

The Role of Energy Modeling in Building Design and Construction

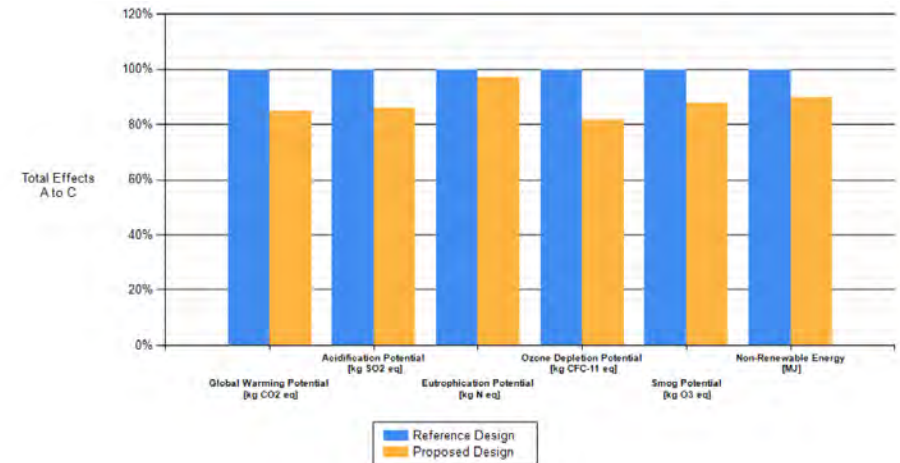
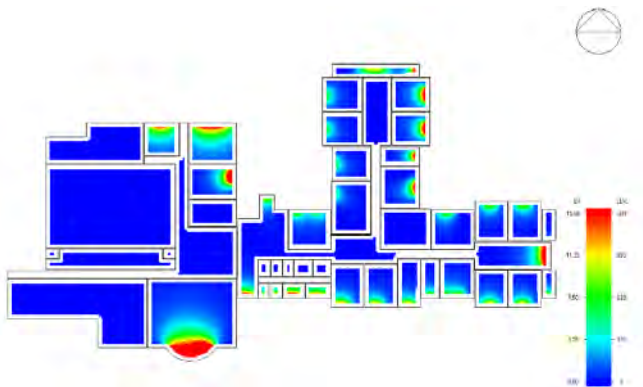
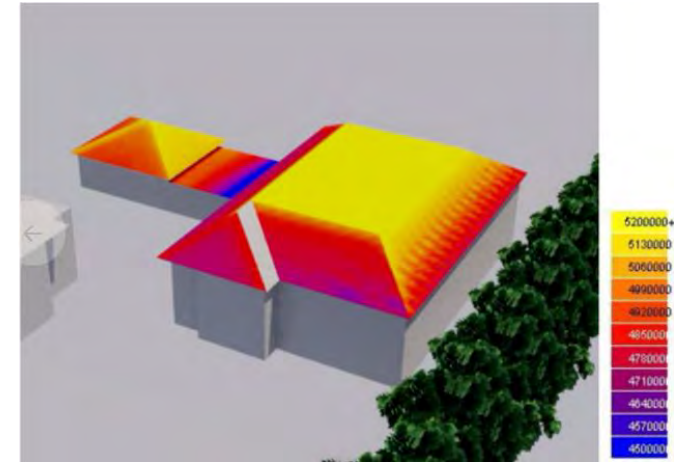
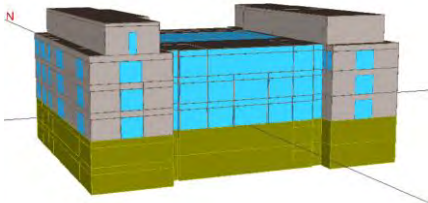
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Today's Objectives

- What is energy modeling?
- What information goes into a model?
- What information comes out a model?
- How are models used to inform designs?
- What other purposes do models serve?
- How is Daylight Modeling used?

What is Energy Modeling?

- Whole building energy simulation
- Daylight analysis
- Solar PV analysis
- Life cycle analysis (LCA)

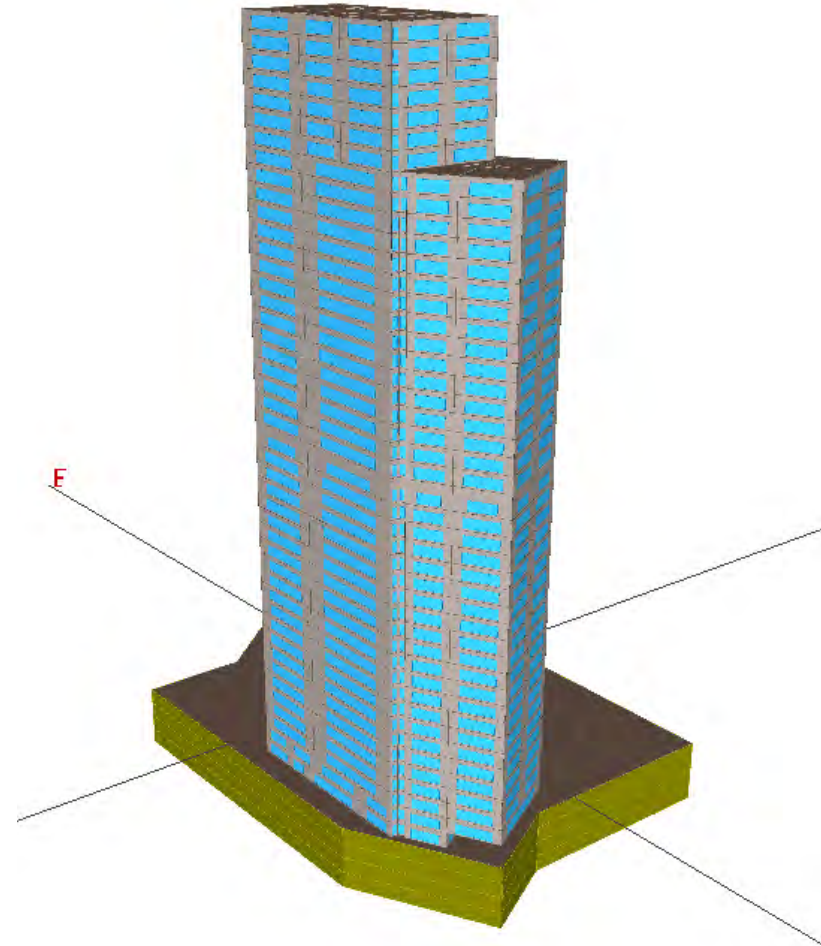


Whole Building Energy Simulation

A computational model,
which includes the:

- Envelope
- Mechanical systems
- Internal loads
- Occupancy patterns
- Local annual weather

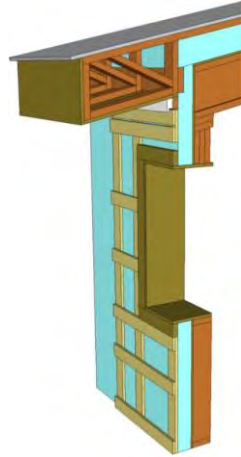
In order to predict the annual
operational energy use of a
building



What Goes into a Model?

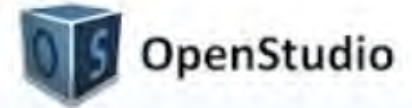
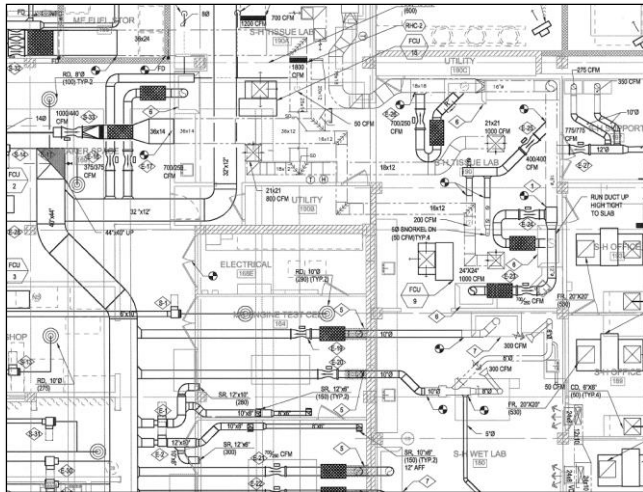
ROOF TOP AIR HANDLING UNIT WITH ENERGY RECOVERY															
UNIT	NAME#	AREA SERVED	TYPE	TIME	D.A. (F)	R.A. (F)	S.A. (F)	WALL	HEATING DATA		COOLING DATA		HEATING WHEELS	SUPPLY AIR FLOW	RETURN EXHAUST FLOW
									HEAT LOSS (BTU/H)	COOLING (COOLING TONS)	WHEEL EFF.	CFM (GPM)	CFM (GPM)		
UNIT 1	ROOF TOP EXHAUST	ROOF TOP EXHAUST	EXHAUST	1200	1.000	1.000	1.000	YES	1000000	0.00	100%	10000	10000		
UNIT 2	ROOF TOP EXHAUST	ROOF TOP EXHAUST	EXHAUST	1200	1.000	1.000	1.000	YES	1000000	0.00	100%	10000	10000		
UNIT 3	ROOF TOP EXHAUST	ROOF TOP EXHAUST	EXHAUST	1200	1.000	1.000	1.000	YES	1000000	0.00	100%	10000	10000		
UNIT 4	ROOF TOP EXHAUST	ROOF TOP EXHAUST	EXHAUST	1200	1.000	1.000	1.000	YES	1000000	0.00	100%	10000	10000		
UNIT 5	ROOF TOP EXHAUST	ROOF TOP EXHAUST	EXHAUST	1200	1.000	1.000	1.000	YES	1000000	0.00	100%	10000	10000		
UNIT 6	ROOF TOP EXHAUST	ROOF TOP EXHAUST	EXHAUST	1200	1.000	1.000	1.000	YES	1000000	0.00	100%	10000	10000		
UNIT 7	ROOF TOP EXHAUST	ROOF TOP EXHAUST	EXHAUST	1200	1.000	1.000	1.000	YES	1000000	0.00	100%	10000	10000		
UNIT 8	ROOF TOP EXHAUST	ROOF TOP EXHAUST	EXHAUST	1200	1.000	1.000	1.000	YES	1000000	0.00	100%	10000	10000		
UNIT 9	ROOF TOP EXHAUST	ROOF TOP EXHAUST	EXHAUST	1200	1.000	1.000	1.000	YES	1000000	0.00	100%	10000	10000		
UNIT 10	ROOF TOP EXHAUST	ROOF TOP EXHAUST	EXHAUST	1200	1.000	1.000	1.000	YES	1000000	0.00	100%	10000	10000		
UNIT 11	ROOF TOP EXHAUST	ROOF TOP EXHAUST	EXHAUST	1200	1.000	1.000	1.000	YES	1000000	0.00	100%	10000	10000		
UNIT 12	ROOF TOP EXHAUST	ROOF TOP EXHAUST	EXHAUST	1200	1.000	1.000	1.000	YES	1000000	0.00	100%	10000	10000		
UNIT 13	ROOF TOP EXHAUST	ROOF TOP EXHAUST	EXHAUST	1200	1.000	1.000	1.000	YES	1000000	0.00	100%	10000	10000		
UNIT 14	ROOF TOP EXHAUST	ROOF TOP EXHAUST	EXHAUST	1200	1.000	1.000	1.000	YES	1000000	0.00	100%	10000	10000		
UNIT 15	ROOF TOP EXHAUST	ROOF TOP EXHAUST	EXHAUST	1200	1.000	1.000	1.000	YES	1000000	0.00	100%	10000	10000		
UNIT 16	ROOF TOP EXHAUST	ROOF TOP EXHAUST	EXHAUST	1200	1.000	1.000	1.000	YES	1000000	0.00	100%	10000	10000		
UNIT 17	ROOF TOP EXHAUST	ROOF TOP EXHAUST	EXHAUST	1200	1.000	1.000	1.000	YES	1000000	0.00	100%	10000	10000		
UNIT 18	ROOF TOP EXHAUST	ROOF TOP EXHAUST	EXHAUST	1200	1.000	1.000	1.000	YES	1000000	0.00	100%	10000	10000		
UNIT 19	ROOF TOP EXHAUST	ROOF TOP EXHAUST	EXHAUST	1200	1.000	1.000	1.000	YES	1000000	0.00	100%	10000	10000		
UNIT 20	ROOF TOP EXHAUST	ROOF TOP EXHAUST	EXHAUST	1200	1.000	1.000	1.000	YES	1000000	0.00	100%	10000	10000		
UNIT 21	ROOF TOP EXHAUST	ROOF TOP EXHAUST	EXHAUST	1200	1.000	1.000	1.000	YES	1000000	0.00	100%	10000	10000		
UNIT 22	ROOF TOP EXHAUST	ROOF TOP EXHAUST	EXHAUST	1200	1.000	1.000	1.000	YES	1000000	0.00	100%	10000	10000		
UNIT 23	ROOF TOP EXHAUST	ROOF TOP EXHAUST	EXHAUST	1200	1.000	1.000	1.000	YES	1000000	0.00	100%	10000	10000		
UNIT 24	ROOF TOP EXHAUST	ROOF TOP EXHAUST	EXHAUST	1200	1.000	1.000	1.000	YES	1000000	0.00	100%	10000	10000		
UNIT 25	ROOF TOP EXHAUST	ROOF TOP EXHAUST	EXHAUST	1200	1.000	1.000	1.000	YES	1000000	0.00	100%	10000	10000		

NOTES: 1. ALL UNITS ARE ASSUMED TO BE OPERATING AT 100% CAPACITY. 2. HEATING DATA IS BASED ON A DESIGN WINTER DAY. 3. COOLING DATA IS BASED ON A DESIGN SUMMER DAY. 4. WHEEL EFFICIENCY IS BASED ON A DESIGN WINTER DAY. 5. SUPPLY AIR FLOW IS BASED ON A DESIGN WINTER DAY. 6. RETURN EXHAUST FLOW IS BASED ON A DESIGN WINTER DAY. 7. HEATING DATA IS BASED ON A DESIGN WINTER DAY. 8. COOLING DATA IS BASED ON A DESIGN SUMMER DAY. 9. WHEEL EFFICIENCY IS BASED ON A DESIGN WINTER DAY. 10. SUPPLY AIR FLOW IS BASED ON A DESIGN WINTER DAY. 11. RETURN EXHAUST FLOW IS BASED ON A DESIGN WINTER DAY. 12. HEATING DATA IS BASED ON A DESIGN WINTER DAY. 13. COOLING DATA IS BASED ON A DESIGN SUMMER DAY. 14. WHEEL EFFICIENCY IS BASED ON A DESIGN WINTER DAY. 15. SUPPLY AIR FLOW IS BASED ON A DESIGN WINTER DAY. 16. RETURN EXHAUST FLOW IS BASED ON A DESIGN WINTER DAY. 17. HEATING DATA IS BASED ON A DESIGN WINTER DAY. 18. COOLING DATA IS BASED ON A DESIGN SUMMER DAY. 19. 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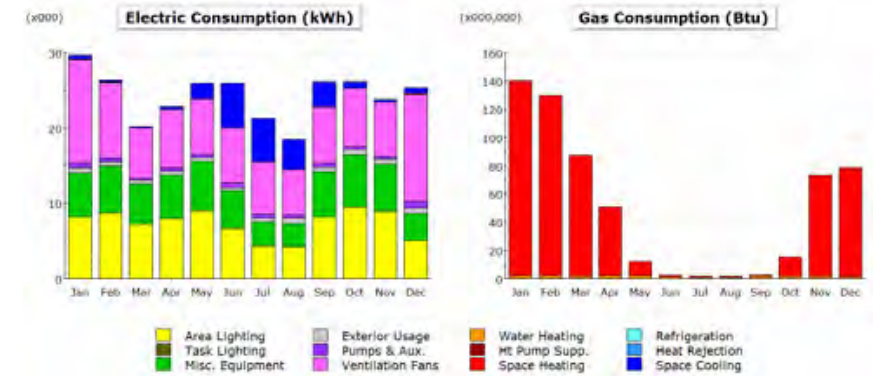
National Solar Radiation Data Base

1991- 2005 Update: Typical Meteorological Year 3



What Comes out of a Model?

Annual operational energy use



REPORT- BEPU Building Utility Performance									WEATHER FILE- Boston				MA TMY2	
	LIGHTS	TASK LIGHTS	MISC EQUIP	SPACE HEATING	SPACE COOLING	HEAT REJECT	PUMPS & AUX	VENT FANS	REFRIG DISPLAY	HT PUMP SUPPLEM	DOMEST HOT WTR	EXT USAGE	TOTAL	
EM1 ELECTRICITY KWH	88256.	0.	63931.	206.	24189.	0.	6286.	102579.	0.	0.	0.	6812.	292259.	
FM1 NATURAL-GAS THERM	0.	0.	0.	5753.	0.	0.	0.	0.	0.	0.	208.	0.	5961.	

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What is the Model Used For?

Inform the design

Model various energy conservation measures early in the design

- Assess potential energy savings and incremental cost to determine payback period

- Make informed selection of ECMs to achieve greatest amount of energy savings with available capital

Validate the design

Required validation

- MEPA compliance
- Code compliance
- MSBA Compliance
- Municipality Compliance
- LEED (Certified/Certifiable)

Elective validation

Certification Programs

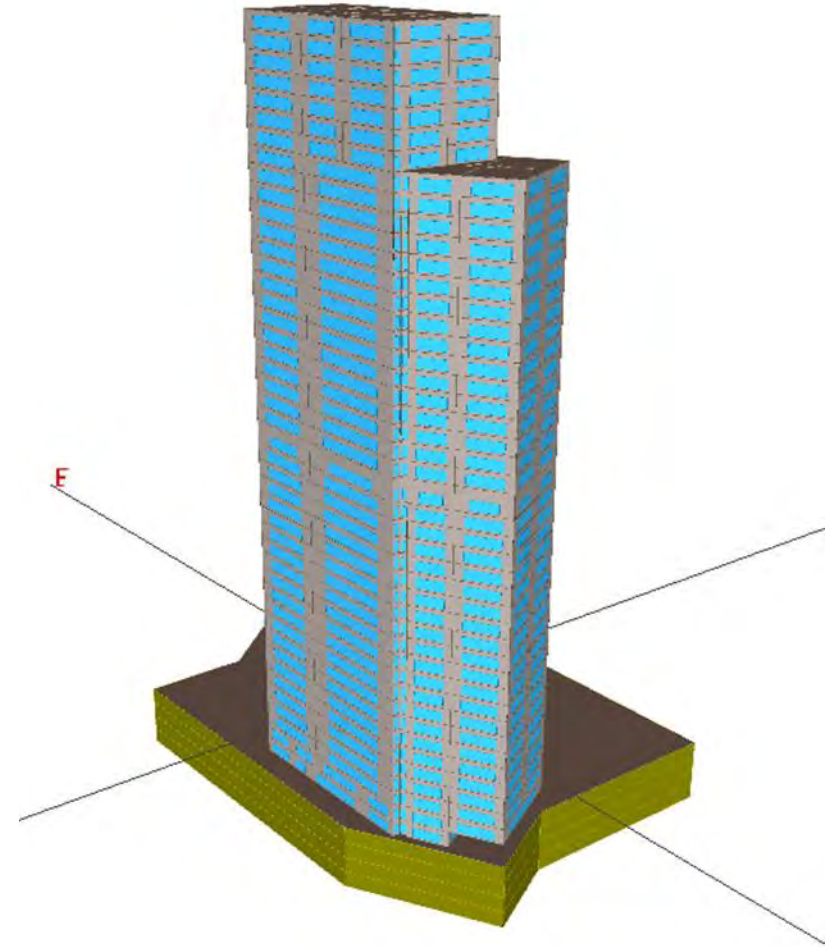
- LEED Certification
- CHPS
- Passive House

Utility Incentive Programs

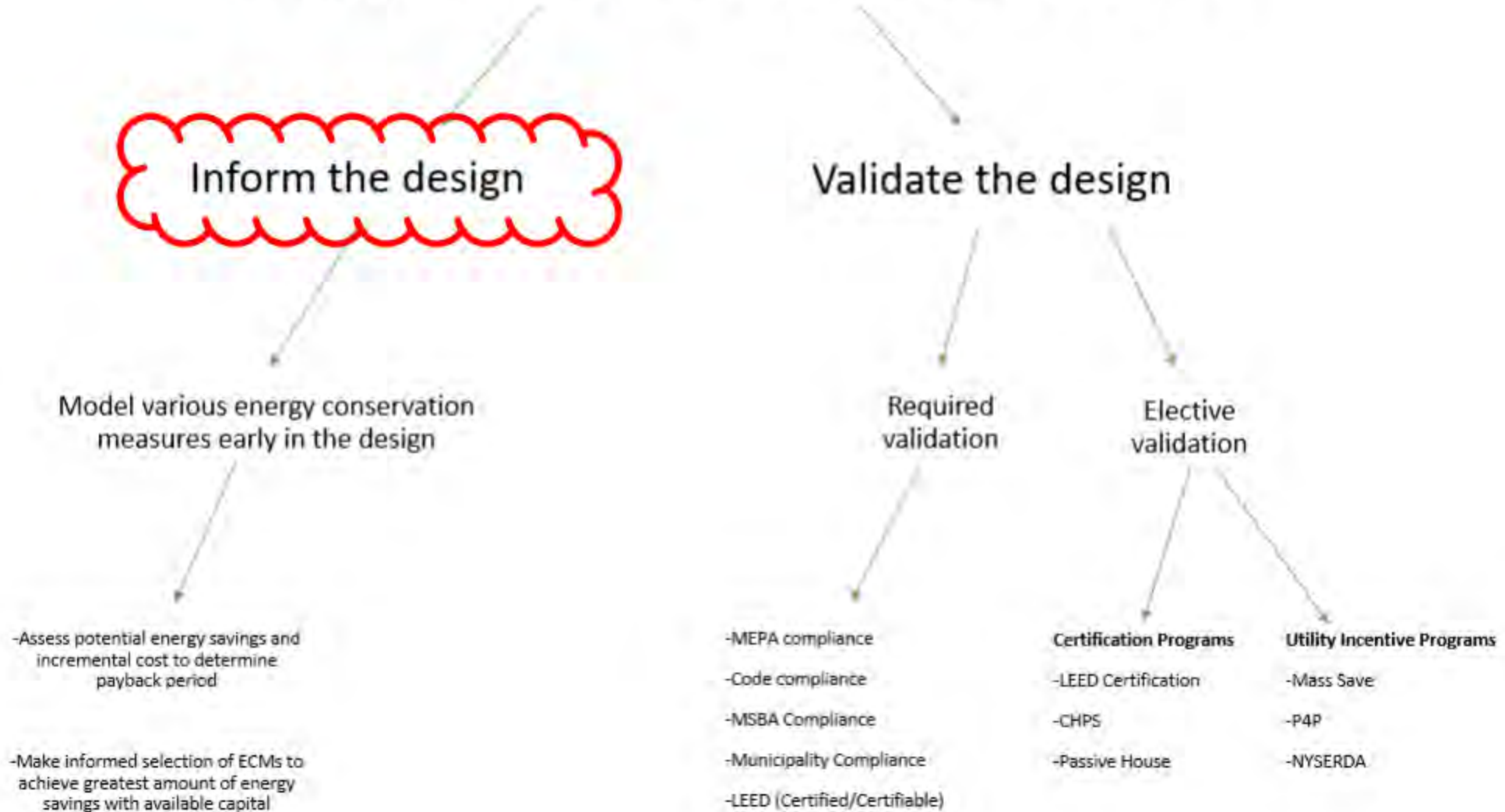
- Mass Save
- P4P
- NYSERDA

Often, a Project Requires all of Those Residential Tower in Boston

- Started Model in Jan 2014
- Design Assistance Modeling in SD-DD
- Utility Incentive Model in DD-CD
- Code Compliance Model at 100% CD
- LEED Model at 100% CD



What is the Model Used For?



Modeling to Inform the Design

- Model various Energy Conservation Measures (ECMs) to assess how different design alternatives can reduce energy use.

Typical ECMs:

- Envelope (walls/roof/floor assemblies, windows, infiltration)
- HVAC equipment (system types, unit efficiencies, energy recovery ventilation, DCV, fuel switching)
- Internal Loads (Lighting Power Density, daylighting/occupancy controls)
- Occupancy patterns, setpoint controls

Informing the Design (Envelope ECMs)

Glazing U-value and SHGC

Table 1: ASHRAE 90.1 2007 Baseline and As Designed Energy by End-Use (CW U-0.053)

	Lights (MBTU)	Plug (MBTU)	Heating (MBTU)	Cooling (MBTU)	Ht Reject (MBTU)	Pumps (MBTU)	Fans (MBTU)	DHW (MBTU)	Ext Light (MBTU)	Total (MBTU)	Energy Savings (%)	Cost (\$)	\$ Savings over Base
2007 Baseline	4,630	5,035	12,890	2,281	0	24	4,008	5,249	112	34,229	NA	919,558	NA
Proposed	2,048	5,035	3,803	2,501	14	1,454	5,030	3,299	112	23,297	31.9%	815,200	11.3%
Low SHGC on SE and SW	2,048	5,035	4,056	2,156	12	1,365	5,014	3,299	112	23,097	32.5%	796,891	13.3%
Low SHGC on all Facades	2,048	5,035	4,239	1,955	10	1,310	5,008	3,299	112	23,017	32.8%	786,571	14.5%
Argon Windows ECM	2,048	5,035	3,706	2,053	10	1,358	5,008	3,299	112	22,630	33.9%	788,029	14.3%

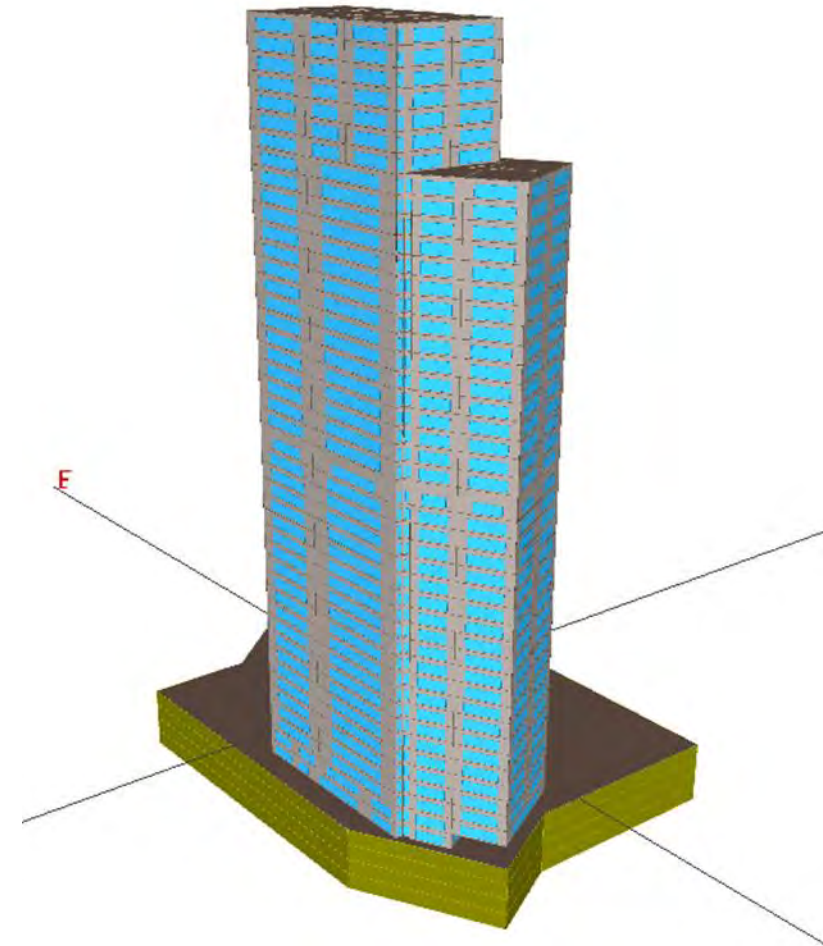
Reduced
gas use by
533 MBTU

Increased
electricity
use by 98
MBTU

Net energy
savings of
387 MBTU
(4.2%)

Net cost
increase of
\$1,458
(0.2%)

- Used lowest viable SHGC
- Did not pursue lower U-value windows
 - If shades/overhangs were viable, results would have been different



Informing the Design (HVAC ECMs)

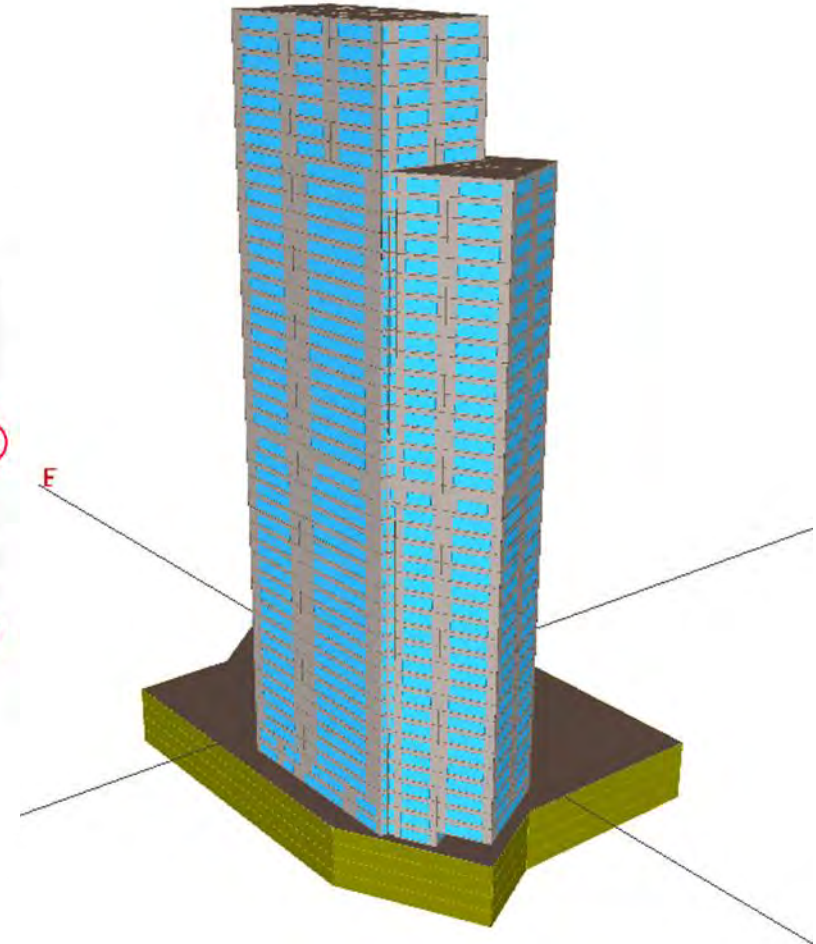
- Water Source Heat Pumps
- Hybrid Heat Pumps (Hydronic Heating)

Table 2: Energy Savings

	Total Site (MBTU)	Cost (\$)	Source (MBTU)	Site Energy (%)	Cost (%)	Source Energy (%)
Baseline	37,437	\$1,032,321	74,103	NA	NA	NA
Whalen Hybrid 2 GPM/Ton	27,330	\$943,935	64,639	27.0%	8.6%	12.8%
Whalen Hybrid 2.5 GPM/Ton	27,332	\$944,035	64,645	27.0%	8.6%	12.8%
Whalen WSHP 2 GPM	26,487	\$955,447	64,896	29.2%	7.4%	12.4%
Whalen WSHP 2.5 GPM	26,557	\$959,891	65,173	29.1%	7.0%	12.1%
Climatemaster WSHP 2 GPM	26,448	\$952,062	64,690	29.4%	7.8%	12.7%
Climatemaster WSHP 2.5 GPM	26,380	\$948,939	64,487	29.5%	8.1%	13.0%

- Highest site & source energy savings
- 2nd highest cost savings
- Didn't require running hydronic piping throughout building

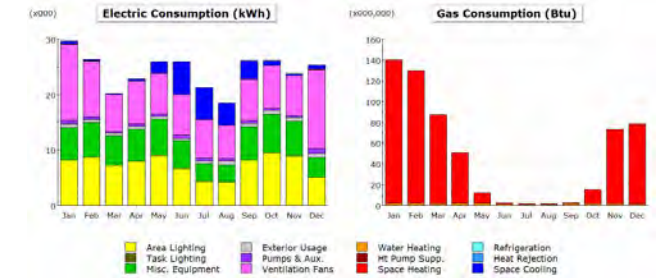
- Used Climatemaster WSHP 2.5 GMP/Ton



Modeling to Inform the Design

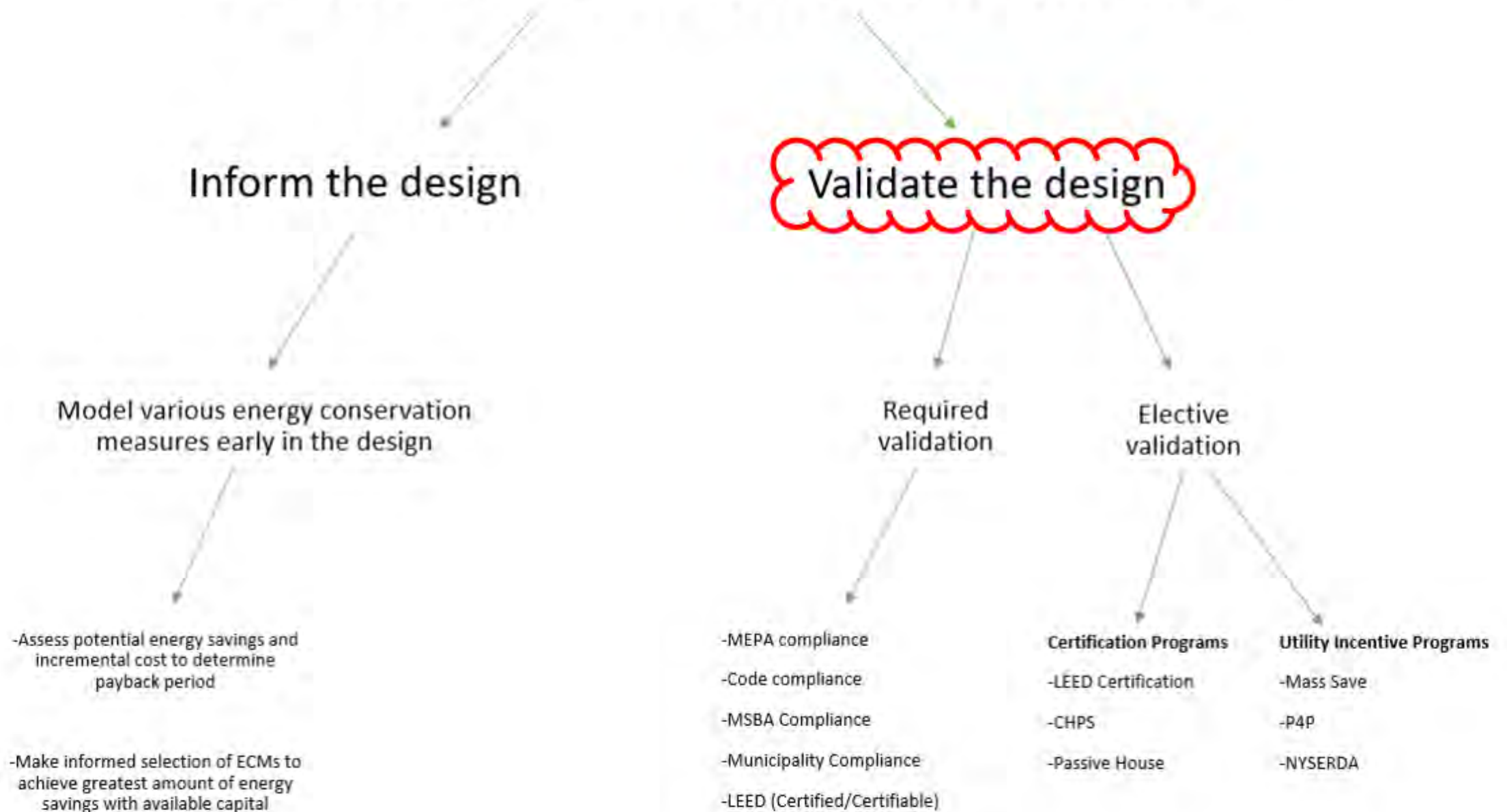
Assess the potential operational energy savings and incremental cost of design alternatives.

In order to select ECMs that achieve greatest amount of energy savings with available capital.



\$\$\$

What is the Model Used For?



Validation Modeling

Baseline Case

vs

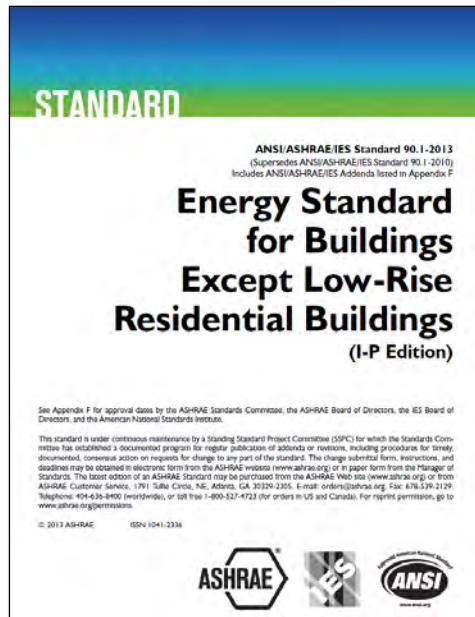
Proposed Case

Per Code, based on:

- ASHRAE 90.1 (2007,2010,2013)
- IECC (2012, 2015)
- Stretch Code (10% better than code)
- Mass Save Baseline Document

-As Designed, based on:

- Architectural drawings
- MEP drawings
- Landscape drawings
- HVAC Narratives

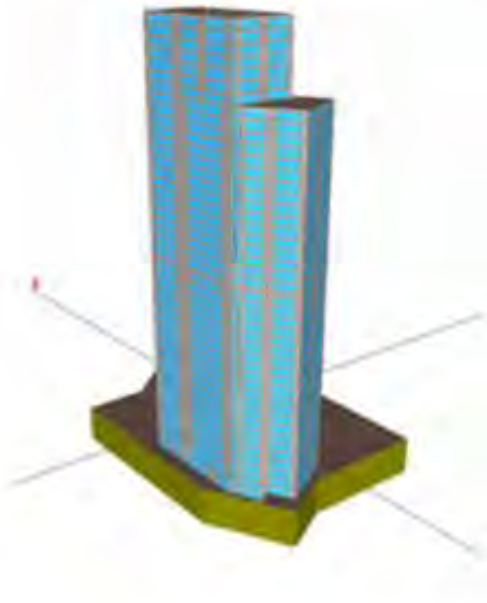


ROOFTOP AIR HANDLING UNIT																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																					
DESIGNATION	MANUF. MODEL NUMBER	LOCATION	SUPPLY FANS															RETURN FANS										CHILLED WATER COOLING COIL																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																									
			TOTAL CFM	OUTSIDE AIR CFM	CAPACITY CONTROL		MODEL	WHEEL					STAT. PRESS (IN. H ₂ O)	WHEEL					TOTAL INCH	SENS. INCH	UNIT EAF		UNIT LAF		CHILLED WATER BECK																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																												
					TYPE	RANGE/RAVEN		TENT	EXTERNAL	CLASS	OUT. VEL. (FPM)	FAN QTY		DN. IN.	TYPE	RPM	BHP	MOTOR H.P.			DN. IN.	TYPE	RPM	BHP	MOTOR H.P.	FACE VELOC. (FPM)	UNIT EAF	UNIT LAF	BWT (T)	BWT (T)	BWT (T)	BWT (T)																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																					

Validation Modeling

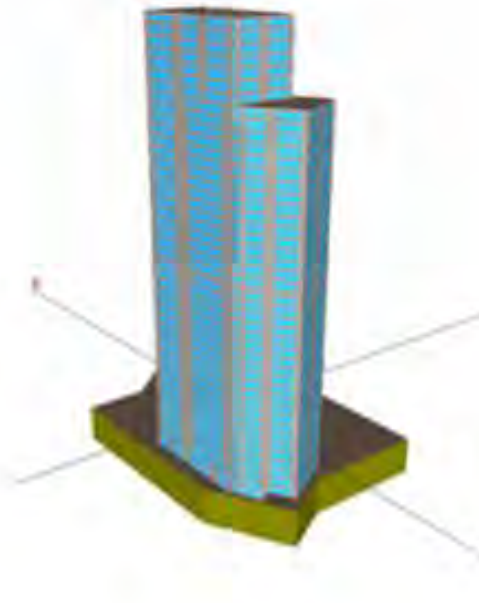
Baseline Case Model

Identical Geometry, but all components built according to relevant code.



Proposed Case Model

Built to reflect all components of the design



-(/)

=Savings (%)

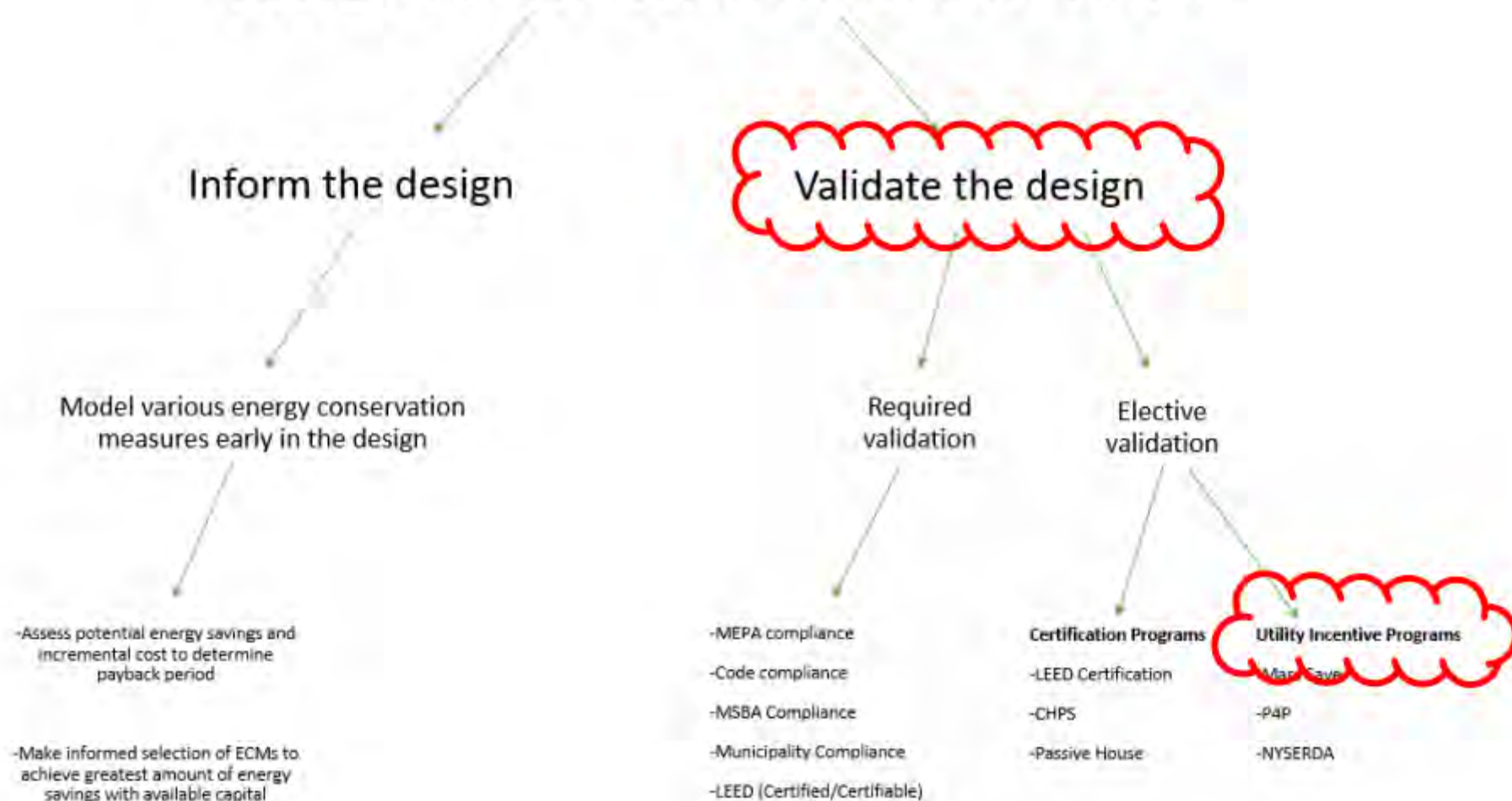
Validation Modeling

Metric to measure savings:

- Site Energy
- EUI (site energy kBTU/SF)
- Source Energy
- Energy Cost
- Green House Gas Emissions

Unfortunately, no standard metric, which confuses clients to no end.

What is the Model Used For?



Utility Incentives

Commercial version of Mass Save program

- Baseline code: Altered version of ASHRAE 90.1 2013/IECC 2015)
- Energy Metric: Site energy
- Pays \$/kWh saved
- Pays \$/Therms saved



2017 Baseline Document: Energy Code Base Case Overview

Prepared by: Fran Boucher (National Grid), Ryan Willingham (Eversource), Maddy Messer (DMI), and Rob Bialobrzewski (DMI)

Version Date: January 13, 2017

The Baseline Document defines base case (or baseline) parameters for projects pursuing energy savings and incentives under the Program Administrators' (PA) New Construction program(s). This document is intended to inform assumptions for New Construction applications as well as "end of life replacements". In this case, "end of life replacement" is defined as a specific age of existing equipment this has been established by the PA's in cooperation with state regulators. This document is applicable to commercial buildings and systems in these buildings.

In general, the base case for a given system or piece of equipment is defined by one of two primary methods:

State Energy Code: For equipment and systems whose performance is explicitly governed by the applicable state's building energy code, the baseline for that equipment is generally based on the minimum allowable performance in the energy code (ASHRAE 90.1-2013 or IECC 2015).

Standard Practice/Industry Standard: For equipment and systems that are not governed by energy code, the baseline is defined based on the minimum performance option that is still considered to be industry standard or standard practice within the given industry.

Note: In select cases, there are performance requirements in energy code that are below the current industry standard, as determined by the PAs. For those cases, the PAs have set the baseline requirements within this document to reflect the current industry standard. These apply for energy conservation measure (ECM) applications regardless of their inclusion or exclusion from the national model codes and state amendments. Those cases are identified in this document with a note that the baseline is different from the energy code requirement.

Guide for Energy Code Baselines

Energy Code requirements vary by state. The Massachusetts energy code as of January 2, 2017 is based on one of two national code standards options, which are used to define the MA program baselines:

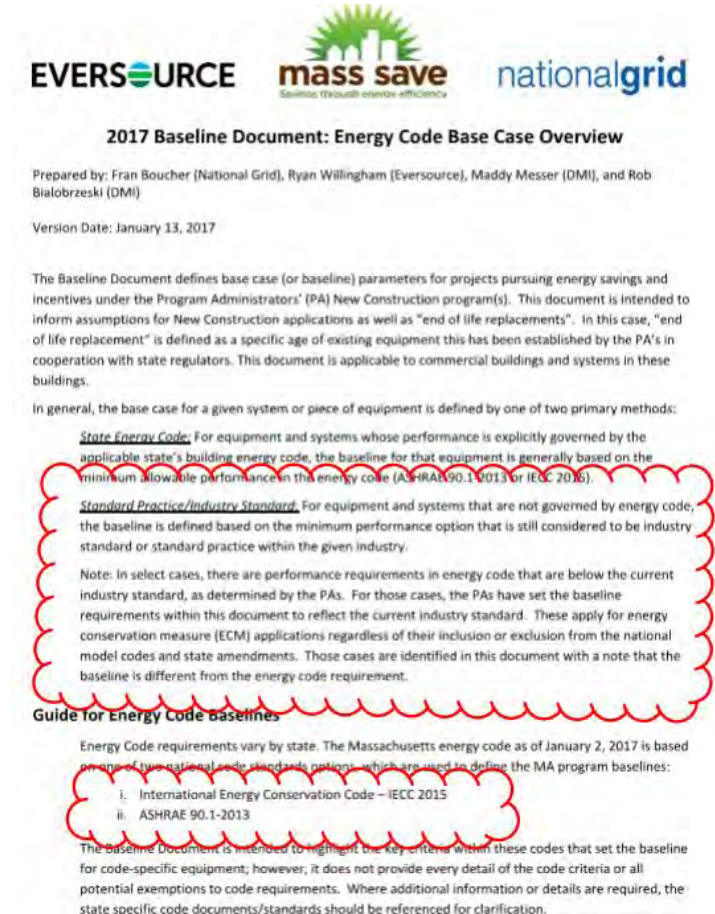
- i. International Energy Conservation Code – IECC 2015
- ii. ASHRAE 90.1-2013

The baseline Document is intended to highlight the key criteria within these codes that set the baseline for code-specific equipment; however, it does not provide every detail of the code criteria or all potential exemptions to code requirements. Where additional information or details are required, the state specific code documents/standards should be referenced for clarification.

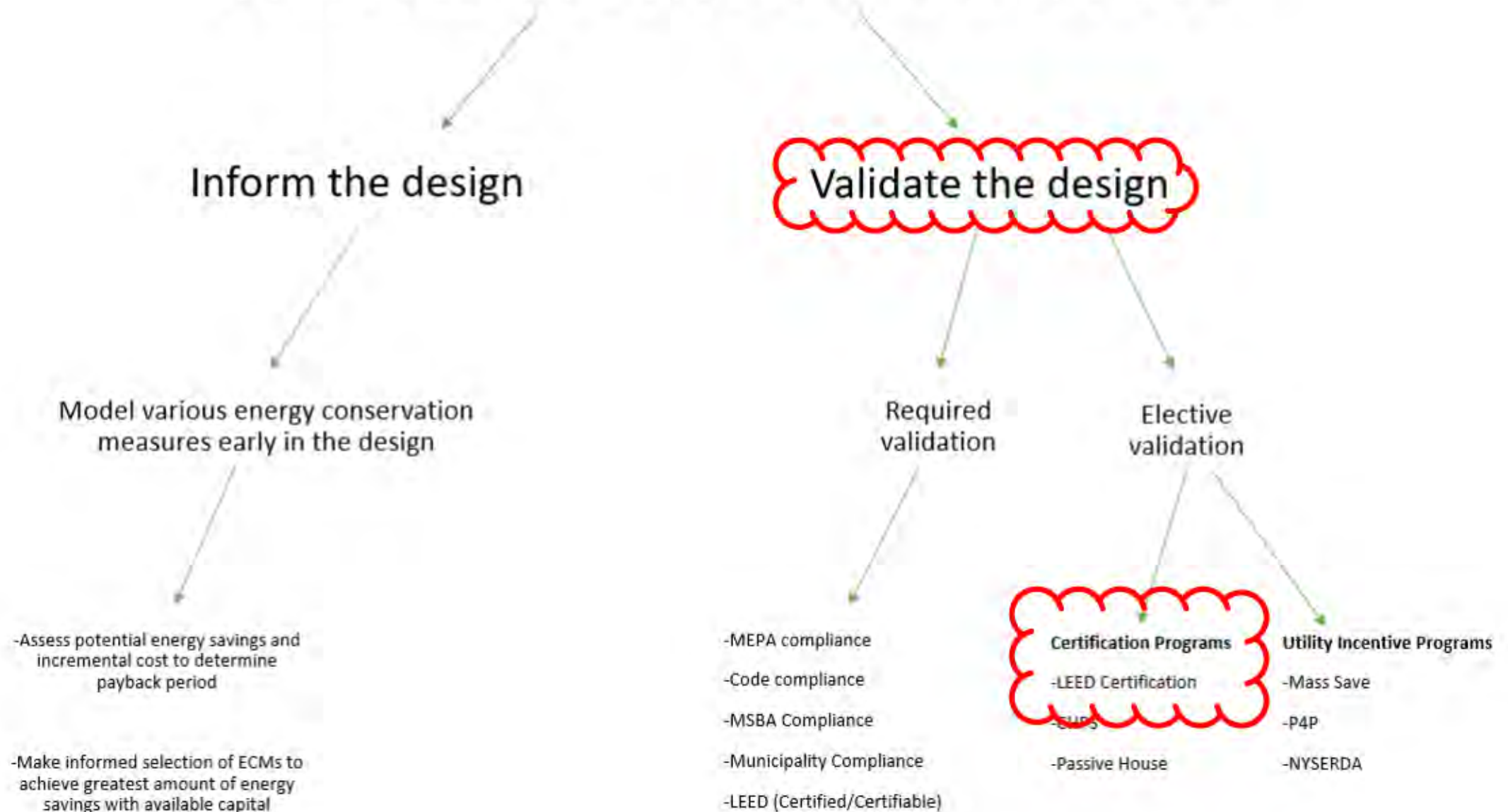
Utility Incentives

- Utility Incentive Process

- SD/DD Design Charrette (Potential ECMs)
- DD Model with projected ECMs
- Mass Save projects potential incentive \$
- Owner decides which ECMs to pursue
- 100% CD Model with final ECMs
- Post Construction inspection of Installed ECMs
- Incentives distributed



What is the Model Used For?





LEED Minimum Energy Prerequisite / Optimize Energy Performance

Optimize Energy Performance Credit



TABLE 1. Points for percentage improvement in energy performance

New Construction	Major Renovation	Core and Shell	Points (except Schools, Healthcare)	Points (Healthcare)	Points (Schools)
6%	4%	3%	1	3	1
8%	6%	5%	2	4	2
10%	8%	7%	3	5	3
12%	10%	9%	4	6	4
14%	12%	11%	5	7	5
16%	14%	13%	6	8	6
18%	16%	15%	7	9	7
20%	18%	17%	8	10	8
22%	20%	19%	9	11	9
24%	22%	21%	10	12	10
26%	24%	23%	11	13	11
28%	27%	26%	12	14	12
30%	30%	29%	13	15	13
32%	32%	31%	14	16	14
34%	34%	33%	15	17	15
36%	36%	35%	16	18	16
38%	38%	37%	17	19	17
40%	40%	39%	18	20	18
42%	42%	41%	19	21	19
44%	44%	43%	20	22	20
46%	46%	45%	21	23	21
48%	48%	47%	22	24	22
50%	50%	49%	23	25	23

LEED Minimum Energy Performance / Optimize Energy Performance

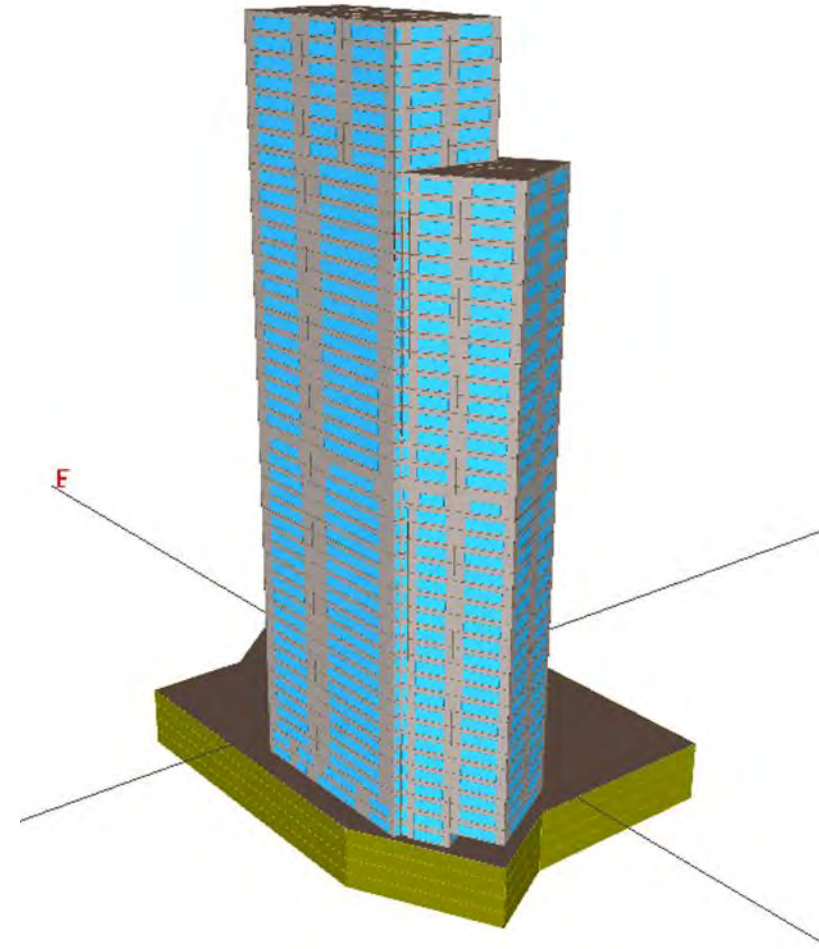
- LEED V4
 - Baseline Code: ASHRAE 90.1 2010
 - Savings metric: % energy cost savings (typically)
 - Pre-requisite requires 5% energy cost savings (NC)
 - Optimize Energy Performance Credit 6%-50% (up to 18 points)

New Construction	Major Renovation	Core and Shell	Points (except Schools, Healthcare)	Points (Healthcare)	Points (Schools)
6%	4%	3%	1	3	1
8%	6%	5%	2	4	2
10%	8%	7%	3	5	3
12%	10%	9%	4	6	4
14%	12%	11%	5	7	5
16%	14%	13%	6	8	6
18%	16%	15%	7	9	7
20%	18%	17%	8	10	8
22%	20%	19%	9	11	9
24%	22%	21%	10	12	10
26%	24%	23%	11	13	11
29%	27%	26%	12	14	12
18%	16%	15%	7	9	7
20%	18%	17%	8	10	8
22%	20%	19%	9	11	9
24%	22%	21%	10	12	10
26%	24%	23%	11	13	11
29%	27%	26%	12	14	12
32%	30%	29%	13	15	13
35%	33%	32%	14	16	14
38%	36%	35%	15	17	15
42%	40%	39%	16	18	16
46%	44%	43%	17	19	-
50%	48%	47%	18	20	-

LEED Optimize Energy Performance Credit

Pursued Alternative Energy Performance Metric ACP

- Replaces Energy cost as the energy savings metric with:
 - Source energy savings
 - GHG emissions savings
- Provides a more meaningful environmental metric, in which relative cleanliness of the local grid is accounted for
- Beneficial for projects in New England, given how clean our grid is



LEED Optimize Energy Performance Credit

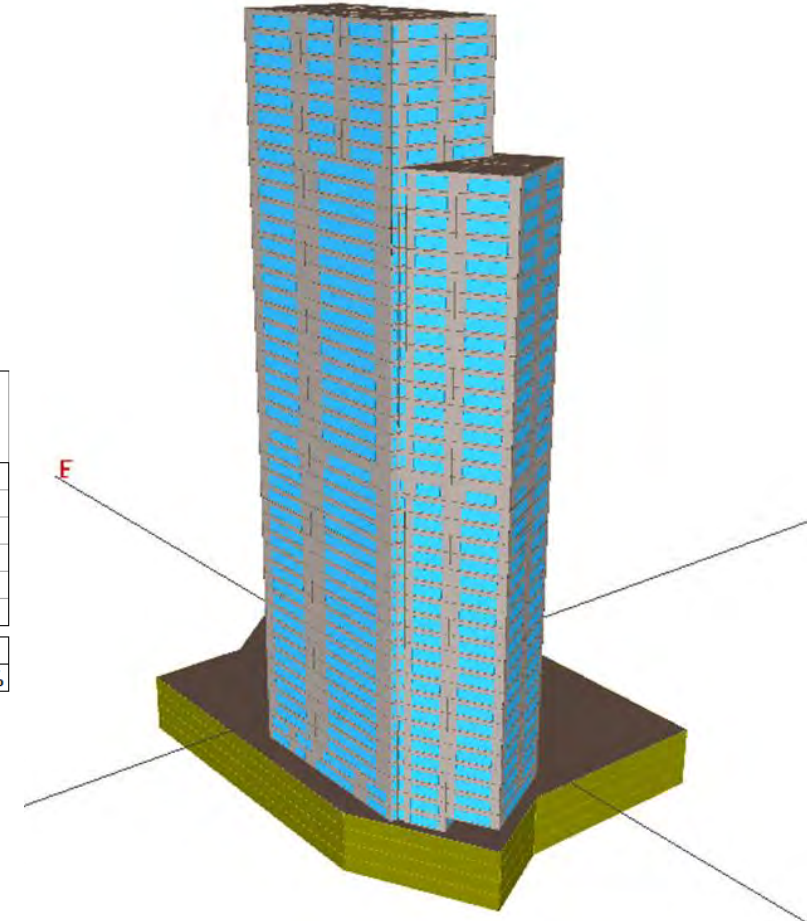
ACP: Greenhouse Gas Emissions



Figure 5 – Indirect Greenhouse Gas Emission Factors for Electricity in the U.S.

eGRID Regional Description	eGRID Acronym	CO ₂ _{eq} Emissions (kg/MBtu)
South/Central Alaska	AKGD	143.21
Most of Alaska	AKMS	67.11
Southwest US	AZNM	139.45
Southwest Coast	CAMX	70.44
Most of TX	ERCT	134.81
Most of Florida	FRCC	135.11
HI excluding Oahu	HIMS	154.03
Oahu Island	HIOA	222.70
Eastern WI	MROE	223.24
Upper Midwest	MROW	165.95
New England	NEWE	74.94
New York City	NYCW	84.69
Long Island, NY	NYLI	157.66
Upstate NY	NYUP	39.34
Mid Atlantic	RFCE	101.31
Most of Michigan	RFCM	170.01
Ohio Valley	RFCW	166.36
CO-Eastern WY	RMPA	183.02
KS-Western MO	SPNO	189.06
TX Panhandle-OK	SPSO	166.81
Lower Mississippi	SRMV	111.95
Middle Mississippi	SRMW	215.68
SE US, Gulf Coast	SRSO	145.58
Tennessee Valley	SRTV	158.54
Virginia/Carolina	SRVC	107.69
National Average		133.49

Energy Source	GHG Emission Factor (kg/Btu x 10 ⁶)	Baseline (kg CO ₂ Emissions)	Proposed (kg CO ₂ Emissions)
Electricity	76.67	1,320,798.3	1,316,659.8
Natural Gas	53.11	1,131,715.7	611,094.3
		-	-
		-	-
		-	-
Total		2,452,514.0	1,927,754.1
Savings			21.40%



LEED Optimize Energy Performance Credit

ACP: Source Energy

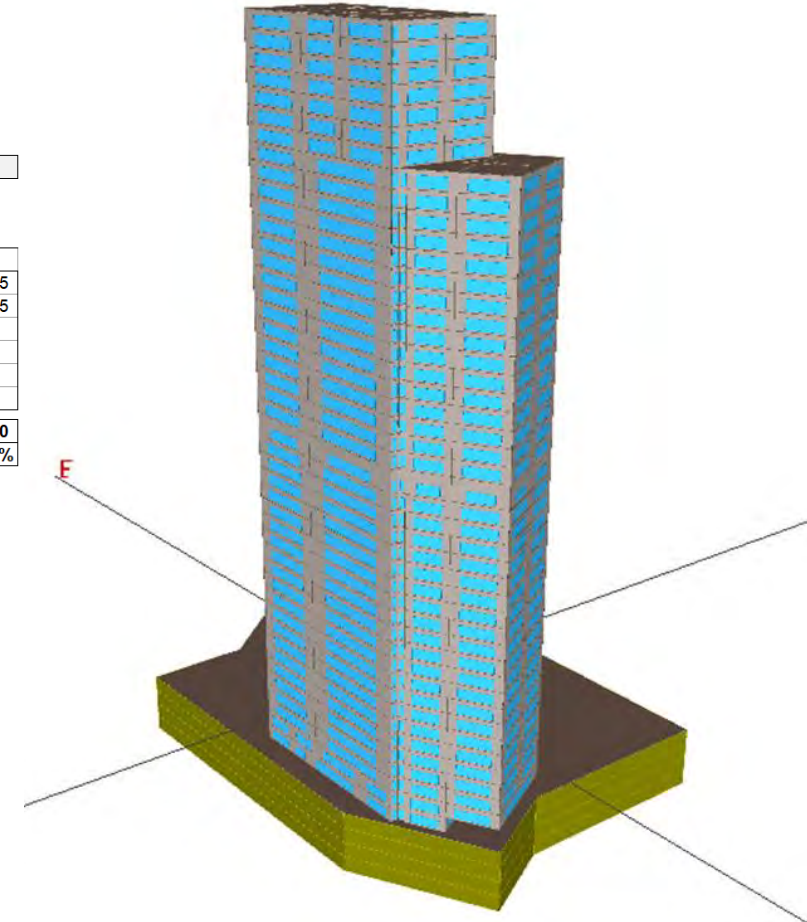
Figure 1 – Source-Site Ratios for all Portfolio Manager Energy Meter Types

Energy Type	U.S. Ratio	Canadian Ratio
Electricity (Grid Purchase)	2.80	1.96
Electricity (Onsite Solar or Wind, RECs Retained)	1.00	1.00
Electricity (Onsite Solar or Wind, RECs Sold/Arbitrage)	2.80	1.96
Natural Gas	1.05	1.01
Fuel Oil (No. 1,2,4,5,6, Diesel, Kerosene)	1.01	1.01
Propane & Liquid Propane	1.01	1.04
Steam	1.20	1.33
Hot Water	1.20	1.33
Chilled Water	0.91	0.57
Wood	1.00	1.00
Coal/Coke	1.00	1.00
Other	1.00	1.00

Source Energy (US) - ENERGY STAR Portfolio Manager

Indicate the source-to-site ratios or primary energy factors for each building energy source.

Energy Source	Source-to-Site Ratio	Baseline (Btu x 10 ⁶)	Proposed (Btu x 10 ⁶)
Electricity	3.14	54,093.0	53,923.5
Natural Gas	1.05	22,374.3	12,081.5
		-	-
		-	-
		-	-
		-	-
Total		76,467.3	66,005.0
Savings			13.68%



LEED Optimize Energy Performance Credit

Energy Source	GHG Emission Factor (kg/Btu x 10 ⁶)	Baseline (kg CO ₂ Emissions)	Proposed (kg CO ₂ Emissions)
Electricity	76.67	1,320,798.3	1,316,659.8
Natural Gas	53.11	1,131,715.7	611,094.3
		-	-
		-	-
		-	-
Total		2,452,514.0	1,927,754.1
Savings			21.40%

Source Energy (US) - ENERGY STAR Portfolio Manager

Indicate the source-to-site ratios or primary energy factors for each building energy source.

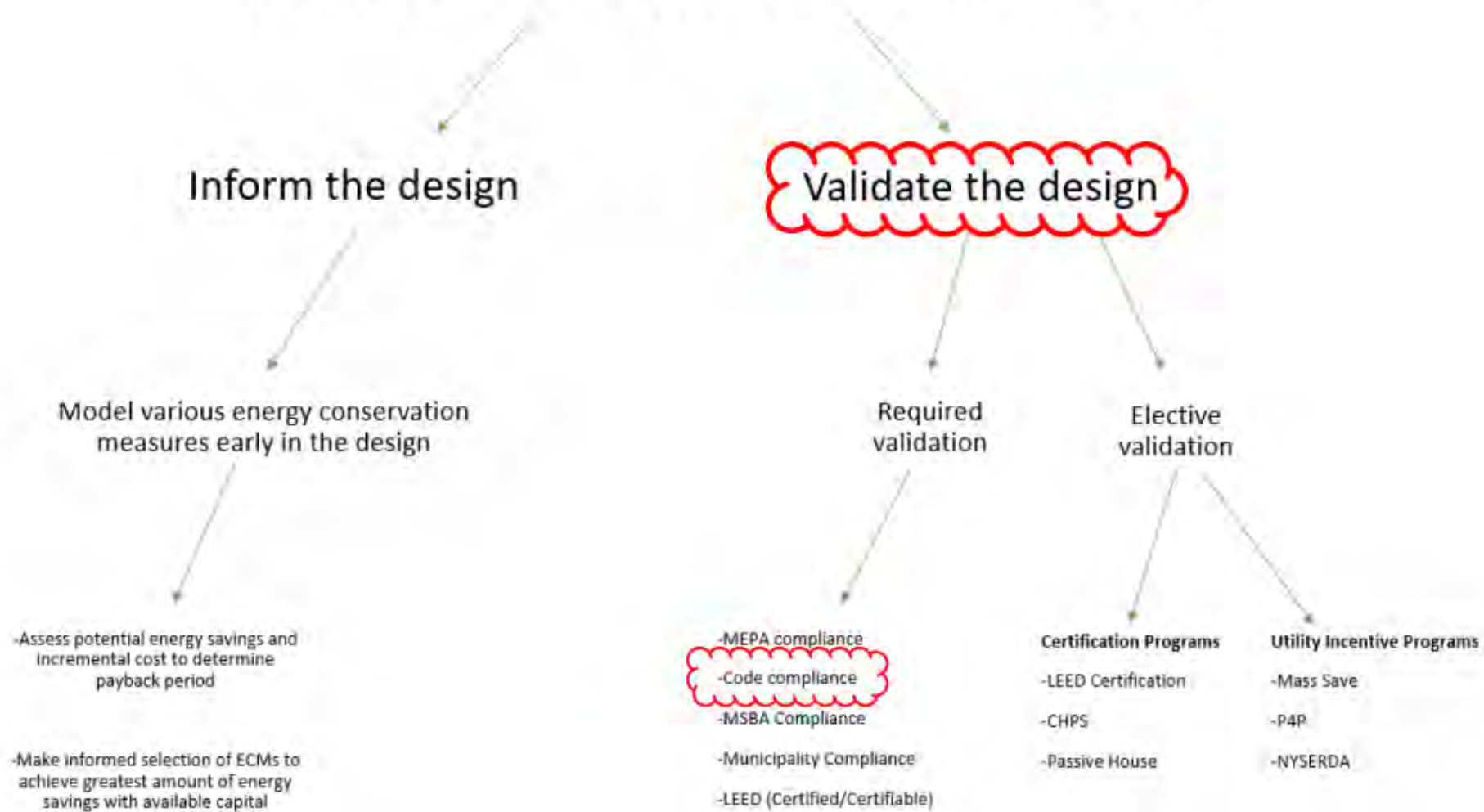
Energy Source	Source-to-Site Ratio	Baseline (Btu x 10 ⁶)	Proposed (Btu x 10 ⁶)
Electricity	3.14	54,093.0	53,923.5
Natural Gas	1.05	22,374.3	12,081.5
		-	-
		-	-
		-	-
Total		76,467.3	66,005.0
Savings			13.68%

Percentage Improvement Used to Determine Minimum Energy Performance Prerequisite Compliance and Optimize Energy Performance Points:

Savings	17.54%
----------------	---------------

TABLE 1. Points for percentage improvement in energy performance					
New Construction	Major Renovation	Core and Shell	Points (except Schools, Healthcare)	Points (Healthcare)	Points (Schools)
6%	4%	3%	1	1	1
8%	6%	5%	2	4	2
10%	8%	7%	3	5	3
12%	10%	9%	4	6	4
14%	12%	11%	5	7	5
16%	14%	13%	6	8	6
18%	16%	15%	7	9	7
20%	18%	17%	8	10	8
22%	20%	19%	9	11	9
24%	22%	21%	10	12	10
26%	24%	23%	11	13	11
29%	27%	26%	12	14	12
38%	36%	35%	7	9	7
40%	38%	37%	8	10	8
42%	40%	39%	9	11	9
44%	42%	41%	10	12	10
46%	44%	43%	11	13	11
48%	46%	45%	12	14	12
50%	48%	47%	13	15	13
			14	16	14
			15	17	15
			16	18	16
			17	19	17
			18	20	18

What is the Model Used For?



Code Compliance

Code Compliance in Massachusetts

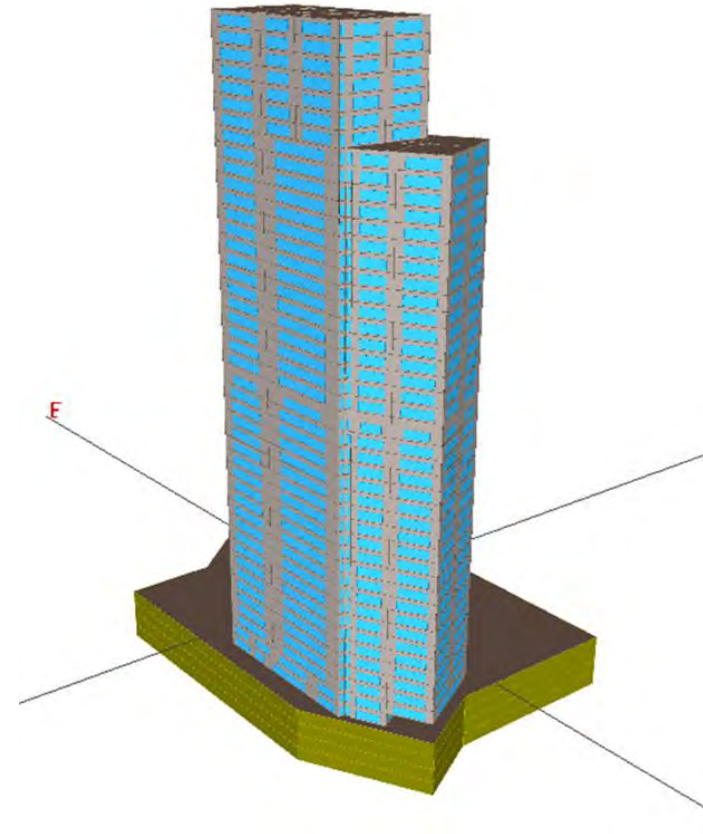
- Energy modeling is used when a project can't use prescriptive compliance path
- Baseline Code: IECC 2015 / ASHRAE 90.1 2013 (with MA amendments)
- Energy metric: Site energy
- Projects must use meet, or use less energy than the Baseline
- Massachusetts Stretch Code: Buildings >100,000 SF must use 10% less site energy than Baseline (if in a stretch code community)

Code Compliance

Table 2: Energy Savings

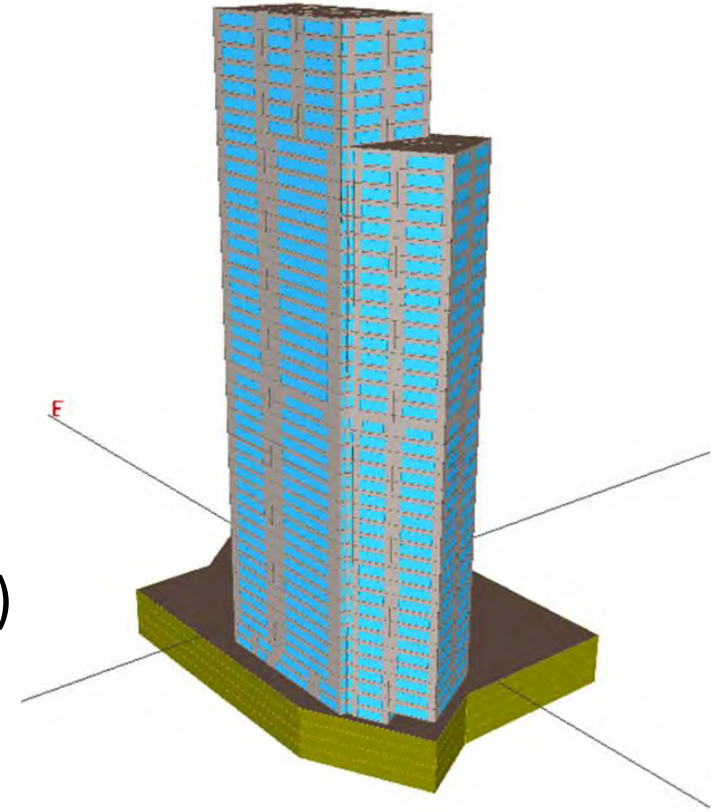
	Total Site (MBTU)	Site Energy (%)
Baseline	34,686	NA
Proposed	27,796	19.8%

Propose design used 19.8% less site
energy than ASHRAE 90.1 2013
Baseline



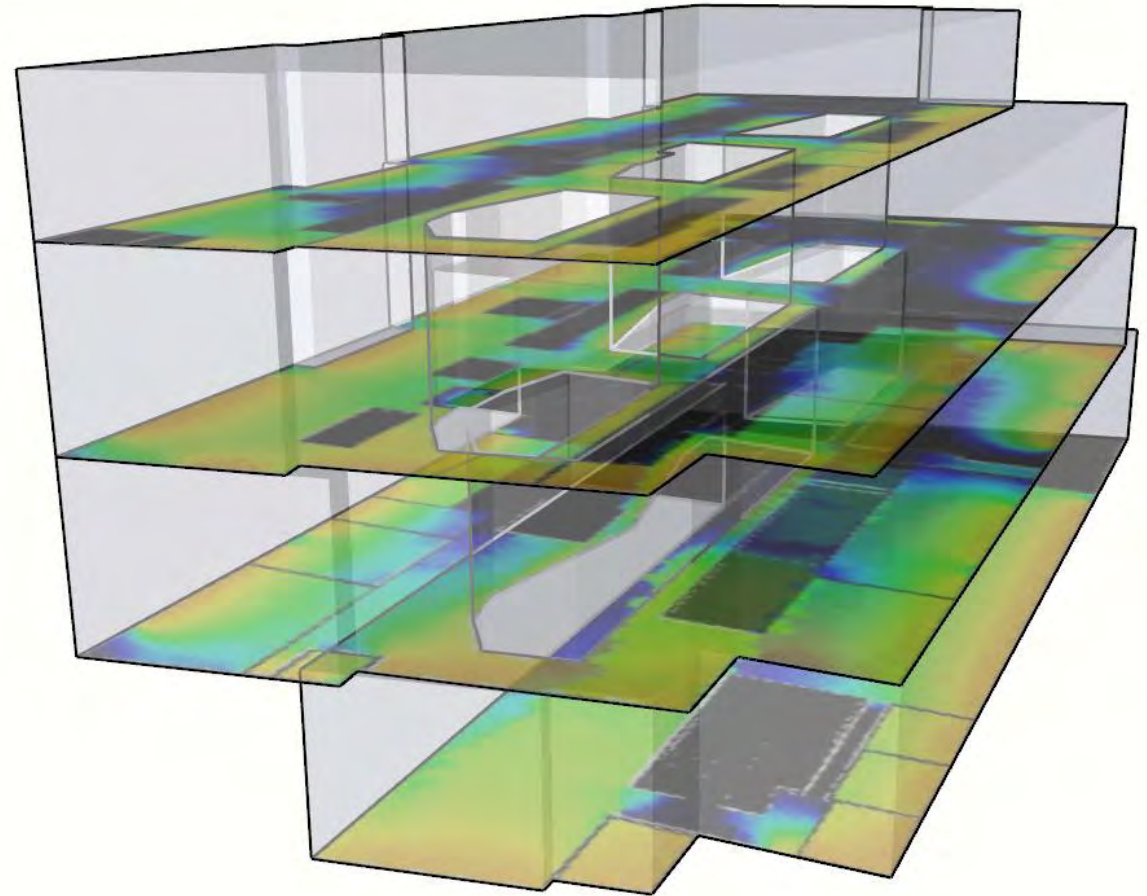
Models Completed for Project

- Design Assistance Model (~15 sets of ECMs)
- Final 100% CD Proposed Case model
- LEED Baseline (ASHRAE 90.1 2010)
- Utility incentive Baseline (Altered ASHRAE 90.1 2013)
- Code Compliance Baseline (ASHRAE 90.1 2013)

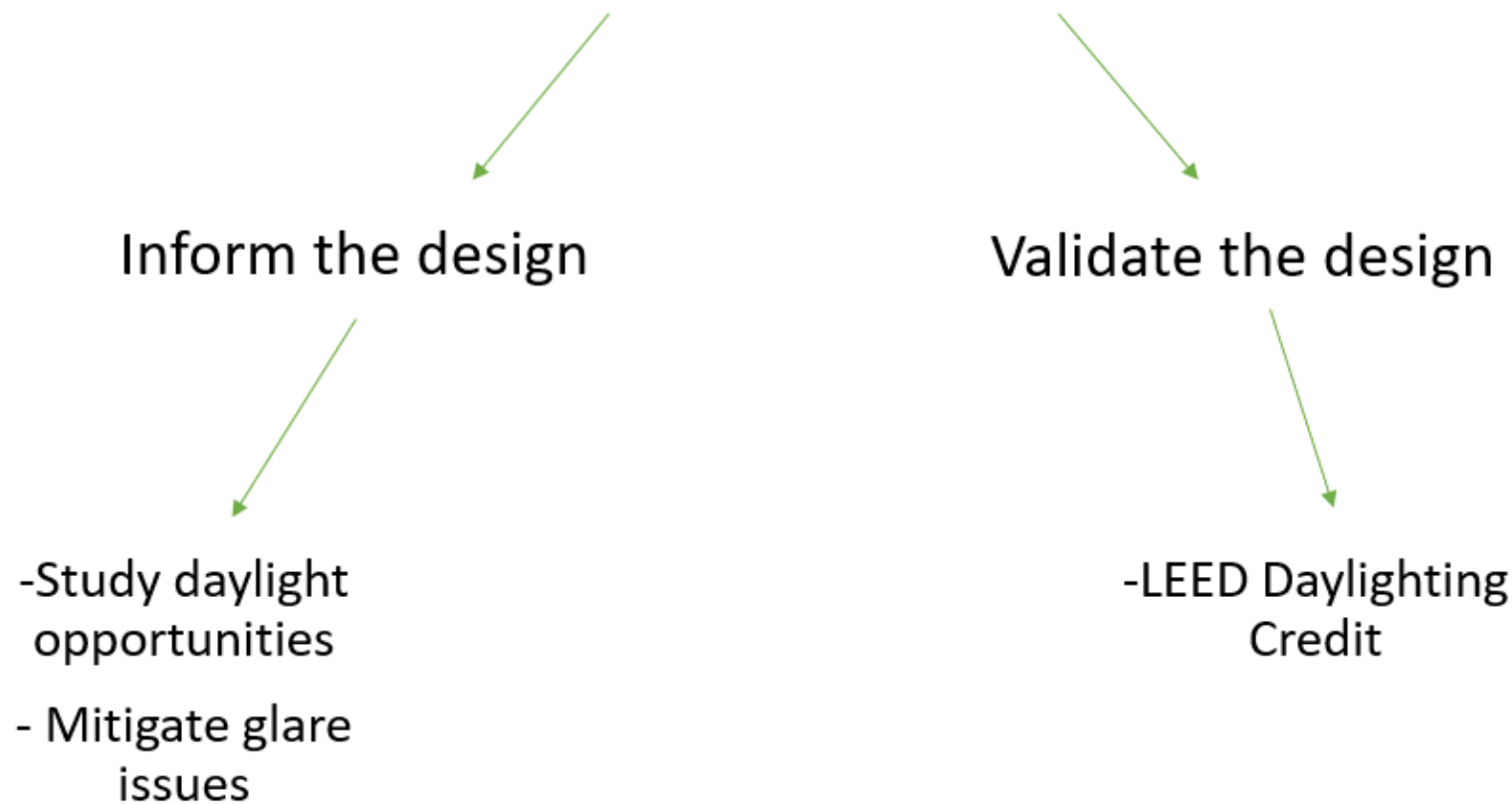


Daylighting Analysis

- Types of Daylighting Analysis
- Illuminance study
 - Point in time analysis (typically 9am, 12pm, 3pm on the Solstices and equinox)
- Spatial Daylight autonomy
 - Runs daylight analysis of every hour of the year, based on TMY weather file
 - Percent of occupied hours that there is adequate daylight (300 lux) such that artificial light is not needed.
 - ASE: Percent of occupied hours that there is greater than 1,000 lux, creating glare issues



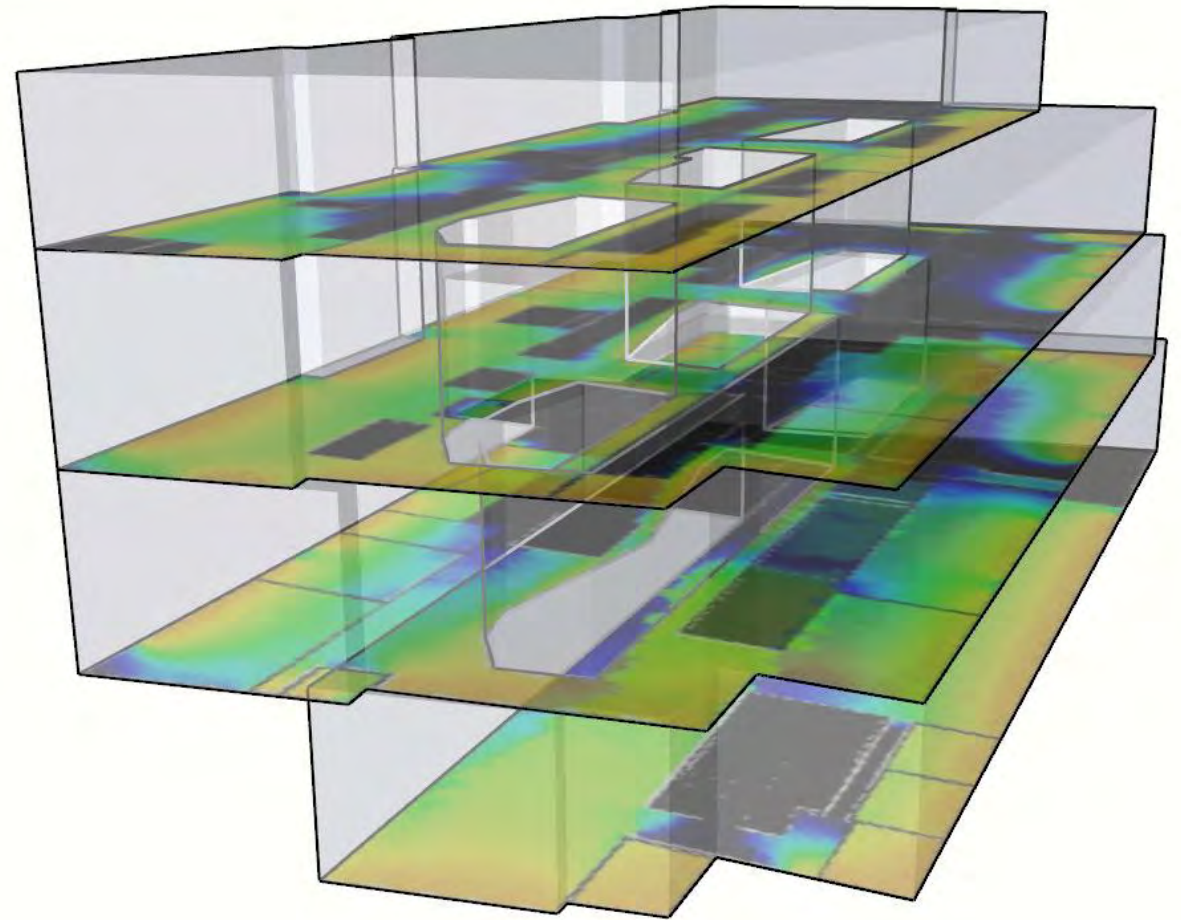
What Are Daylight Models Used For



Daylight to Inform the Design

Large Office Building in Boston

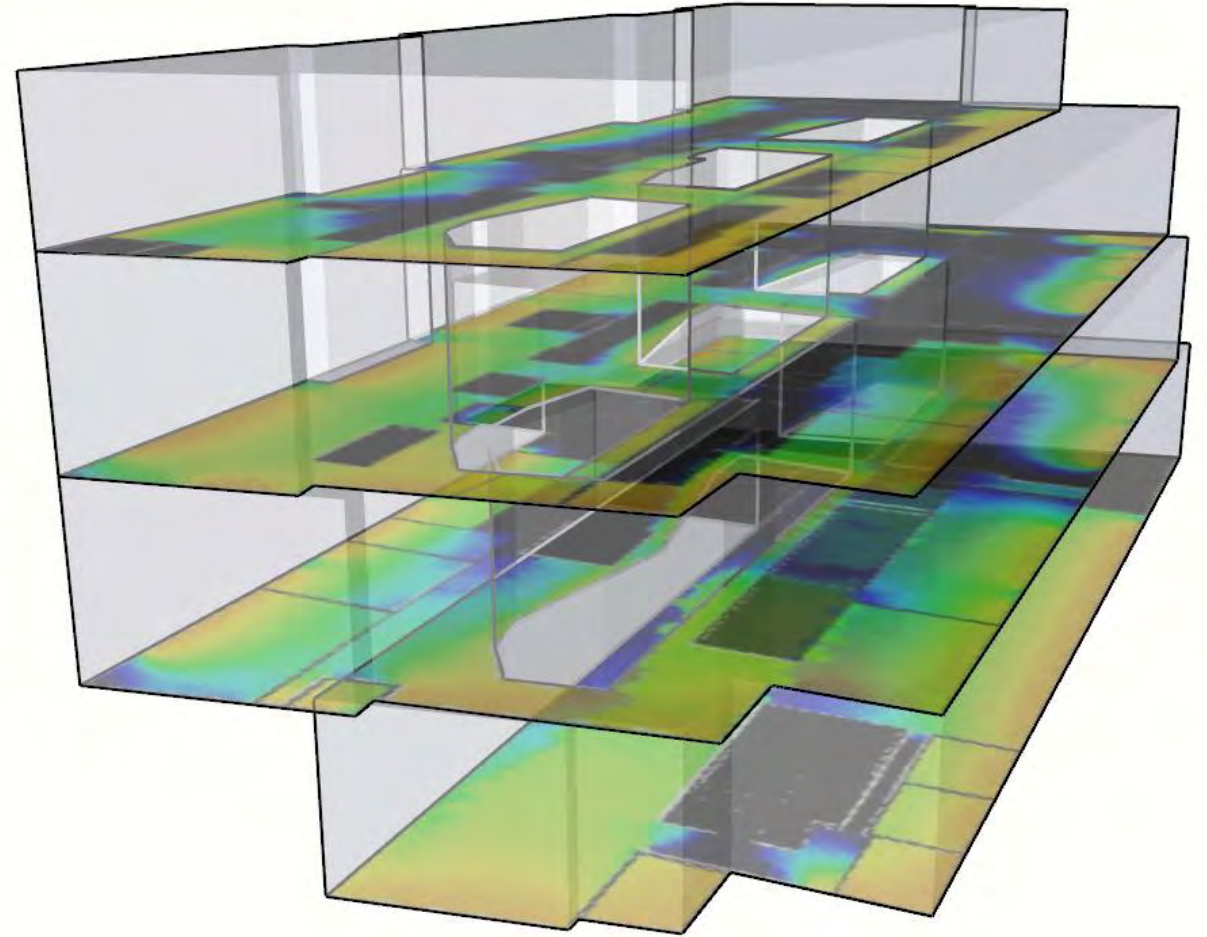
- First floor Lobby/Café adjacent to a heavily glazed wall
- Primary concern was controlling glare in Lobby/Café without reducing daylight too much



Daylight to Inform the Design

Options Studied

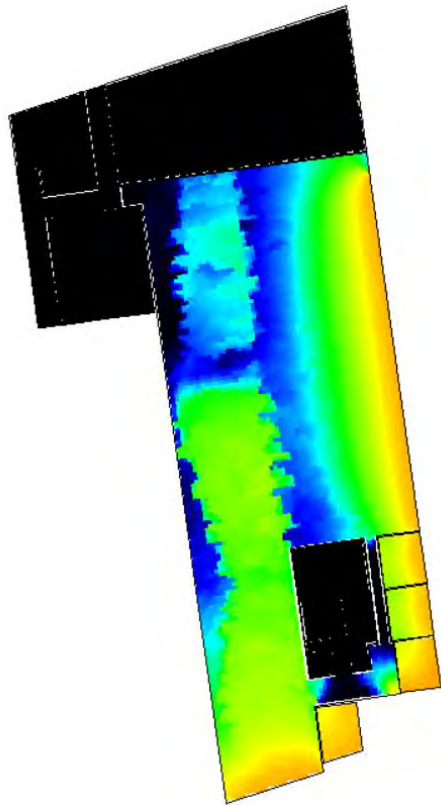
- Original Design
- Reduced VLT
- Shading fins



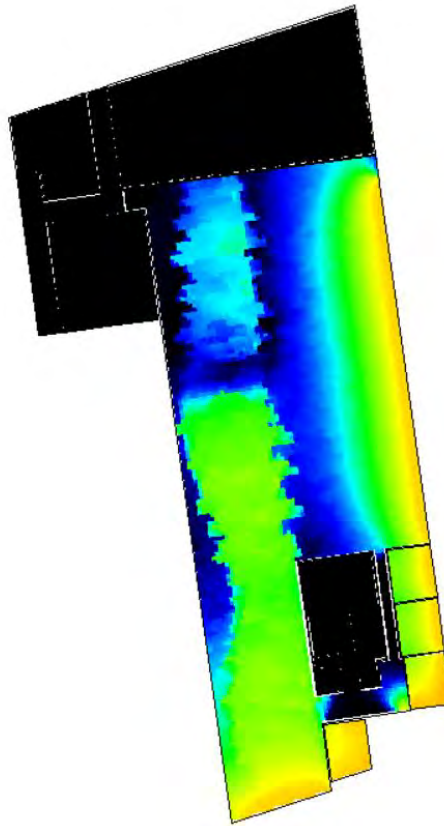
Daylighting to Inform the Design

SDA Analysis (% of occupied hours above 300 lux)

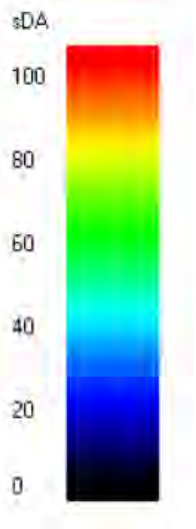
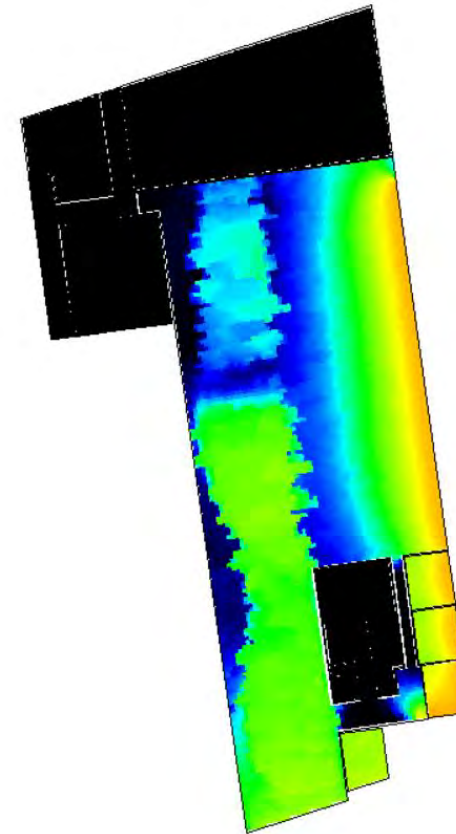
Original Design



Low VLT



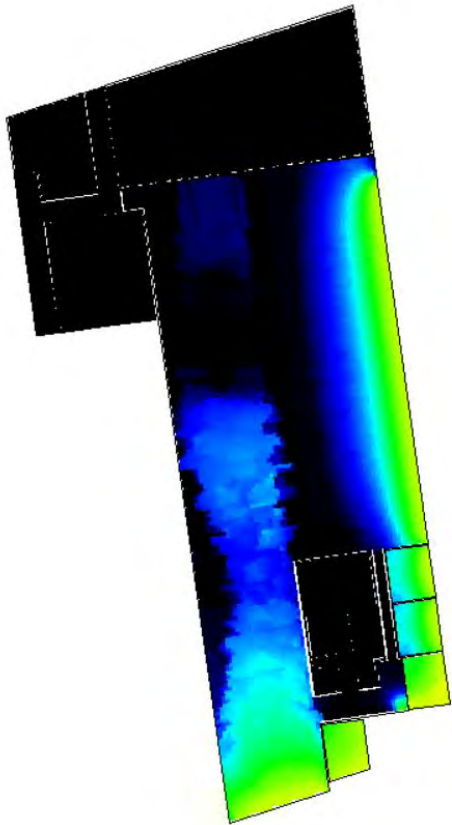
Shading Fins



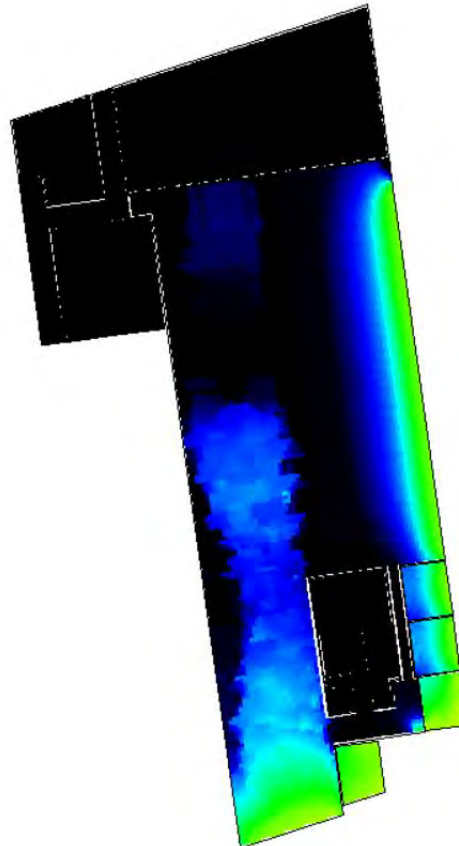
Daylighting to Inform the Design

Glare Analysis (% of occupied hours above 1,000 lux)

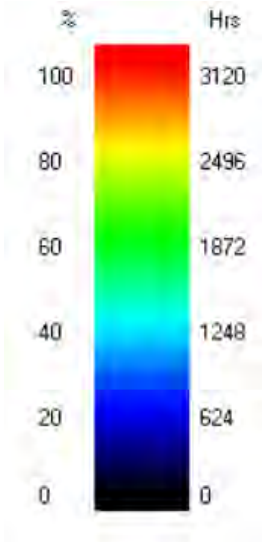
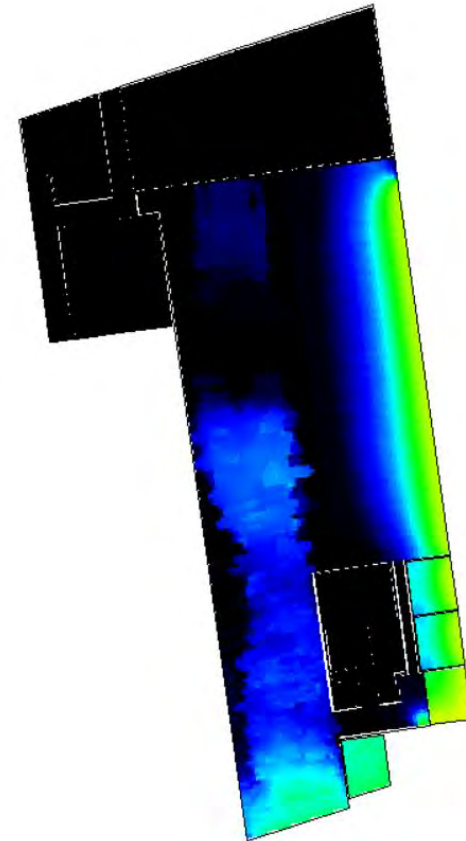
Original Design



Low VLT



Shading Fins



Daylighting for LEED

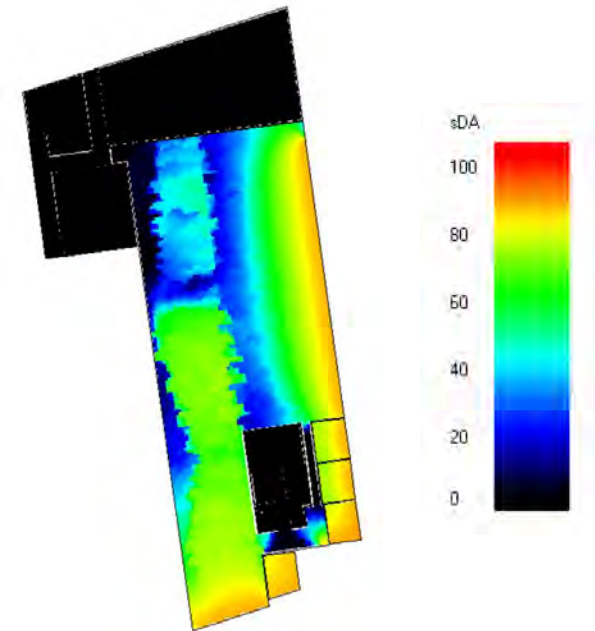
- 3 ways to achieve daylight credit
 - SDA 300/50 (300 lux for 50% of occupied hours)
 - Illuminance
 - On site measurement options
- Only counts “Regularly occupied spaces”
- Daylighting credit was very difficult in LEED V4, but has been updated to be more achievable in LEED V4.1.

Daylighting for LEED

SDA analysis for LEED V4.1

Table 1. Points for Option 1

	<i>New Construction, Core and Shell, Schools, Retail, Data Centers, Warehouses and Distribution Centers, Hospitality</i>	Healthcare
The average $sDA_{300/50\%}$ value for the regularly occupied floor area is at least 40%	1 point	1 point
The average $sDA_{300/50\%}$ value for the regularly occupied floor area is at least 55%	2 points	2 points
The average $sDA_{300/50\%}$ value for the regularly occupied floor area is at least 75%	3 points	Exemplary performance



- If over 10% of regularly occupied spaces with over 1,000 Lux for 250 hours/year identify how the glare will be addressed.