

BEYOND

SMART CITIES

ENERGY SIMULATION OF HIGH PERFORMANCE GREEN BUILDINGS

FOR ENERGY AND GREEN BUILDING SPECIALISTS

KRISHNAJI PAWAR, LEED AP BD+C, GSAS CGP, ISO 14001:2015, GCP

ENERGY SPECIALIST CURRICULUM



BEYOND

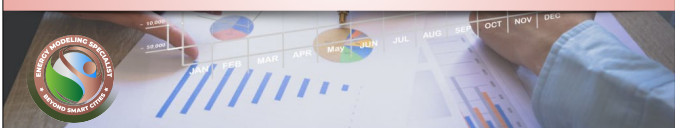
SMART CITIES

ENERGY MODELING TOOLS

FOR ENERGY AND GREEN BUILDING PROFESSIONALS

KRISHNAJI PAWAR, LEED AP BD+C, GSAS CGP, ISO 14001:2015, GCP

ENERGY SPECIALIST CURRICULUM



LEARNING OBJECTIVES



- Why do we need energy modeling software?
- Modeling Inputs in General
- Building Energy Modeling Tools
- Common Energy and Renewable Energy Tools
- Summary of Available Analysis & Modeling Tools



WHY DO WE NEED ENERGY MODELING SOFTWARE?

- ✓ In 2018, the residential and commercial sectors accounted for about 40% (or about 40 quadrillion British thermal units) of total U.S. energy consumption [EIA, May 2019]
- ✓ Opportunity exists for project teams to utilize energy modeling software to help evaluate design decisions in terms of life-cycle cost impacts in order to maximize building performance
- ✓ Building energy performance is a function of numerous, interdependent internal and external factors, such as material selection, mechanical and electrical systems, solar orientation, climate, and occupant usage
- ✓ Modification of various design components can produce complex interactions that are difficult to analyze in isolation
- ✓ Building energy simulation softwares provide tools for evaluating energy impacts across dynamic interrelated systems



MODELING INPUTS IN GENERAL

These are the overall steps followed to create an energy model

- ✓ Step 1
 - Collects data at the site enough to fully define the building and energy consuming features o Inputs that are unknown should be highlighted and used as calibration parameters
 - List of data required to build an energy model
 - ✓ Drawings ,as built
 - ✓ Utility Bills
 - ✓ Equipment Schedules
 - ✓ Lighting Drawings
 - ✓ Sure Footage
 - ✓ Occupancy(24/7, Intermittent, conference rooms etc)
 - ✓ SCHEDULE- mechanical and occupancy
 - ✓ Building function ,Purpose and usage



MODELING INPUTS IN GENERAL

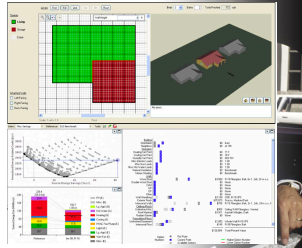
- ✓ Step 2
 - Fills out the model and run the simulationList of data required to build an energy model
 - ✓ Copies the monthly output tables to an excel spreadsheet and calibrates the model to within 5-10% of the Step 3 monthly/annual utility bills
- ✓ Step 3
 - Uses the model to run various "what if" scenarios to calculate energy savings associated with identified energy conservation measures



BEOPT: RESIDENTIAL BUILDING ENERGY MODELING TOOL

✓The BEopt™ (Building Energy Optimization Tool) software provides capabilities to evaluate residential building designs and identify cost-optimal efficiency packages at various levels of whole-house energy savings along the path to zero net energy

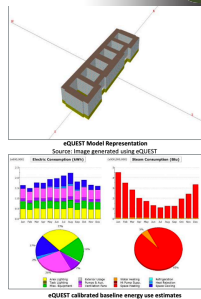
✓BEopt™ provides detailed simulation-based analysis based on specific house characteristics, such as size, architecture, occupancy, vintage, location, and utility rates. Discrete envelope and equipment options, reflecting realistic construction materials and practices, are evaluated



EQUEST: COMMERCIAL BUILDING ENERGY MODELING TOOLS

✓The Quick Energy Simulation Tool, or eQUEST is a DOE-2 interface which allows users to develop 3-dimensional simulation models of a particular building design

✓These simulations incorporate building location, orientation, wall/roof construction, window properties, as well as HVAC systems, day-lighting and various control strategies, along with the ability to evaluate design options for any single or combination of energy conservation measure(s)



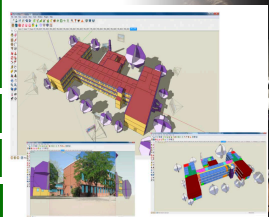
OPENSTUDIO: COMMERCIAL BUILDING ENERGY MODELING TOOL

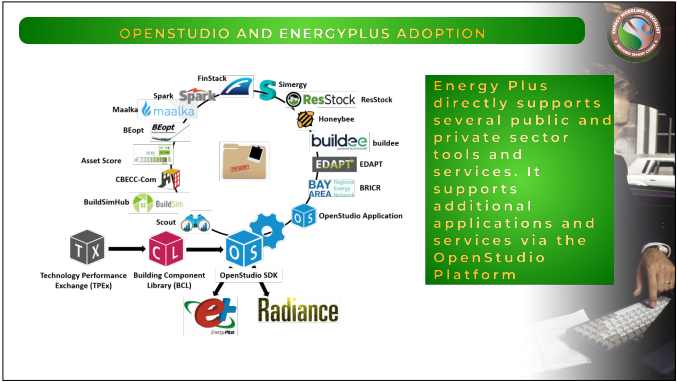
✓OpenStudio® is a cross-platform (Windows, Mac, and Linux) collection of software tools to support whole building energy modeling using EnergyPlus and advanced daylight analysis using Radiance

✓OpenStudio is the front-end of the EnergyPlus

✓EnergyPlus is an energy analysis and thermal load simulation program

✓EnergyPlus is not a user interface. It is intended to be the simulation engine around which a third-party interface can be wrapped





HTTPS://WWW.NREL.GOV/RESEARCH/DATA-TOOLS.HTML

Data and Tools
NREL develops data sets, maps, models, tools, and software for the analysis and development of innovative energy and energy efficiency technologies.
Many of these resources are offered publicly to support the transition to a clean energy future. Explore the collections below to find data and tools for your own use.

By Research Area

- Bioenergy >
- Buildings >
- Energy Analysis >
- Grid Modernization >
- Geothermal >
- Hydrogen and Fuel Cells >

SUMMARY OF AVAILABLE ANALYSIS & MODELING TOOLS

Stage	Requirements	Tools	Reality Checks
Scoping	<ul style="list-style-type: none">- Quick analysis- Comparative results- Reduce alternatives to consider- Control strategy modeling	<ul style="list-style-type: none">- System Analyzer™- Modified bin analysis (where load is not entirely dependent on ambient conditions)	<ul style="list-style-type: none">- Operation cost per ft²- Payback or other financial measure
System Design	<ul style="list-style-type: none">- Accurate output- Industry-accepted methods	<ul style="list-style-type: none">- HAP- TRACE 700- Elite Design	<ul style="list-style-type: none">- cfm/ft²- cfm/ton
Energy/Cost Analysis	<ul style="list-style-type: none">- Accurate- Industry-accepted methods- Flexible- Allows modeling of complex control strategies- Complies with ECB method requirements of ASHRAE 90.1-2001- Works for existing building and systems	<ul style="list-style-type: none">- EnergyPlus- DOE- HAP- TRACE 700- SUNREL	<ul style="list-style-type: none">- Btu/h-ft² per year- Operation cost per ft²- Payback or other financial measure
Monitoring	<ul style="list-style-type: none">- Simplicity- Intuitive interface- Systemwide- Interoperable	<ul style="list-style-type: none">- BacNET—compatible automation systems	<ul style="list-style-type: none">- Trended operating characteristics- Benchmark comparisons (such as system kW/ton)

FEATURES OF ENERGY SIMULATION

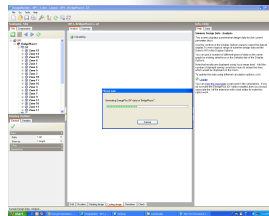
A comprehensive range of simulation data can be shown in annual, monthly, daily, hourly or sub-hourly intervals:

- ✓Energy consumption broken down by fuel and end-use
- ✓Internal air, mean radiant and operative temperatures and humidity
- ✓Comfort output including temperature distribution curves,
- ✓Site weather data
- ✓Heat transmission through building fabric including walls, roofs, infiltration, ventilation etc.
- ✓Heating and cooling loads
- ✓CO2 generation



THE PROCESS OF CARRYING OUT ENERGY SIMULATION

1. Building Layout Study (*.dwg) collection
2. Building Activity Data.
3. Construction Data Collection.
4. Glazing Data Collection.
5. Lighting Data Collection.
6. HVAC Data Collection.
7. Energy Metering Data for the facility
8. Model Calibration / Simulation.
9. Compilation and interpretation of results



BEYOND
SMART CITIES

THANK YOU

THE WORLD'S 1ST GREEN TECHNOLOGY
MARKETPLACE