installed in new building construction covered under Title 24 Part 6
     2. Covers appliances sold in California with a few exceptions - Includes lights
     3. Covers twenty-three categories of equipment
       a. Requires that equipment meet state and federal standards for energy and water efficiency
       b. Requires testing, certification, and labeling
       c. All appliances are added to online database. The database can be used to search and compare models
   D. Title 20 compliance
     1. Self policing
     2. Beginning to develop fines for non-compliance

IV. California Green Building Standards Code (CALGreen) Title 24 section 11
   A. History
     1. First statewide mandatory green building code
     2. First published with the 2008 California building Code
     3. Request from Governor Schwarzenegger that green code be investigated
   B. Goals
     1. Improve public health, safety and welfare
     2. Encourage sustainable construction practices
       a. Planning and design
       b. Energy Efficiency
       c. Water efficiency and conservation
       d. Material conservation and resource efficiency
       e. Environmental quality
   C. Versions and Accomplishments
     1. 2008 version was voluntary
     2. 2010 version became mandatory
     3. 2013 version out now. Will become effective January 1, 2014
   D. Title 24 section 11 implementation
     1. Residential is regulated by California Department of Housing and Community Development
     2. Non-residential is regulated by the Building Standards Commission
     3. Applies to new buildings only
     4. Provides a set of Mandatory Provisions that are required for all new construction
       a. Basic Quality construction practices

b. Green practices not addressed in the building code
c. Duplication of requirements found elsewhere in the code
d. Additive to other code requirements
5. Includes two voluntary tiers that may be adopted via local amendment
E. Title 24 section 11 compliance
V. Building Information Modeling Programs
A. History
1. Programs began being developed in the 1970's
2. Traditional design was on 2D drawings. BIM adds 3D, time, and cost
B. Description
1. DOE website list 408 building software tools for evaluating energy efficiency
2. Components
a. 3D Model
1.) Virtual equivalent of actual building
2.) Create realistic visualization
3.) Compare alternatives
4.) Assess impact of planned building modifications
b. Change management
1.) Floor plan
2.) Section
3.) Model
4.) Changes recorded and transferred to other aspects of program
c. Building Simulation
1.) Structure
2.) Mechanical equipment
3.) Lighting
4.) Envelope
5.) Building lifecycle and future modifications
C. Ecotect
1. Purchased by AutoDesk in 2008, makers of AutoCAD
2. Wizard based approach
3. Student version is free
4. Strengths:
a. Users can play with design ideas at the conceptual stages
b. Guides users as more detailed design information becomes available
5. Weaknesses: User needs to be aware of different modeling requirements otherwise the outputs may be misleading
D. EnergyPro
1. Incorporates Title 24
2. Can be used for LEED and ASHRAE 90.1
3. Can be purchased in modules to make it cheaper
4. Cost is $300 to $3300
5. Strengths
a. Easy to use Wizards
b. Debugging tools
6. Weaknesses: Does not handle cogeneration, day lighting, or off site steam production
E. eQUEST
1. Description
a. Designed to provide whole building performance analysis
b. Free software
c. Based on DOE 2.2 simulation engine
2. Strengths
a. Wizards to help create models and measures

b. Automated Title 24 compliance
        c. Evaluates whole building performance throughout the design process
    3. Weaknesses
        a. Defaults and automated compliance analysis has not yet been extended from Title 24 to ASHRAE 90.1
        b. Limited ground – coupling and infiltration/natural ventilation
        c. Day lighting can only be applied to convex spaces
        d. Custom function in DOE 2.1E have not yet been made available in DOE 2.2 or eQUEST
    4. How to use
        a. Wizards
            1.) Schematic Design Wizard: Single building shell
            2.) Design Development Wizard: Multiple Shells
            3.) Energy Efficiency Measures Wizard
                i. "EEM analysis"
                ii. Quick analysis
        b. Detailed Interface
            1.) Analysis of measures "Parametric Analysis"
            2.) Modeling requires detailed data
            3.) Can be used to add refinements to models made with wizards

TYPES OF ASSIGNMENTS:

I.   In-class
     A. Participation in class discussions
     B. Building modeling exercises using eQUEST
     C. Oral presentation of final building model project
II. Out-of-class
     A. Readings as assigned from codes, web-based resources, instructor handouts
     B. Research of assigned code questions for discussion
     C. Several short written papers (1-2 pages) on topics such as comparing various BEMS programs, various code applications
     D. Final project of creating a building model using eQuest, explore energy usage under various equipment selections, and present findings to class

TEXTBOOKS & RESOURCES:

- Websites such as http://www.energy.ca.gov/title24/2013standards/, http://www.energy.ca.gov/appliances/, http://www.bsc.ca.gov/home/calgreen.aspx
- eQUEST software (free)

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

CC BY-NC 4.0
Attribution-NonCommercial 4.0