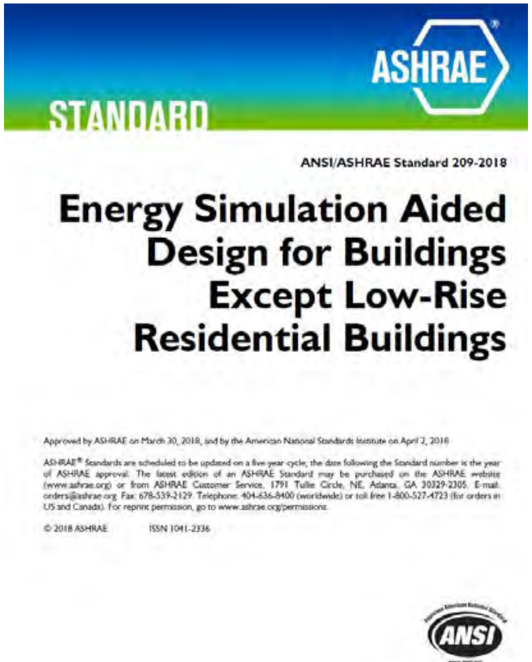


STANDARD

ANSI/ASHRAE Standard 209-2018

Energy Simulation Aided Design for Buildings Except Low-Rise Residential Buildings

Approved by ASHRAE on March 30, 2018, and by the American National Standards Institute on April 2, 2018.

ASHRAE® Standards are scheduled to be updated on a five-year cycle; the date following the Standard number is the year of ASHRAE approval. The latest edition of an ASHRAE Standard may be purchased on the ASHRAE website (www.ashrae.org) or from ASHRAE Customer Service, 1791 Tullie Circle, NE, Atlanta, GA 30329-2305. E-mail: orders@ashrae.org. Fax: 678-539-2129. Telephone: 404-636-8400 (worldwide) or toll free 1-800-527-4723 (for orders in US and Canada). For reprint permission, go to www.ashrae.org/permissions.

 ISSN 1041-2336

ASHRAE Standard 209 and the Quest to Make a Difference

IBPSA-USA San Francisco Bay Area

August 15, 2018

Erik Kolderup
erik@kolderupconsulting.com
www.kolderupconsulting.com
(415) 531-5198

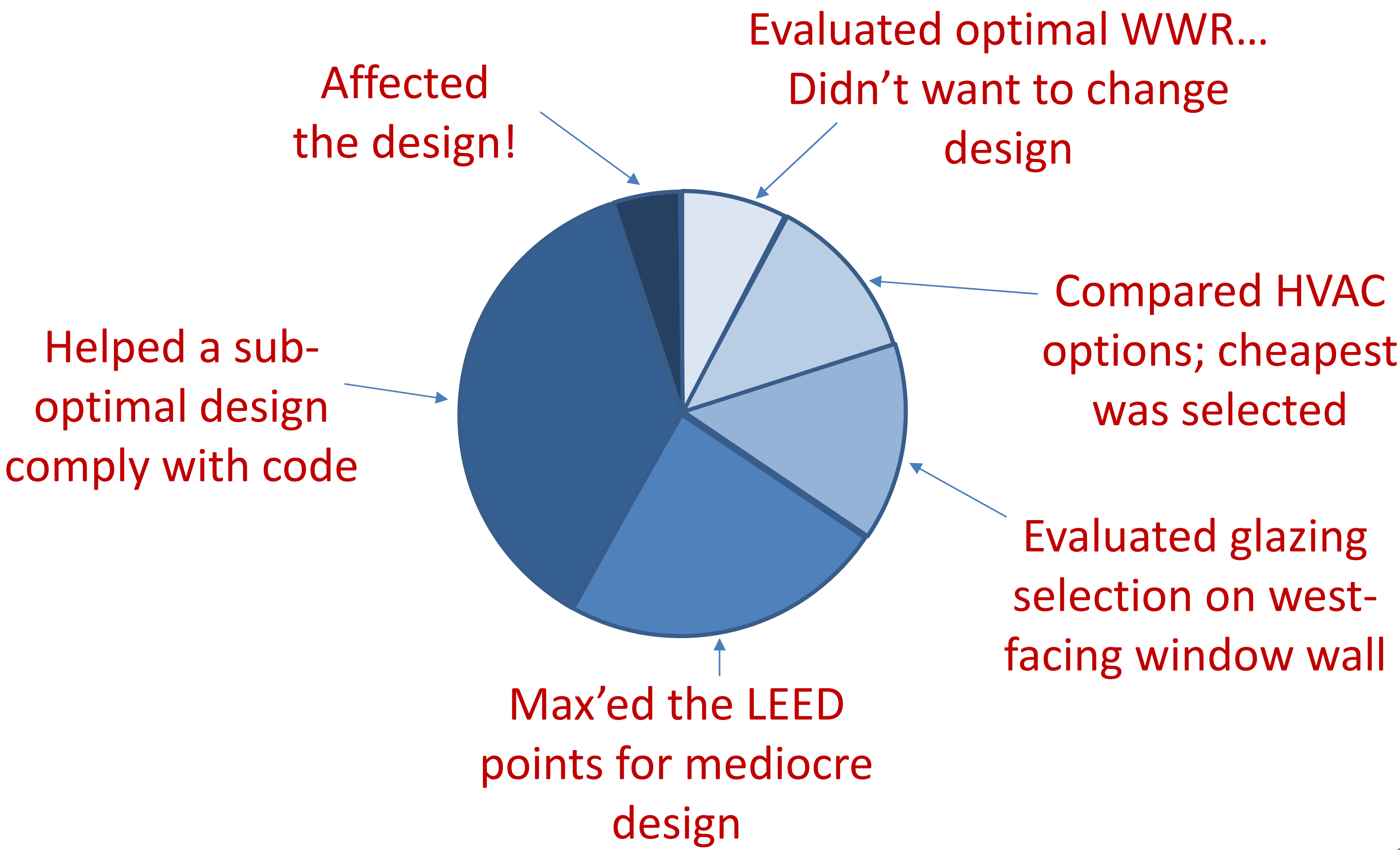
kolderup CONSULTING

Outline

ASHRAE Standard 209

- How it came to be
- What it is
- What it means to modelers
  - What we do
  - How we do it
  - When we do it

Energy modeler's lament



How we got here

- In olden days (pre-1980)
  - Research and design
  - Expensive and uncommon
- Performance-based codes (mid 1980’s)
  - Title 24, ASHRAE 90.1
  - Utility incentive programs
  - Desktop computers
- LEED
  - 1998 version 1.0
  - 2000 version 2.0
  - 2007 required 2 points in EAc2
- Standard 209-2018

1987 - IBPSA established

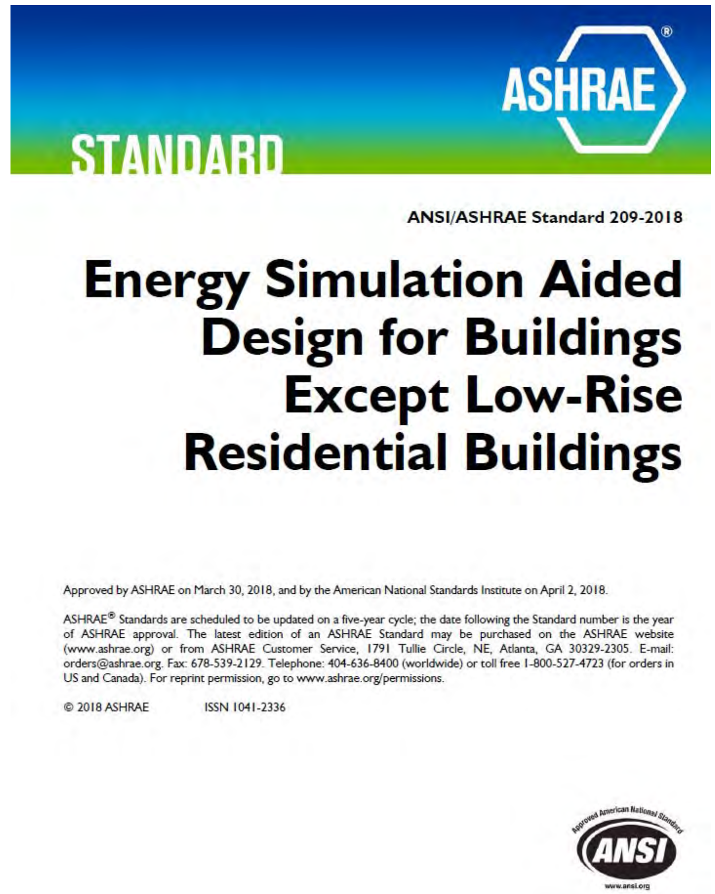
2004 - ASHRAE 90.1 Appendix G

How 209 came to be

- BLDG-SIM discussion, Spring 2011
  - Title, purpose and scope
- Committee approved, Oct. 2011
- Reviews
  - March 2016
  - May 2017
  - November 2017
- Publication
  - April 2018

What it is

- Process standard
- Minimum requirements
    1. Specific activities
    2. Modeling cycles
        1. One for load-reduction
        2. One more design-phase cycle
- Optional modeling cycles
    - Construction phase
    - Occupancy phase



STANDARD

ASHRAE®

ANSI/ASHRAE Standard 209-2018

Energy Simulation Aided Design for Buildings Except Low-Rise Residential Buildings

Approved by ASHRAE on March 30, 2018, and by the American National Standards Institute on April 2, 2018.

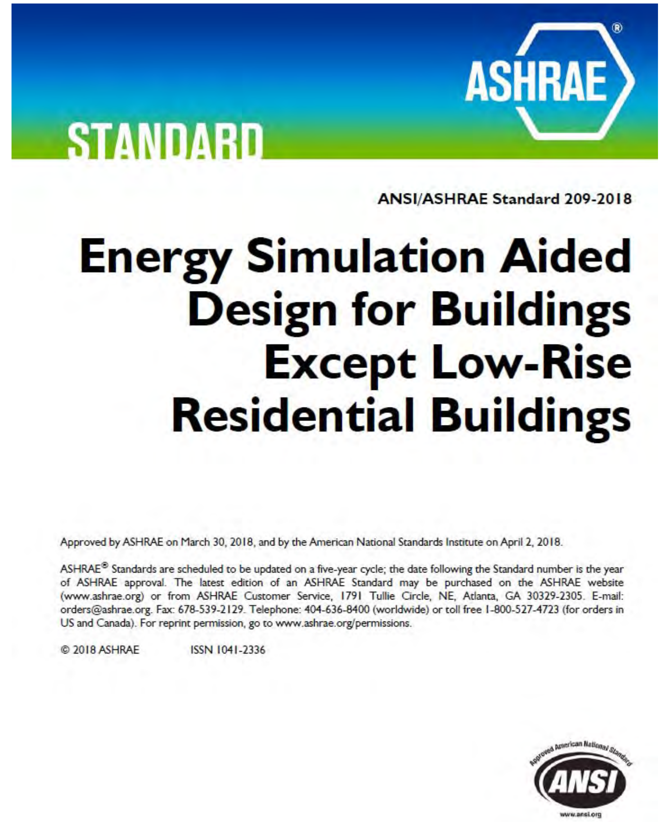
ASHRAE® Standards are scheduled to be updated on a five-year cycle; the date following the Standard number is the year of ASHRAE approval. The latest edition of an ASHRAE Standard may be purchased on the ASHRAE website (www.ashrae.org) or from ASHRAE Customer Service, 1791 Tullie Circle, NE, Atlanta, GA 30329-2305. E-mail: orders@ashrae.org. Fax: 678-539-2129. Telephone: 404-636-8400 (worldwide) or toll free 1-800-527-4723 (for orders in US and Canada). For reprint permission, go to www.ashrae.org/permissions.

© 2018 ASHRAE ISSN 1041-2336

ANSI

What it is

1. Purpose
2. Scope
3. Definitions
4. Utilization
5. General Requirements
6. Design Modeling Cycles
7. Construction and Operations Modeling
8. Post-Occupancy Energy Performance Comparison



STANDARD

ASHRAE

ANSI/ASHRAE Standard 209-2018

Energy Simulation Aided Design for Buildings Except Low-Rise Residential Buildings

Approved by ASHRAE on March 30, 2018, and by the American National Standards Institute on April 2, 2018.

ASHRAE® Standards are scheduled to be updated on a five-year cycle; the date following the Standard number is the year of ASHRAE approval. The latest edition of an ASHRAE Standard may be purchased on the ASHRAE website (www.ashrae.org) or from ASHRAE Customer Service, 1791 Tullie Circle, NE, Atlanta, GA 30329-2305. E-mail: orders@ashrae.org. Fax: 678-539-2129. Telephone: 404-636-8400 (worldwide) or toll free 1-800-527-4723 (for orders in US and Canada). For reprint permission, go to www.ashrae.org/permissions.

 ISSN 1041-2336

ANSI

What it is

1. Purpose
2. Scope
3. Definitions
4. Utilization
5. **General Requirements**
6. Design Modeling Cycles
7. Construction and Operations Modeling
8. Post-Occupancy Energy Performance Comparison

5.1 Software Requirements
5.2 Modeler Credentials
5.3 Climate and Site Analysis
5.4 Benchmarking
5.5 Energy Charrette
5.6 Establish Energy Performance Goals
5.7 General Modeling Cycle Requirements

What it is

1. Purpose
2. Scope
3. Definitions
4. Utilization
5. **General Requirements**
6. Design Modeling Cycles
7. Construction and Operations Modeling
8. Post-Occupancy Energy Performance Comparison

5.7 General Modeling Cycle Requirements

- 5.7.1 Energy Baselines and Goals
- 5.7.2 Input Data
- 5.7.3 Reporting
- 5.7.4 Quality Assurance

What it is

6.1 #1 Simple Box Model
6.2 #2 Conceptual Design
6.3 #3 Load Reduction
6.4 #4 HVAC System Selection
6.5 #5 Design Refinement
6.6 #6 Design Integration & Optimization
6.7 #7 Energy Simulation-Aided Value Engineering

1. Purpose
2. Scope
3. Definitions
4. Utilization
5. General Requirements
6. **Design Modeling Cycles**
7. Construction and Operations Modeling
8. Post-Occupancy Energy Performance Comparison

What it is

1. Purpose
2. Scope
3. Definitions
4. Utilization
5. General Requirements
6. Design Modeling Cycles
7. **Construction and Operations Modeling**
8. Post-Occupancy Energy Performance Comparison

7.1 #8 As-Designed Performance
7.2 #9 Change Orders
7.3 #10 As-Built Energy Performance

What it is

1. Purpose
2. Scope
3. Definitions
4. Utilization
5. General Requirements
6. Design Modeling Cycles
7. Construction and Operations Modeling
8. **Post-Occupancy Energy Performance Comparison**

8.1 #11 Post-Occupancy Energy Performance Comparison

Compliance

Required: all of these activities

- 5.3 Climate and Site Analysis
- 5.4 Benchmarking
- 5.5 Energy Charrette
- 5.6 Energy Performance Goals in OPR
- 5.7 General Modeling Cycle Requirements + 6.3 Modeling Cycle #3 Load Reduction Modeling

Compliance

Required: <u>one</u> of the following

5.7	+	6.1 Modeling Cycle #1 – Simple Box Modeling
5.7	+	6.2 Modeling Cycle #2 – Conceptual Design Modeling
5.7	+	6.4 Modeling Cycle #4 – HVAC System Selection Modeling
5.7	+	6.5 Modeling Cycle #5 – Design Refinement
5.7	+	6.6 Modeling Cycle #6 – Design Integration and Optimization
5.7	+	6.7 Modeling Cycle #7 – Energy Simulation Aided Value Engineering

Compliance

Optional (if required by adopting authority)

5.7	+	7.1 Modeling Cycle #8 – As-Design Energy Performance
5.7	+	7.2 Modeling Cycle #9 – Contemplated Change Orders
5.7	+	7.3 Modeling Cycle #10 – As-Built Energy Performance
5.7	+	8. Post-Occupancy Energy Performance Comparison

Timing

Section 6. Design Modeling Cycles

Conceptual Design	#1 Simple Box Model #2 Conceptual Design
Schematic Design	#3 Load Reduction #4 HVAC System Selection
Design Development	#5 Design Refinement #6 Design Integration & Optimization
Construction Documents	#7 Energy Simulation-Aided Value Engineering

Timing

Section 7. Construction Modeling Cycles

Construction & Operations	#8 As-Designed Performance #9 Change Orders #10 As-Built Energy Performance

Section 8. Post-Occupancy Energy Performance Comparison

Post Occupancy	#11 Post-Occupancy Energy Performance Comparison

Can we do this?

- Challenges?
  - Modeler Credentials
  - Climate and Site Analysis
  - Benchmarking
  - Energy Charrette
  - Establish Energy Performance Goals
  - General Modeling Cycle
    - Update goals
    - Input data
    - Input and output reporting
    - Quality assurance
    - Quality control

#1 Simple Box Model

#2 Conceptual Design

#3 Load Reduction

#4 HVAC System Selection

#5 Design Refinement

#6 Design Integration & Optimization

#7 Energy Simulation-Aided Value Engineering

Can we do this successfully?

- Timing
- Input information
- Communication
- Compelling stories

Timing

- What's a reasonable turnaround time?

  #1 Simple Box Model

  #2 Conceptual Design

  #3 Load Reduction

  #4 HVAC System Selection

  #5 Design Refinement

  #6 Design Integration & Optimization

  #7 Energy Simulation-Aided Value Engineering

Input Information

- What do we need to know?
- How do we figure out the rest?

Communication

- What information do we need to give the designers?

Compelling stories

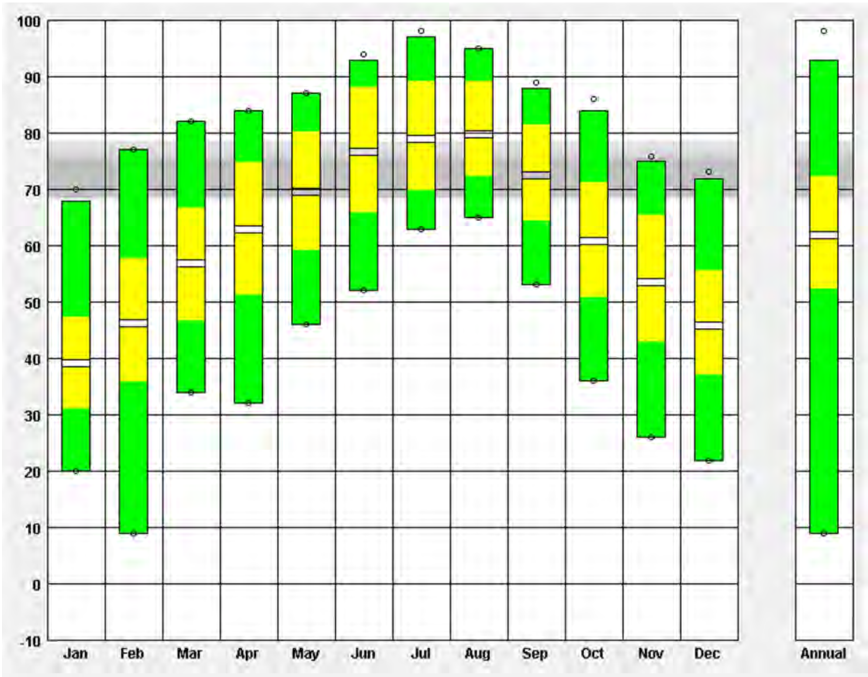
- Please share!

Thanks!

Erik Kolderup
erik@kolderupconsulting.com

5.3 Climate and Site Analysis

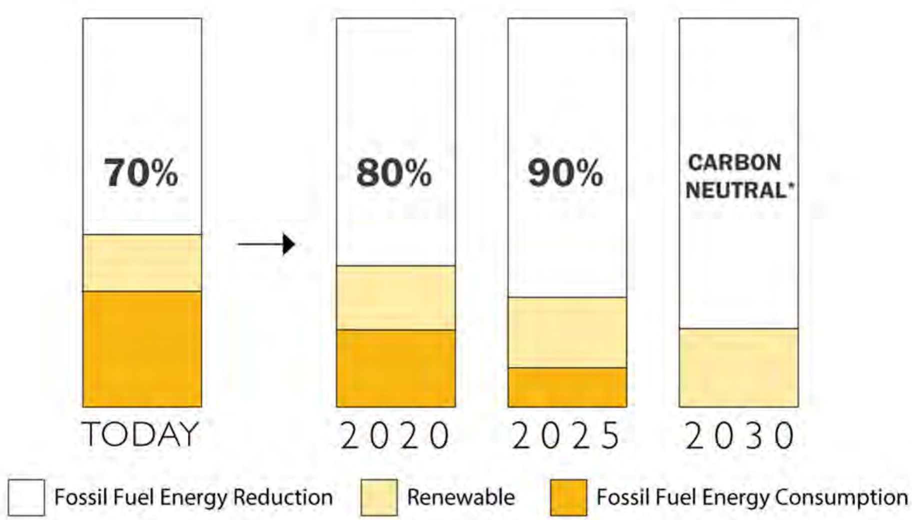
- Review local climate data
- Assess site characteristics
- Create list of climate- and site-specific design strategies



5.4 – 5.6 Benchmarking, Charrette, Performance Goals

Benchmarking / Overall Goals

- CBECS database
- Energy Star Target Finder
- AIA 2030 Challenge
- DOE Building Performance Database



The 2030 Challenge

*Using no fossil fuel GHG-emitting energy to operate.

Charrette Topics

- Purpose of energy modeling in project
- Project performance metrics and goals
- Results of any previous modeling
- Financial criteria for decision making
- Project schedule and follow-up items

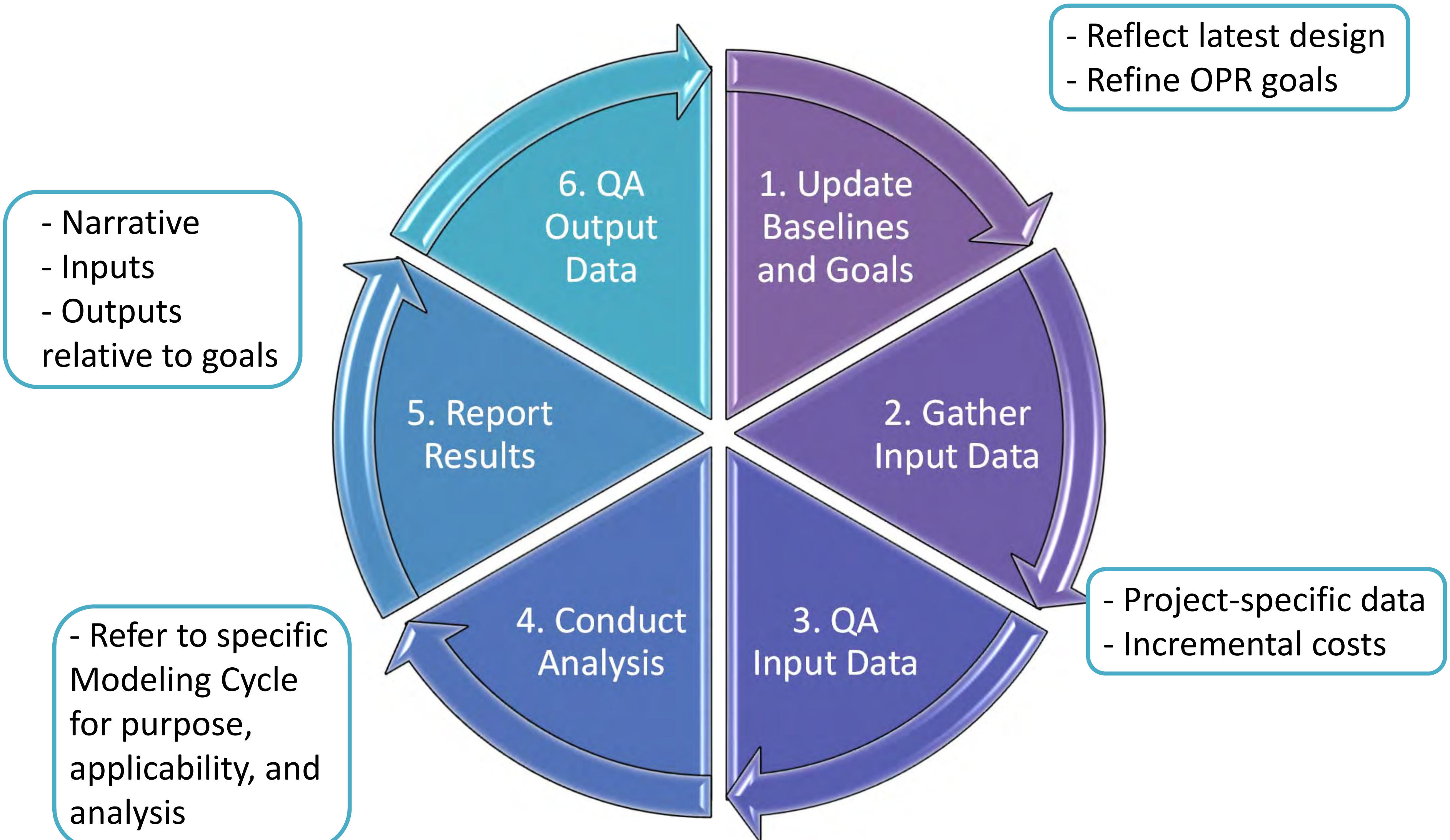
ENERGY STAR

5.6 Energy Performance Goals in OPR

- Overall Building Energy Goals
- Discipline- or system-specific energy goals
  - Envelope
  - Lighting/Daylighting
  - Plugs/Process Loads
  - Service Water Heating
  - HVAC

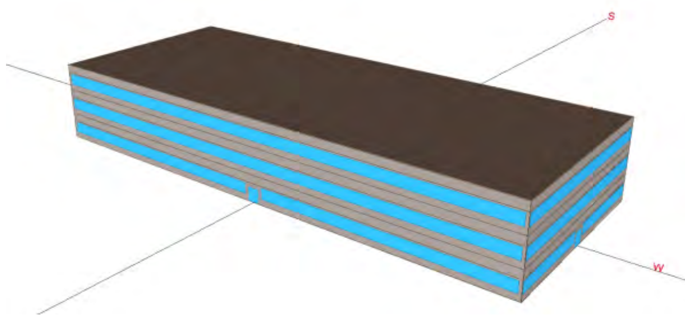
	Item	Component	Recommendation
	Form/space planning	Proper zoning	Group similar space types within the building footprint.
Envelope	Roofs	Insulation entirely above deck	R-30.0 c.i.
		Solar reflectance index (SRI)	Comply with Standard 90.1*
	Walls	Mass (HC > 7 Btu/ft^2)	R-13.3 c.i.
		Steel framed	R-13.0 + R-7.5 c.i.
		Below-grade walls	R-7.5 c.i.
	Floors	Mass	R-14.6 c.i.
		Steel framed	R-38.0
	Slabs	Unheated	Comply with Standard 90.1*
		Heated	R-20 for 24 in.
	Doors	Swinging	U-0.50
		Nonswinging	U-0.50
	Vestibules	At primary visitor building entrance	Comply with Standard 90.1*
	Continuous air barriers	Continuous air barriers	Entire building envelope
	Vertical fenestration (full assembly—NFRC rating)	Window-to-wall ratio	40% of net wall (floor-ceiling)
		Thermal transmittance	Nonmetal framing windows = 0.38 Metal framing windows = 0.44
		Solar heat gain coefficient (SHGC)	Nonmetal framing windows = 0.26 Metal framing windows = 0.38
		Light-to-solar gain ratio (LSG)	All orientations ≥ 1.5
		Exterior sun control	South orientation only – PF = 0.5
Daylighting/ Lighting	Form-driven daylighting option	All spaces	Comply with LEED for healthcare credits IEQ 8.1 (daylighting) and IEQ 8.2 (views)
		Diagnostic and treatment block	Shape the building footprint and form such that the area within 15 ft of the perimeter exceeds 40% of the floorplate.
		Inpatient units	Ensure that 75% of the occupied space not including patient rooms lies within 20 ft of the perimeter.
		Staff areas (exam rooms, nurse stations, offices, corridors); public spaces (waiting, reception); and other regularly occupied spaces as applicable	Design the building form to maximize access to natural light, through sidelighting and toplighting.
	Nonform-driven daylighting option	Staff areas (exam rooms, nurse stations, offices, corridors) and public spaces (waiting, reception)	Add daylight controls to any space within 15 ft of a perimeter window.
	Interior finishes	Room interior surface average reflectance	Ceilings ≥ 80% Walls ≥ 70%
	Interior lighting	Lighting power density (LPD)	Whole building = 0.9 W/ft^2 Space-by-space per Table 5-4
		Light source efficacy (mean lumens per watt)	T8 & T5 > 2 ft = 92 T8 & T5 < 2 ft = 85 All other >50
		Ballasts—4 ft T8 Lamps	Nondimming = NEMA Premium Dimming= NEMA Premium Program Start
		Ballasts—Fluorescent and HID	Electronic
		Dimming controls daylight harvesting	Dim all fixtures in daylighted zones.
		Lighting controls—General	Manual ON, auto/timed OFF in all areas as possible.
		Surgery task lights	Use LED lights exclusively.
		Exit signage	0.1–0.2 W Light Emitting Capacitor (LEC) exit signs exclusively

Typical Energy Modeling “Cycle”



Modeling Cycle #1 – Simple Box Modeling

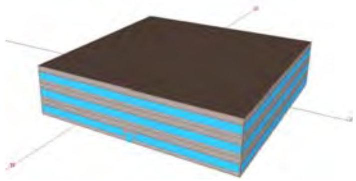
- Create a model based on project location, principal building type, and gross floor area
- Using a building energy model, vary the following characteristics:
  - Building geometry
  - Window-to-wall ratio
  - Orientation
  - Thermal performance of envelope

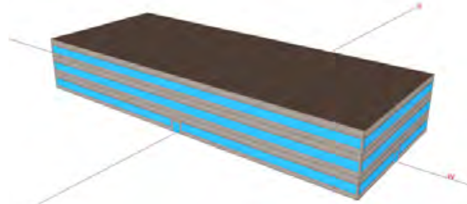


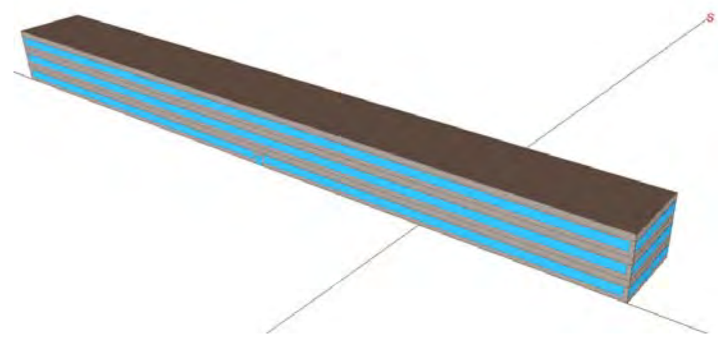
- Identify distribution of energy by end-use and determine which characteristics more significantly affect energy performance

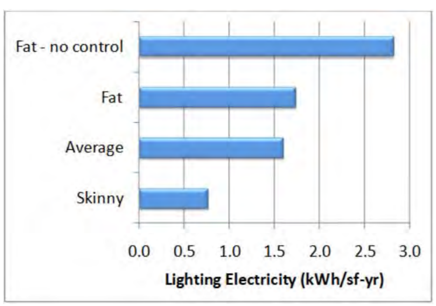
Modeling Cycle #2 – Conceptual Design Modeling

- Not applicable to buildings when energy consumption from plug/process loads is greater than 75% of total.
- Evaluate design strategies related to building form and architecture, holding internal loads and HVAC systems constant among concepts considered.







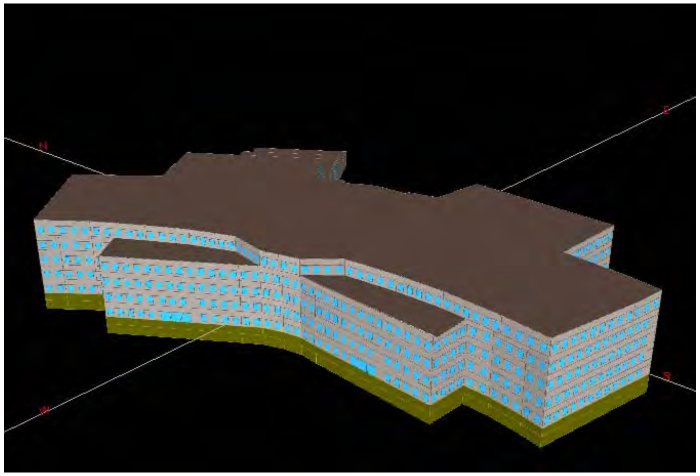


Modeling Cycle #4 – HVAC System Selection

- Evaluate impact of HVAC System Type on energy performance
- Must take place after Load Reduction modeling
- Use energy model to compare at least two alternate HVAC systems

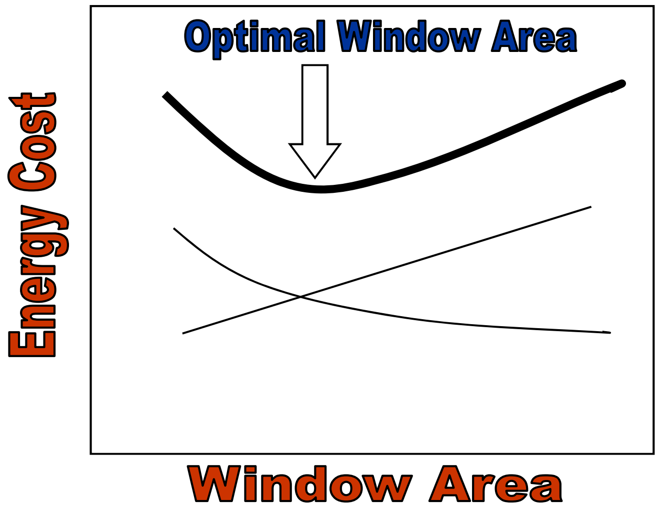
Modeling Cycle #5 – Design Refinement

- Support further development of building design
- Must take place after "Load Reduction" cycle and before end of construction documents phase
- Analysis could focus on one or more of the following categories:
  - HVAC
  - Lighting
  - Envelope
  - Service water heating
  - Plug and process loads



Modeling Cycle #6 – Integration and Optimization

- Facilitate integration of building systems through an optimization process.
- Identify Optimization Objective, Design Variables, Design Constraints or test range for each variable
- Use energy modeling to conduct optimization analysis of the parameters defined above

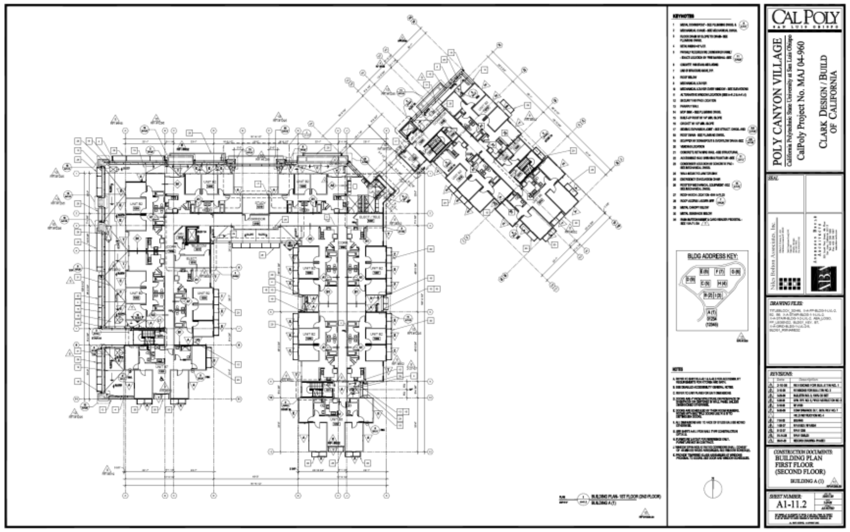


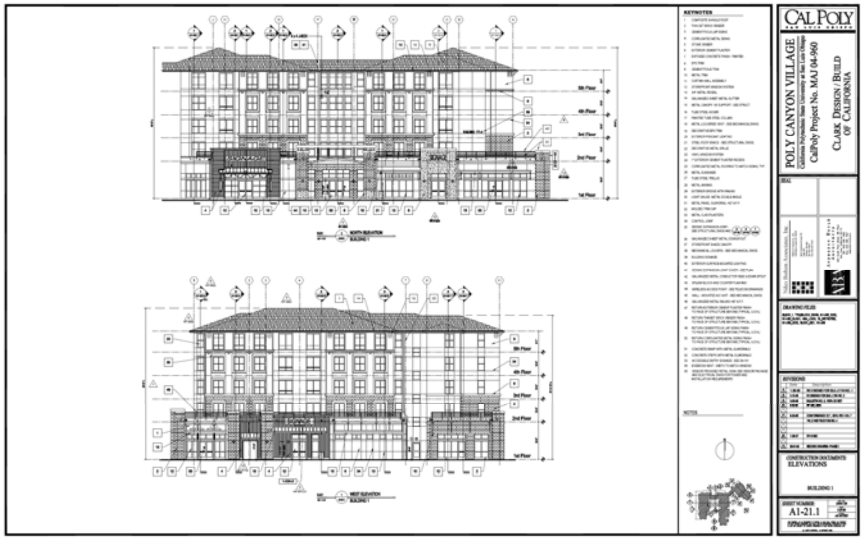
Modeling Cycle #7 – Value Engineering

- Provide information on implications of value engineering proposals on performance goals to ensure a more informed design decision.
- Identify project alternatives from at least one VE proposal
- Identify first cost and operating cost consequences to building systems directly and indirectly affected
- Use energy model to simulate each alternative

Modeling Cycle #8 – As-Designed Energy Performance

- Develop a building energy model to represent the as-designed project in order to compare as-designed performance to project goals.
- Based on 100% design drawings
- Schedules represent best guess on expected use.





Modeling Cycle #9 – Contemplated Change Orders

- Provide feedback on all contemplated change orders (CCOs) that impact the project's energy performance goals
- Provide either a qualitative or quantitative (energy model) review of all CCOs that negatively affect performance goals
- At least one CCO must be evaluated using the energy model

Modeling Cycle #10 – As-Built Energy Performance

- Develop a building energy model to represent the as-built project in order to compare as-built performance to project goals.
- As-built drawings and contractor submittals
- Same schedules as ‘As-Designed’ unless new information is known

Source: www.sfwater.org

Model Cycle #11 – Post-Occupancy Energy Comparison

- To identify potential energy savings opportunities and provide feedback to future energy modeling projects
- Compare modeled energy performance from design phase energy model to actual energy performance from utility bills.
- If available, use actual weather data rather than "typical" weather data.
- Calculate error metrics NMBE and CV(RMSE)
- Conduct weather-based regression analysis (optional)

$$NMBE = 100 \times \sum^{n} (y_i - \hat{y}_i) \, / \, [(n - p) \times \bar{y}]$$

$$CVRSME = 100 \times \left[\sum^{n} (y_i - \hat{y}_i)^2 / (n - p) \right]^{1/2} / \bar{y}$$