Minding The Gap

From Sustainable Policy to Practice

The Weidt Group®

The Company for Energy Decision Makers℠

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Minding The Gap

From Sustainable Policy to Practice

- Energy codes, modeling and benchmarking are powerful tools to improve efficiency
- But there are gaps
  - Codes promoting more energy consumption
  - Benchmarking that misleads by not accounting for building use
  - Modeling done for points instead of decision making

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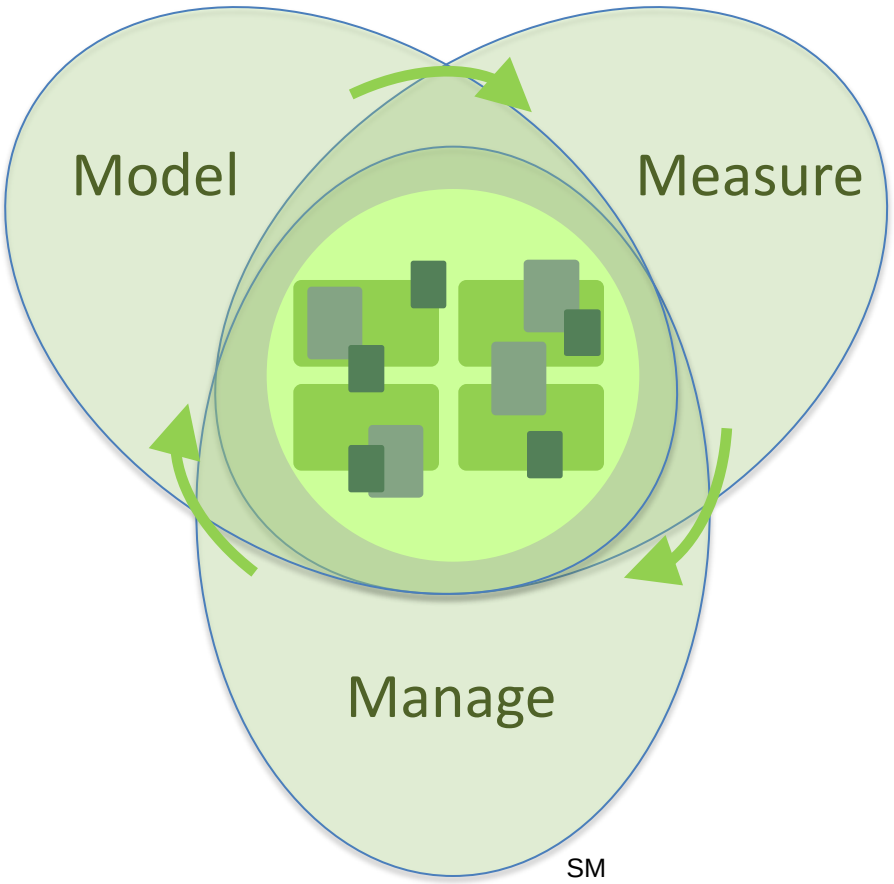
Minding The Gap

Agenda

- Introduction
- Design Energy Modeling
- Codes
- Operational Energy Modeling
- Conclusions



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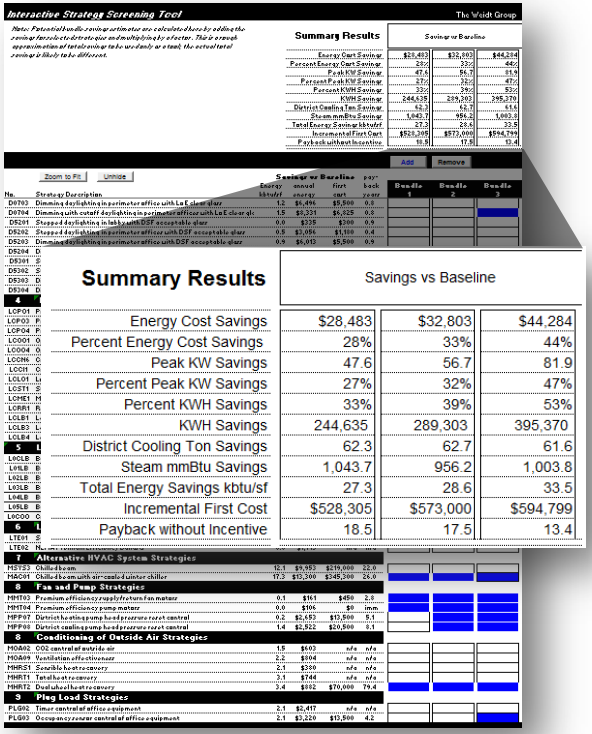
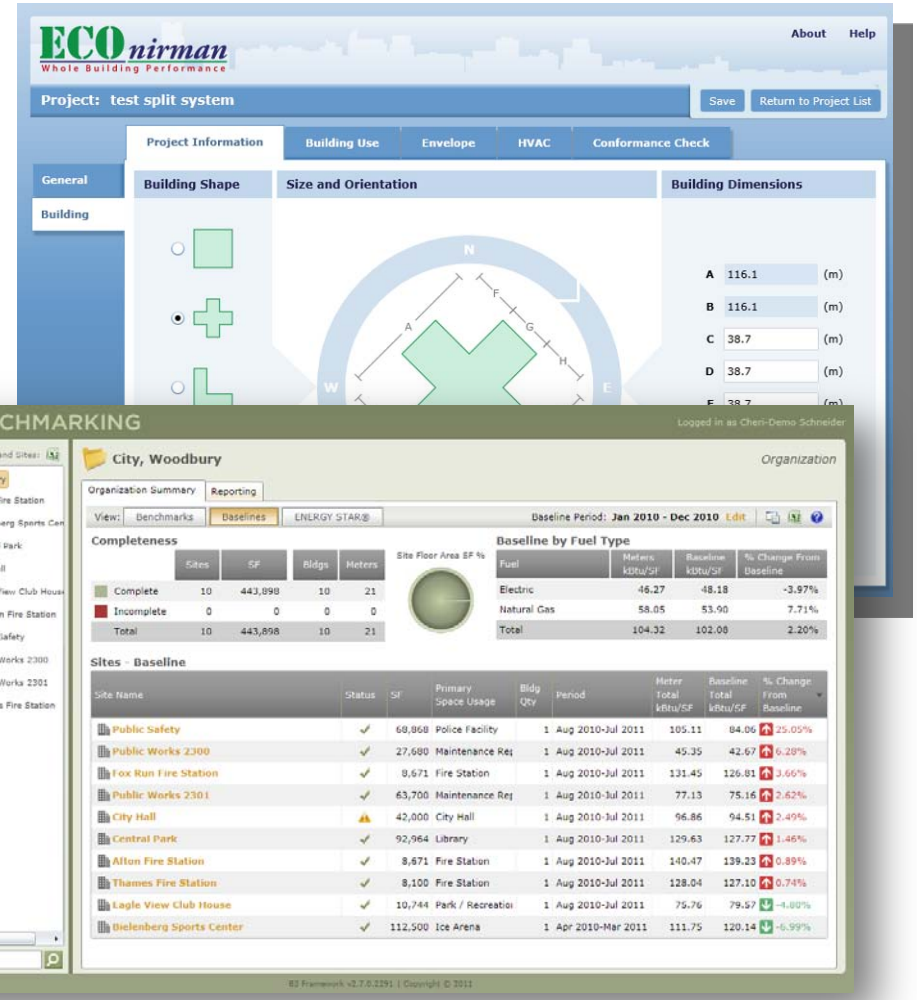
Introduction

What The Weidt Group Does

- Tools and consulting for energy decision makers
  - New Construction
  - Existing Buildings
  - Software Tools





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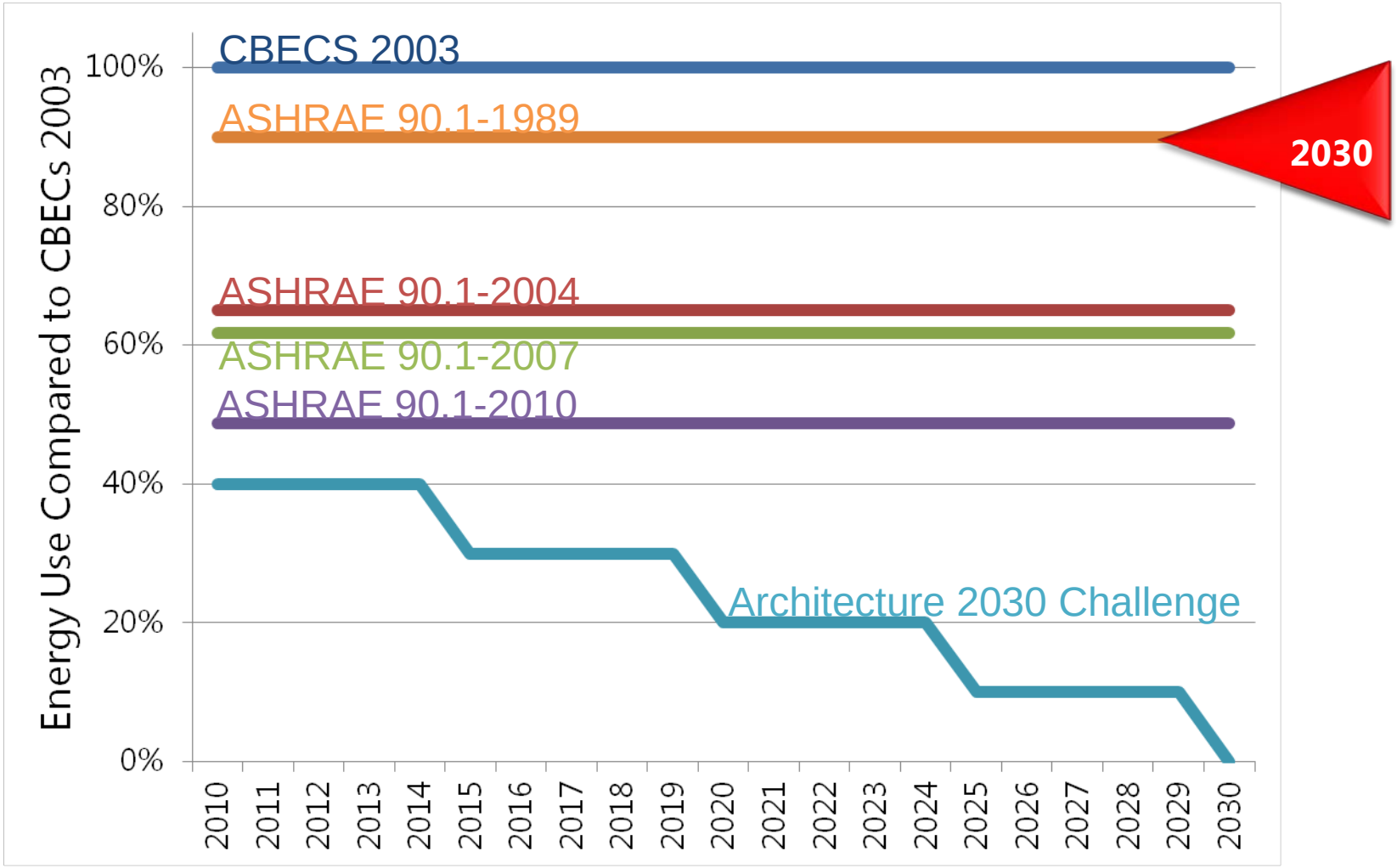
Introduction

Codes are Getting More Stringent



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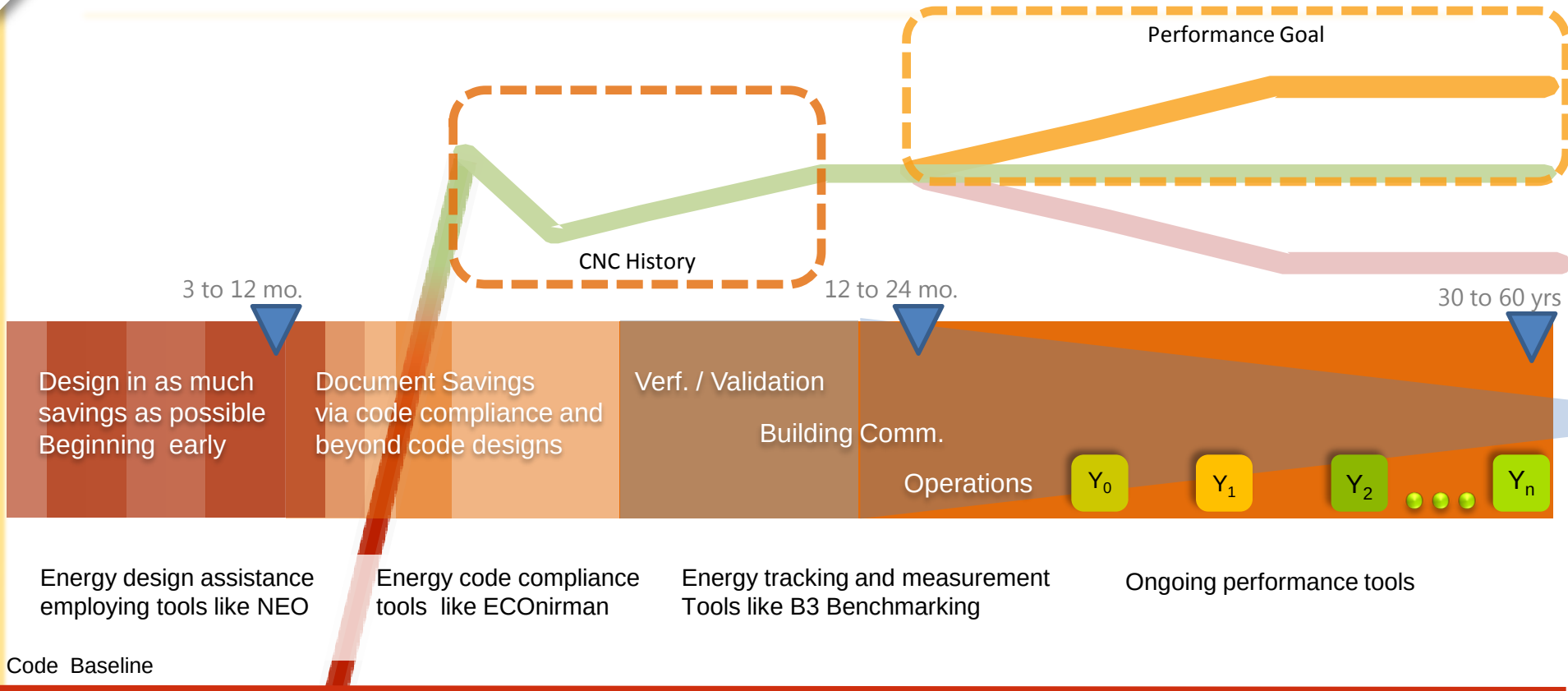
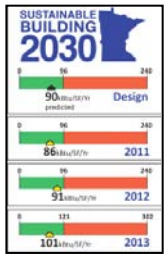
The Big Picture



NEO net energy optimizer



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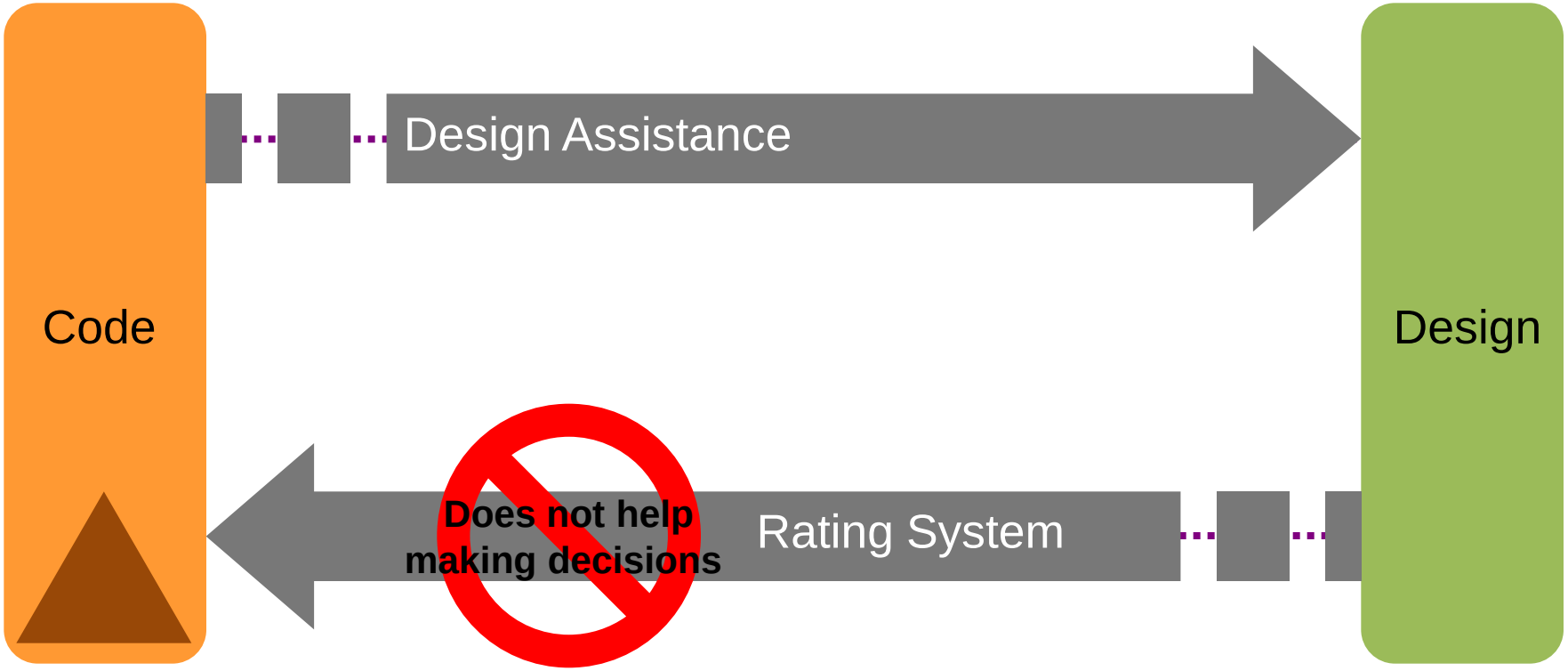
Design Energy Modeling

Compliance verse Assistance



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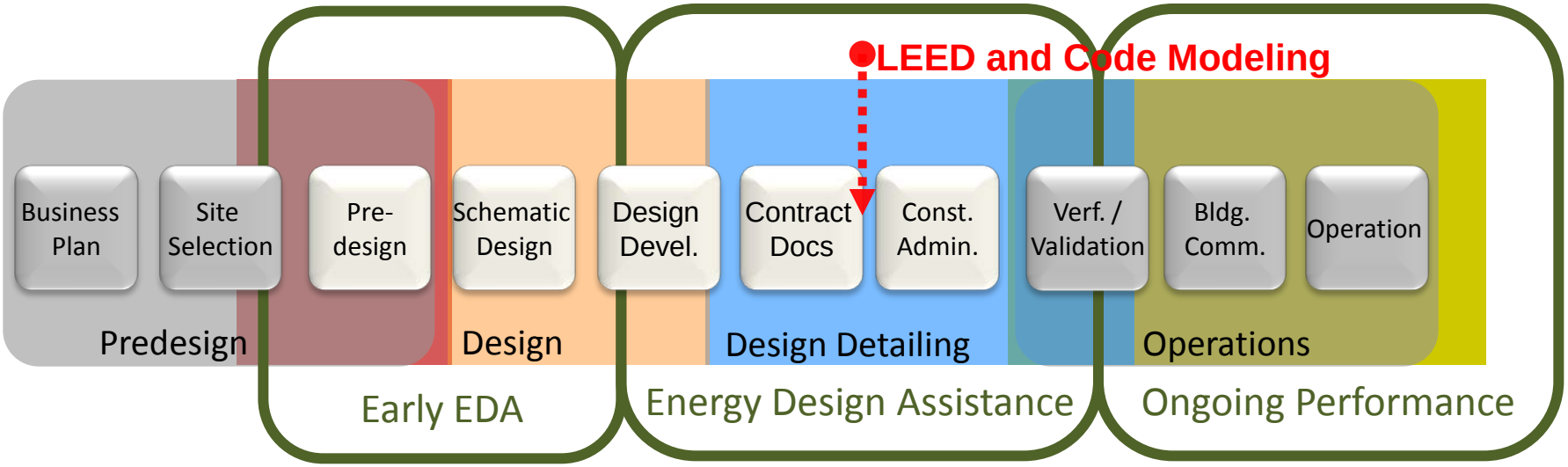
Design Energy Modeling

Code Modeling verse



- Most modeling happens for LEED points or Code Compliance
- Modeling for comparative analysis is more valuable
- Design development modeling has the deepest impact
- Earlier analysis has longer term impact
- Ongoing performance analysis optimizes operations

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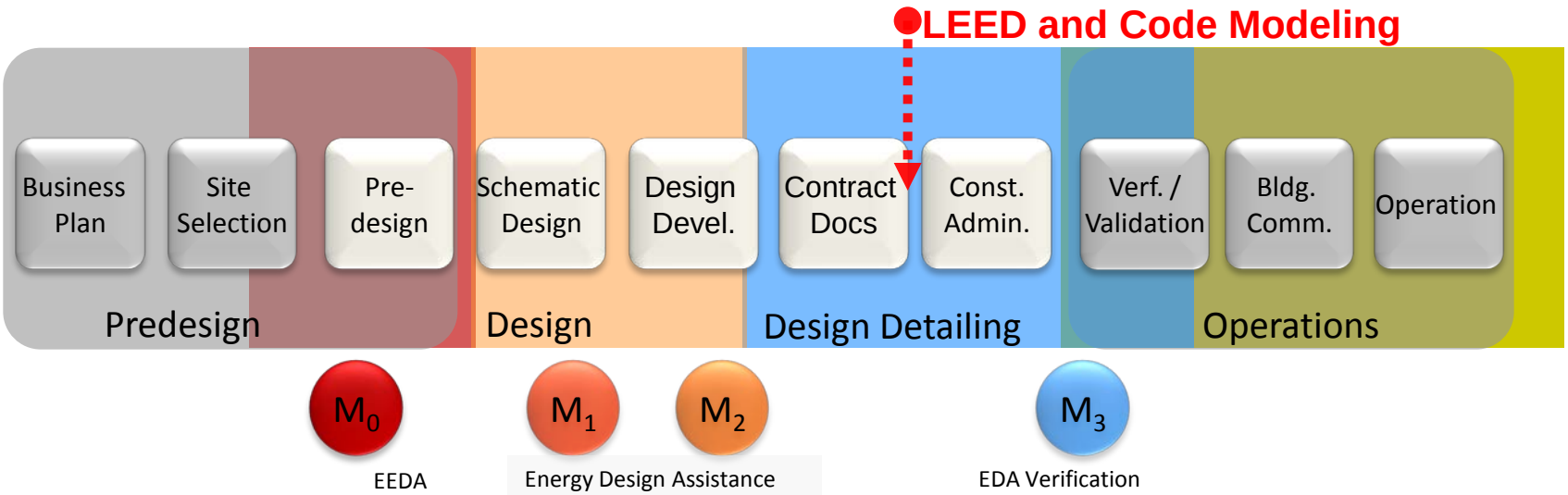
Design Energy Modeling

Iterative Modeling for Decision Making



- Modeling starts early
- Models have different attributes depending on their purposes

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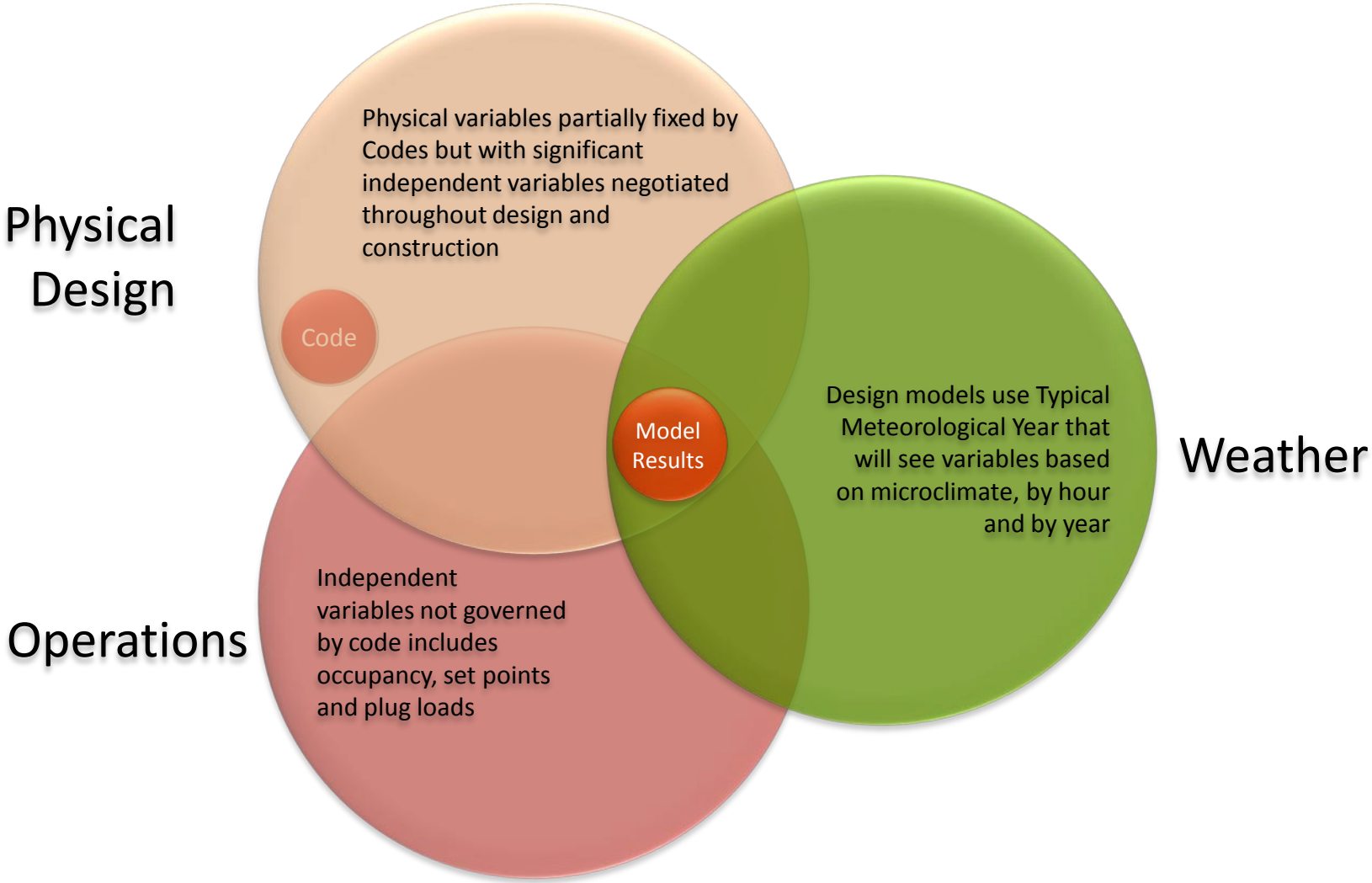
Design Energy Modeling

Modeling Variables



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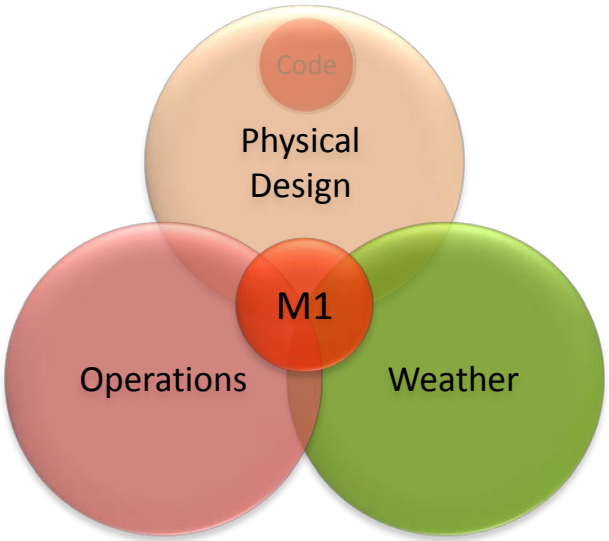
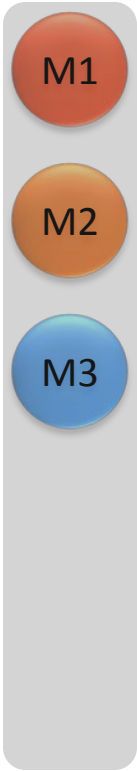
Design Energy Modeling

M1 – Code Base / Baseline Model

- The M1 model is established using the *Protocol* approved for interpretation of the *Code* and uses the standard weather file for the location.
- The model is operated according to criteria in the *Code* and according to discretionary parameters not governed by the *Code.*
- This is the starting point for the initial utility savings calculation.





M1 = Pre-Construction Baseline for Energy Efficiency

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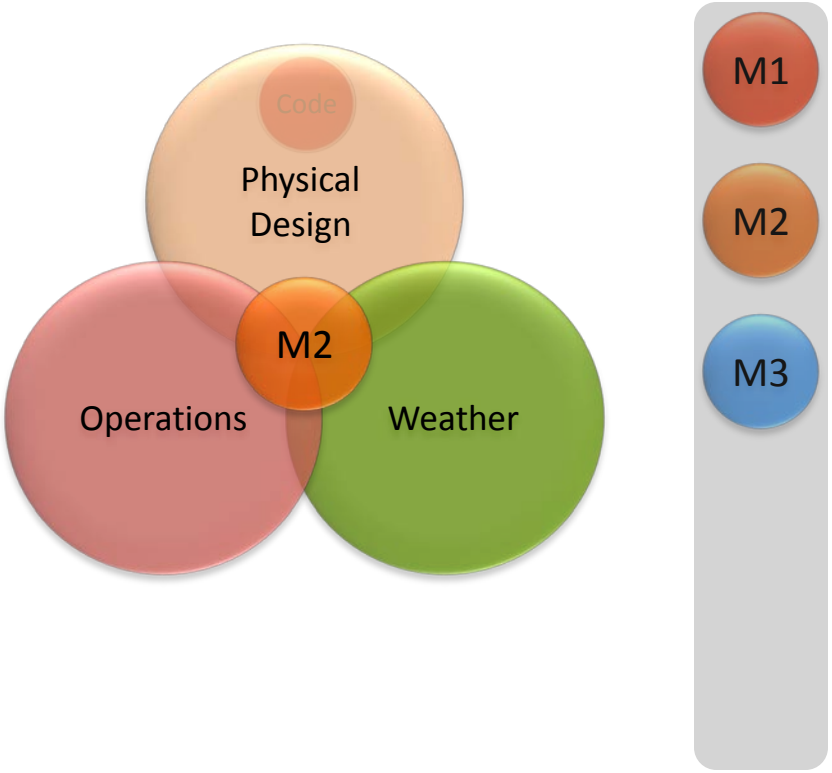
Design Energy Modeling

M2 - Selected Bundle Model

- The M2 model contains the set of strategies selected by the design team and owner that are operated the same as M1 and uses the standard weather file for the location.
- M1 and M2 have the same operating and code parameters.
- M1 – M2 is the first basis for the estimate of savings to be claimed by the utility.



M1 - M2 = 1st Estimated Energy Efficiency

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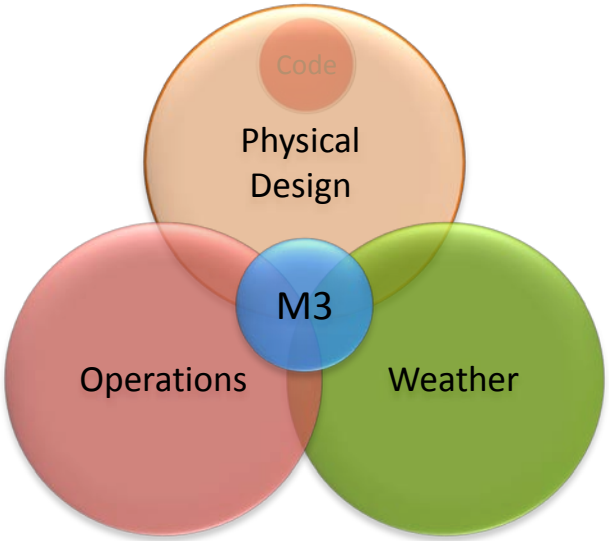
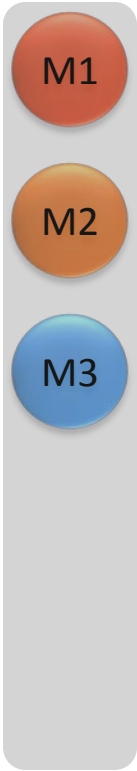
Design Energy Modeling

M3 - As Verified Bundle Model

- M3 may be the same as M2 if 100% of selected strategies are implemented and verified.
- This model adjusts for physical design changes and uses the standard weather file for the location.
- M3 equals or replaces M2 and becomes the adjusted energy efficiency potential and estimate of savings to be claimed by the utility and the basis for incentive payment.





End of Predictive Models

Basis for Incentive Payment

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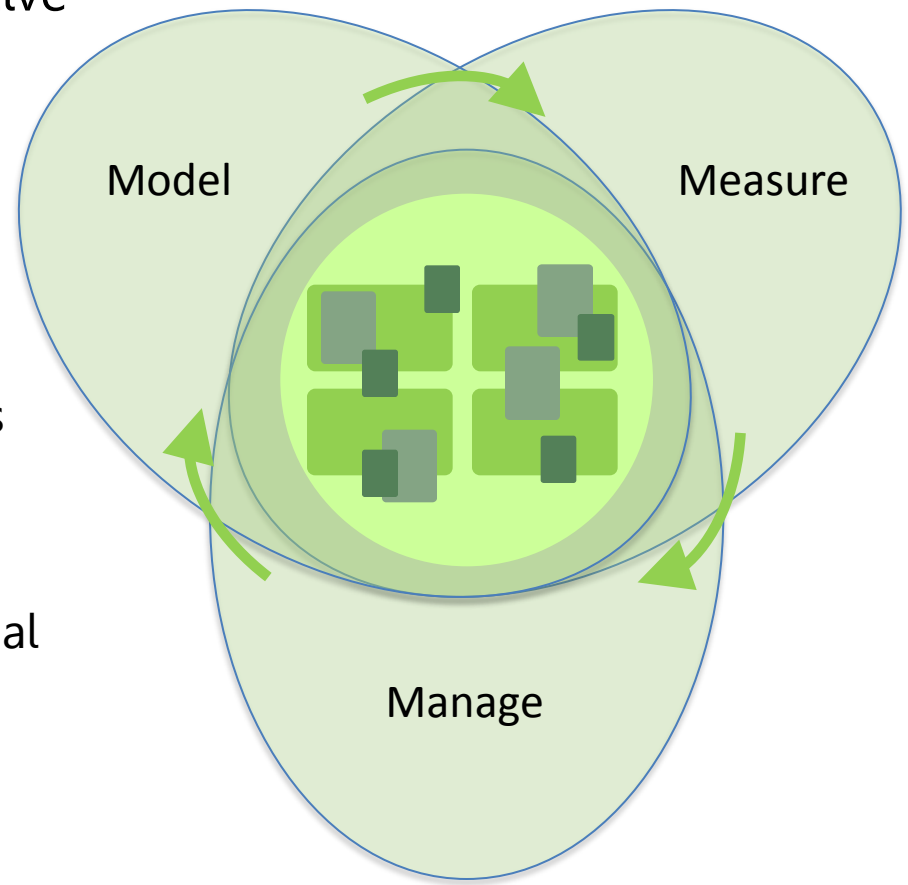
Design Energy Modeling

Energy Efficiency Is Ongoing

- Energy efficiency is an iterative process through the design and life of a building
- Model—Measure—Manage applies to both new and existing buildings
  - Model alternative scenarios
  - Measure performance compared to a baseline
  - Manage by selecting optimal scenario given your criteria



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Design Energy Modeling

Early Decisions have the Longest Lifespan

	Lifetime
Location	
Wall systems	70 years
Glazing system	45 years
HVAC systems	20 years
Space asset type	15 years
Lighting design	15 years
Lighting controls	10 years
Space use	3 years
Office equipment	
Control sequences	
Setpoints	
Schedules	
Occupant behavior	

Predesign 15%

Design Development 30%

Operational tuning ~10%

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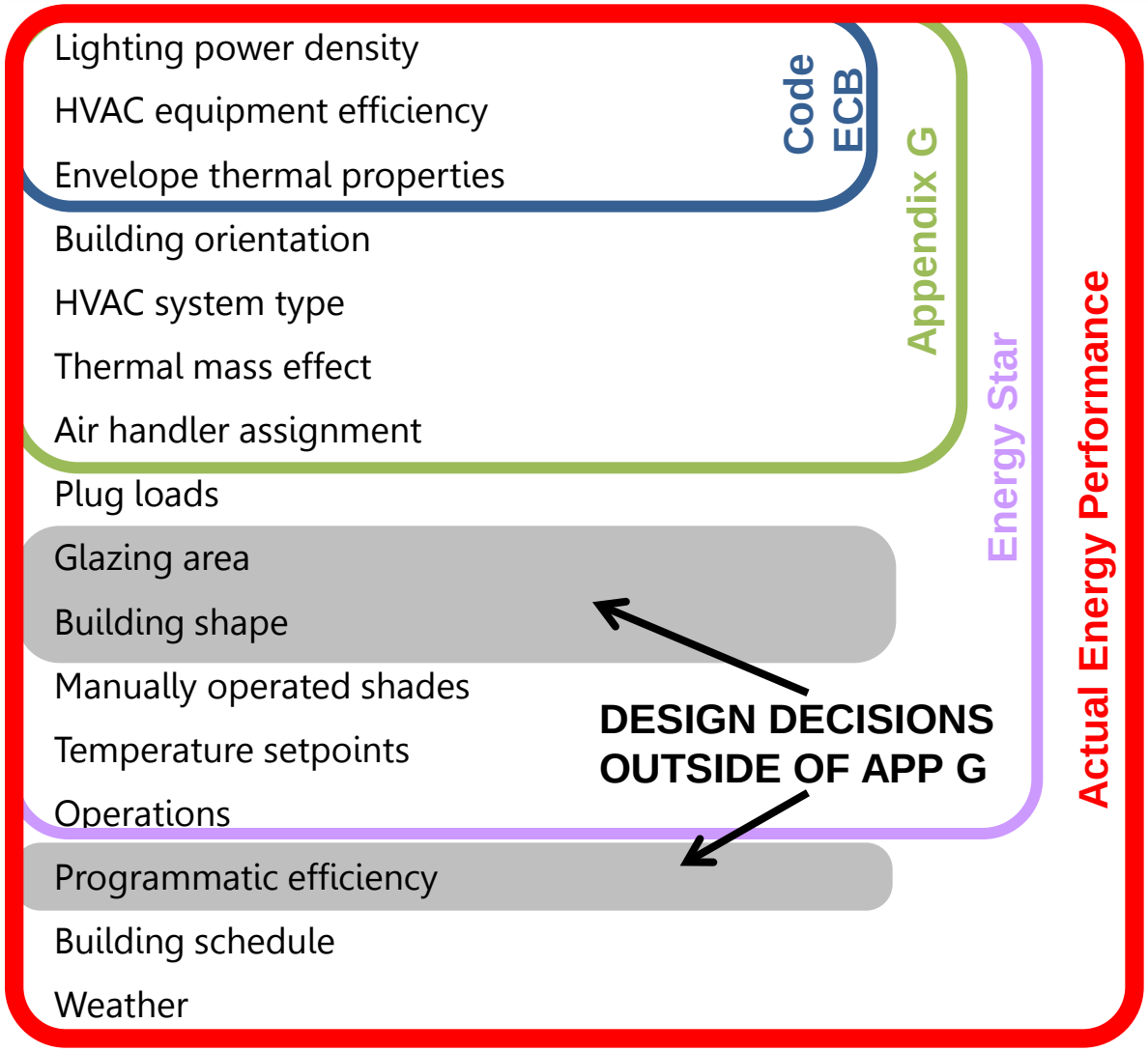
Energy Codes

Encompass Only Some Energy Factors



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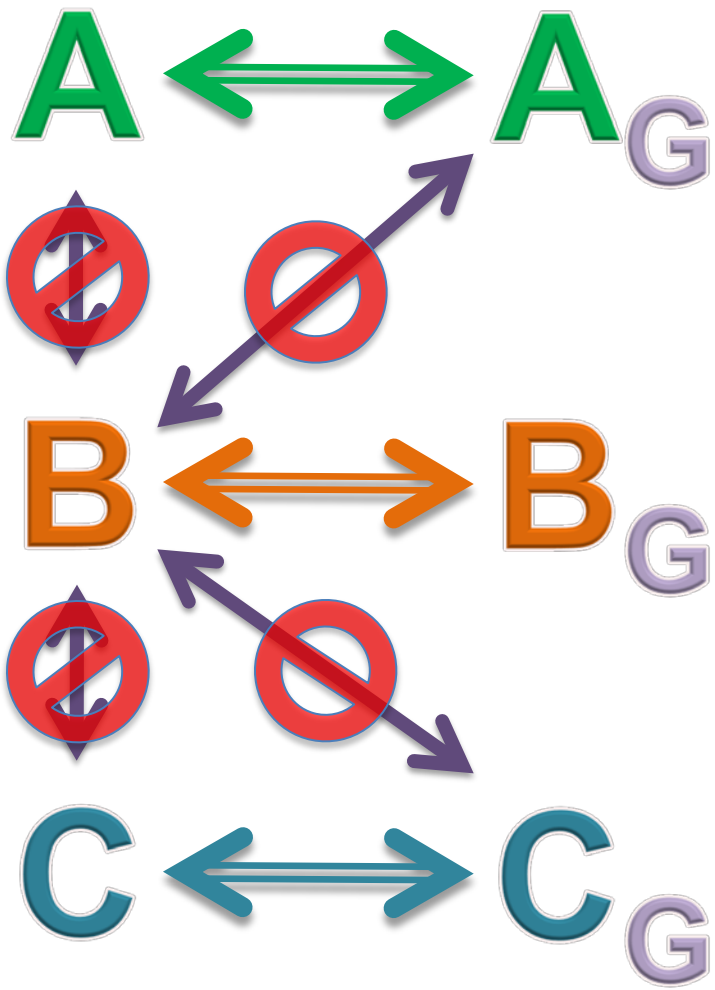
Baseline is Derived from Design

The Design Side



App. G Baseline

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Impact of Deriving Baseline from Design

- Sounds pretty theoretical, does it actually matter on real projects?

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Programmatic Efficiency

- Appendix G compares a design to a building with the same shape
  - No credit for having less wasted space
  - No credit for changing the number of floors
  - No credit for picking a compact shape with less envelope

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Programmatic Efficiency Methodology

- Four real projects in the Midwest
- An Appendix G baseline version of each of those schemes was modeled
- Total energy cost is compared to Appendix G energy savings to give credit for more efficient use of space

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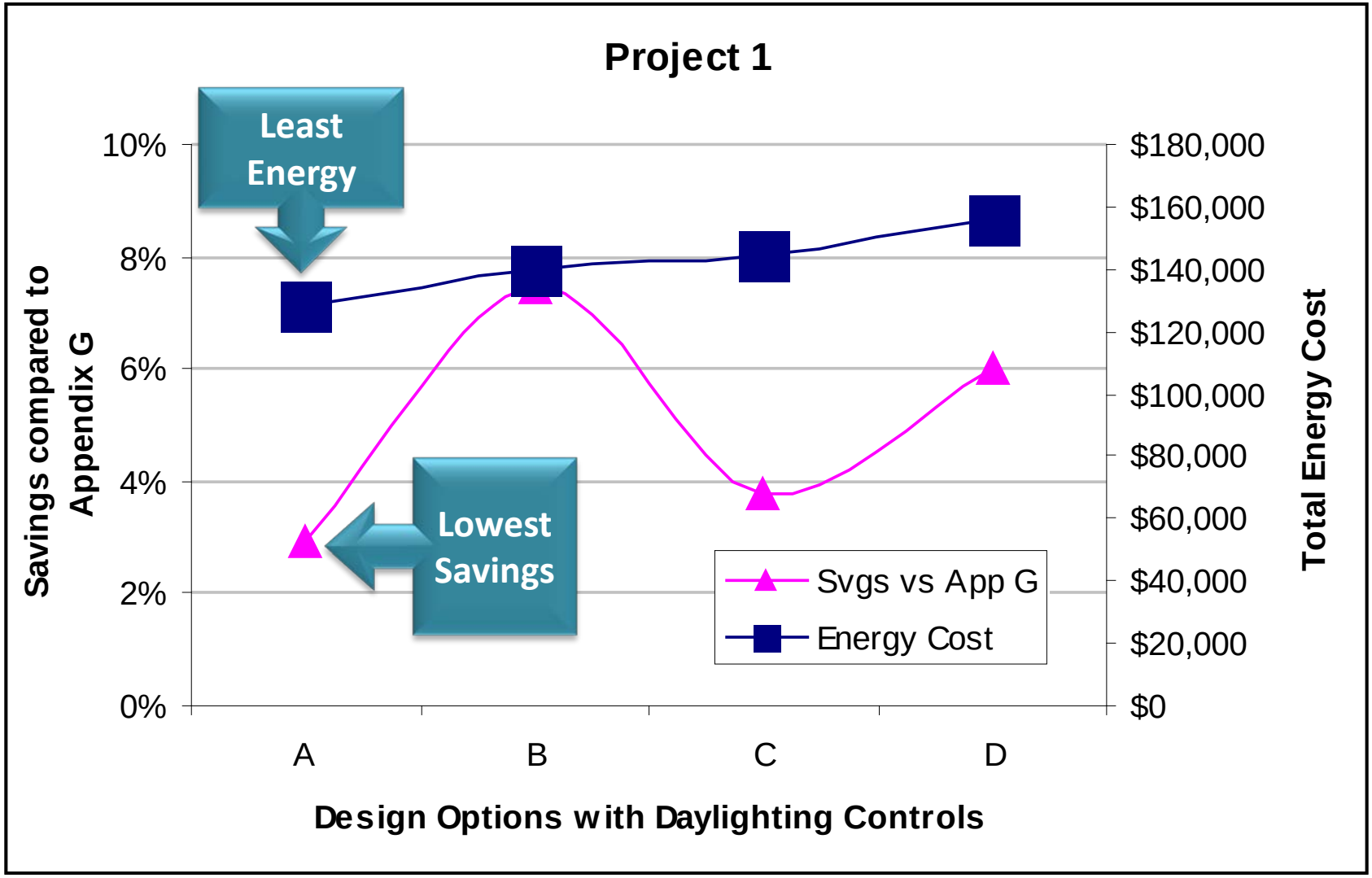
Programmatic Efficiency

Library and Office in Southern Iowa



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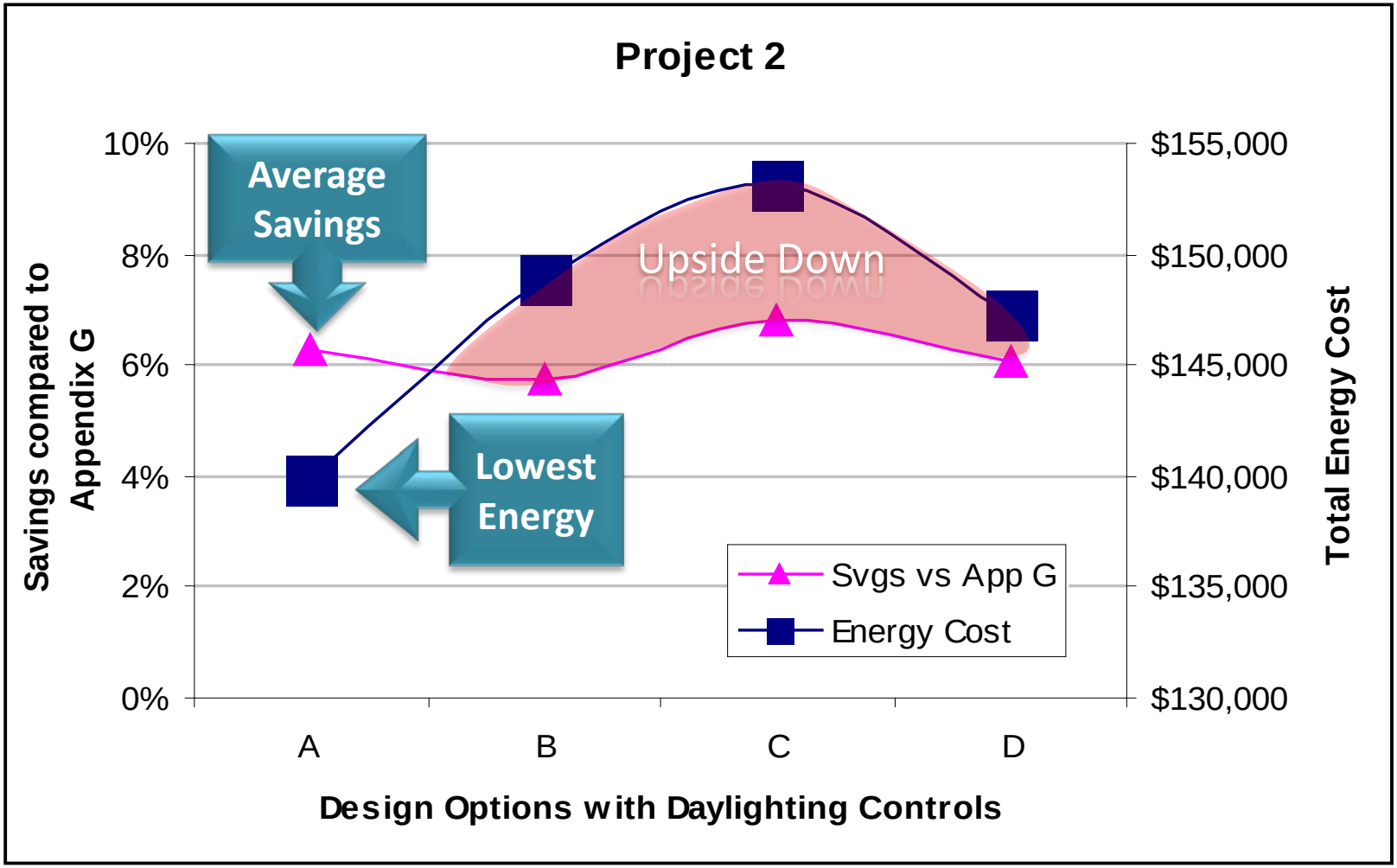
Programmatic Efficiency

Bank in Southern Iowa



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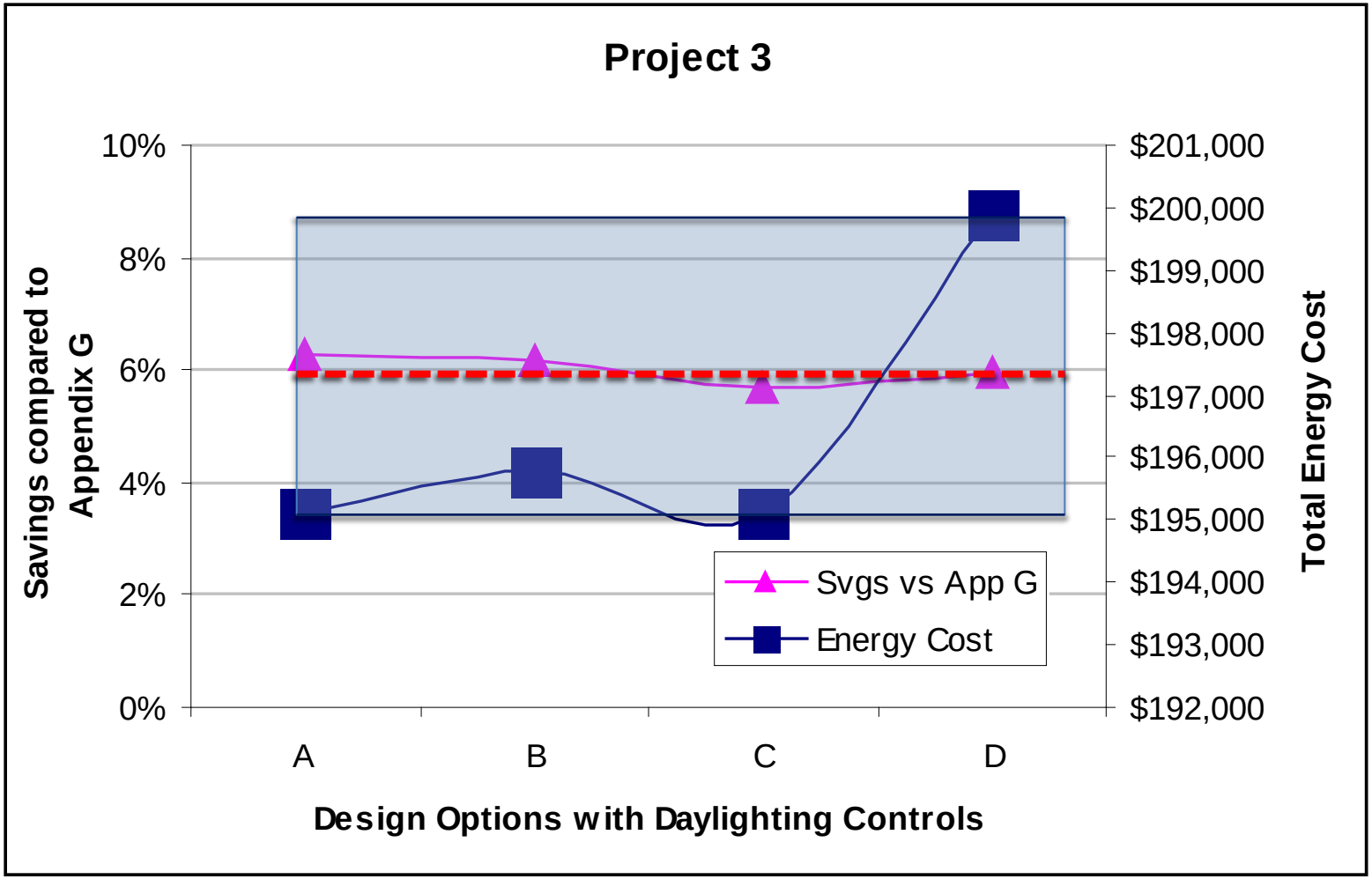
Programmatic Efficiency

Iowa High School



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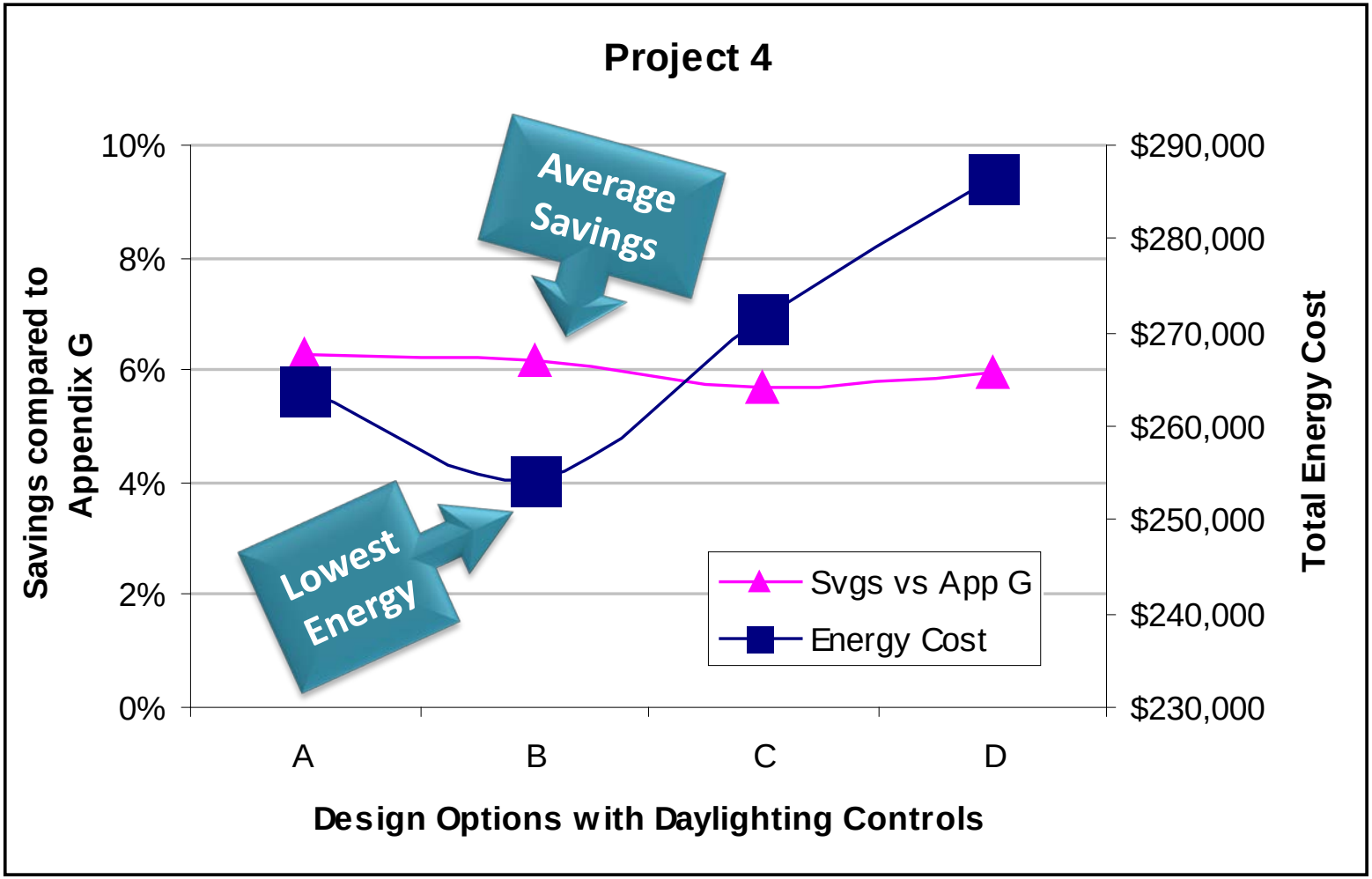
Programmatic Efficiency

Wisconsin Laboratory



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Energy Code

Building Massing Methodology

- Six real Midwestern Projects
- An Appendix G baseline version of each of those schemes was modeled
- Energy savings for each scheme with automatic daylighting controls were calculated against three separate baselines
- Costs are per square foot to isolate massing from programmatic efficiency

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Building Shape

Appendix G Savings Compared to Lowest Energy Cost

Project 1	Massing			
	A	B	C	D
App G	**$1.01**	**$1.17**	**$1.16**	**$1.22**
Scheme	**$1.01**	**$1.17**	**$1.16**	**$1.20**
Scheme w/ daylight	**$0.98**	**$1**	**$1.11**	**$1.15**
Savings with daylight				
vs least efficient scheme	**18%**	**10%**		**4%**
vs ave. scheme	**14%**	**5%**	**%**	**-1%**
vs App G	**2%**	**7%**	**4%**	**6%**

Lowest Energy

App G Savings

Project 2	Massing			
	A	B	C	D
App G	**$1.77**	**$1.72**	**$1.68**	**$1.7**
Scheme	**$1.81**	**$1.72**	**$1.63**	
Scheme w/ daylight	**$1.81**	**$1**	**$1.63**	
Savings with daylight				
vs least efficient scheme	**0.0%**		**10.0%**	**13.5%**
vs ave. scheme	**-7.6%**	**-2**	**3.1%**	**7.0%**
vs App G	**-1.8%**	**0.2%**	**3.1%**	**0.2%**

Lowest Energy

App G Savings

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Building Shape

Appendix G Savings Compared to Lowest Energy Cost

Project 3	Massing			
	A	B	C	D
App G	**$1.15**	**$1.20**	**$1.18**	**$1.19**
Scheme	**$1.15**	**$1.20**	**$1.17**	**$1.19**
Scheme w/ daylight	**$1.08**	**$1.14**	**$1.10**	**$1.12**
Savings with daylight				
vs least efficient scheme	**10.3%**	**5.6%**	**8.7%**	**6.9%**
vs ave. scheme	**8.5%**	**3.8%**	**7.0%**	**5.1%**
vs App G	**6.3%**	**5.7%**	**6.8%**	**6.1%**

Project 4	Massing			
	A	B	C	D
App G	**$2.27**	**$2.30**	**$2.25**	**$2.32**
Scheme	**$2.27**	**$2.29**	**$2.25**	**$2.32**
Scheme w/ daylight	**$2.13**	**$2.16**	**$2.13**	**$2.18**
Savings with daylight				
vs least efficient scheme	**8.1%**	**6.8%**	**8.3%**	**5.8%**
vs ave. scheme	**6.6%**	**5.4%**	**6.9%**	**4.4%**
vs App G	**6.3%**	**6.2%**	**5.7%**	**5.9%**

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Building Shape

Appendix G Savings Compared to Lowest Energy Cost

Project 5	Massing			
	A	B	C	D
App G	**$1.52**	**$1.55**	**$1.52**	**$1.55**
Scheme	**$1.53**	**$1.54**	**$1.56**	**$1.58**
Scheme w/ daylight	**$1.32**	**$1.37**	**$1.36**	**$1.42**
Savings with daylight				
vs least efficient scheme	**16.2%**	**13.5%**	**14.1%**	**10.3%**
vs ave. scheme	**14.7%**	**11.9%**	**12.5%**	**8.7%**
vs App G	**12.9%**	**11.7%**	**10.7%**	**8.5%**

Project 6	Massing			
	A	B	C	D
App G	**$1.54**	**$1.53**	**$1.84**	**$1.95**
Scheme	**$1.53**	**$1.52**	**$1.83**	**$1.96**
Scheme w/ daylight	**$1.43**	**$1.41**	**$1.76**	**$1.88**
Savings				
vs least efficient scheme	**27.1%**	**28.2%**	**9.8%**	**4.1%**
vs ave. scheme	**16.5%**	**17.8%**	**-3.2%**	**-9.7%**
vs App G	**7.1%**	**8.4%**	**4.4%**	**3.8%**

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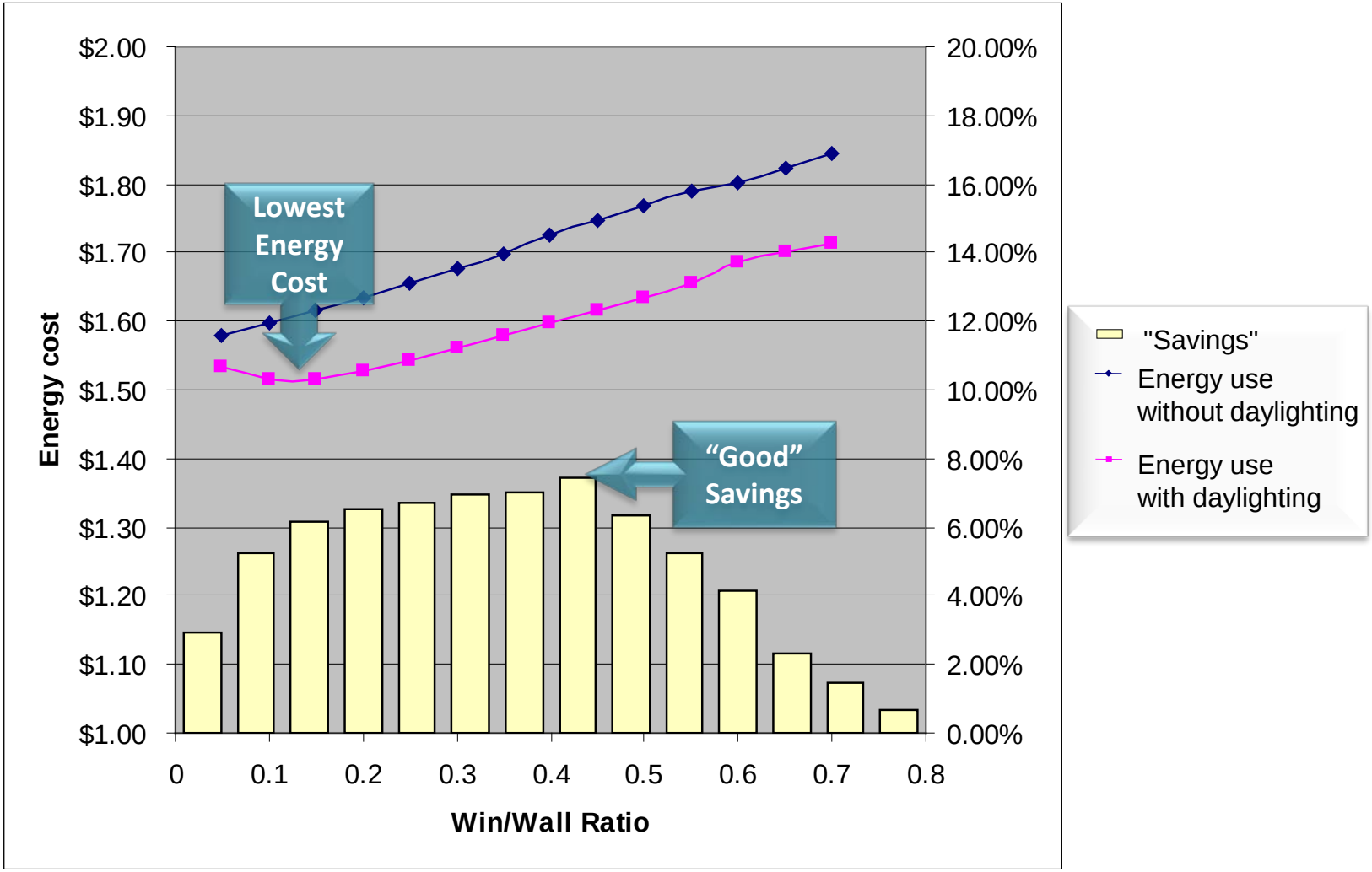
Glazing Ratio Methodology

- The WWR is tested for a range from 0% to 80%
- The outer 20' were provided with automatic dimming daylighting controls
- An office and a classroom building were modeled in Minneapolis, Denver and Phoenix
- Savings are calculated against the Appendix G baselines for two scenarios of each WWR design
  - With daylighting controls at the perimeter
  - No daylighting controls

Energy Codes

Glazing Ratio for Minneapolis Office



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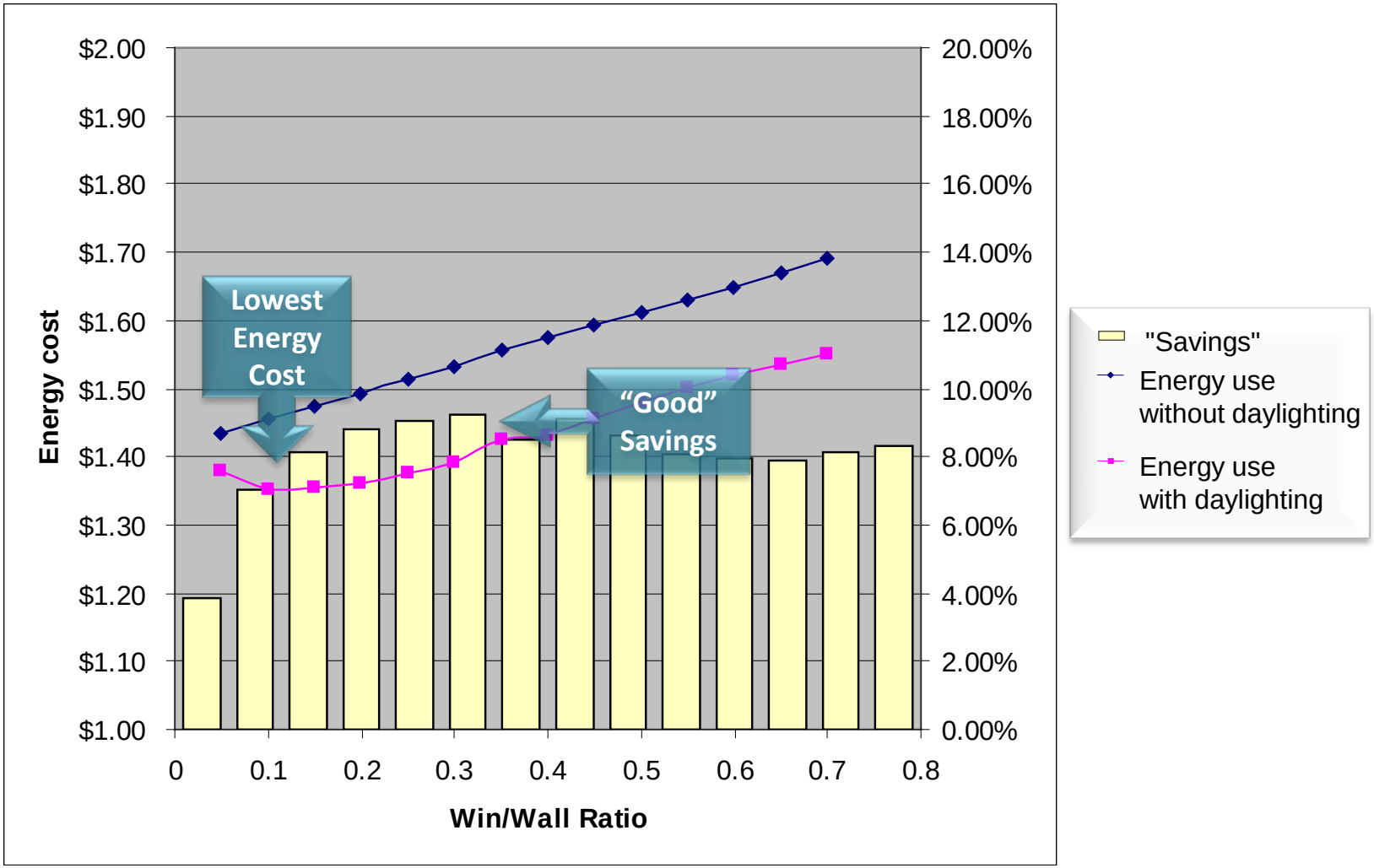
Glazing Ratio for Denver Office



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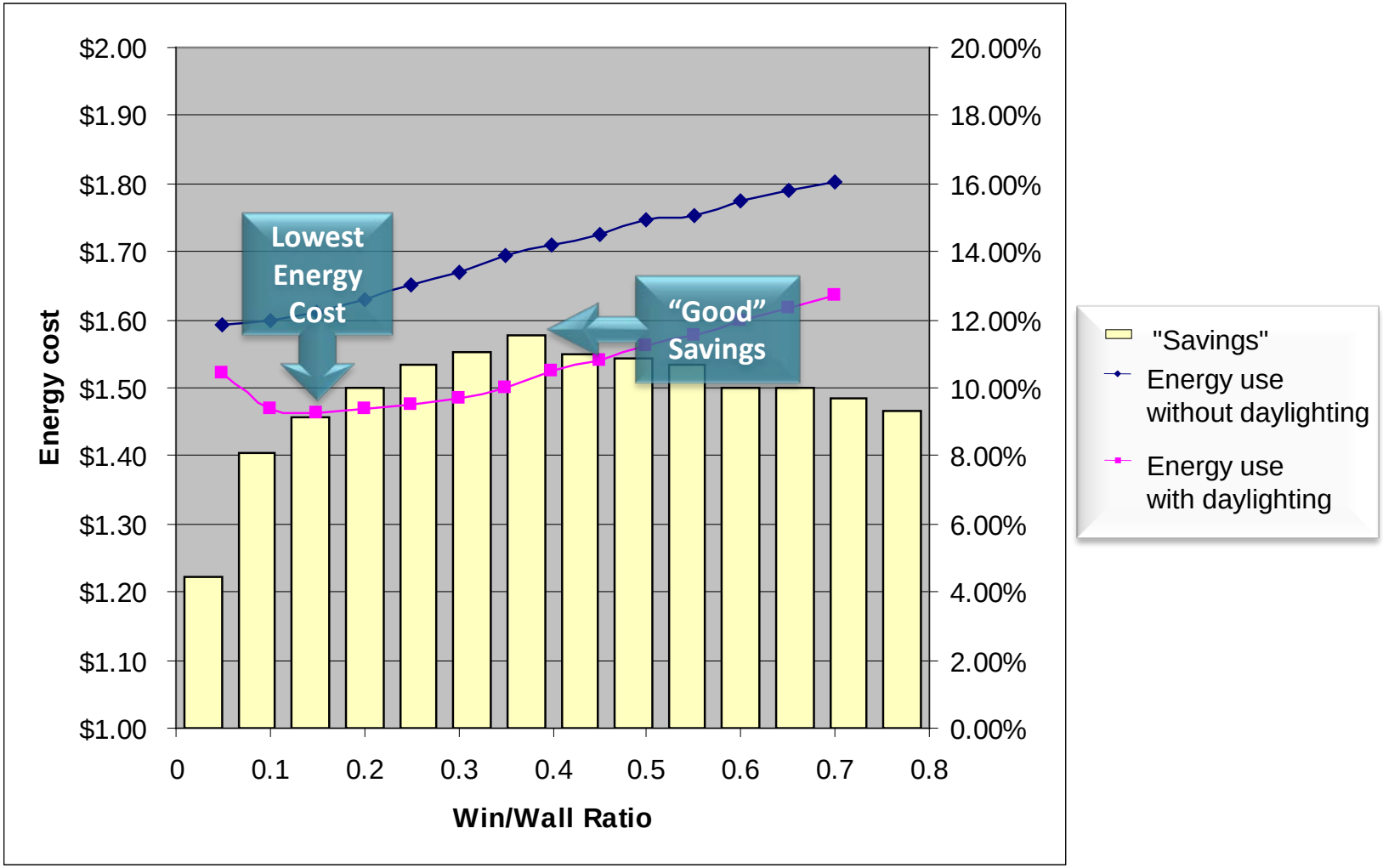
Glazing Ratio for Phoenix Office



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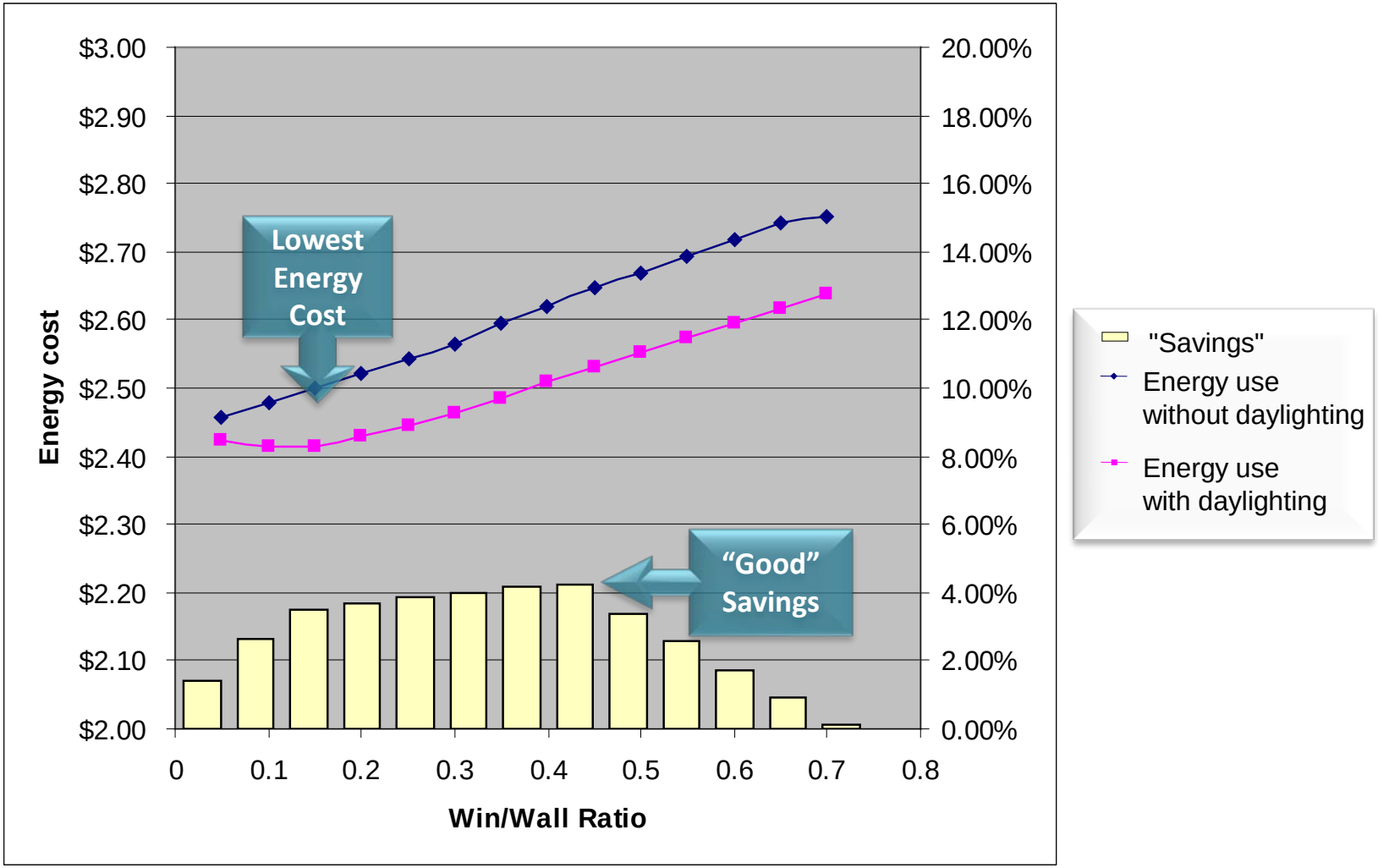
Glazing Ratio for Minneapolis Classroom



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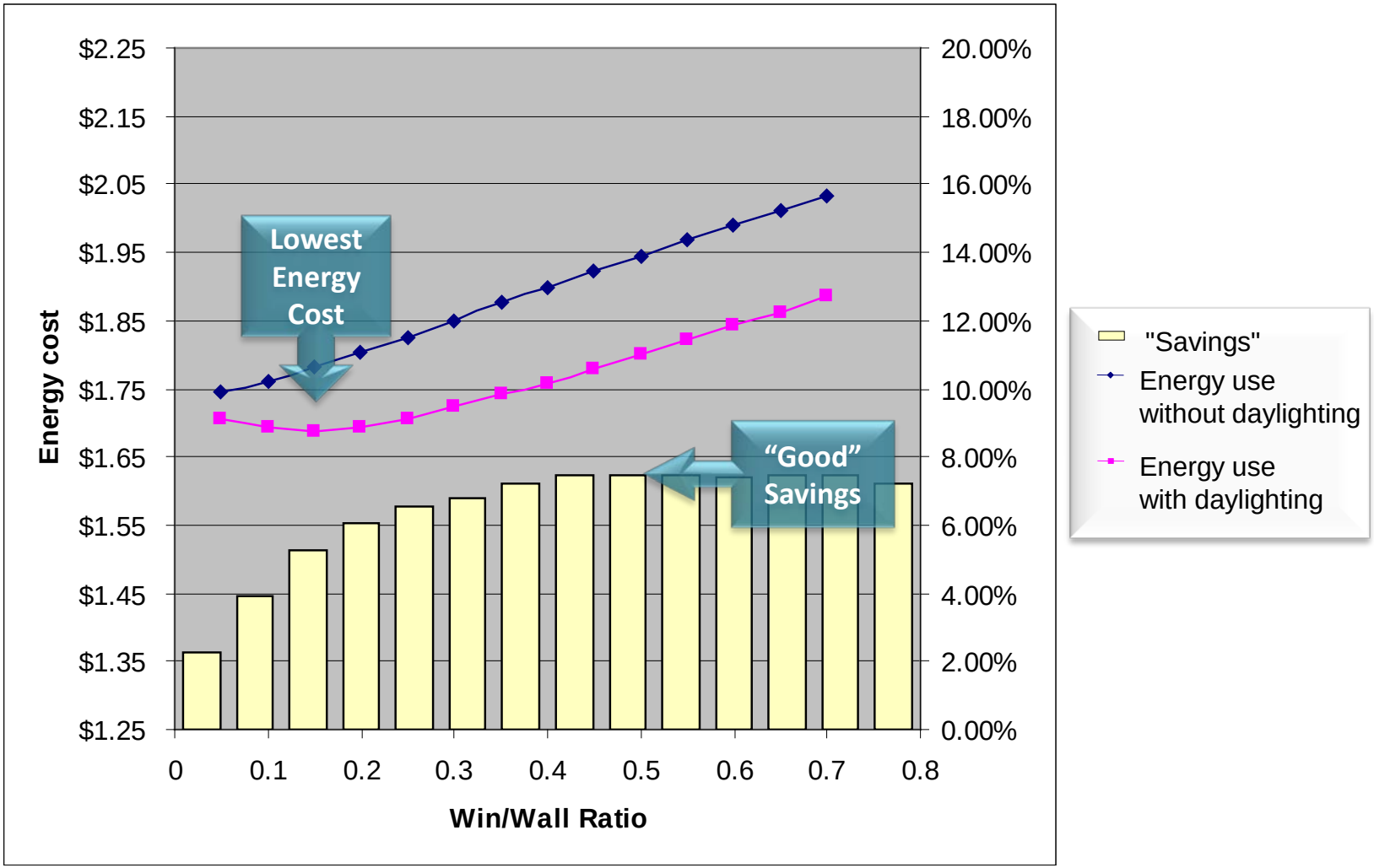
Glazing Ratio for Denver Classroom



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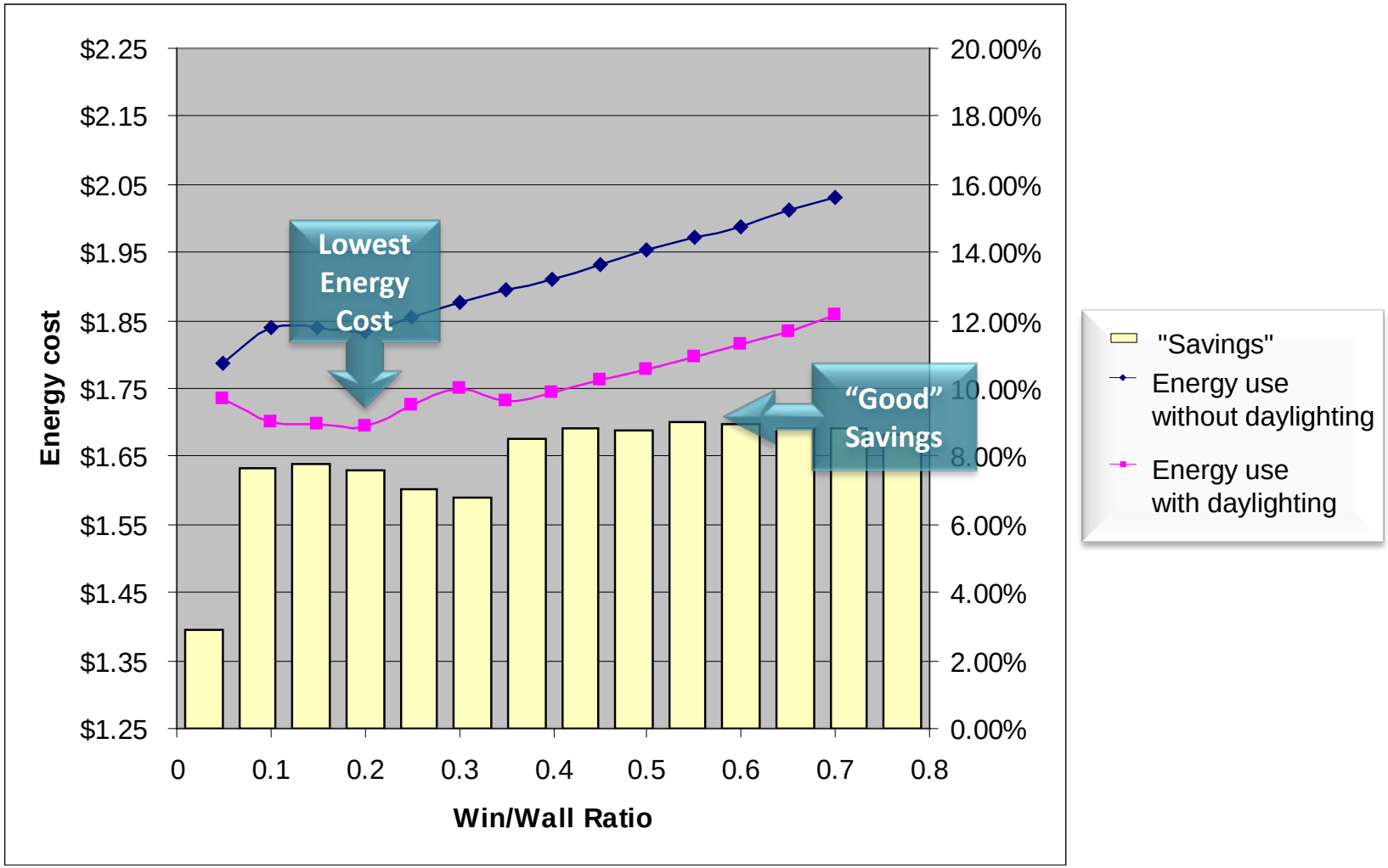
Glazing Ratio for Phoenix Office



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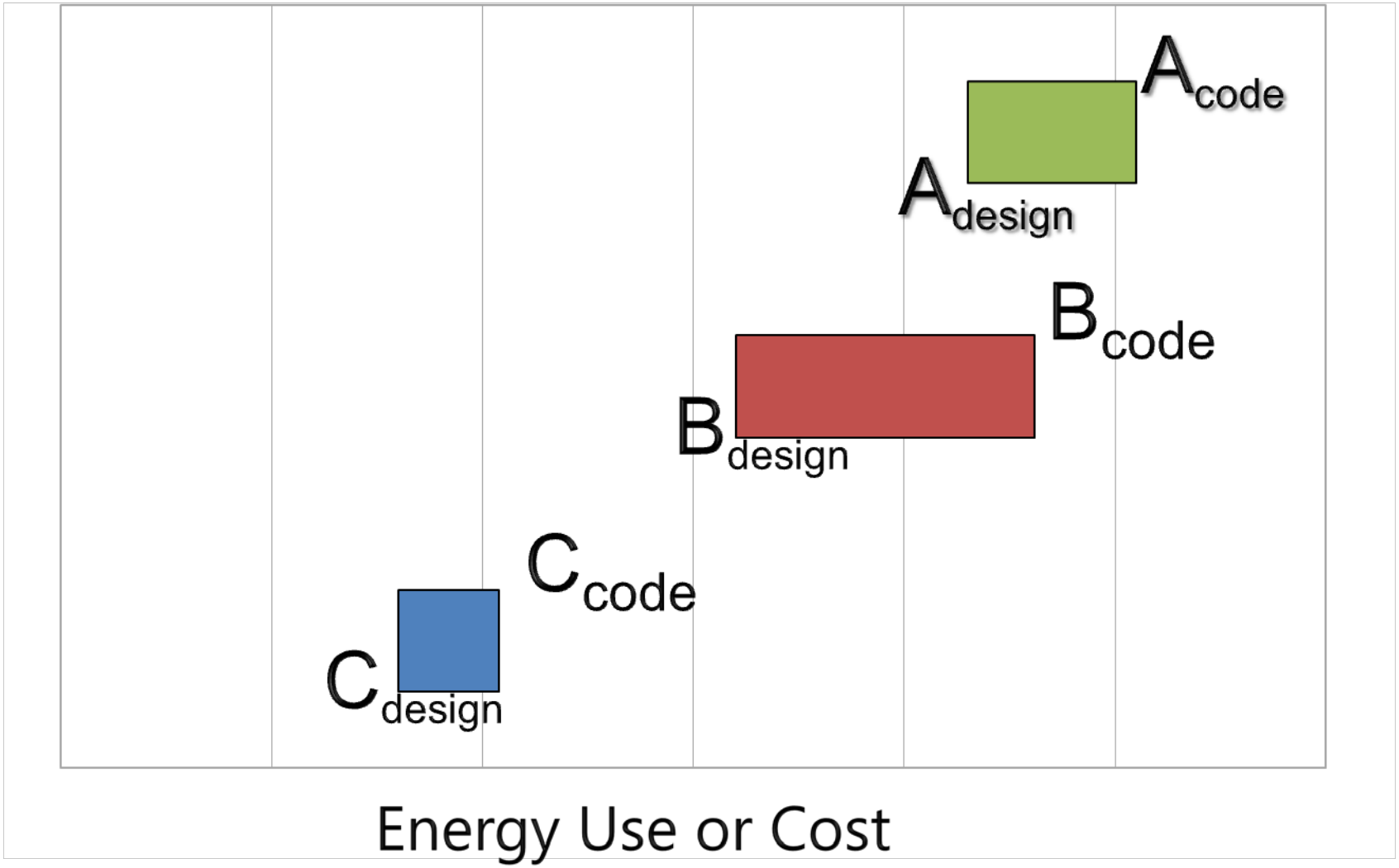
Even Comparison



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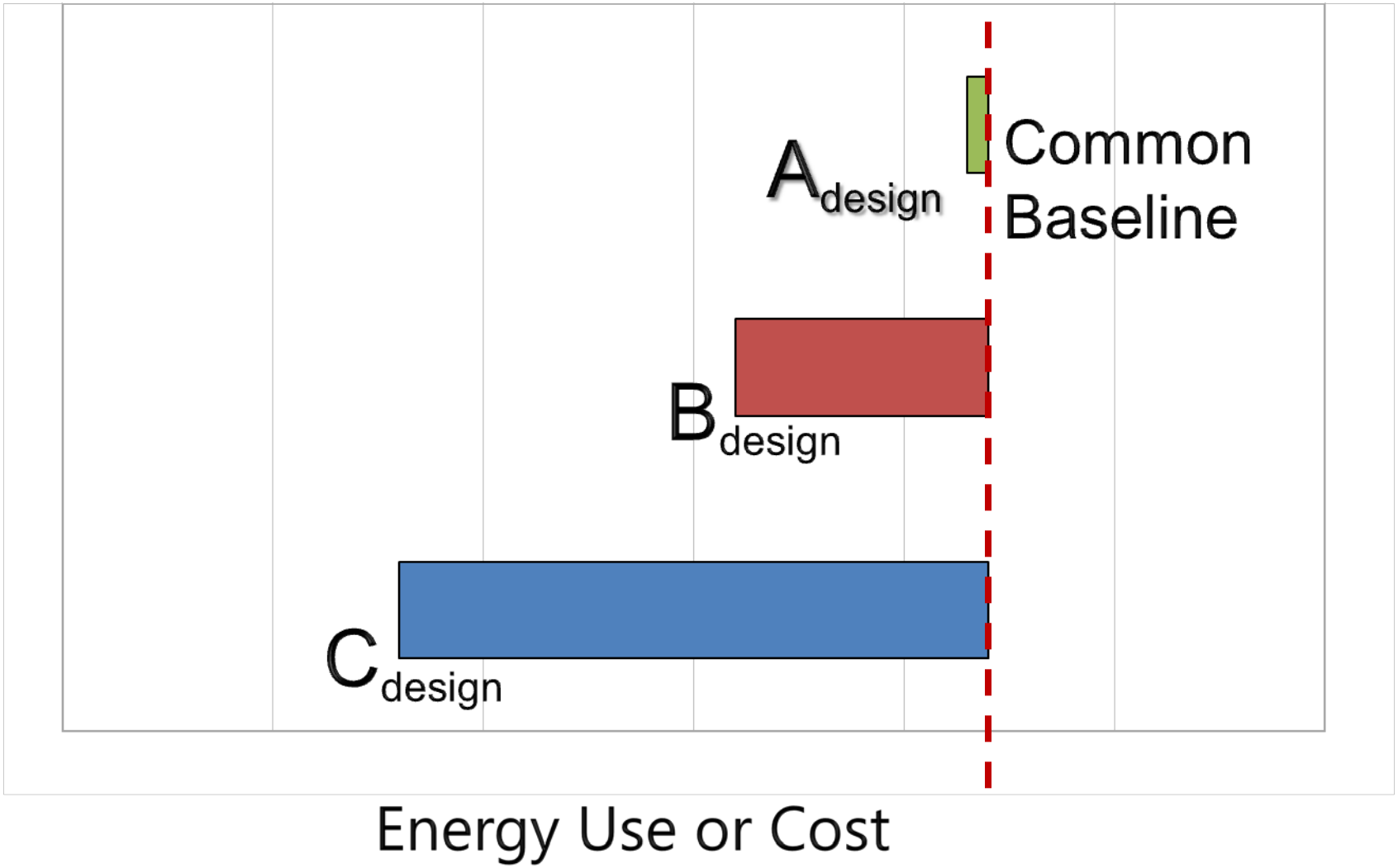
Even Comparison



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Energy Code

Summary

- Programmatic efficiency
  - Range from 3 to 25% of the total energy cost
  - Average 11% of total energy cost
  - Independent of "code savings"
  - Inherently the longest lived attribute of a building
- Massing
  - Four out of six of the projects had more savings for options that used more energy
- Glazing Ratio
  - Lowest energy is at 20% window to wall
  - Appendix G gives the most savings for 40%

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In-Operations Buildings

- Buildings are "existing" buildings much longer than they are "new" buildings
- Only 2% of building stock is new or renovated in a year
- Existing buildings opportunities
  - Large number of buildings
  - Often performing below current codes
  - Capital and operational opportunities

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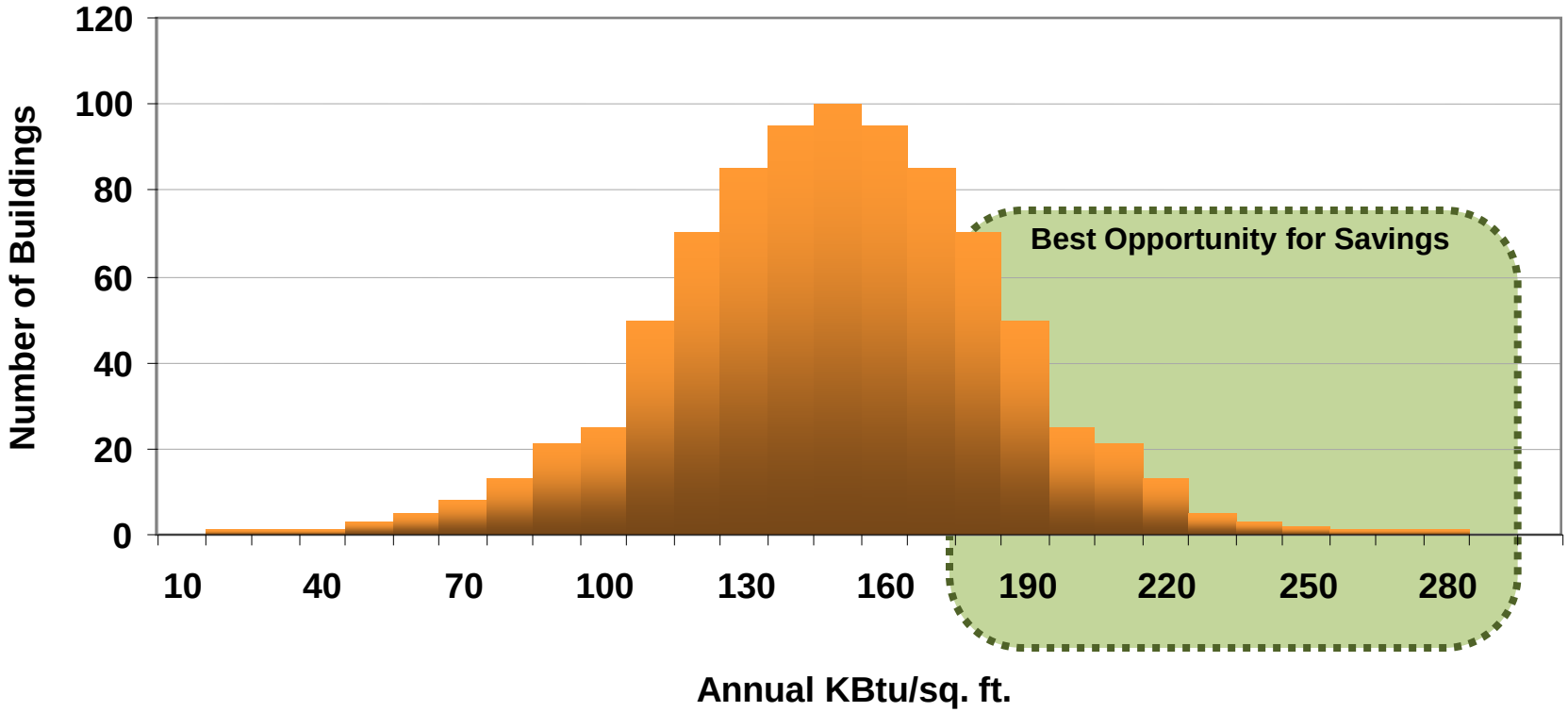
Operational Energy Modeling

Start with Benchmarking



- Benchmarking can help identify projects with the highest potential savings
- Benchmarking needs to control of building use, hours of operation and other characteristics

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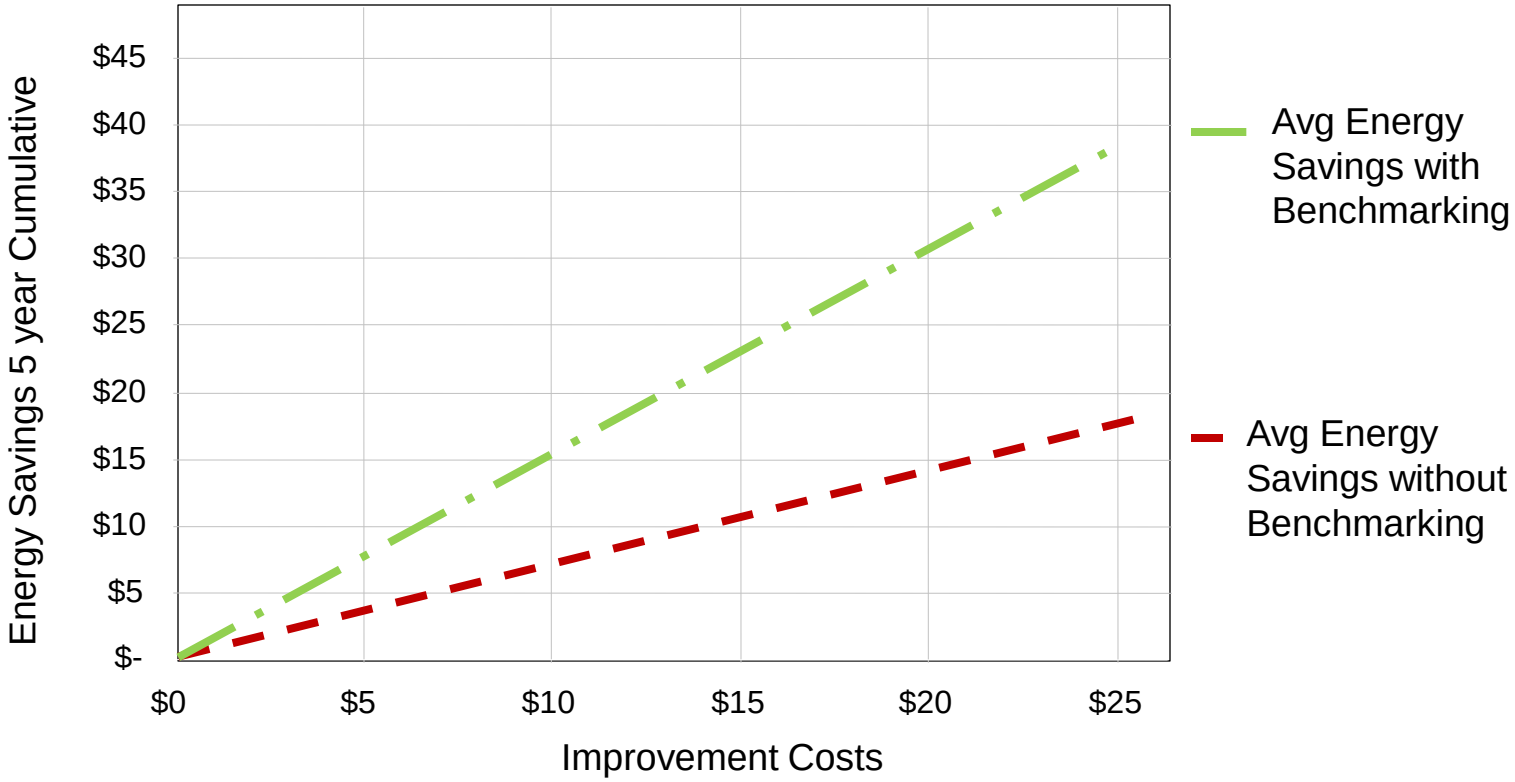
Operational Energy Modeling

Benefits of Benchmarking

- Buildings filtered through benchmarking are
  - Worse energy performers have greater potential for savings
  - Get higher return on investment



Source: Lawrence Berkeley National Lab

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Operational Energy Modeling

Targeting Retrofits with Benchmarking

Logged in as Cheri-Demo Schneider

Organization

Site Name	Meter Total kBtu/SF	Bnchmk Total kBtu/SF	Ratio Meter /Bnchmk	Potential Savings kBtu	Rating
Afton Fire Station	140.47	125.73	111.73%	127,832	★★☆☆☆
Fox Run Fire Station	131.45	125.38	104.84%	52,652	★★½☆☆
Thames Fire Station	128.04	122.74	104.32%	42,907	★★½☆☆
Central Park	129.63	129.63	100.00%	-159	★★½☆☆
City Hall	96.86	101.07	95.84%	-176,620	★★½☆☆
Eagle View Club House	75.76	82.56	91.76%	-73,113	★★★☆☆
Public Works 2301	77.13	95.25	80.97%	-1,154,734	★★★☆☆
Public Safety	105.11	132.63	79.25%	-1,895,349	★★★☆☆
Bielenberg Sports Center	111.75	148.03	75.49%	-4,082,138	★★★½☆
Public Works 2300	45.35	78.15	58.03%	-908,001	★★★★½

Type

Meters kBtu/SF	Benchmark kBtu/SF	% Ratio Mtr To Bnchmrk
46.27		
58.05		
104.32	122.49	85.16%

Central Park	✓	92,964	Library	1	129.63	129.63	100.00%	-159	★★½☆☆
City Hall	⚠	42,000	City Hall	1	96.86	101.07	95.84%	-176,620	★★½☆☆
Eagle View Club House	✓	10,744	Park / Recreation	1	75.76	82.56	91.76%	-73,113	★★★☆☆
Public Works 2301	✓	63,700	Maintenance Repair	1	77.13	95.25	80.97%	-1,154,734	★★★☆☆
Public Safety	✓	68,868	Police Facility	1	105.11	132.63	79.25%	-1,895,349	★★★☆☆
Bielenberg Sports Center	✓	112,500	Ice Arena	1	111.75	148.03	75.49%	-4,082,138	★★★½☆
Public Works 2300	✓	27,680	Maintenance Repair	1	45.35	78.15	58.03%	-908,001	★★★★½

B3 Framework v2.7.0.2291 | Copyright © 2011

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Operational Energy Modeling

Modeling Allows you to Quantify Opportunities

- Compare a building to expected energy consumption from the energy model
- Identify differences and investigate
  - Do not just tweak the model to get it to fit
  - Errors may be in the model or the building
- Identify conservation opportunities
  - Operational changes
  - Capital improvements

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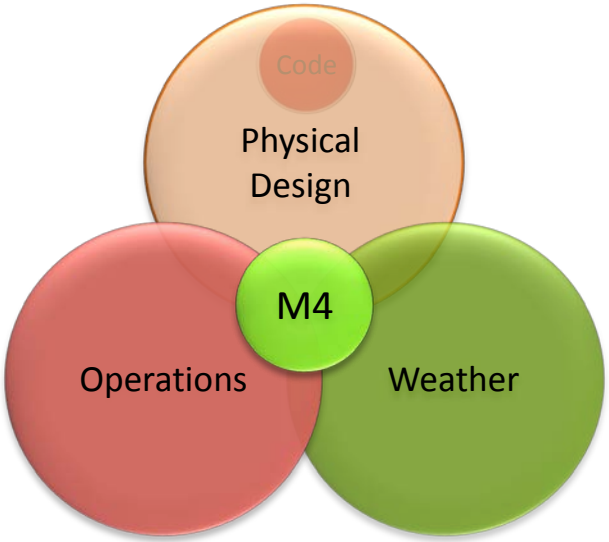
M4 - As Operated (Code) Baseline Model

- M4 is an updated M1 with adjusted operational behavior assumptions.
- M4 may also include adjustments to the physical design parameters of the model that affect the baseline code characteristics.
- M4 establishes a NEW baseline savings estimate for ongoing management and is weather adjusted.
- M4 replaces M1 but should not be used for savings calculations until M5 is similarly adjusted.



M1 = Post-Construction Baseline for Energy Efficiency

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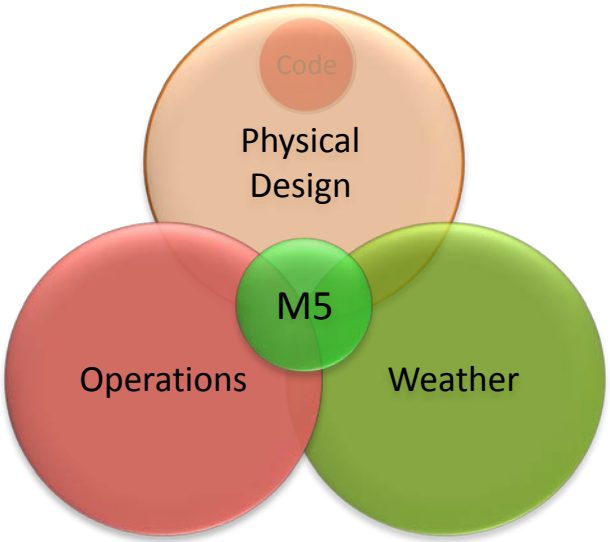
M5 – As Operated Actualized Bundle Model

- M5 contains the adjusted set of strategies implemented by the design team and owner as documented in M3 and as actually operated.
  It replaces M3.
- M4 – M5 is the new estimated operating savings for the initial time period and may become a performance baseline for targeted operating savings.



M4 - M5 = Actual operating savings for a given period

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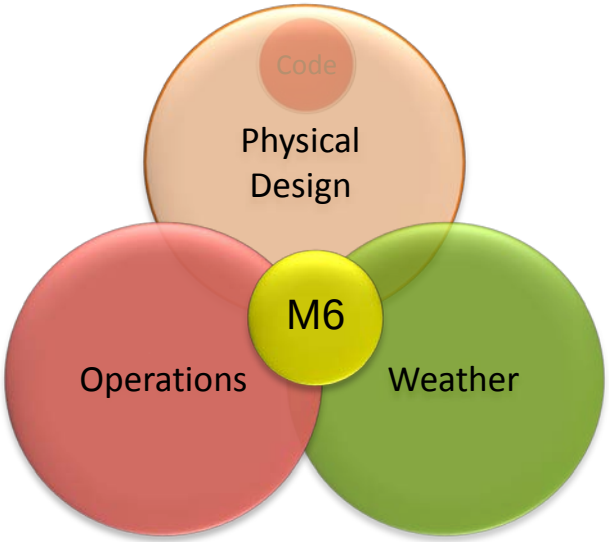
M6 – Further Potential Bundle Model

- M6 is the Further Potential Bundle Model for a future period for which there will be actual utility data. It is based on the Actualized Model because it adjusts for variables in all three areas—physical design, operational and weather parameters—that have changed since the design team handed over operations to the owner.



M6 = Actual operating savings for a given period

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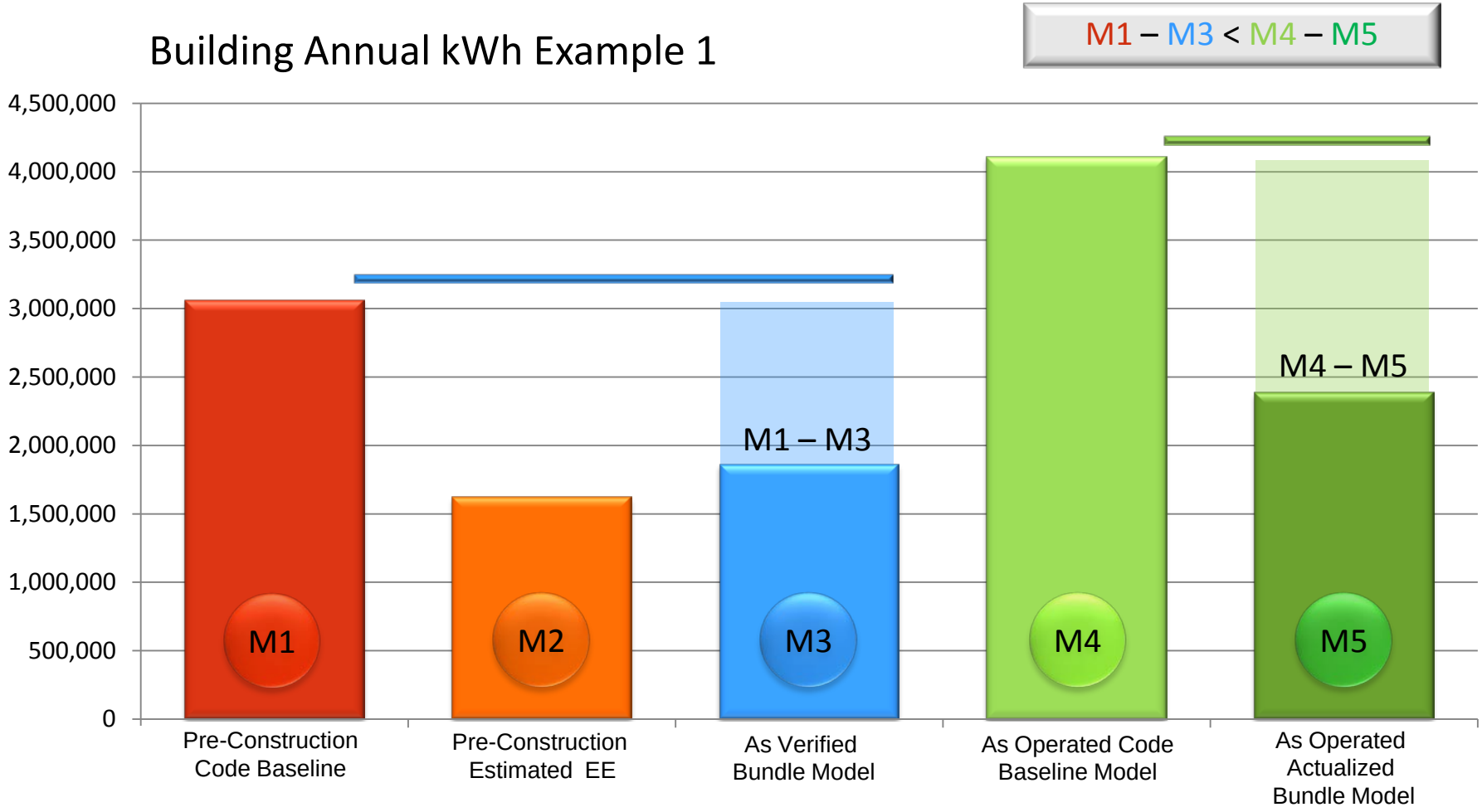
Additional Savings In Operations



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Operational Energy Modeling

Tracking Year Over Year Savings

B3 BENCHMARKING

Logged in as Cheri-Demo Schneider

My Organizations and Sites:

- City, Woodbury
  - Afton Fire Station
  - Bielenberg Sports Cen
  - Central Park
  - City Hall
  - Eagle View Club Hous
  - Fox Run Fire Station
  - Public Safety
  - Public Works 2300
  - Public Works 2301
  - Thames Fire Station

City, Woodbury — Organization

Organization Summary | Reporting

View: Benchmarks | Baselines | ENERGY STAR®

Baseline Period: **Jan 2010 - Dec 2010** Edit

Completeness

	Sites	SF	Bldgs	Meters
Complete	10	443,898	10	21
Incomplete	0	0	0	0
Total	10	443,898	10	21

Site Floor Area SF %

Baseline by Fuel Type

Fuel	Meters kBtu/SF	Baseline kBtu/SF	% Change From Baseline
Electric	46.27	48.18	-3.97%
Natural Gas	58.05	53.90	7.71%
Total	104.32	102.08	2.20%

Sites - Baseline

Site Name	Status	SF	Primary Space Usage	Bldg Qty	Period	Meter Total kBtu/SF	Baseline Total kBtu/SF	% Change From Baseline
Eagle View Club House						79.57		-4.80%
Bielenberg Sports Center						120.14		-6.99%
Central Park	✓	92,964	Library	1	Aug 2010-Jul 2011	129.63	127.77	1.46%
Afton Fire Station	✓	8,671	Fire Station	1	Aug 2010-Jul 2011	140.47	139.23	0.89%
Thames Fire Station	✓	8,100	Fire Station	1	Aug 2010-Jul 2011	128.04	127.10	0.74%
Eagle View Club House	✓	10,744	Park / Recreatio	1	Aug 2010-Jul 2011	75.76	79.57	-4.80%
Bielenberg Sports Center	✓	112,500	Ice Arena	1	Apr 2010-Mar 2011	111.75	120.14	-6.99%

B3 Framework v2.7.0.2291 | Copyright © 2011

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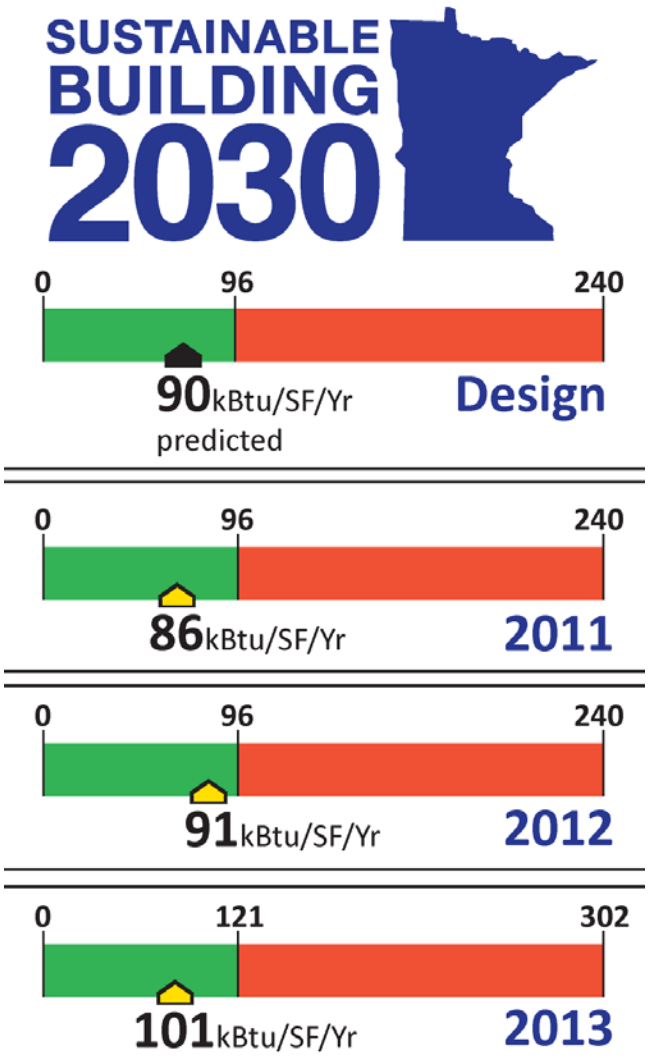
Sustainable Buildings 2030

Energy Rating from Design Through Operation

- Total Energy kBtu/SF goal based on 2030 Challenge™ independent of building design
- Design and Operation Label
  - Pre-Design
  - Design
  - Annual Operations
- Adjusted baseline for building use changes
- Mandated for state bonded buildings in Minnesota
- Voluntary for other Minnesota Buildings



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Minding the Gap

Conclusions

- For some early design decisions energy codes encourage higher energy usage
- Comparing design alternatives to each other or a common baseline avoid that
- Energy modeling should be used as a design tool, not just a compliance tool
- Modeling can help bridge the gap from policy to efficient buildings

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Thank You

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