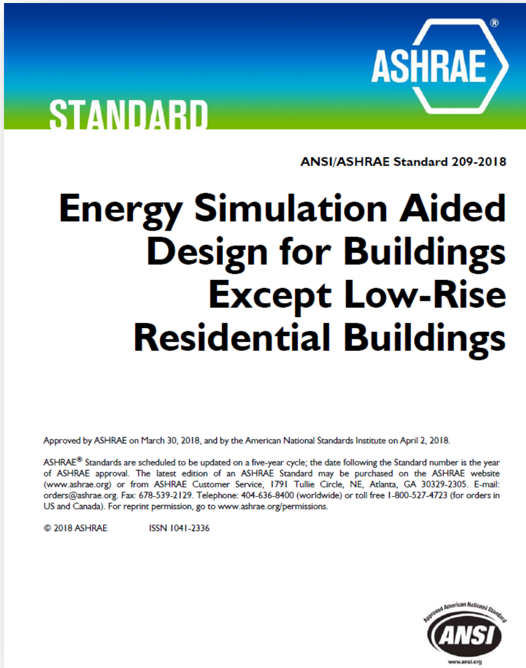
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ANSI

ASHRAE Standard 209

ASHRAE Golden Gate Seminar
October 17, 2018

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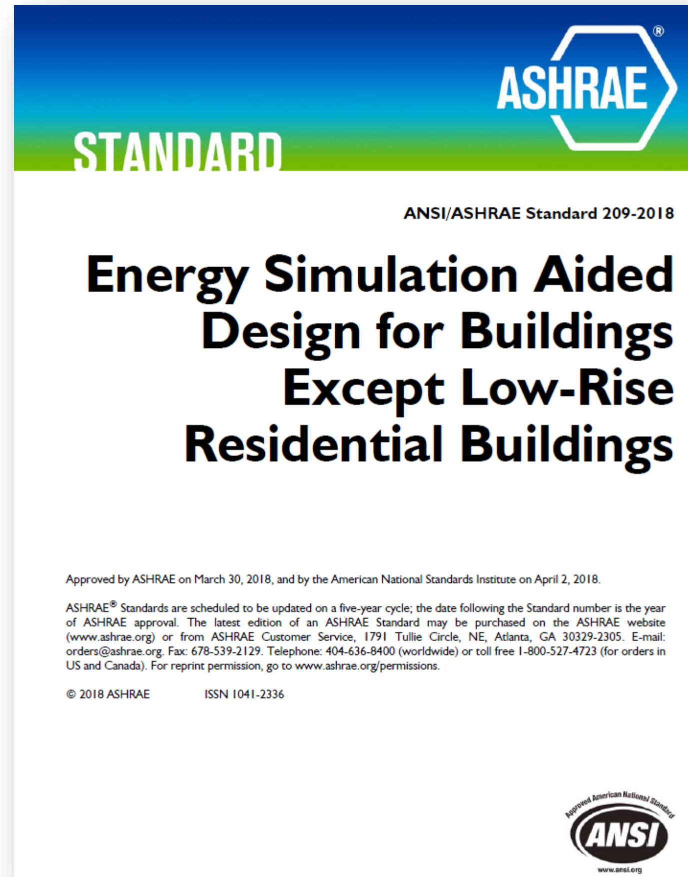
kolderup CONSULTING

Outline

ASHRAE Standard 209

- Why and how it came to be
- What it is
- How to use it



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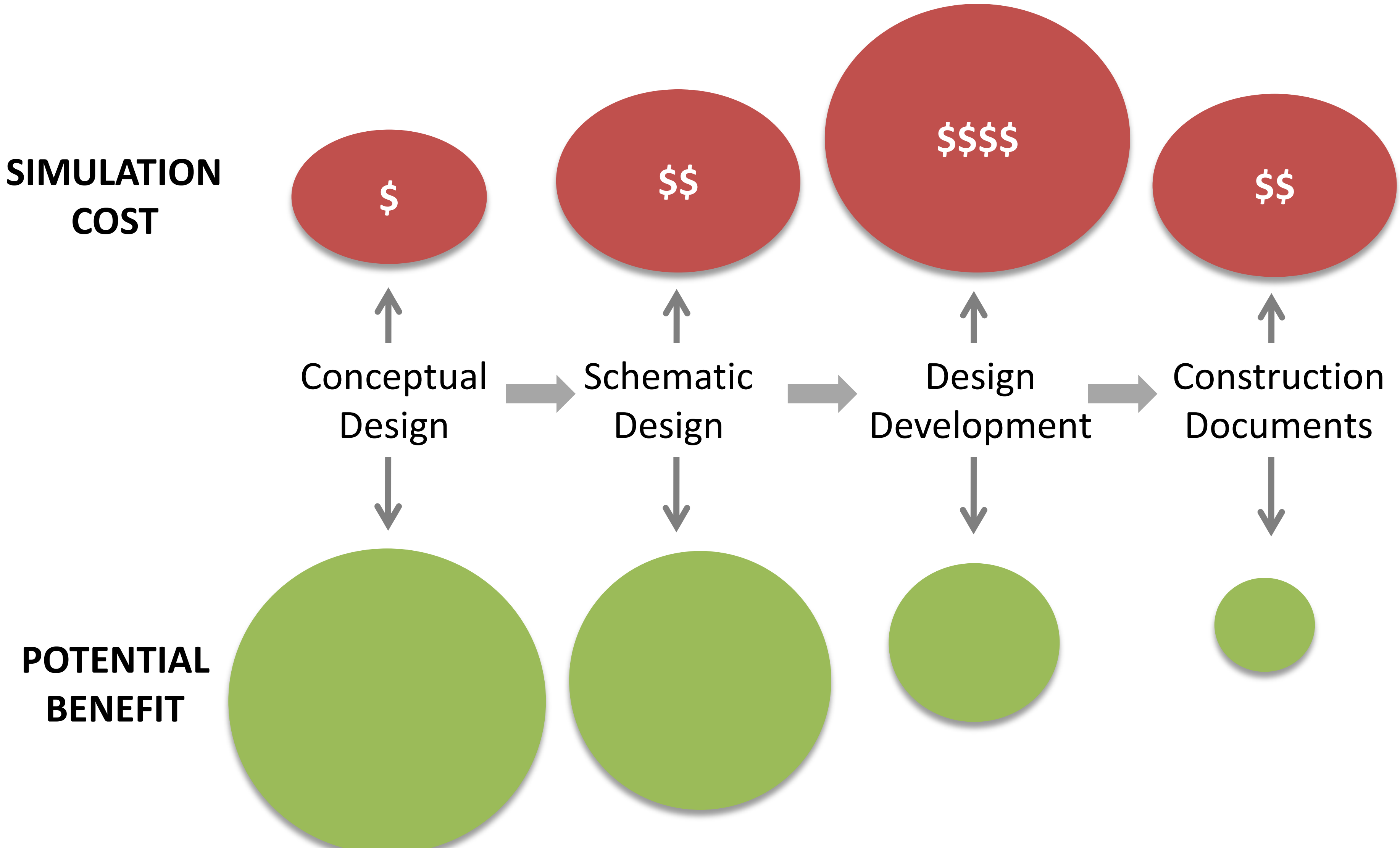
Motivation


SIMULATION COST
$
$$
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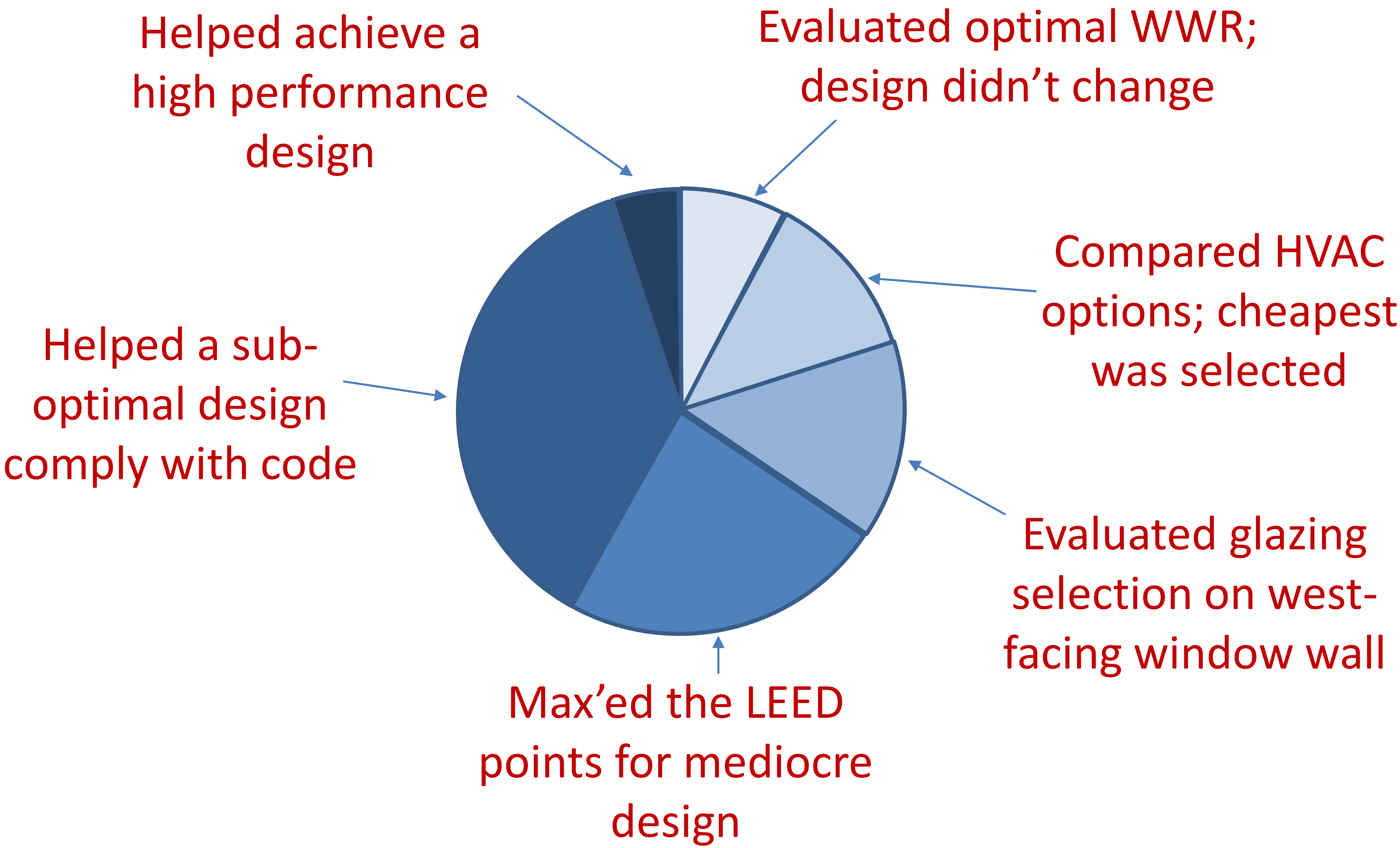
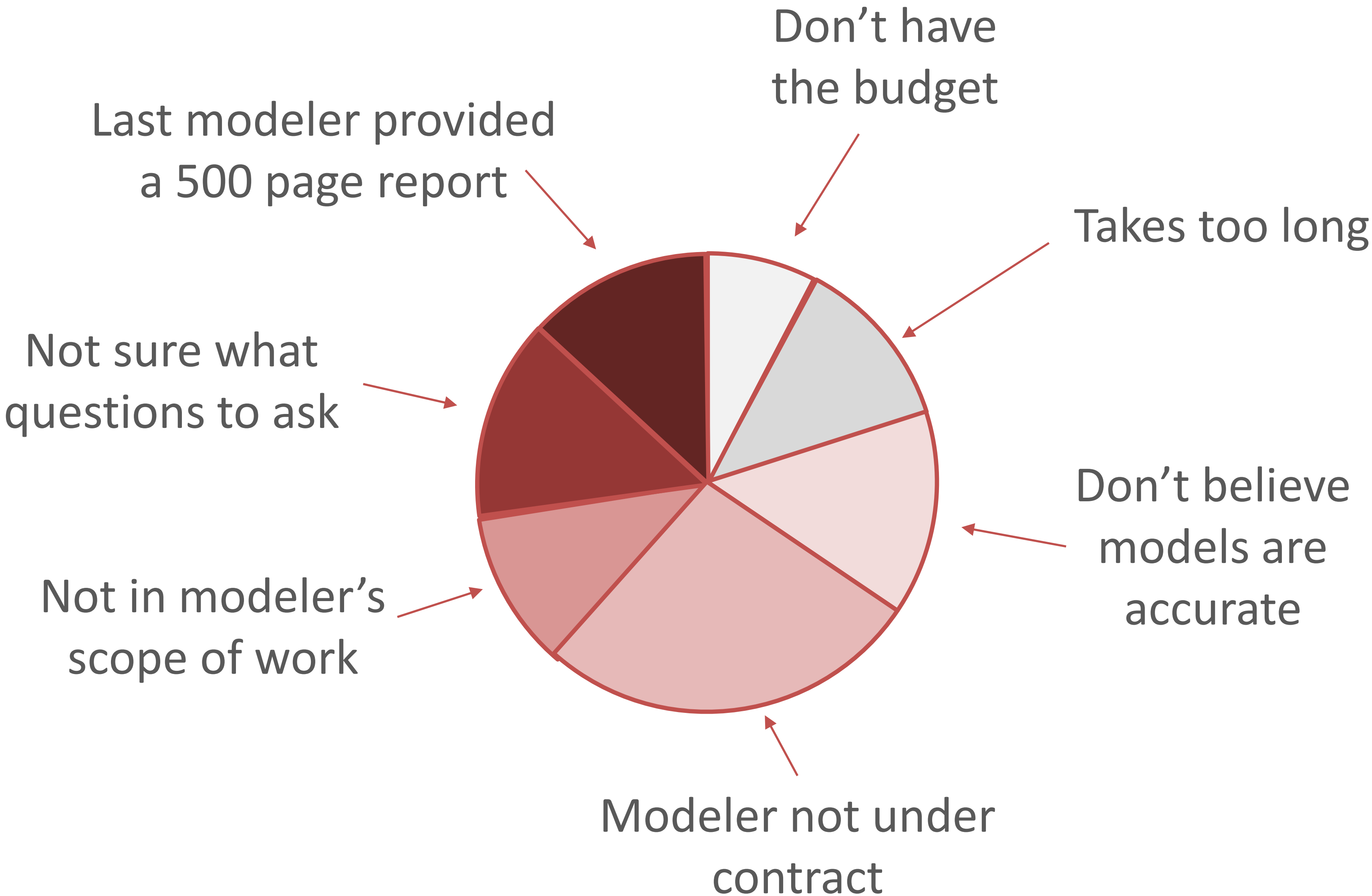
Conceptual Design
Schematic Design
Design Development
Construction Documents
POTENTIAL BENEFIT

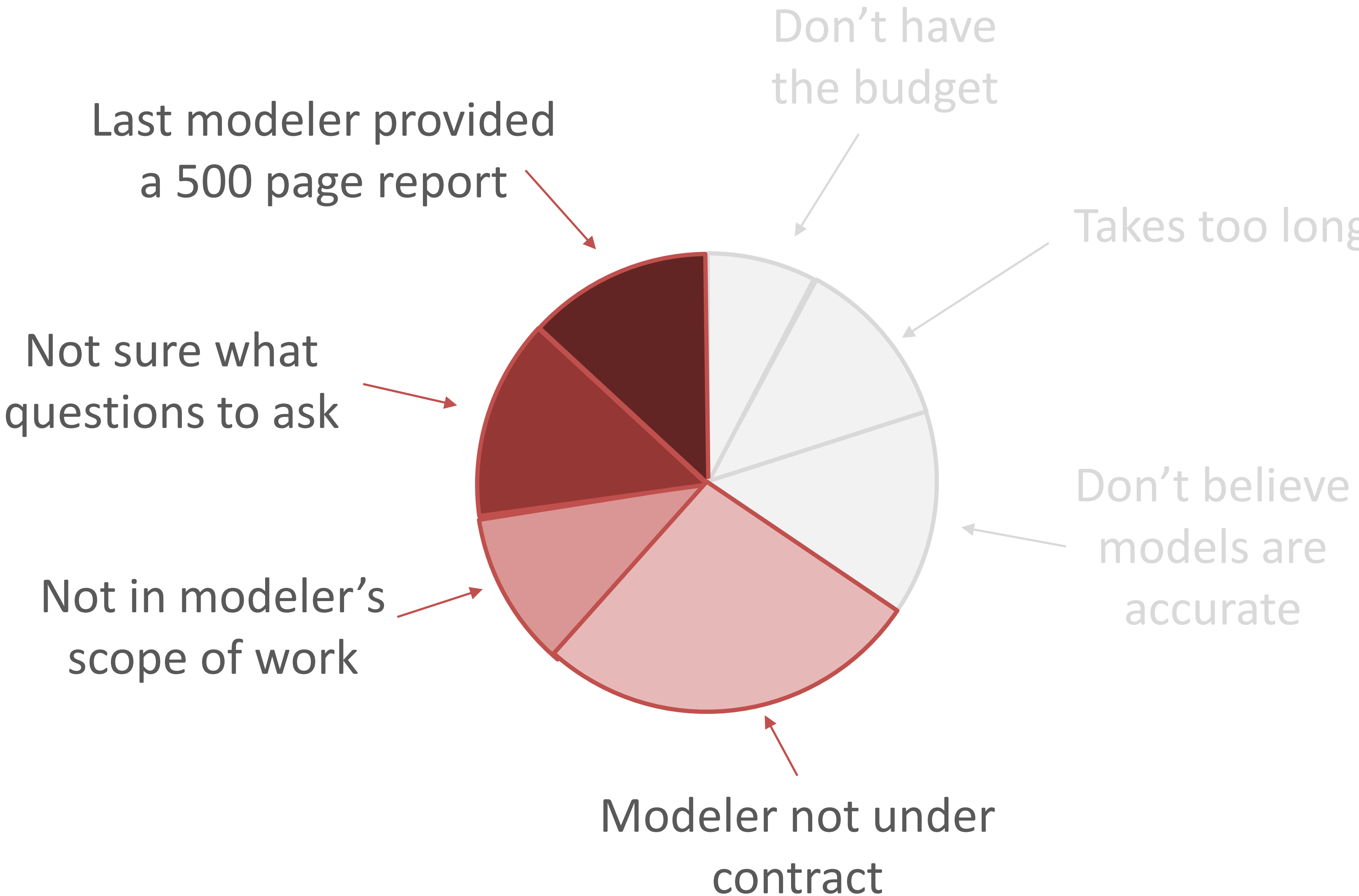
Energy modeler’s lament



Why is it so?


Don't have the budget
Takes too long
Don't believe models are accurate
Modeler not under contract
Not in modeler's scope of work
Not sure what questions to ask
Last modeler provided a 500 page report

Why is it so?


Don’t have the budget
Last modeler provided a 500 page report
Takes too long
Not sure what questions to ask
Don’t believe models are accurate
Not in modeler’s scope of work
Modeler not under contract

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 (International Building Performance Simulation Association)

2004 - ASHRAE 90.1 Appendix G

How 209 came to be

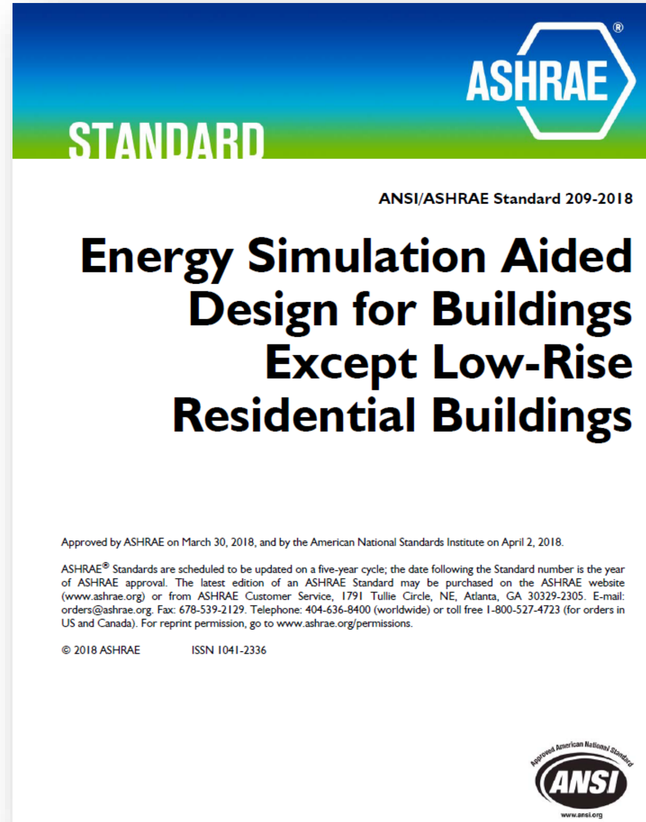
2011 Spring	Email list discussion

- Title, purpose and scope

2011 Oct.	Committee approved
…	
2016 Mar.	1st Public Review
2017 May	2nd Public Review
2017 Nov.	3rd Public Review
2018 Apr.	Publication

What it is

- Process standard
- Minimum requirements
  1. Four specific activities
  2. Two modeling cycles
     1. Load-reduction
     2. Additional design-phase cycle
- Optional modeling cycles
  - Construction phase
  - Occupancy phase



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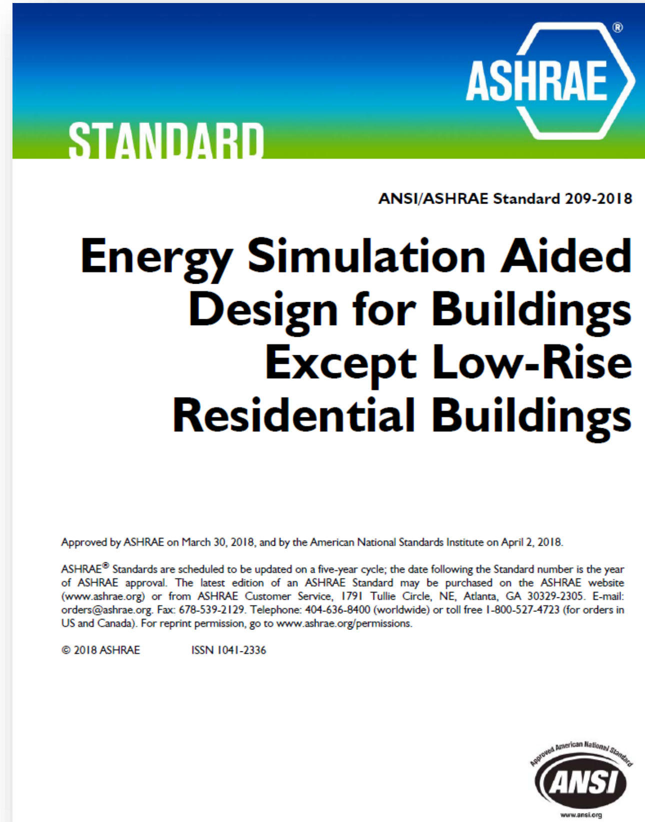
What it is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1. Purpose
2. Scope
3. Definitions
4. Utilization
5. General Requirements
6. Design Modeling Cycles
7. Construction and Operations Modeling
8. Post-Occupancy Energy Performance Comparison

What it is

5. General Requirements

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

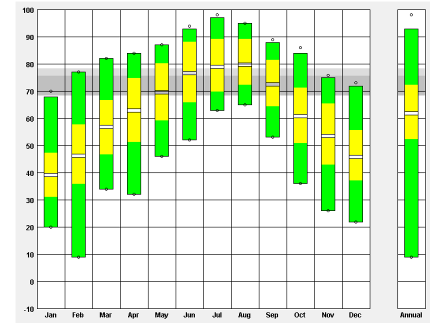
5.7 General Modeling Cycle Requirements

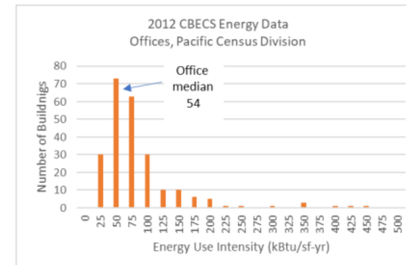
5.7.1 Energy Baselines and Goals

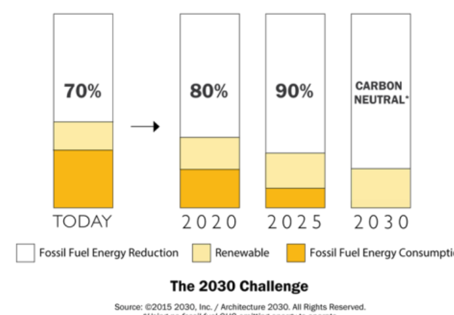
5.7.2 Input Data

5.7.3 Reporting

5.7.4 Quality Assurance







What it is

6. Design Modeling Cycles

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

What it is

6.1 Modeling Cycle # 1—Simple Box Modeling

6.1.1 Purpose. Identify the distribution of energy by end use. Evaluate *energy end uses* and demand characteristics that affect building conceptual design.

6.1.2 Applicability. This *modeling cycle* applies before the building's geometry and site orientation have been set in the design process. This must be completed before or during the energy *charrette* described in Section 5.5.

6.1.3 Analysis. Create *energy models* to calculate annual building energy by end use and peak heating and cooling loads with identical *HVAC systems*. Perform a sensitivity analysis by varying the following building characteristics:

a. Building geometry
b. Window-to-wall ratio, by orientation, and shading options (if applicable)
c. Orientation
d. Thermal performance of the envelope and structure

Informative Note: See Informative Appendix C for guidance.

What it is

7. Construction and Operations Modeling

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

8. Post-Occupancy Energy Performance Comparison

- 8.1 #11 Post-Occupancy Energy Performance Comparison

Compliance

Required

5.3 Climate and Site Analysis

5.4 Benchmarking

5.5 Energy Charrette

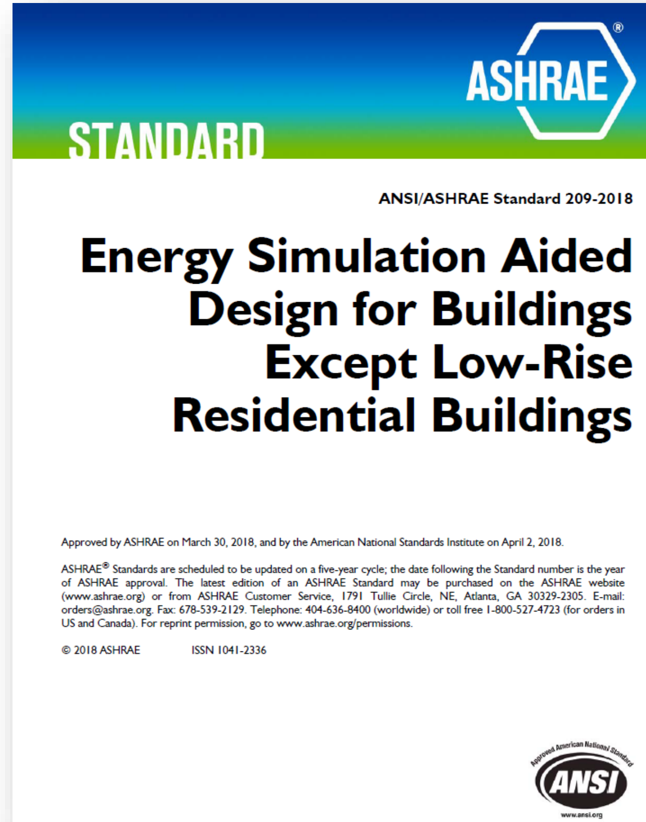
5.6 Energy Performance Goals in OPR

5.7 General Modeling Cycle Requirements + 6.3 Modeling Cycle #3 Load Reduction Modeling

5.7 General Modeling Cycle Requirements + One additional design-phase modeling cycle (earlier or later)

How to use it

- Policy
- Request for proposal
- Scope of work
- Guide for design process
  - Analyses
  - Interactions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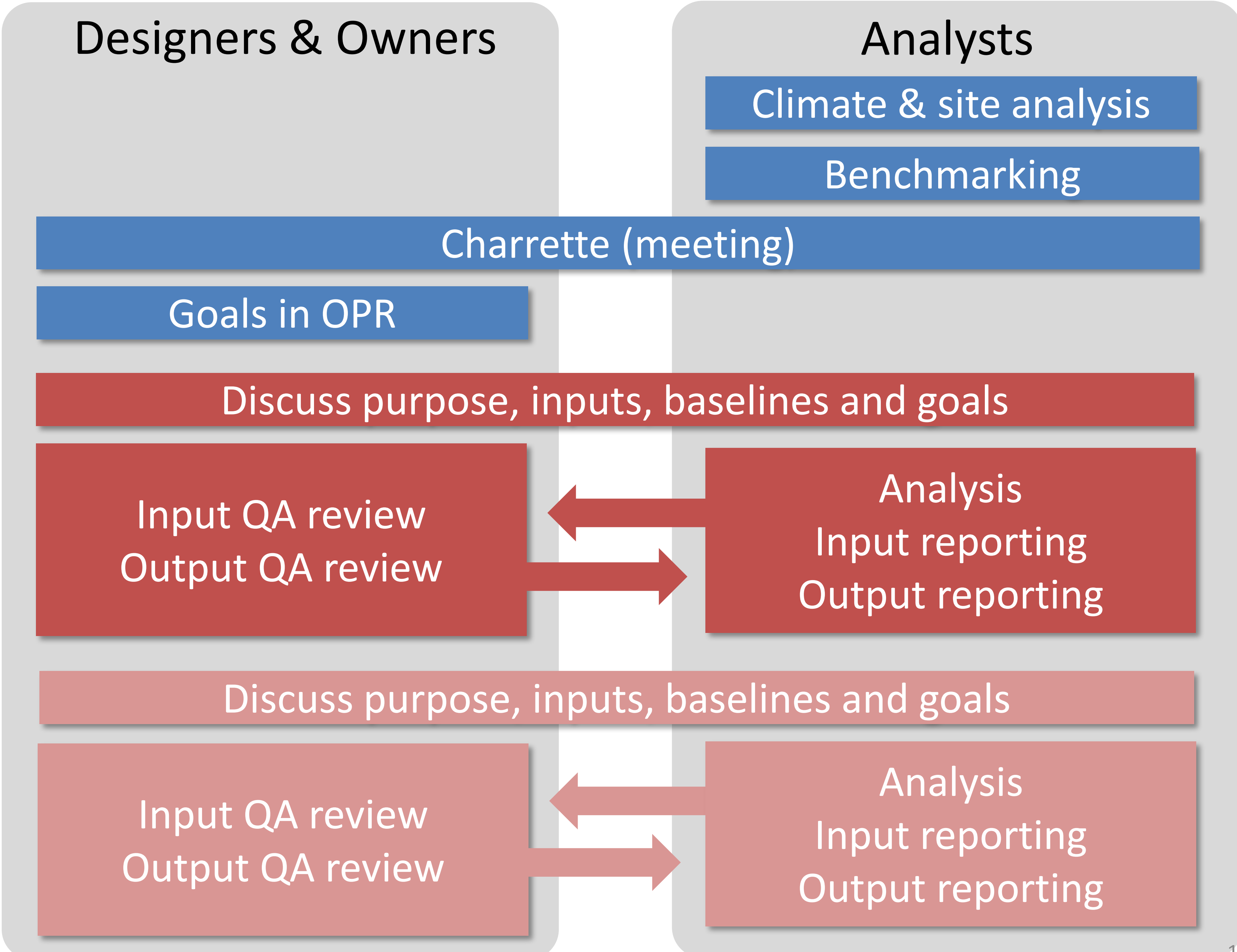

Designers & Owners
Analysts
Climate & site analysis
Benchmarking
Charrette (meeting)
Goals in OPR
Discuss purpose, inputs, baselines and goals
Input QA review
Output QA review
Analysis
Input reporting
Output reporting
Discuss purpose, inputs, baselines and goals
Input QA review
Output QA review
Analysis
Input reporting
Output reporting

Parting thoughts

- Simulation is more important than ever
- We can get more benefit from simulation
- We are still learning how to integrate simulation
- Standard 209 is a step towards a common understanding

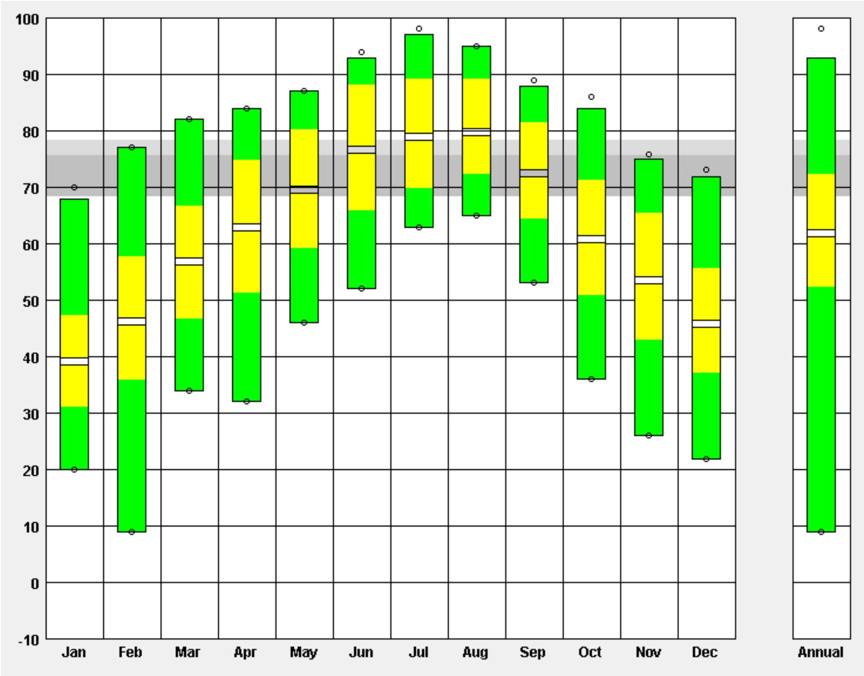
Thanks!

Erik Kolderup
erik@kolderupconsulting.com

Additional slides for reference

5.3 Climate and Site Analysis

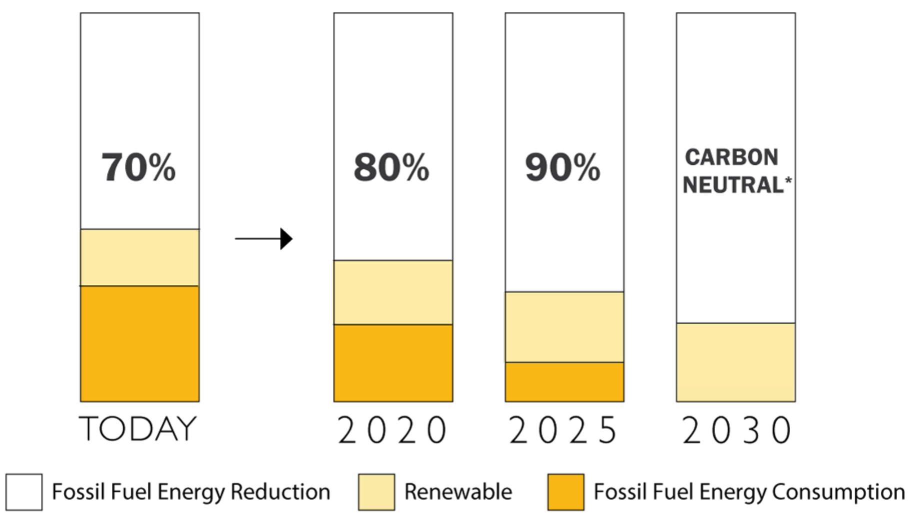
- Review local climate data
- Assess site characteristics
- Create list of climate- and site-specific design strategies



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

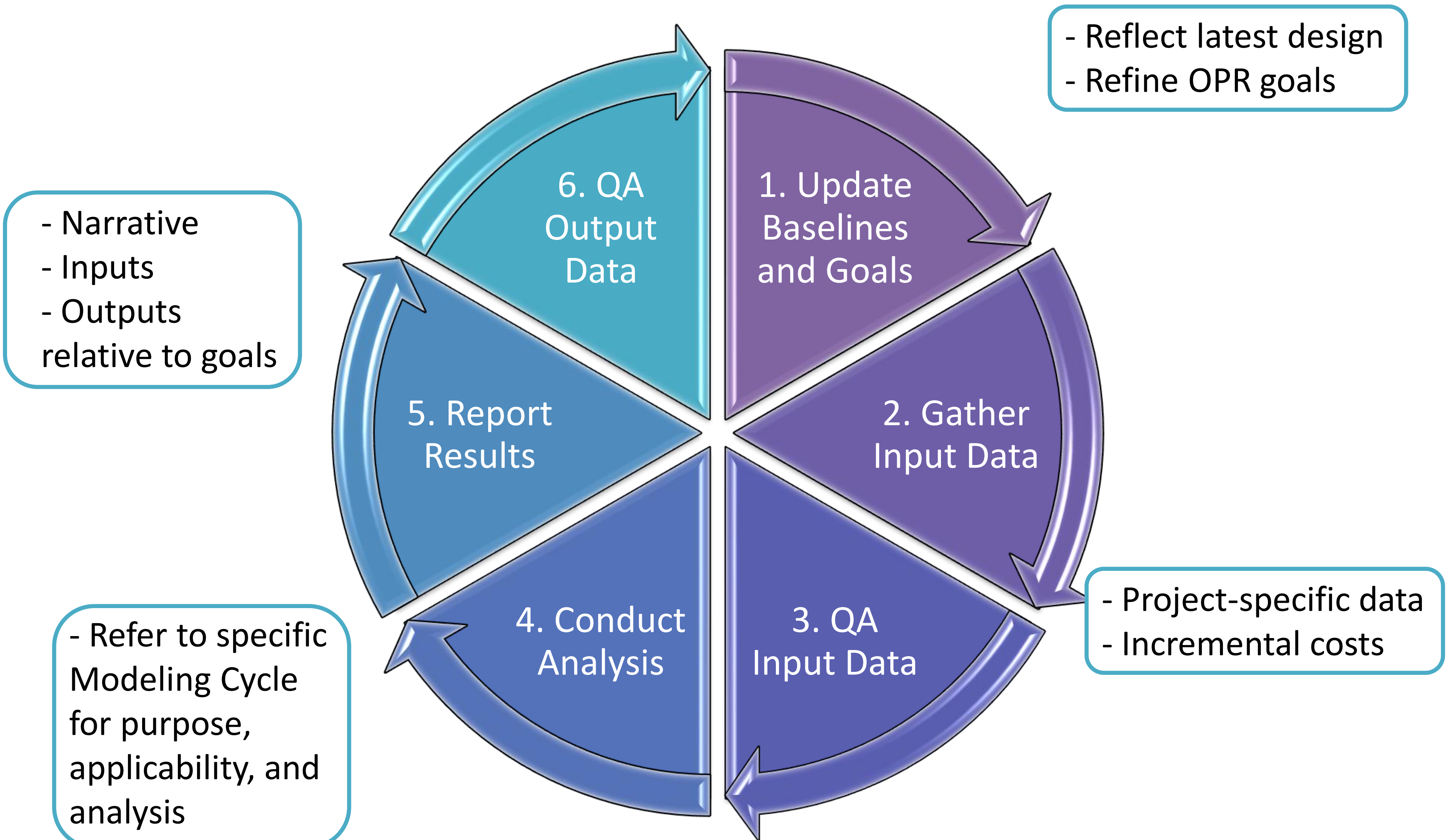
ENERGY STAR

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

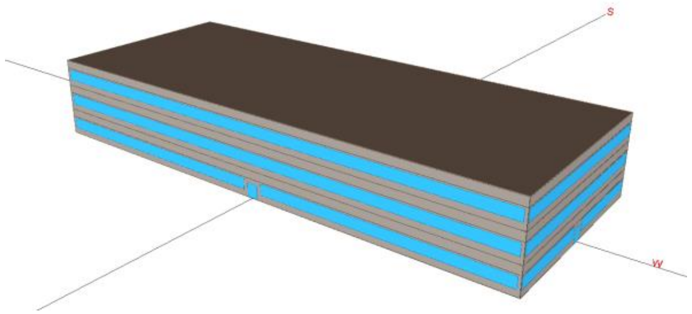
	Item	Component	Recommendation
	Form/space planning	Proper zoning	Group similar space types within the building footprint.
Envelope	Roofs	Insulation entirely above deck	R-30.0 c.i.
		Solar reflectance index (SRI)	Comply with Standard 90.1*
	Walls	Mass (HC > 7 Btu/ft^2)	R-13.3 c.i.
		Steel framed	R-13.0 + 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

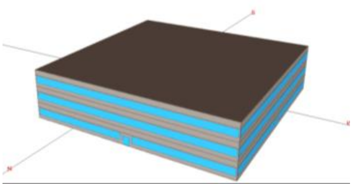
- Create a model based on project location, principal building type, and gross floor area
- Using a building energy model, vary the following characteristics:
  - Building geometry
  - Window-to-wall ratio
  - Orientation
  - Thermal performance of envelope

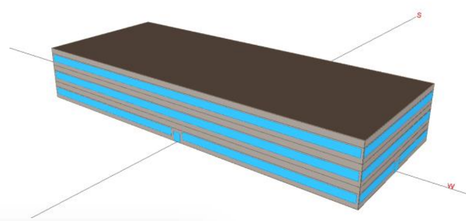


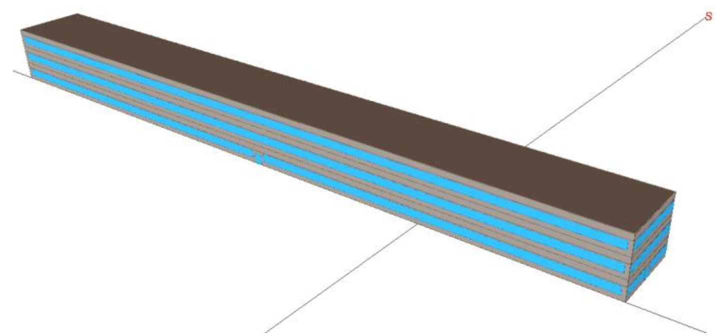
- Identify distribution of energy by end-use and determine which characteristics more significantly affect energy performance

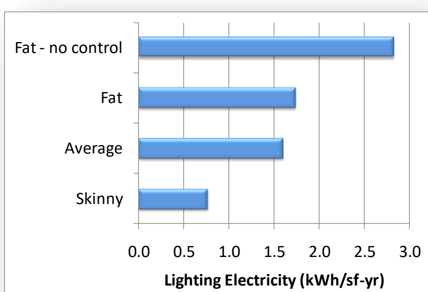
Modeling Cycle #2
Conceptual Design Modeling

- 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.







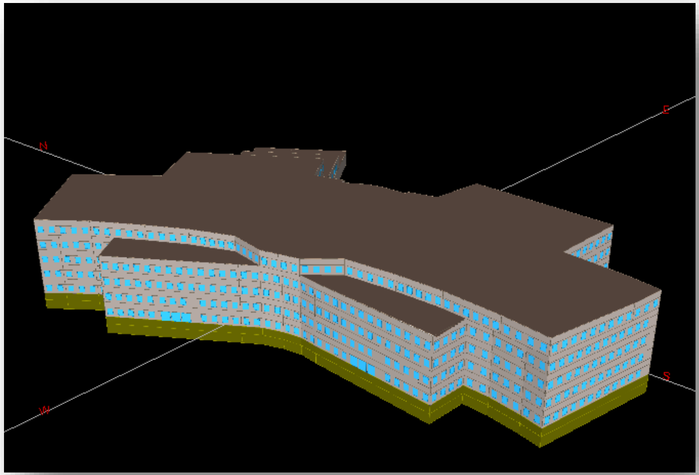


Modeling Cycle #4
HVAC System Selection

- 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

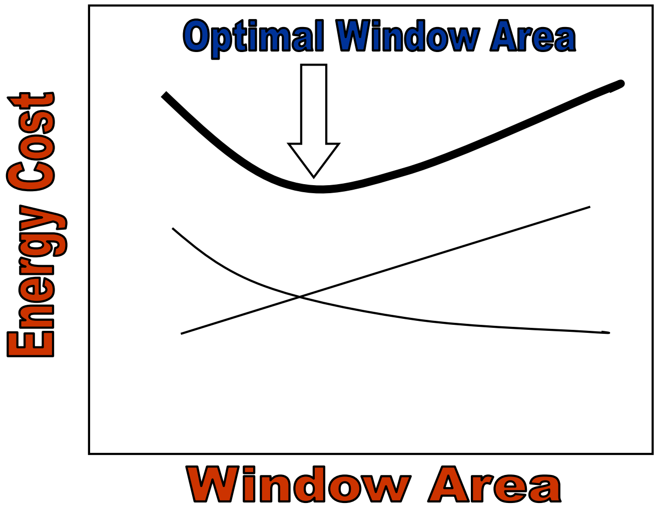
Modeling Cycle #5
Design Refinement

- 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

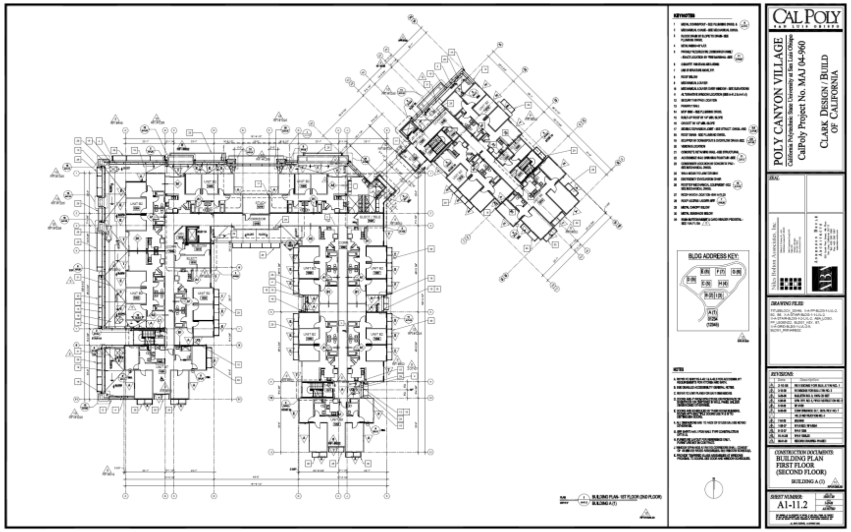


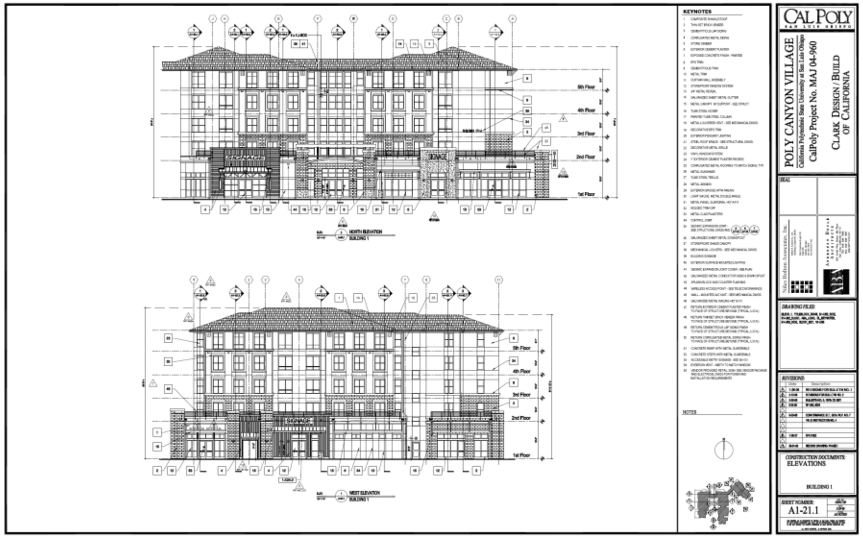
Modeling Cycle #7
Value Engineering

- 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)

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

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