Enhanced Energy Modeling
Through Parametrics

INTELLIGENCE FOR ACHIEVING BEST VALUE LOW ENERGY AND NET ZERO BUILDINGS

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ASHRAE CNY Chapter
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Learning Objectives
Enhanced Energy Modeling Through Parametrics

1. Building Industry Trends in Energy Performance
2. Energy Efficiency Design Challenges
3. Energy Models and Use as a Design Optimization Tool
4. Enhanced Energy Modeling Using a Parametrics Approach
5. How to Apply Parametric Models to Different Design Challenges
Learning Objective - 1

Building Industry Trends in Energy Performance
Market Forces

Source: Barclay’s Capital

Source: www.gbcio.org
Market Drivers - Building Energy Performance

1. Steep rise in energy costs & risk
   Market awareness & demand

2. Innovation, expansion in products & services
   Emerging public policy & regulations

3. Inevitable mass market adoption of energy efficiency
ASHRAE Standard 90.1,
Driving Energy Efficiency in Building Industry

Issued (1975)
>4.5% (1999)
>+12.0% (2004)
>+30.0% (2010)

Net Zero (2030)
Trends in Existing Building Markets

Rapidly expanding building energy disclosure laws

> Energy benchmarking

Energy benchmark scores to influence

> Influence public’s mindset
> Monetizing energy performance
> Valuing real estate assets
> Focusing code compliance
> Prioritizing retrofits
> Push for deep energy retrofits
> Utility incentives, financing and tax benefits
Key Take Away from Industry Trends

1. Building Industry Trends in Energy Performance

Building energy use metrics to become primary driver
Progressive move towards Net Zero Buildings

Where are we?  Where do we want to go?  How do we get there?
Learning Objective – 1
Question #1

> What are some driving forces that have pushed energy efficiency to the forefront of design considerations?

   A. Rising energy costs
   B. Public awareness of “Green” buildings and products
   C. Federal, state, and local utility incentives/programs
   D. All of the above

Answer

D. All of the above
Learning Objective – 1

Question #2

> What is the current trend/goal of ASHRAE 90.1?

A. 5% better than the original publication in 1975
B. 10% better than the 2004 publication
C. Design a building to minimally meet the 2013 standard
D. Net Zero by 2030

Answer

D. Net Zero by 2030
Learning Objective – 1
Question #3

> What is the popular energy metric used in building benchmarking?

A. kBtu/ft²
B. Therms/kWh
C. kWh/MMBtu
D. Therms/MMBtu

Answer

A. kBtu/ft²
Learning Objective - 2

Energy Efficiency Design Challenges
Understanding The Challenge

The low hanging fruits are gone
- Low cost, easy savings are baseline

Need to reach higher
- Growing demand for high performing building
- Owners are cost conscious

How do we do it Efficiently?
- Balance investment & return
- Eliminate or minimize redundancy
Design Problem 1

Diminishing Returns: Is more better?

a) R-2 to R-5
b) R-5 to R-11
c) R-11 to R-19
d) R-19 to R-38

Source: www.nmca.org
Law of Interactive Effects

Interactive effects get pronounced with multiple measures
  > Example: Lower lighting power & day light harvesting

Identify redundancies
  > Avoid investing in measures that have little benefit

Determine incremental savings
  > Balance investment to return
Learning Objective – 2
Question #1

> Which wall insulation upgrade offers most energy savings?

A. R-19 to R-38
B. R-50 to R-100
C. R-2 to R-5
D. All of the above provide the same savings

Answer

C. R-2 to R-5
Learning Objective – 2

Question #2

> What are some examples of redundant measures?

A. Energy recovery and demand control ventilation
B. Low lighting power density and daylight savings
C. Low window SHGC and exterior shading devices
D. All of the above

Answer

D. All of the above
Learning Objective – 2
Question #3

> What is an example of a low hanging fruit?

A. Convert T12 lighting to T8
B. Install lighting occupancy sensors
C. Cogeneration
D. Photovoltaics

E. A & B
F. C & D

Answer
E. A & B
Learning Objective - 3

Energy Models and Use as a Design Optimization Tool
Practice Review

> Involved in project that had energy model?

> What reasons prompted the need for energy model?

> How did you engage with the model?

> Did the energy model exercise help you improve the design?
Energy Models

**Tool intended to facilitate integrated design**
- Evaluate measures & strategies
- Captures interactive effects

**Compared Baseline & As-Designed cases**
- Estimate of energy & cost savings
- Compare against investment
- Decide value of measures

**Method for Documentation**
- LEED, incentive calculations
Limitations of Typical Energy Model

> Gets labor intensive and expensive with more measures

> Complex to use and can be hard to engage the modeler

> Cumbersome for optimizing exercises

> Result: Not an effective method for finely refining designs
Learning Objective – 3
Question #1

> What is the purpose of an energy model?

A. Evaluate possible design options
B. Estimate energy and cost savings compared to an established baseline
C. Documentation for LEED points or incentive programs (if applicable)
D. All of the above

Answer

D. All of the above
Learning Objective – 3
Question #2

> What is a limitation of basic energy modeling?

A. Gets labor intensive and expensive with more measures
B. Only predicts electrical energy
C. Does not predict energy costs
D. Does not show electric demand energy

Answer
A. Gets labor intensive and expensive with more measures
Learning Objective – 3
Question #3

> What is a popular energy modeling software?
   A. eQUEST
   B. EnergyPlus
   C. TRACE
   D. All of the above

Answer
D. All of the above
Learning Objective - 4

Enhanced Energy Modeling using a Parametrics Approach
Enhancing Models with Parametrics

> What is Parametrics?

> Iterative process to examine all combinations of potential energy upgrades

> Example: 7 measures, each with 3 options = 2,187 solutions
## Parametric Variables and Iterations

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<th>Baseline Iteration 1</th>
<th>Better Iteration 2</th>
<th>Best Iteration 3</th>
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<tr>
<td>Exterior Wall Insulation R-Value</td>
<td>13.5</td>
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<td>South Window SHGC</td>
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<td>Yes</td>
<td></td>
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<tr>
<td>Energy Recovery Y/N</td>
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<td></td>
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<tr>
<td>Demand Control Ventilation Y/N</td>
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<td>Yes</td>
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<tr>
<td>Chiller COP</td>
<td>4.9</td>
<td>5.6 Frc Chiller</td>
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Parametrics Methodology

1. Build Energy Model
2. Add Efficiency Features
3. Create Parametrics
4. Evaluate Costs and Results
5. Optimize Design and Build
Finding an Optimal Solution

No additional textual content is needed for this page.
Results Analysis Via User Friendly Interface
An Excel®-Based Application

Simple, user-friendly interface to define asset features and measures
Combines 10,000+ energy model results with TCO factors for select measures

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Learning Objective – 4
Question #1

> What is enhanced energy modeling using a parametrics approach?

A. A federally approved modeling software
B. Iterative process to examine all combinations of potential energy upgrades
C. Adding HVAC systems to an energy model that already has envelope properties built in

Answer

B. Iterative process to examine all combinations of potential energy upgrades
Learning Objective – 4
Question #2

> True or False?

An ideal design is the same no matter who the client is.

Answer

False. Every client has different goals, budgets, and economic criteria.
Learning Objective – 4
Question #3

> The parametrics approach can combine which of the following inputs?

A. Wall insulation
B. Roof insulation
C. Percent window area
D. Chiller efficiency
E. System Type
F. Hours of operation

Answer

All, and then some
Learning Objective - 5

How to Apply Parametric Models to Different Design Challenges
Design Problem 2: Cool Roof

Is Cool Roof a cost effective measure in NY?

Key Variables:

> Range of roof insulation scenarios
> Range of roof reflectance scenarios
Parametrics in Action
Evaluating Cool Roof

Weather Station = Albany, NY | Dry-Bulb Economizer

Roof R-Value: 1 5 10 15 20 25 30

Annual Energy Cost

$0 $5,000 $10,000 $15,000 $20,000 $25,000 $30,000 $35,000 $40,000

Roof Absorptance

1 0.9 0.8 0.7 0.6 0.5 0.4 0.3 0.2 0.1

$\Delta = $3,400 = 10%

$\Delta = $600 = 2%
Design Problem 3: HVAC System Type

Hospital building, 24 x 7 patient block.
Which HVAC System type is most efficient?

Choices:
1. 4-pipe fan coil units
2. Packaged single zone reheat systems
3. Constant volume reheat systems
4. Variable volume reheat systems
Parametrics in Action
Evaluating HVAC System Types

Thermal Loads on the Space

Fan Coil Units

Single Zone Reheat Systems

Constant Volume Reheat Systems

Variable Volume Reheat Systems
Design Problem 4: Optimizing Glass

How much glass is optimum on the south facade?

Key Variables:

> Percentage glass
> Glass properties
> Does HVAC system type have an impact?

Glazing energy impact extends beyond glass areas and properties. Parametrics can quickly inform design teams on key variables needed to be considered and optimized to improved designs.
Parametrics in Action
Optimizing Glass

HVAC system type has a significant impact in glass decisions and must be considered as part of glazing decision.
Parametrics + TCO Factors
Drivers for Best Value Solution

- Parametrics utilize intelligence from tens of thousands of energy model results
- TCO factors developed specific for each building type, technology and location
- Rigorous and transparent methodology
- Single user friendly platform for energy analysis, cost evaluation and overall life cycle performance
- Ideal package can be determined that provides the best return on investment

Interface provides the range of possible savings for each variable helping design teams to prioritize their measures and focus their effort
Applications of Parametrics

> Design studies for projects to select the best package of measures
> Prototype development for low-energy and net-zero buildings
> Asset-based energy benchmarking for large portfolios
> Evaluation of energy technologies in multiple scenarios or climates
> Code and policy development support
Learning Objective – 5
Question #1

> True or False?

    Roof insulation does not matter when considering installing a “white” roof.

Answer

False. Roof insulation impedes the transfer of solar energy into the building.
Learning Objective – 5
Question #2

> True or False?

HVAC system type does not matter when determining the effects of percent glass on a design.

Answer
False. Some system types are more responsive to internal loads than others.
Learning Objective – 5
Question #3

> True or False?

Measure implementation cost is a significant factor in determining the best package of measures.

Answer

True. Whether the economic criteria is simple payback, TCO, or LCC, measure implementation cost is a driving factor in making economically sound decisions.
Benefits of Parametrics
Best Practice Methods for Smart Design

> Extend the utilization of traditional energy models through parametrics
> Make informed choices, at any stage, based on tens of thousands of simulations
> Extreme integration and optimization of several energy- and cost-saving features
> Evaluate and optimize measures based on incremental savings and redundancy
> Develop the ideal package that provides the best return on investment
Thank You

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