Performance Path Survival Guide

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DOE National Energy Codes Conference
Austin, TX

July 16, 2018

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IMT's Mission and Codes Work

Thought Leadership

- Intersection of codes, efficiency and resilience
- Develop practices that can be used to assess savings from code compliance

Implementation

- Helping cities save energy through better enforcement
- Making buildings more efficient across their life cycle

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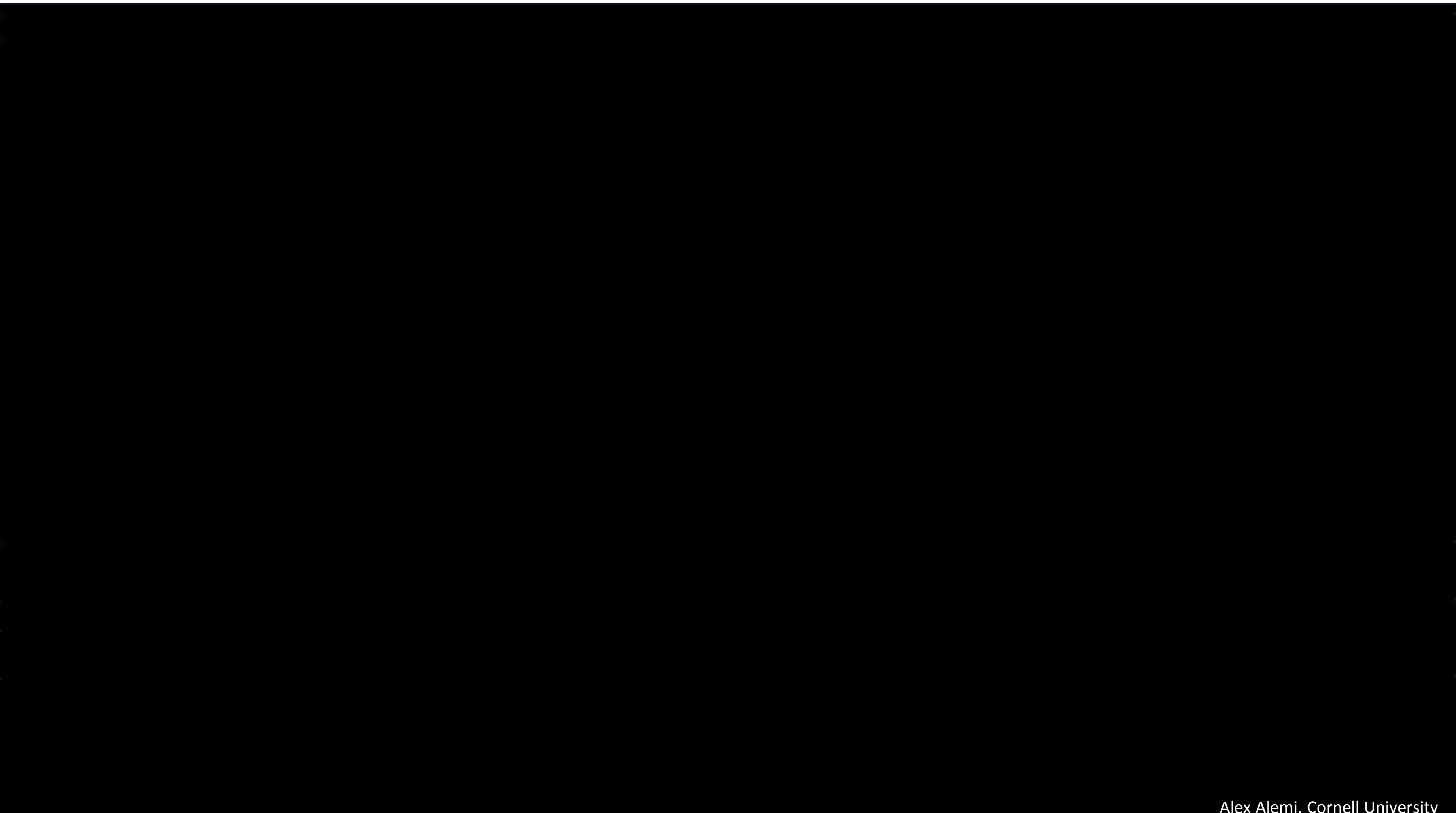
IT'S

COMING

Faster than you think…



CHAPTER 1:
Why Performance Path?

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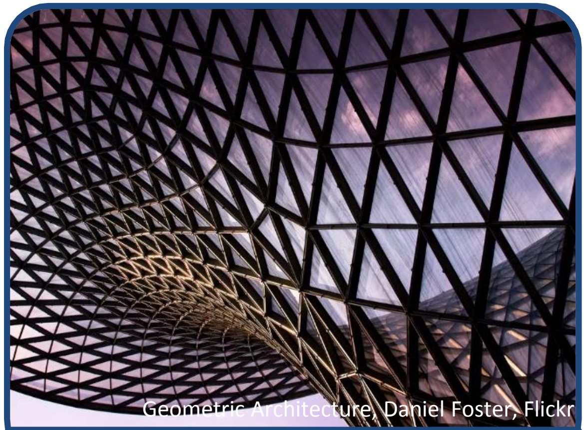
City Commitments

Model Code Trajectory


Geometric Architecture, Daniel Foster, Flickr

Design Goals

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City Commitments: Climate Change

C40 Cities

MAKE A DIFFERENCE

Each city in the C40 is unique in its infrastructure and progress in addressing climate change. C40 works to empower cities to connect with each other and share technical expertise on best practices.

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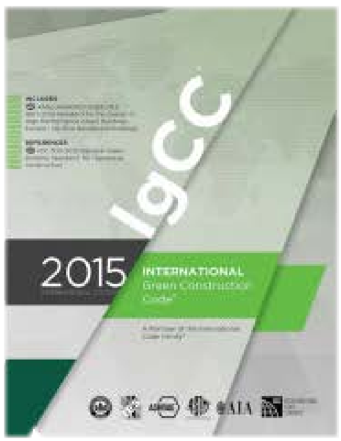
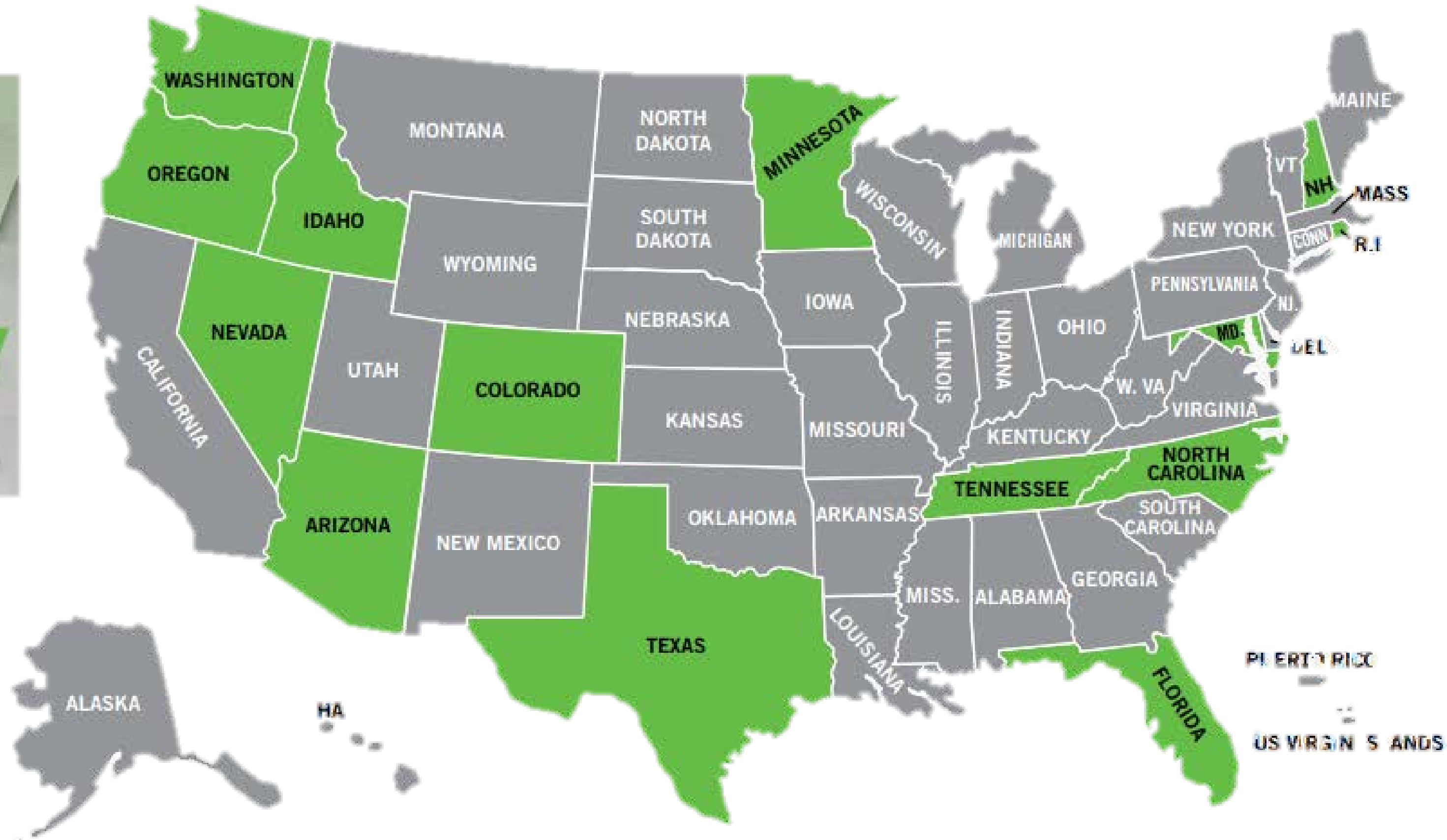
City Commitments: Sustainability





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City Commitments: Resilience

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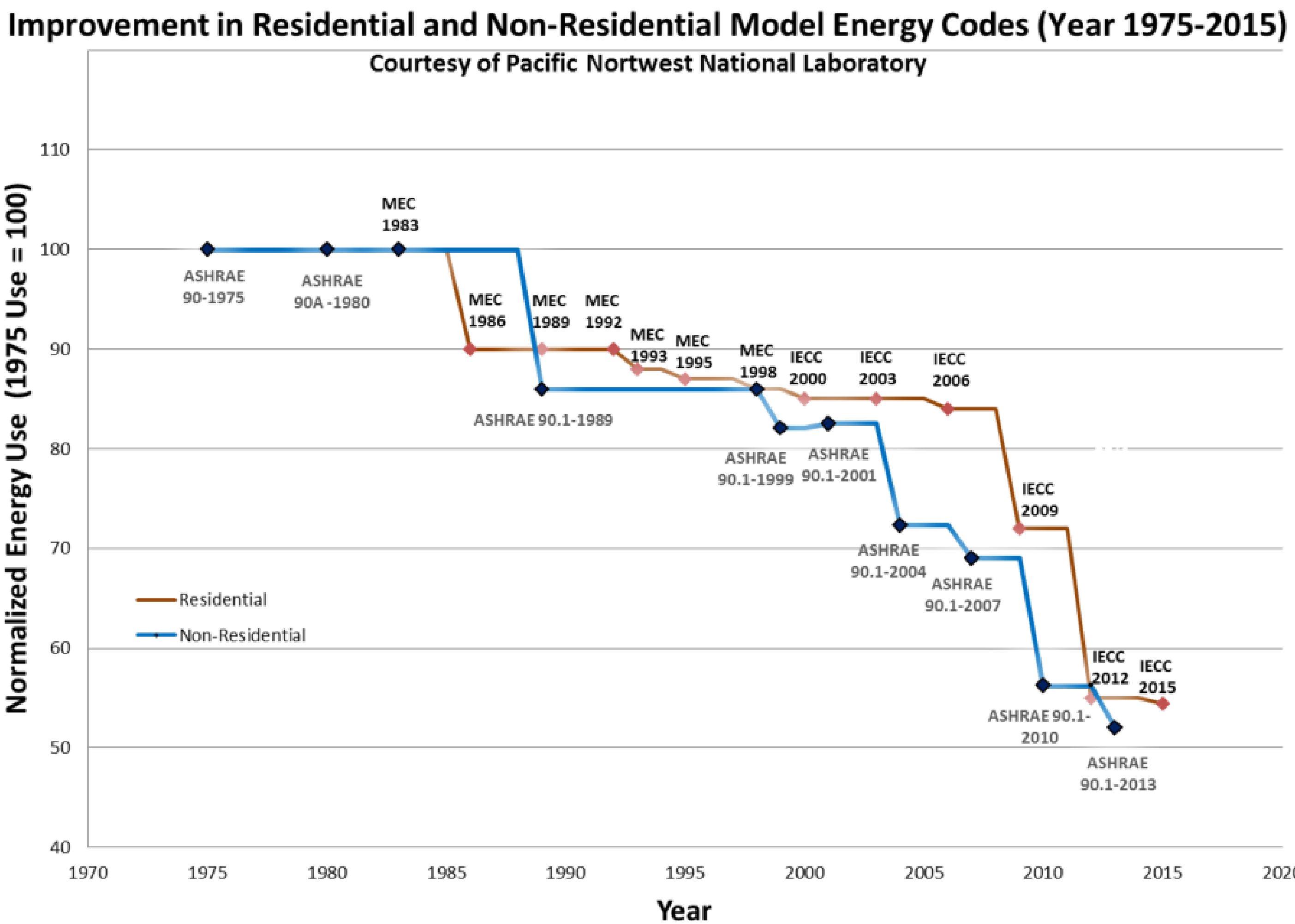
Model Codes: to Date



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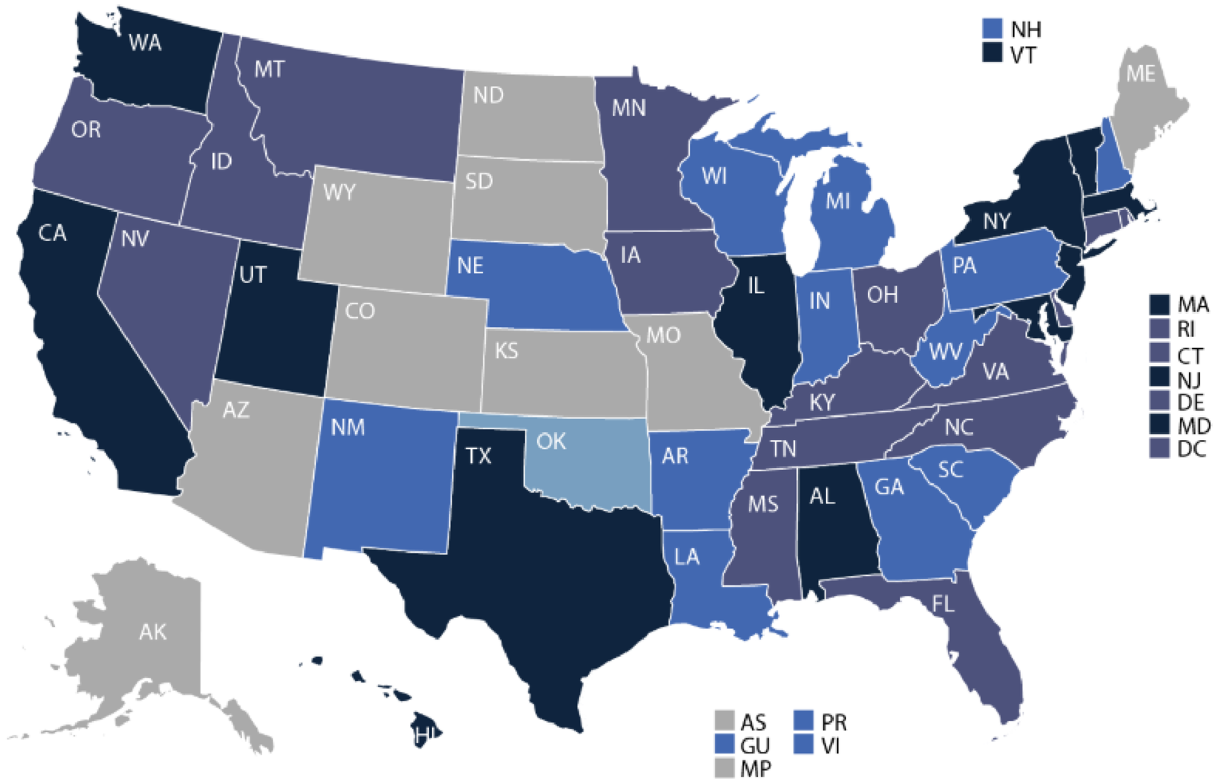
Model Codes: to Date



Meets or exceeds **ASHRAE 90.1-2013** or equivalent (12)

Meets or exceeds **ASHRAE 90.1-2010** or equivalent (17)

Meets or exceeds **ASHRAE 90.1-2007** or equivalent (15)

Meets or exceeds **ASHRAE 90.1-2004** or equivalent (1)

No statewide code or predates ASHRAE 90.1-2004 (11)

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Model Codes: Trajectory

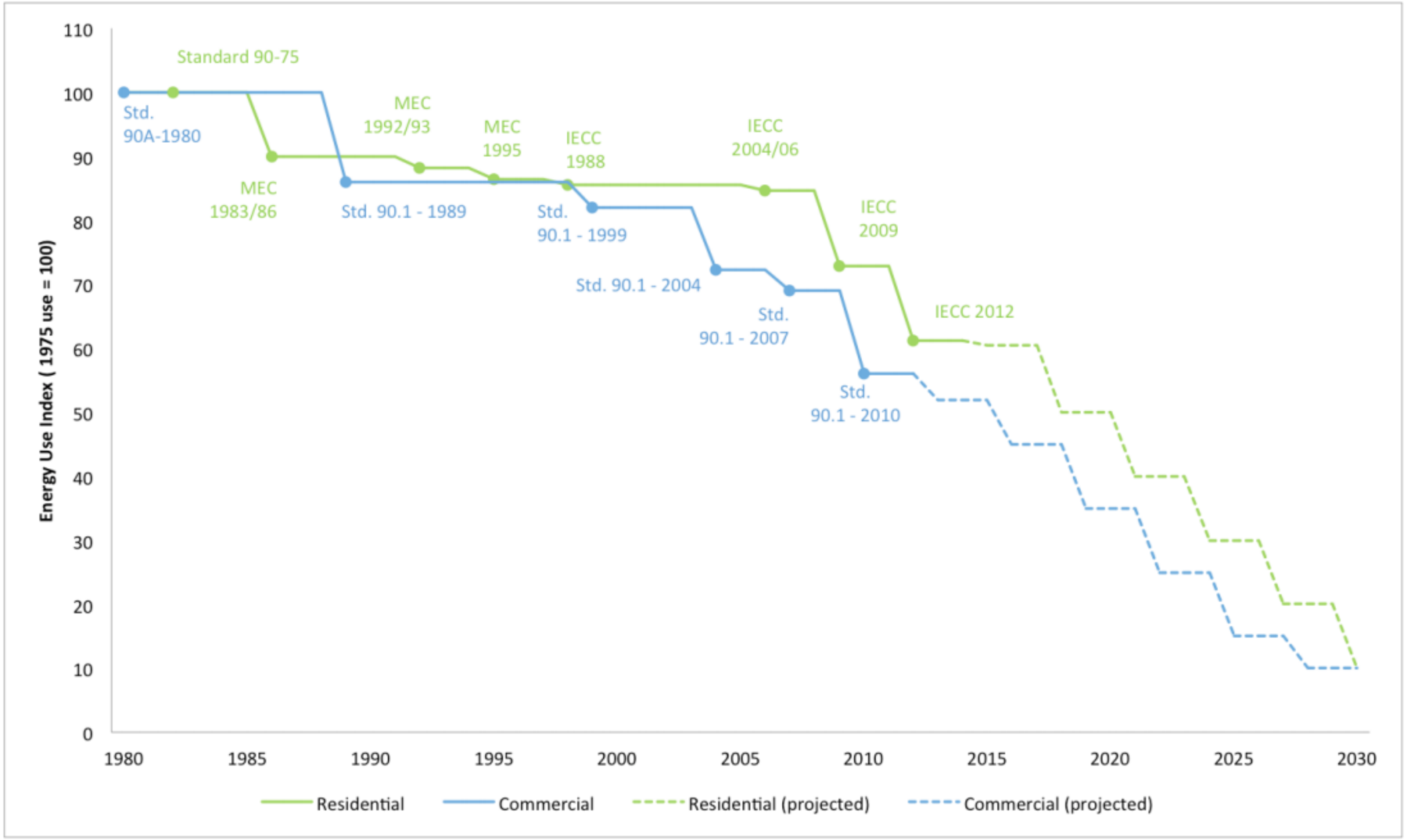

Figure ES1. History of U.S. building codes, 1980–2012. ***Source:*** **Data from U.S. DOE Building Codes Program.**

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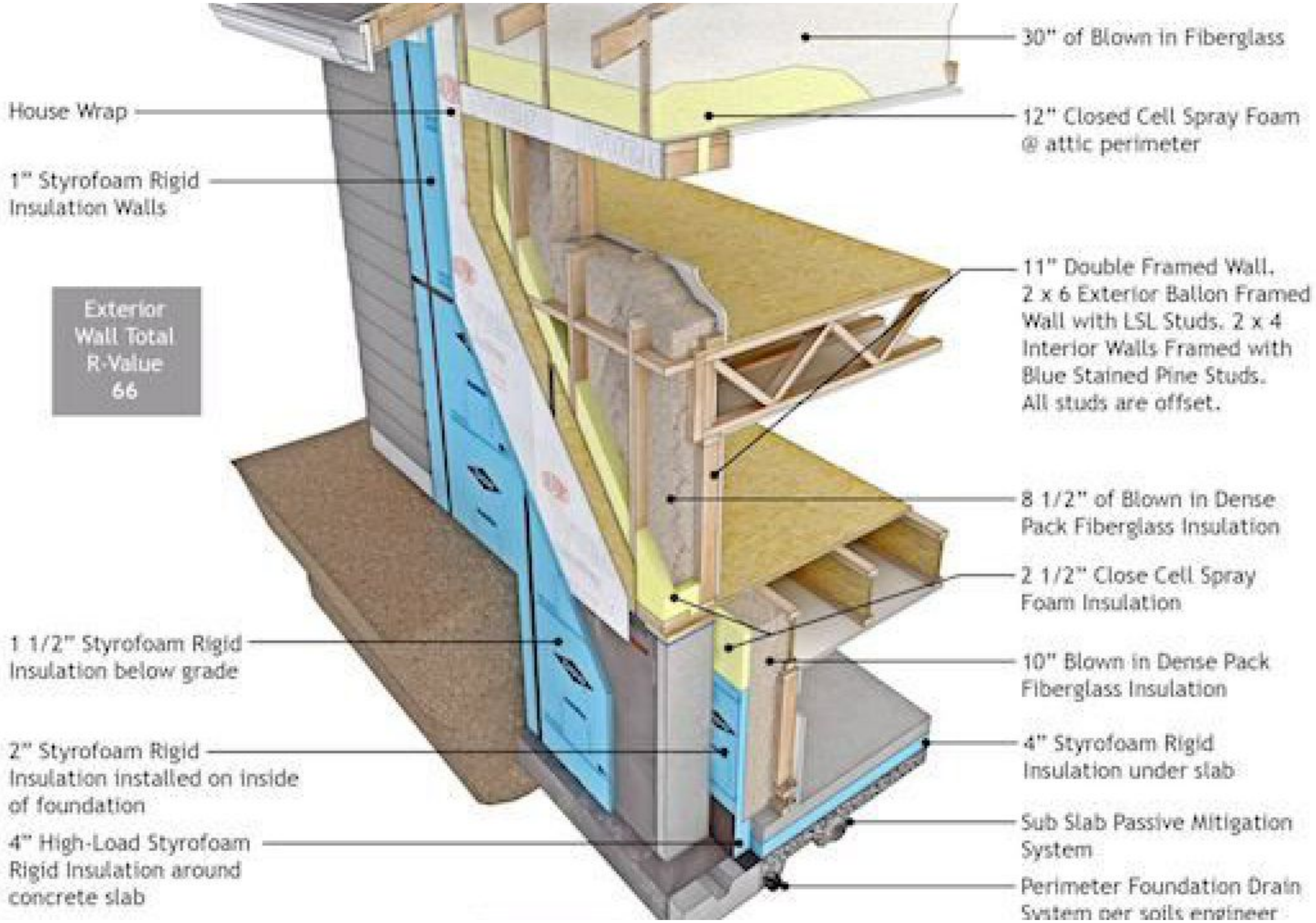
Design: and Prescriptive Path



https://www.rexdixon.com/topic/cross-section-detail-of-wooden-frame-house

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Design Goals: Flexibility

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Design: High Performance Buildings

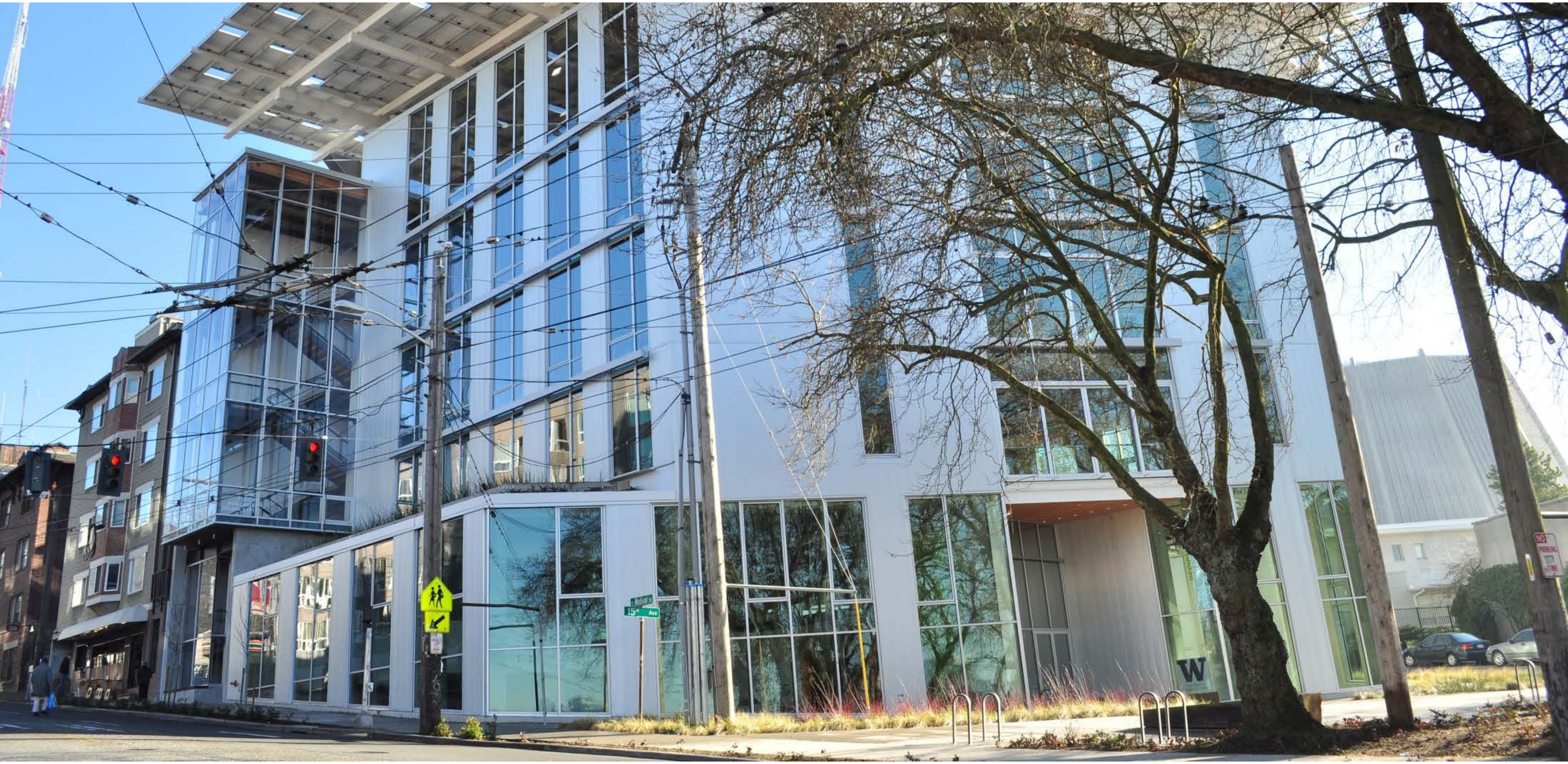

Image courtesy of Joe Mabel, Wikimedia Commons

… And ASHRAE 90.1-2016

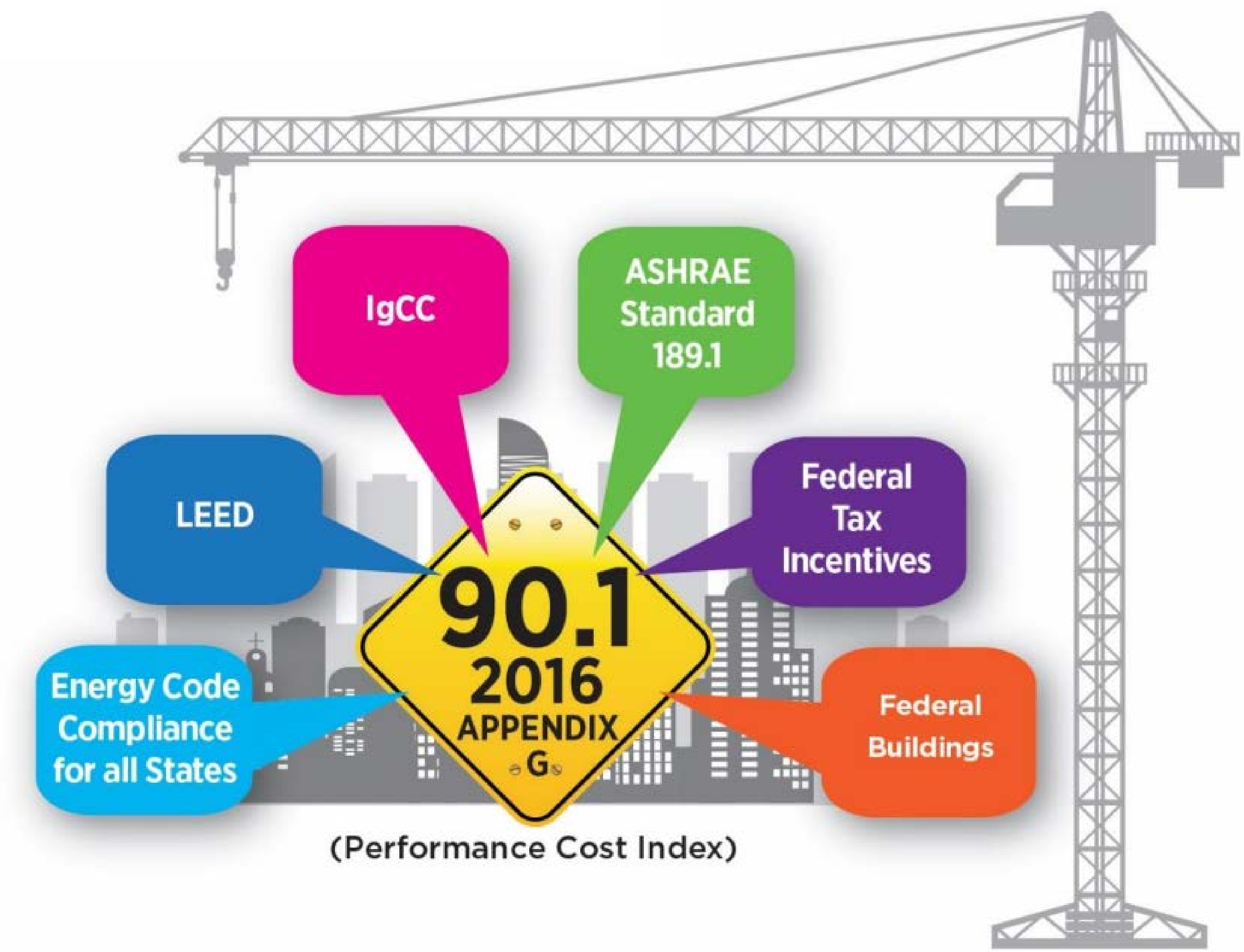

Image courtesy of PNNL

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CHAPTER 2:
Who is Acting?

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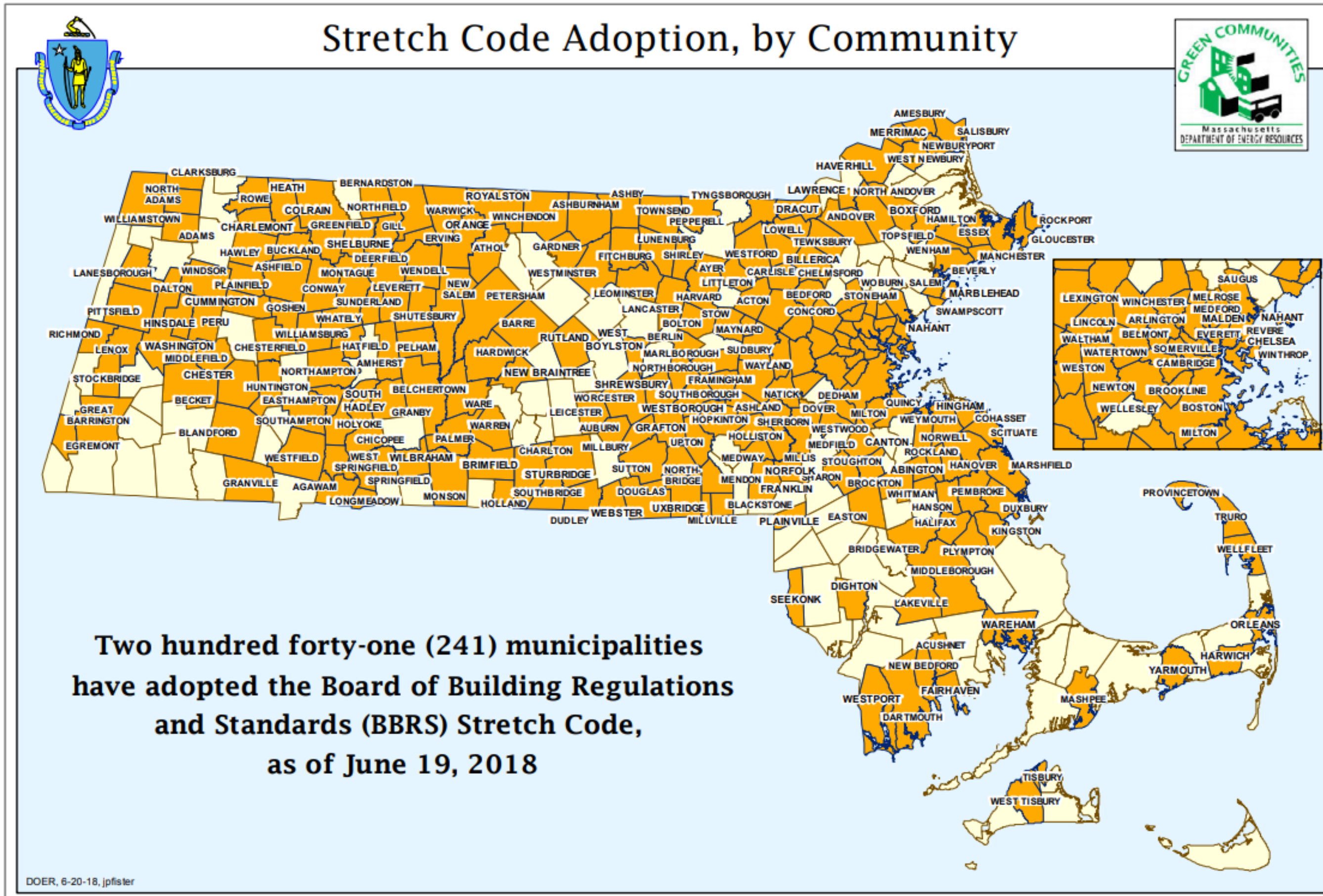
Massachusetts



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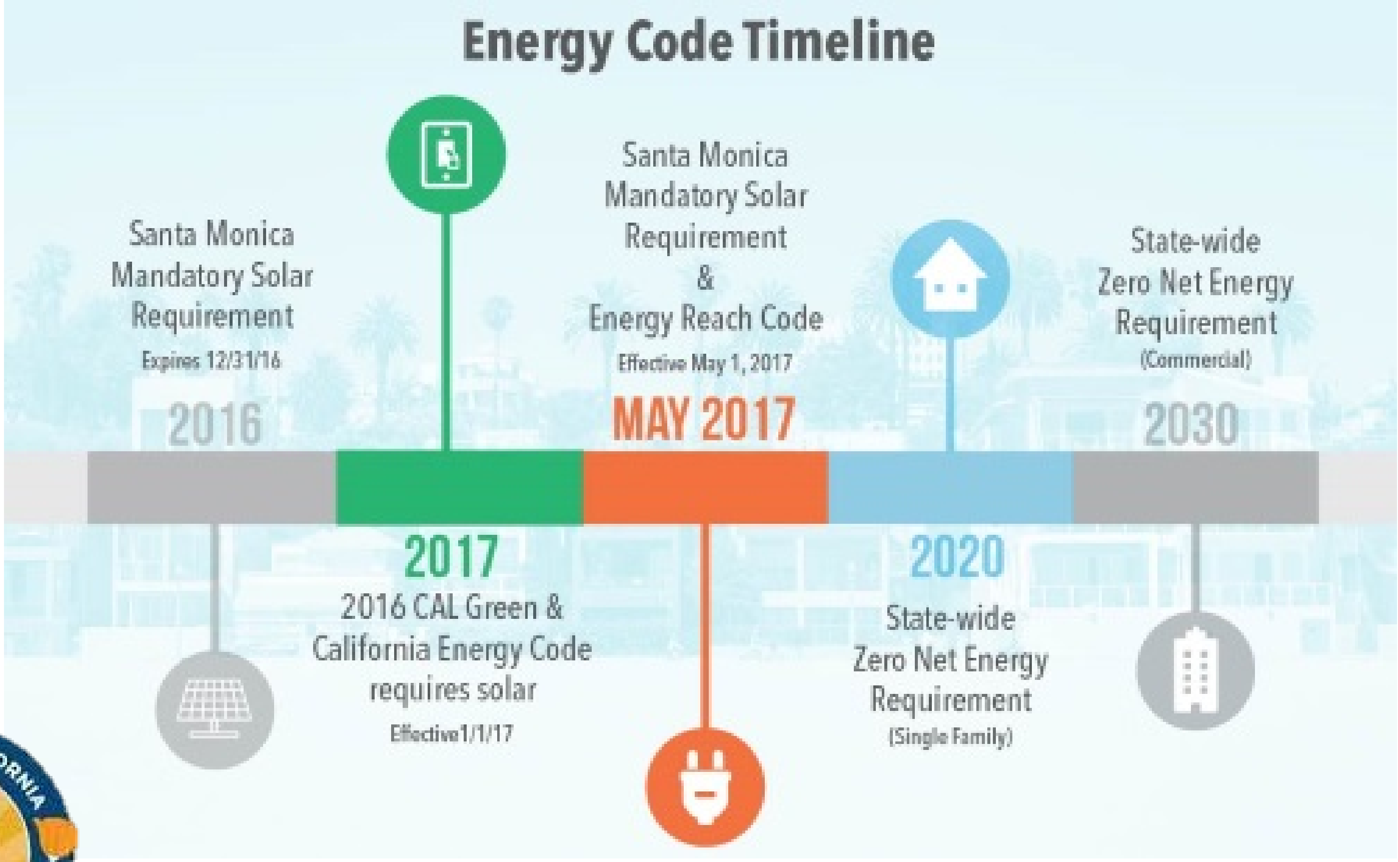
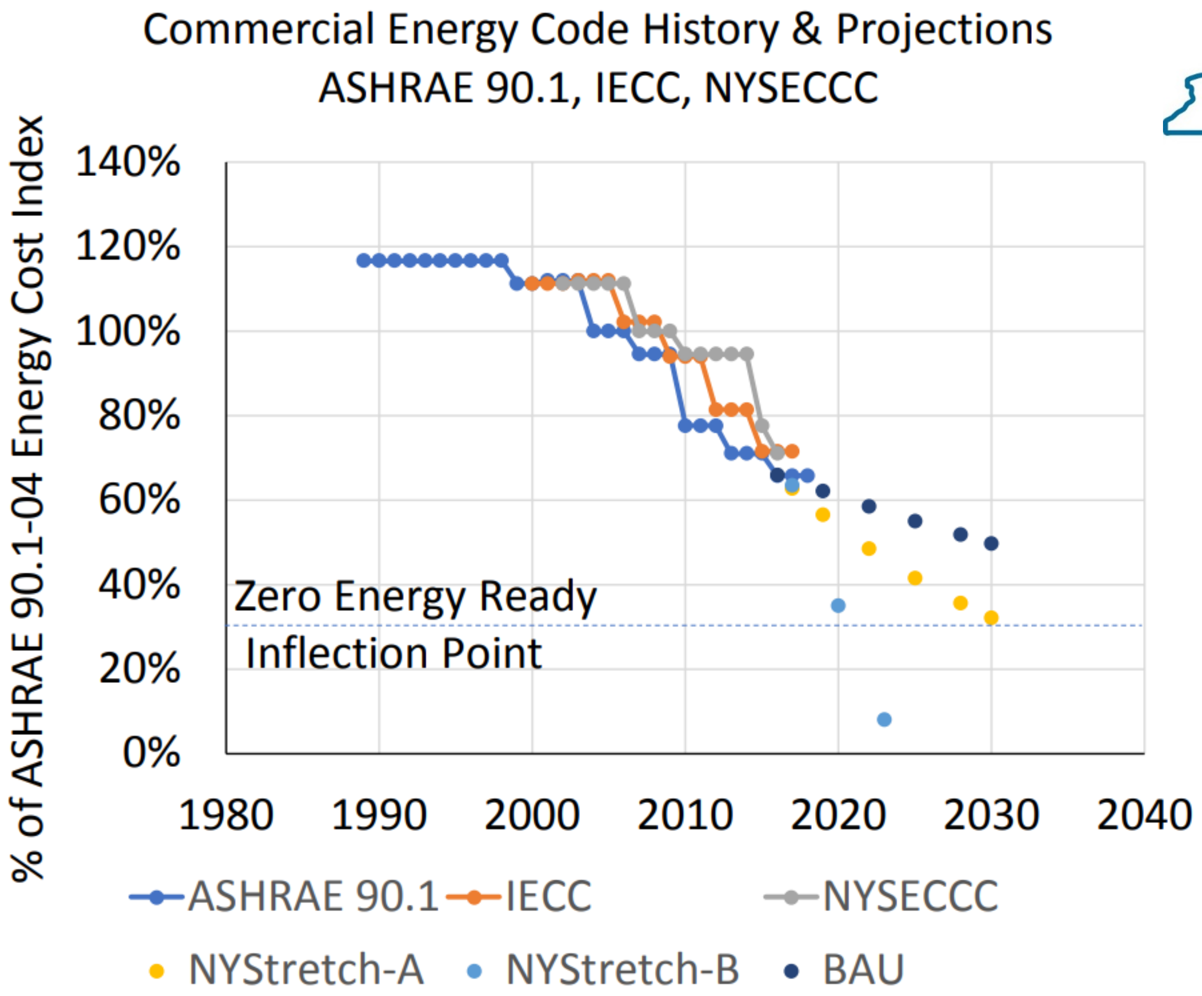
California



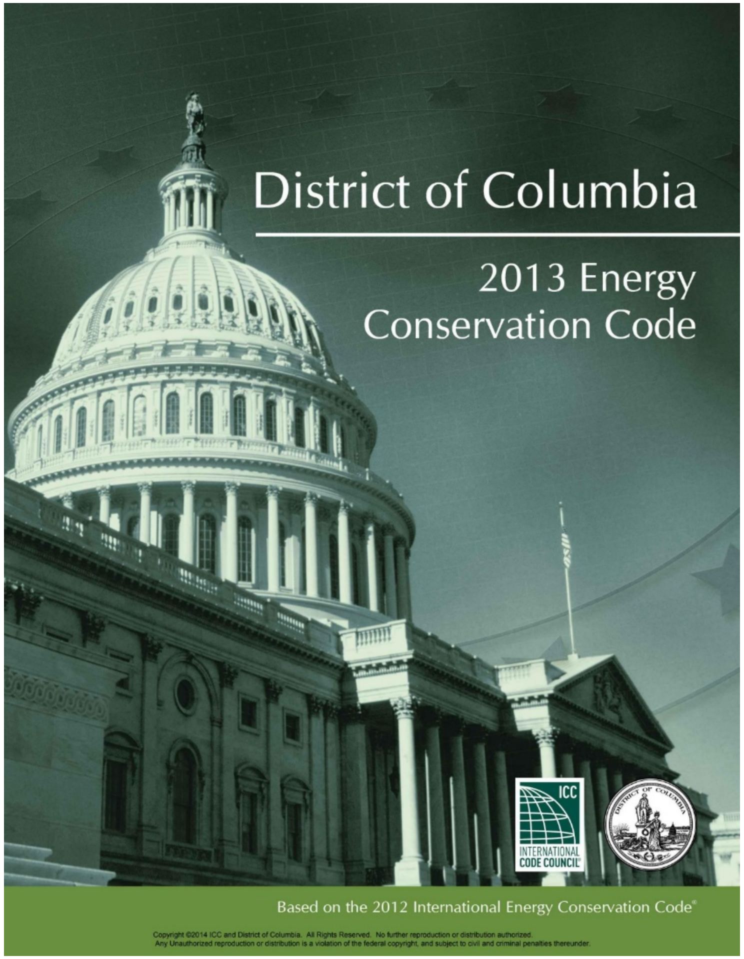
Energy Code Timeline
Santa Monica Mandatory Solar Requirement
Expires 12/31/16
2016
2017
2016 CAL Green & California Energy Code requires solar
Effective 1/1/17
Santa Monica Mandatory Solar Requirement & Energy Reach Code
Effective May 1, 2017
MAY 2017
2020
State-wide Zero Net Energy Requirement
(Single Family)
State-wide Zero Net Energy Requirement
(Commercial)
2030

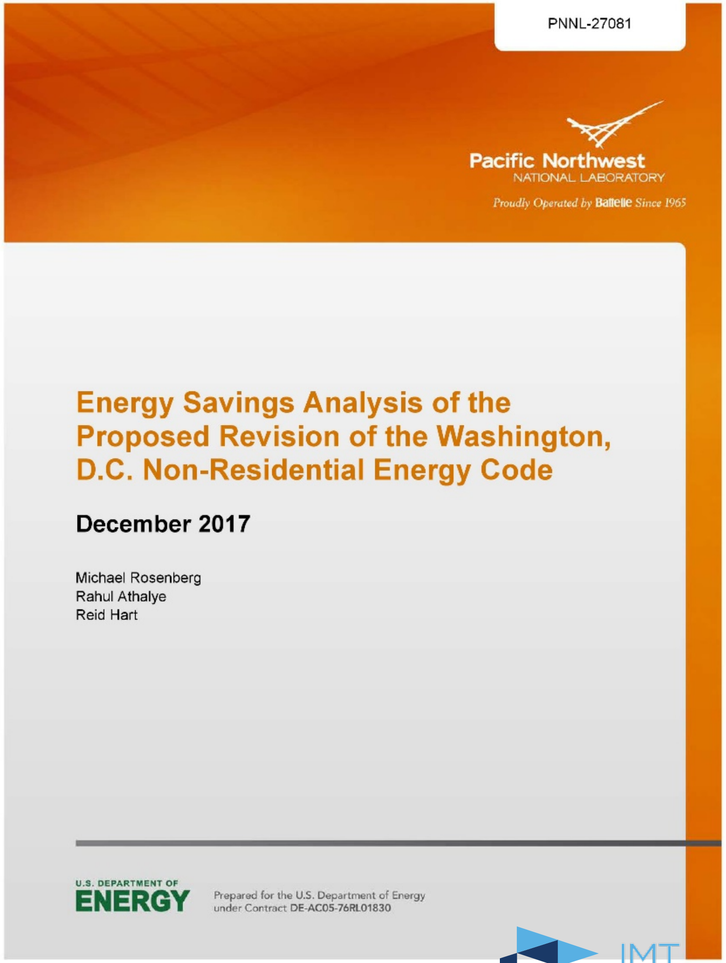
New York



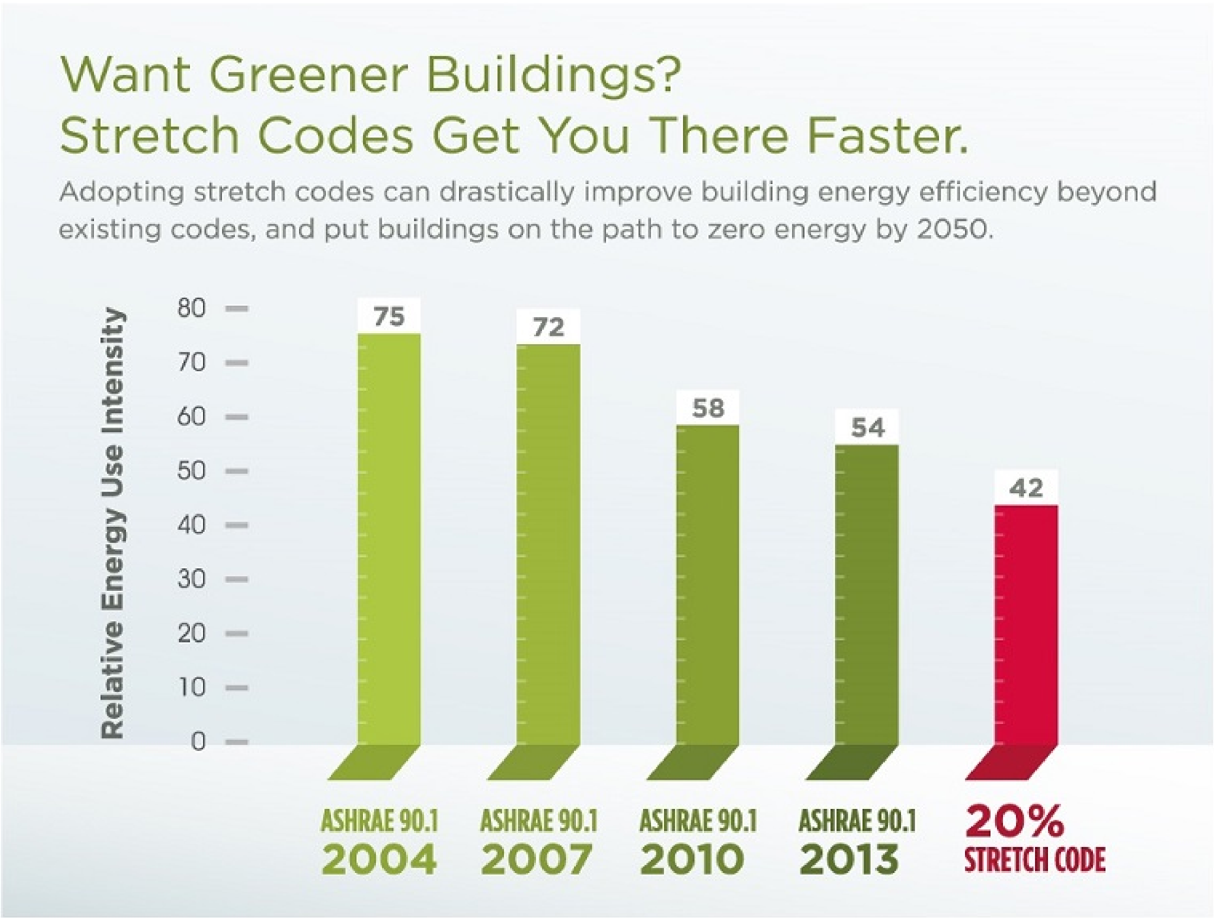
Commercial Energy Code History & Projections
ASHRAE 90.1, IECC, NYSECCC
% of ASHRAE 90.1-04 Energy Cost Index
140%
120%
100%
80%
60%
40%
20%
0%
1980
1990
2000
2010
2020
2030
2040
Zero Energy Ready
Inflection Point
ASHRAE 90.1
IECC
NYSECCC
NYStretch-A
NYStretch-B
BAU

District of Columbia





New Buildings Institute



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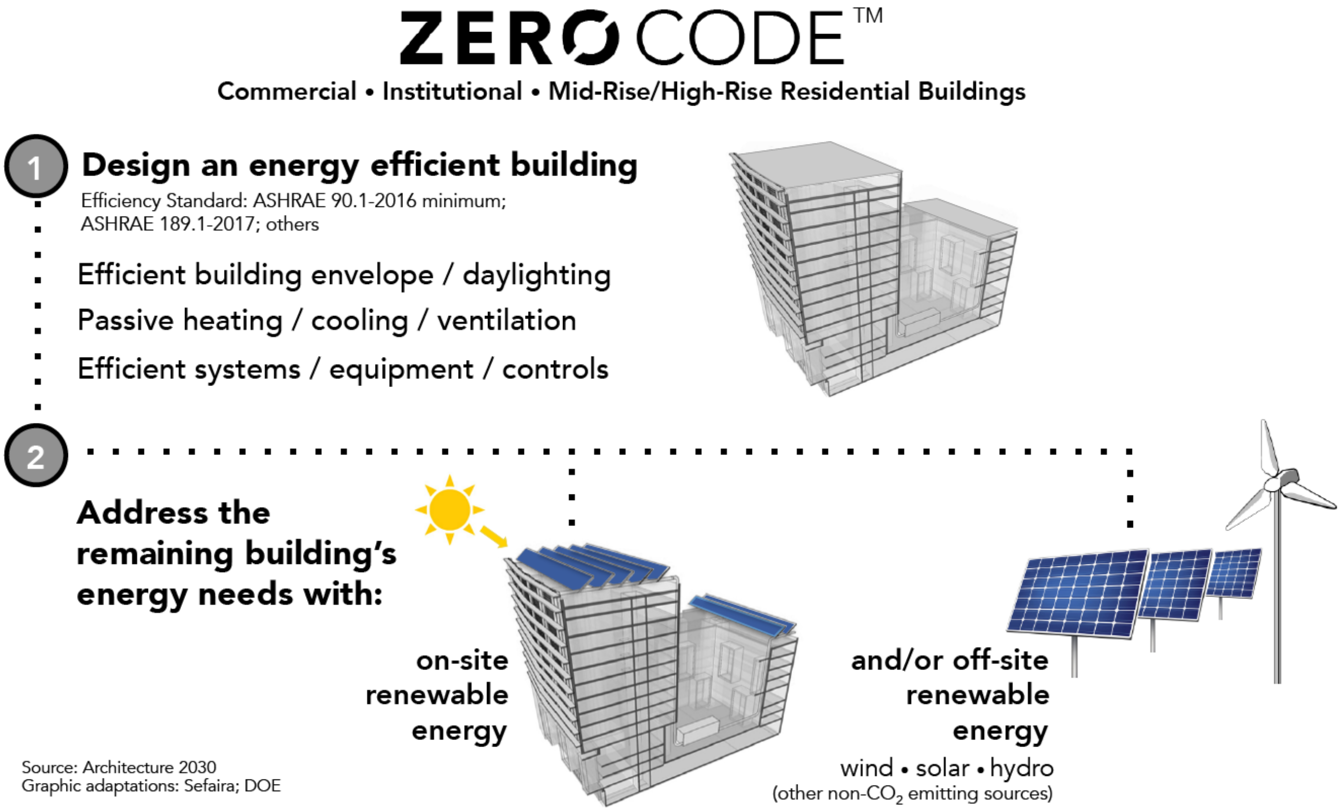
Architecture 2030



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CHAPTER 3:
Key Groups

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Major Stakeholders

ASHRAE®

TRANE®

HAP
HOURLY ANALYSIS PROGRAM
TWO TOOLS IN ONE:
HVAC System Design & Energy Modeling

DEPARTMENT OF ENERGY · UNITED STATES OF AMERICA

U.S. GREEN BUILDING COUNCIL
USGBC®

ICC
INTERNATIONAL
CODE COUNCIL®

EnergyPlus

eQUEST

DOE-2

Stakeholders

+ Modeling Firms

+ Designers

+ Owners/ Developers

+ Building Officials

CHAPTER 4:
Surviving a New World

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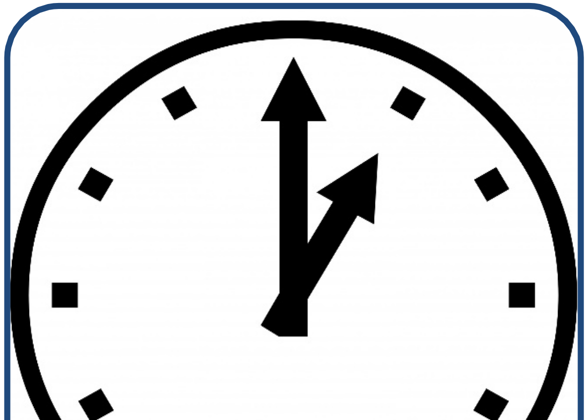
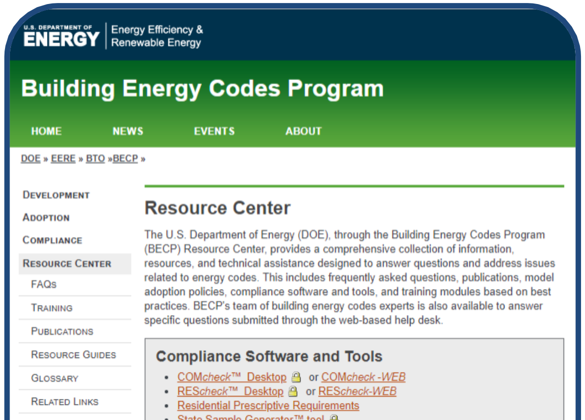
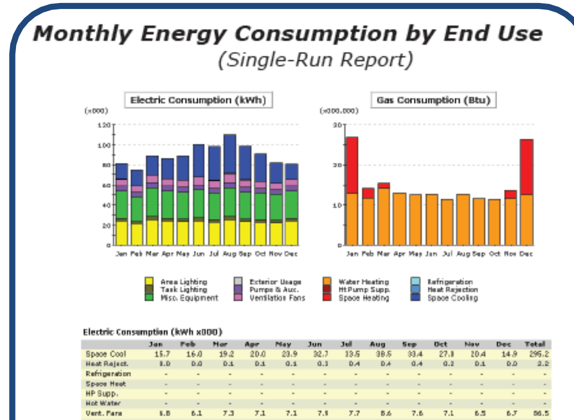
Challenges for Building Officials



Time and Resources

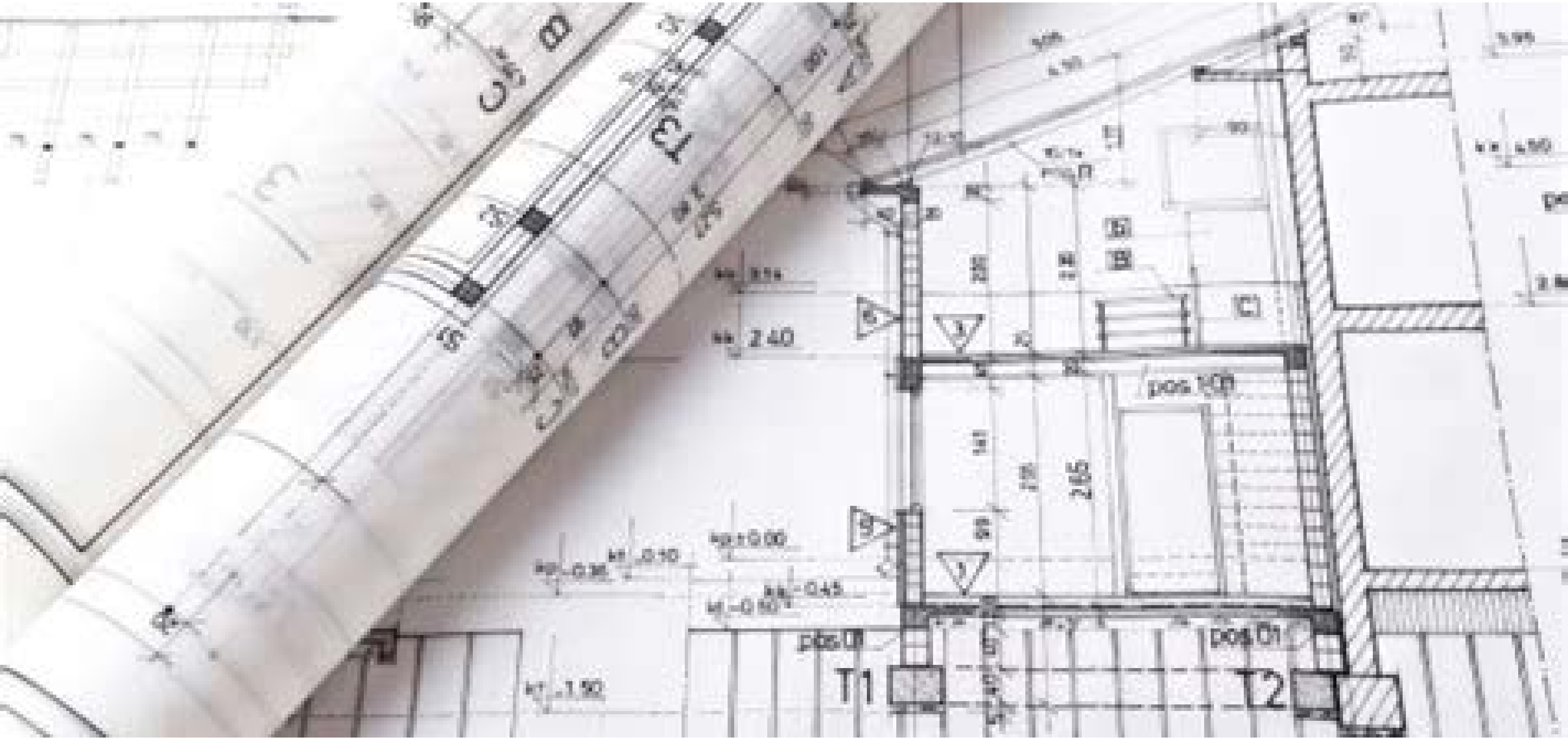


Technical Support



Documentation

Time and Resources



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Technical Support

Energy Modeling Training from Industry Experts

Get Energized & Get Noticed with GBRI's Training Today

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14 Things You Need to Know about Energy Modeling

1 FREE GBCI/AIA CE Hour available now. Hear the top 14 things you need to know (including the break down of energy modeling misconceptions) while earning CE.

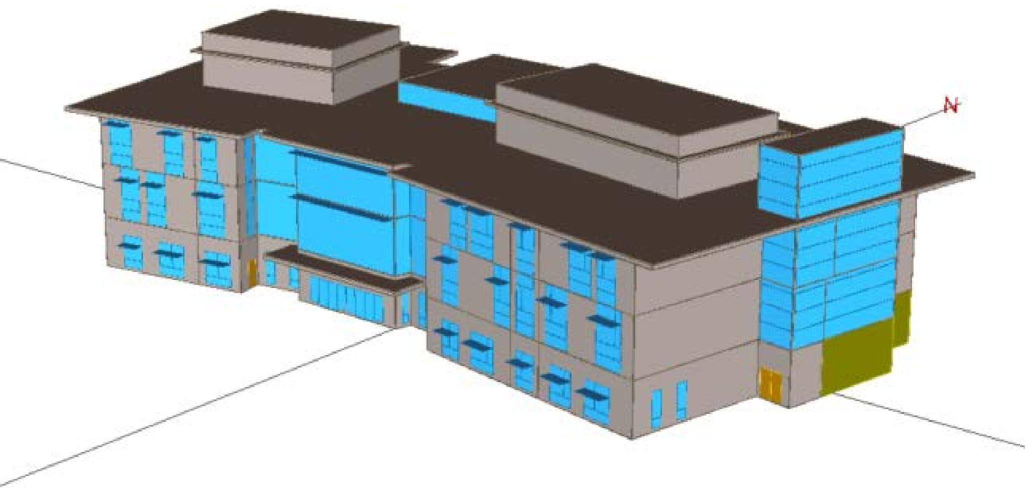
Mastering eQUEST in 7 Days

Extensive eQUEST training package includes the how to's of basic wizards through advanced functions including step by step demo's within the popular eQUEST software.

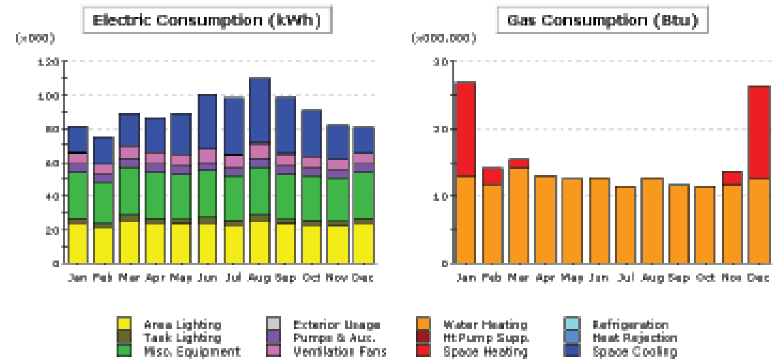
LEED Case Studies

LEED Case Studies feature energy modeling software, uses and techniques giving you insight into how modeling is utilized on live projects.

Documentation



Monthly Energy Consumption by End Use
(Single-Run Report)



Electric Consumption (kWh x000)

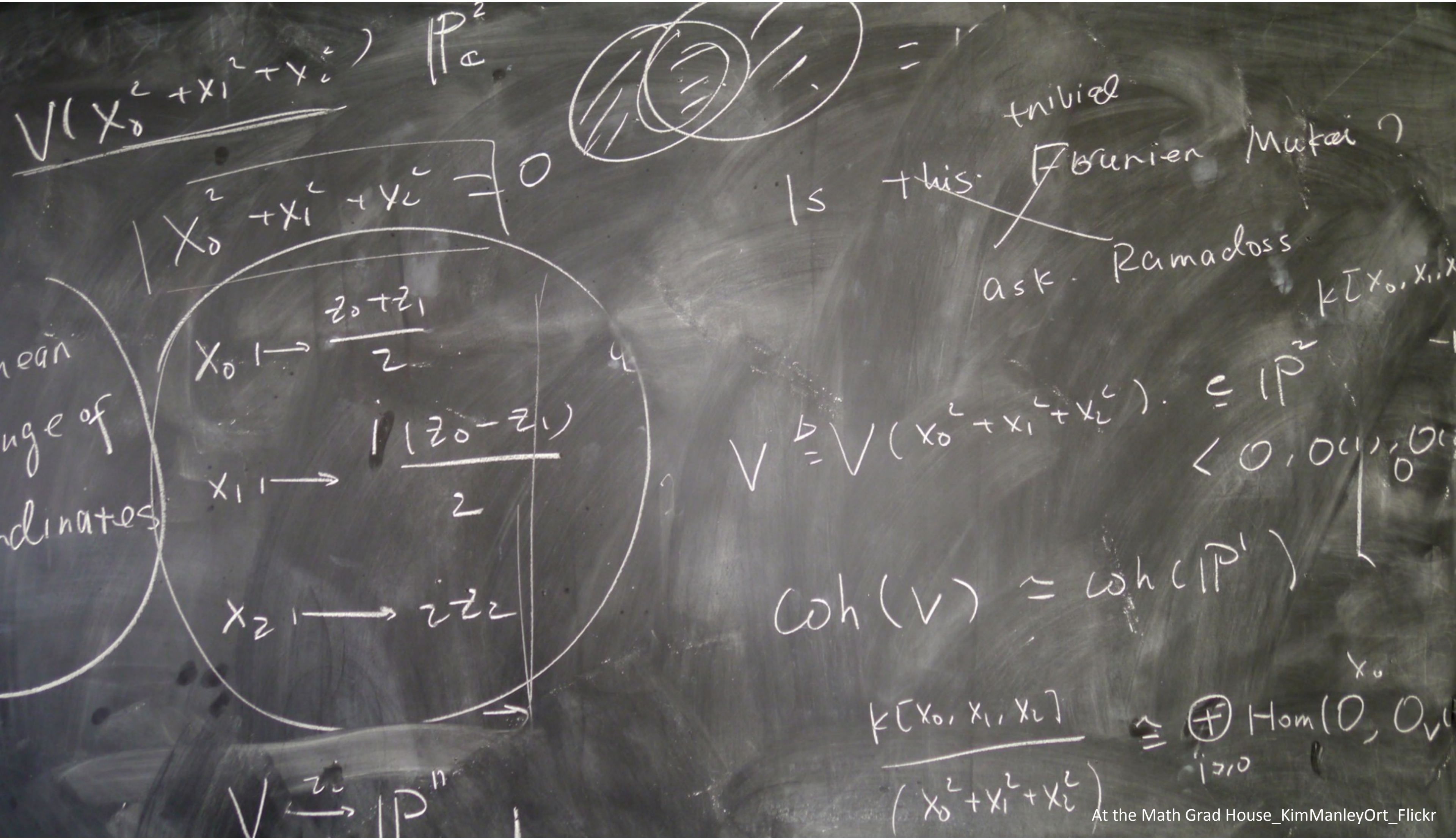
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Space Cool	15.7	16.0	19.2	20.0	23.9	32.7	33.6	38.6	33.4	27.8	20.4	14.9	296.2
Heat Reject.	0.0	0.0	0.1	0.1	0.1	0.3	0.4	0.4	0.4	0.2	0.1	0.0	2.2
Refrigeration	-	-	-	-	-	-	-	-	-	-	-	-	-
Space Heat	-	-	-	-	-	-	-	-	-	-	-	-	-
HP Supp.	-	-	-	-	-	-	-	-	-	-	-	-	-
Hot Water	-	-	-	-	-	-	-	-	-	-	-	-	-
Vent. Fans	5.8	6.1	7.3	7.1	7.1	7.8	7.7	8.6	7.6	7.1	6.5	6.7	86.5
Pumps & Aux.	5.0	4.4	5.2	5.0	4.8	5.8	4.8	5.2	4.8	4.8	4.6	5.0	58.6
Ext. Usage	-	-	-	-	-	-	-	-	-	-	-	-	-
Misc. Equip.	27.2	24.3	28.9	27.3	26.6	27.7	26.1	28.9	26.6	26.1	25.5	27.2	322.6
Task Lights	2.6	2.3	2.8	2.6	2.6	2.7	2.5	2.8	2.6	2.5	2.5	2.6	31.0
Area Lights	23.9	21.3	25.2	23.9	23.2	24.2	22.9	25.2	23.2	22.9	22.3	23.9	282.1
Total	81.3	74.6	88.7	85.9	88.3	100.6	97.9	109.6	98.6	90.6	81.7	80.4	1,078.1

Gas Consumption (Btu x000,000)

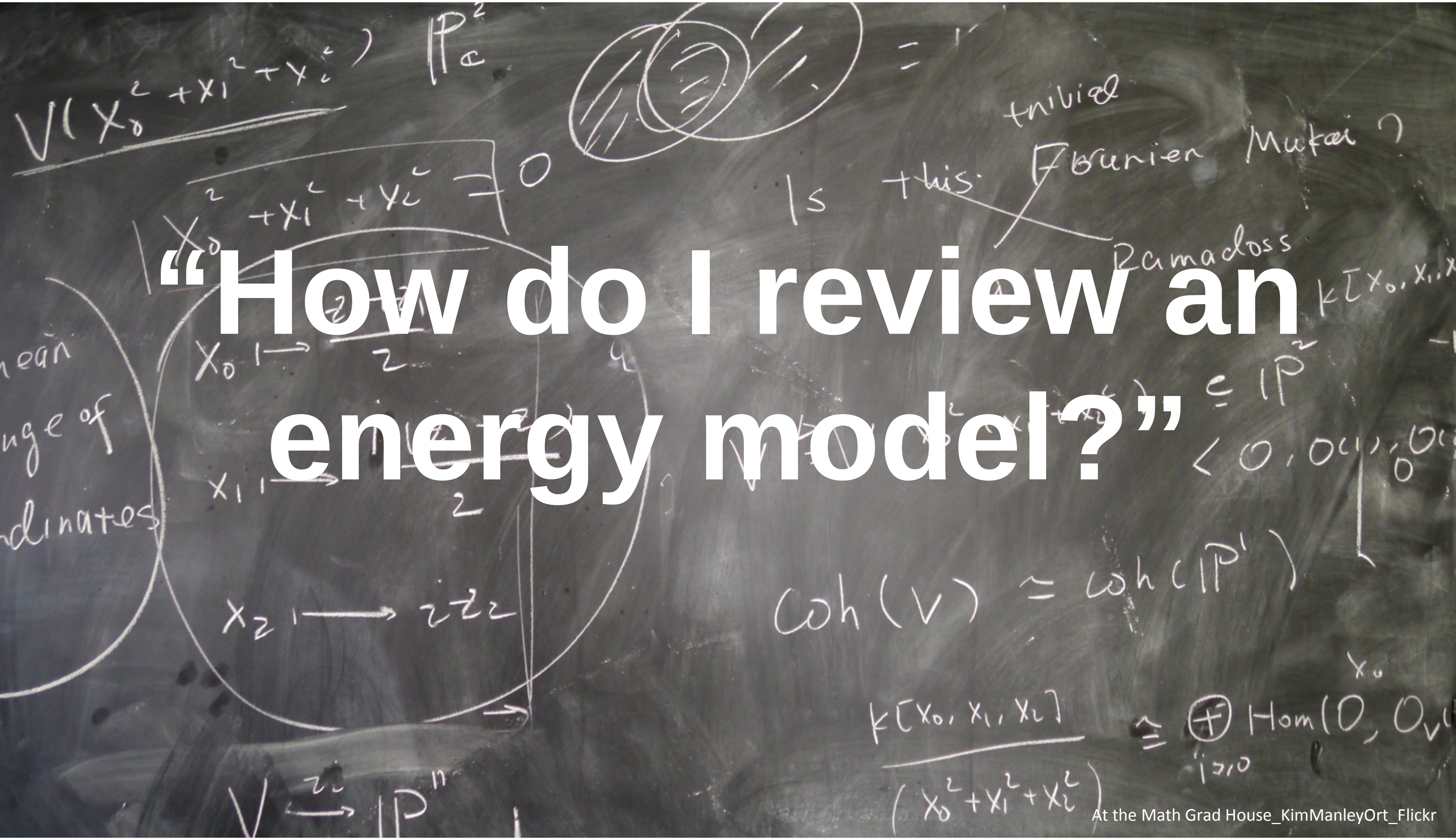
Jan	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Space Cool	-	-	-	-	-	-	-	-	-	-	-	-	-
Heat Reject.	-	-	-	-	-	-	-	-	-	-	-	-	-
Refrigeration	-	-	-	-	-	-	-	-	-	-	-	-	-
Space Heat	14.02	2.43	1.36	-	-	-	-	-	-	-	1.99	13.75	33.55
HP Supp.	-	-	-	-	-	-	-	-	-	-	-	-	-
Hot Water	12.79	11.64	13.97	12.88	12.40	12.62	11.40	12.66	11.60	11.38	11.49	12.51	147.31
Vent. Fans	-	-	-	-	-	-	-	-	-	-	-	-	-
Pumps & Aux.	-	-	-	-	-	-	-	-	-	-	-	-	-
Ext. Usage	-	-	-	-	-	-	-	-	-	-	-	-	-
Misc. Equip.	-	-	-	-	-	-	-	-	-	-	-	-	-
Task Lights	-	-	-	-	-	-	-	-	-	-	-	-	-
Area Lights	-	-	-	-	-	-	-	-	-	-	-	-	-
Total	26.81	14.07	15.33	12.88	12.40	12.62	11.40	12.66	11.60	11.38	11.47	26.26	180.87

Images courtesy of eQuest

What the Building Official Sees



At the Math Grad House_KimManleyOrt_Flickr



“How do I review an energy model?”

At the Math Grad House_KimManleyOrt_Flickr

“How can we support energy model review?”

CHAPTER 5: Resources Review

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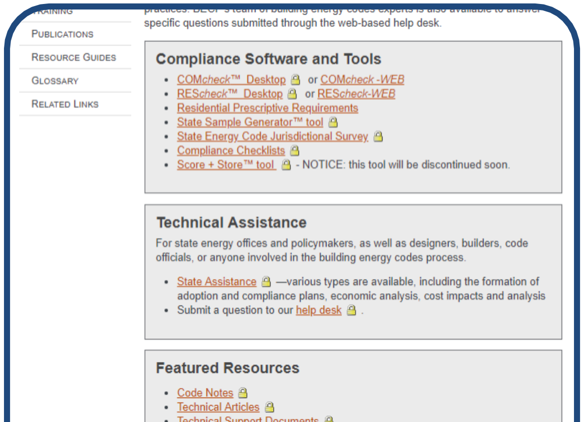
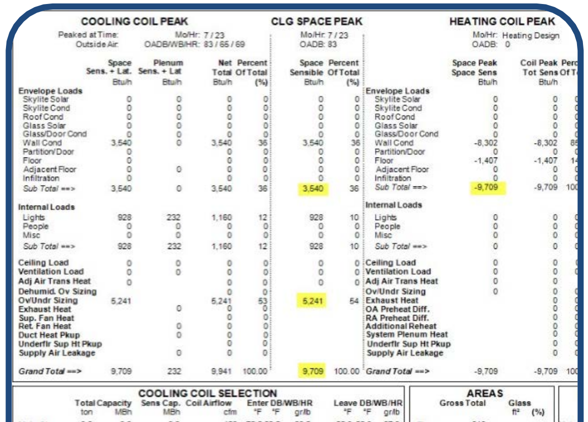
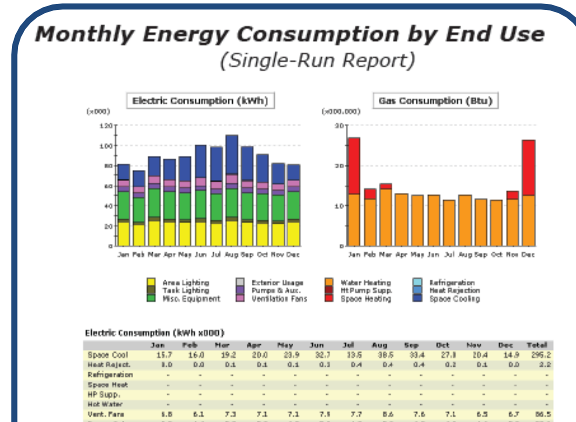
Dyl86, Flickr



Training & Support



Documentation



Automatic Baseline

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What's Not Working
Training: Trial by Fire

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What’s Not Working
Training: Infrastructure

180127ubno1270315, Ria Tan, Flickr

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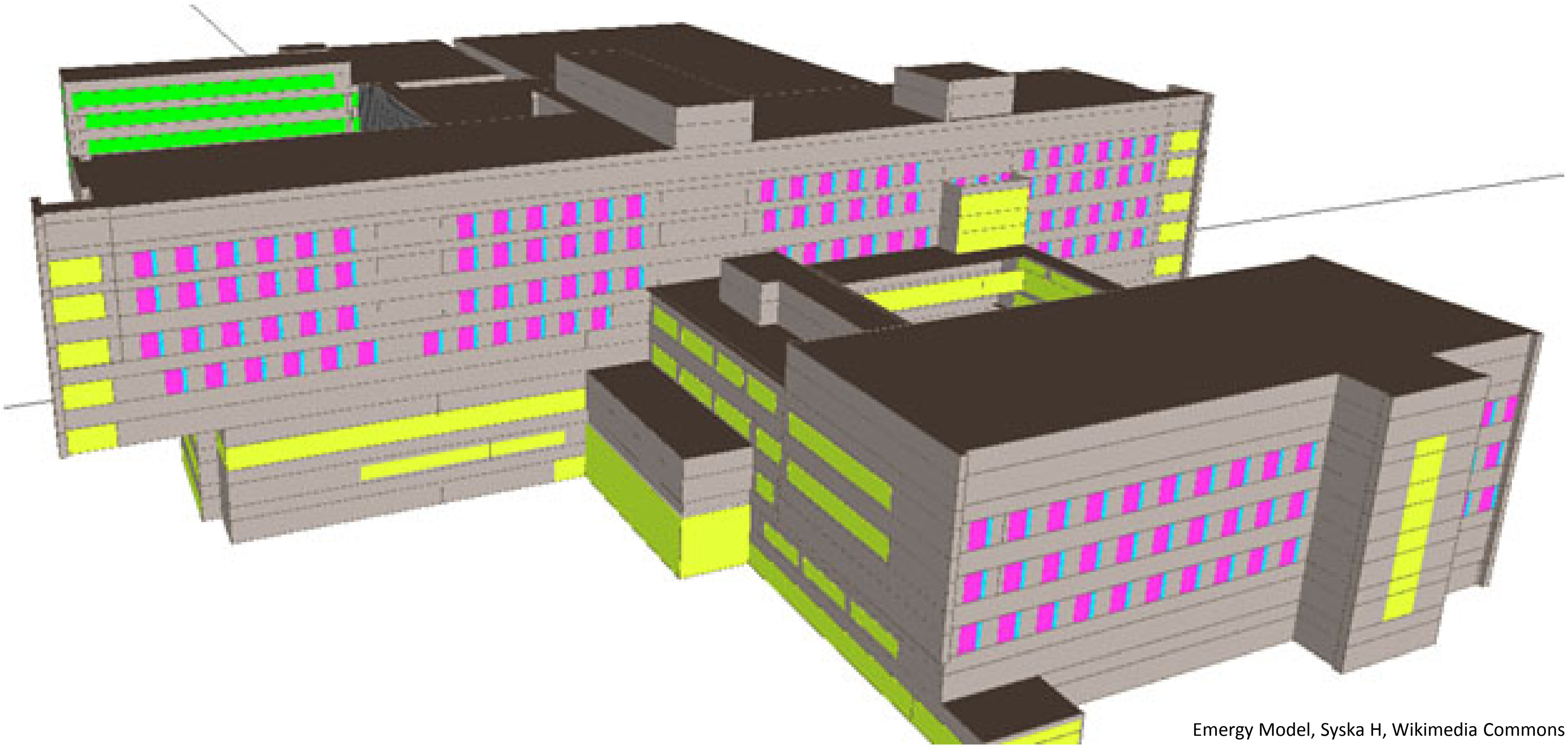
What's Not Working
Training: To be Energy Modelers



Emergy Model, Syska H, Wikimedia Commons

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Standard Training Modules

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What’s Not Working

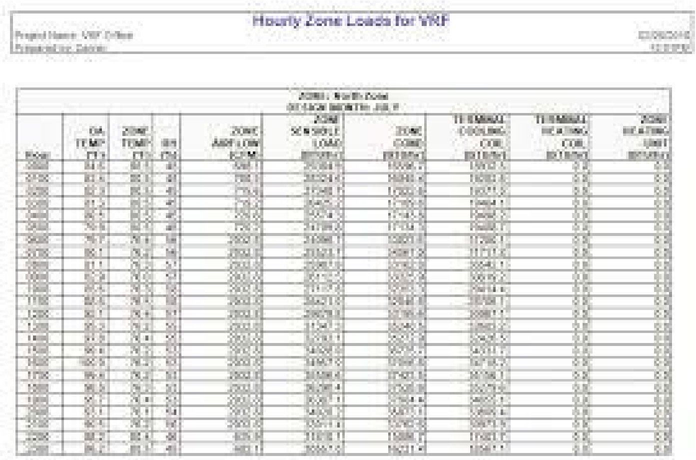
Documentation: Lack of Standard

DOE-2.2-47h2 11/20/2013 18:20:32 BDL RUN 1

REPORT- SS-D Building HVAC Load Summary

MONTH	- - COOLING - - COOLING ENERGY (MBTU)	TIME OF MAX DY	TIME OF MAX HR	DRY-BULB TEMP	WET-BULB TEMP	MAXIMUM COOLING LOAD (KBTU/HR)	- - HEATING - - HEATING ENERGY (MBTU)	TIME OF MAX DY	TIME OF MAX HR	DRY-BULB TEMP	WET-BULB TEMP	MAXIMUM HEATING LOAD (KBTU/HR)	- - ELEC - - ELEC-TRICAL ENERGY (KWH)	MAXIMUM ELEC LOAD (KW)
JAN	0.00129	29	17	43.F	37.F	0.560	-25.925	23	8	4.F	2.F	-175.009	3762.	11.650
FEB	0.00000	28	24	29.F	25.F	0.000	-18.876	5	8	19.F	17.F	-168.875	3405.	11.650
MAR	0.11304	28	15	69.F	53.F	26.591	-14.971	12	8	34.F	33.F	-131.950	3795.	12.840
APR	0.32660	30	15	74.F	55.F	35.054	-6.839	3	8	35.F	28.F	-87.415	3585.	13.365
MAY	5.30432	11	15	84.F	65.F	73.934	-1.009	7	8	42.F	34.F	-47.670	3918.	16.770
JUN	16.26566	18	11	76.F	70.F	106.160	-0.007	1	8	55.F	49.F	-3.004	4561.	19.057
JUL	24.82984	23	11	84.F	72.F	119.349	0.000	31	1	71.F	67.F	0.000	5257.	20.369
AUG	23.71019	27	15	83.F	75.F	121.300	0.000	31	1	70.F	65.F	0.000	5228.	19.694
SEP	14.76745	4	10	78.F	69.F	118.795	-0.090	26	8	60.F	56.F	-4.802	4328.	19.604
OCT	2.56139	9	15	76.F	61.F	63.537	-2.113	31	8	40.F	33.F	-55.397	3746.	15.365
NOV	0.12968	5	11	46.F	43.F	7.356	-9.118	23	8	39.F	35.F	-106.157	3550.	12.268
DEC	0.00738	11	17	45.F	40.F	3.408	-17.617	26	8	28.F	24.F	-157.968	3700.	11.726
TOTAL	88.017						-96.565						48835.	
MAX						121.300						-175.009		20.369

MAXIMUM DAILY INTEGRATED COOLING LOAD (DES DAY) 0.000 (KBTU)
MAXIMUM DAILY INTEGRATED COOLING LOAD (WTH FILE) 0.000 (KBTU)



COOLING COIL PEAK — Peaked at Time: Mo/Hr: 7 / 23; Outside Air: OADB/WB/HR: 83 / 65 / 69
CLG SPACE PEAK — Mo/Hr: 7 / 23; OADB: 83

	Space Sens. + Lat. Btu/h	Plenum Sens. + Lat Btu/h	Net Total Btu/h	Percent Of Total (%)	Space Sensible Btu/h	Percent Of Total (%)
Envelope Loads						
Skylite Solar	0	0	0	0	0	0
Skylite Cond	0	0	0	0	0	0
Roof Cond	0	0	0	0	0	0
Glass Solar	0	0	0	0	0	0
Glass/Door Cond	0	0	0	0	0	0
Wall Cond	3,540	0	3,540	36	3,540	36
Partition/Door	0		0	0	0	0
Floor	0		0	0	0	0
Adjacent Floor	0	0	0	0	0	0
Infiltration	0		0	0	0	0
Sub Total ==>	3,540	0	3,540	36	3,540	36
Internal Loads						
Lights	928	232	1,160	12	928	10
People	0	0	0	0	0	0
Misc	0	0	0	0	0	0
Sub Total ==>	928	232	1,160	12	928	10
Ceiling Load	0	0	0	0	0	0
Ventilation Load	0	0	0	0	0	0
Adj Air Trans Heat	0		0	0	0	0
Dehumid. Ov Sizing			0	0		
Ov/Undr Sizing	5,241		5,241	53	5,241	54
Exhaust Heat		0	0	0		
Sup. Fan Heat			0	0		
Ret. Fan Heat		0	0	0		
Duct Heat Pkup		0	0	0		
Underflr Sup Ht Pkup			0	0		
Supply Air Leakage		0	0	0		
Grand Total ==>	9,709	232	9,941	100.00	9,709	100.00

HEATING COIL PEAK — Mo/Hr: Heating Design; OADB: 0

	Space Peak Space Sens Btu/h	Coil Peak Tot Sens Btu/h	Percent Of Total (%)
Envelope Loads			
Skylite Solar	0	0	0.00
Skylite Cond	0	0	0.00
Roof Cond	0	0	0.00
Glass Solar	0	0	0.00
Glass/Door Cond	0	0	0.00
Wall Cond	-8,302	-8,302	85.51
Partition/Door	0	0	0.00
Floor	-1,407	-1,407	14.49
Adjacent Floor	0	0	0.00
Infiltration	0	0	0.00
Sub Total ==>	-9,709	-9,709	100.00
Internal Loads			
Lights	0	0	0.00
People	0	0	0.00
Misc	0	0	0.00
Sub Total ==>	0	0	0.00
Ceiling Load	0	0	0.00
Ventilation Load	0	0	0.00
Adj Air Trans Heat	0	0	0
Ov/Undr Sizing	0	0	0.00
Exhaust Heat		0	0.00
OA Preheat Diff.		0	0.00
RA Preheat Diff.		0	0.00
Additional Reheat		0	0.00
System Plenum Heat		0	0.00
Underflr Sup Ht Pkup		0	0.00
Supply Air Leakage		0	0.00
Grand Total ==>	-9,709	-9,709	100.00

TEMPERATURES

	Cooling	Heating
SADB	55.0	90.0
Ra Plenum	75.0	70.0
Return	75.5	70.0
Ret/OA	75.5	70.0
Fn MtrTD	0.0	0.0
Fn BldTD	0.0	0.0
Fn Frict	0.0	0.0

AIRFLOWS

	Cooling	Heating
Diffuser	458	458
Terminal	458	458
Main Fan	458	458
Sec Fan	0	0
Nom Vent	0	0
AHU Vent	0	0
Infil	0	0
Min Stop/Rh	0	0
Return	458	458
Exhaust	0	0
Rm Exh	0	0
Auxiliary	0	0
Leakage Dwn	0	0
Leakage Ups	0	0

ENGINEERING CKS

	Cooling	Heating
% OA	0.0	0.0
cfm/ft²	1.48	1.48
cfm/ton	552.93	
ft²/ton	374.21	
Btu/hr·ft²	32.07	-31.32
No. People	0	

COOLING COIL SELECTION

	Total Capacity ton	Total Capacity MBh	Sens Cap. MBh	Coil Airflow cfm	Enter DB °F	Enter WB °F	Enter HR gr/lb	Leave DB °F	Leave WB °F	Leave HR gr/lb
Main Clg	0.8	9.9	9.9	458	75.5	62.5	68.5	55.0	55.0	67.9
Aux Clg	0.0	0.0	0.0	0	0.0	0.0	0.0	0.0	0.0	0.0
Opt Vent	0.0	0.0	0.0	0	0.0	0.0	0.0	0.0	0.0	0.0
Total	0.8	9.9								

AREAS

	Gross Total	Glass ft²	Glass (%)
Floor	310		
Part	0		
Int Door	0		
ExFlr	40		
Roof	0	0	0
Wall	450	0	0
Ext Door	0	0	0

HEATING COIL SELECTION

	Capacity MBh	Coil Airflow cfm	Ent °F	Lvg °F
Main Htg	-9.7	458	70.0	90.0
Aux Htg	0.0	0	0.0	0.0
Preheat	0.0	0	0.0	0.0
Humidif	0.0	0	0.0	0.0
Opt Vent	0.0	0	0.0	0.0
Total	-9.7			

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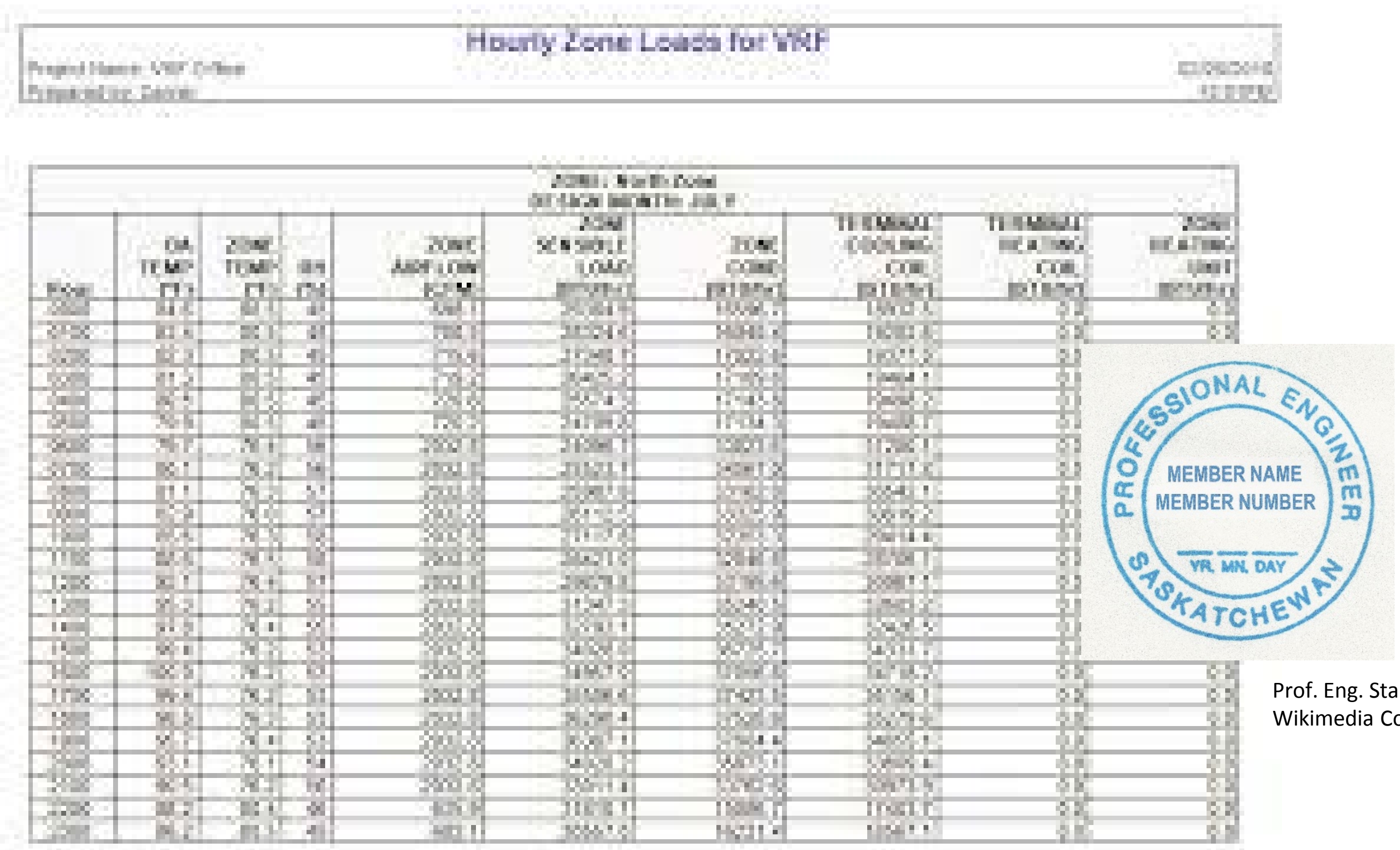
What's Not Working
Documentation: Engineering Stamp



Prof. Eng. Stamp, XA7761B, Wikimedia Commons

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Standard Submission Format

COMcheck Software Version 3.9.1

Envelope Compliance Certificate

2009 IECC

Section 1: Project Information

Project Type: **New Construction**
Project Title : Marvins Gardens

Construction Site:	Owner/Agent:	Designer/Contractor:
123 Main Bozeman, MT 59715		

Section 2: General Information

Building Location (for weather data):	**Bozeman, Montana**
Climate Zone:	**6b**
Building Type for Envelope Requirements:	**Non-Residential**
Vertical Glazing / Wall Area Pct.:	**8%**
Skylight Glazing / Roof Area Pct.:	**2%**

Activity Type(s)	Floor Area
Office	1000
Retail	5000
Workshop	2700

Section 3: Requirements Checklist

Envelope PASSES: Design 5% better than code.

Climate-Specific Requirements:

Component Name/Description	Gross Area or Perimeter	Cavity R-Value	Cont. R-Value	Proposed U-Factor	Budget U-Factor(a)
Roof 1: Non-Wood Joist/Rafter/Truss	6112	40.0	0.0	0.033	0.027
Skylight 1: Metal Frame, Double Pane, Tinted, SHGC 0.80	112	---	---	0.500	0.600
Exterior Wall 1: Solid Concrete:8" Thickness,Medium Density , Furring: Metal	6000	11.0	10.0	0.063	0.080
Door 1: Glass (> 50% glazing):Metal Frame, Entrance Door, SHGC 0.30	42	---	---	0.500	0.800
Window 1: Metal Frame, Double Pane with Low-E, Tinted, SHGC 0.63	1500	---	---	0.600	0.550
Window 2: Metal Frame, Double Pane, Clear, SHGC 0.72	56	---	---	0.700	0.550
Door 2: Insulated Metal, Non-Swinging	288	---	---	0.140	0.500
Door 3: Insulated Metal, Swinging	40	---	---	0.200	0.700
Exterior Wall 2: Solid Concrete:8" Thickness,Medium Density , Furring: Metal	6000	11.0	10.0	0.063	0.080
Exterior Wall 3: Solid Concrete:8" Thickness,Medium Density , Furring: Metal	6000	11.0	10.0	0.063	0.080
Exterior Wall 4: Steel-Framed, 24" o.c.	1000	19.0	0.0	0.094	0.064
Floor 1: Slab-On-Grade:Unheated, Vertical 2 ft.	180	---	10.0	---	---

(a) Budget U-factors are used for software baseline calculations ONLY, and are not code requirements.

Air Leakage, Component Certification, and Vapor Retarder Requirements:

☐ 1. All joints and penetrations are caulked, gasketed or covered with a moisture vapor-permeable wrapping material installed in accordance with the manufacturer's installation instructions.

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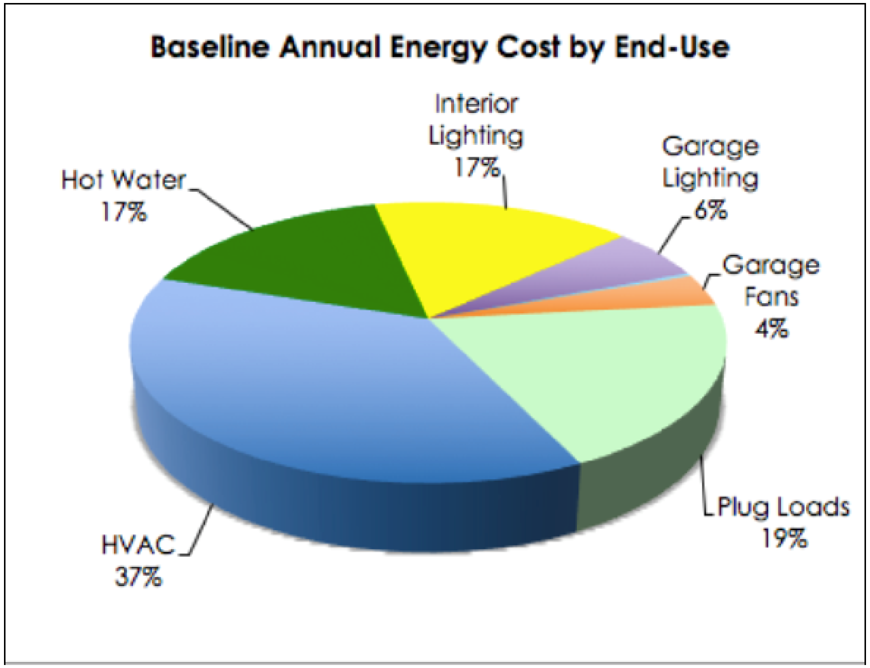
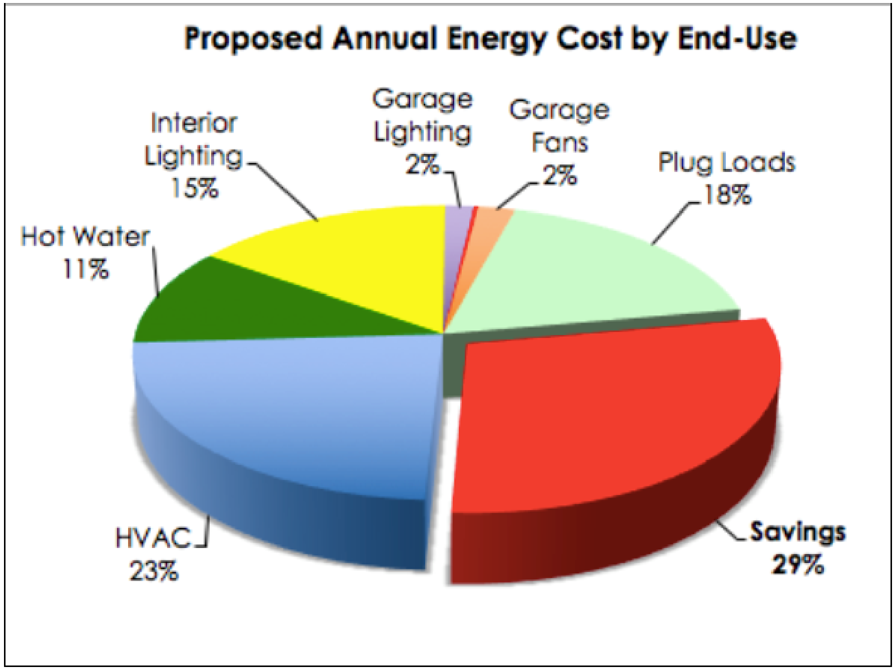
Automatic Baseline Generation





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Thank You

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