Better Buildings
U.S. DEPARTMENT OF ENERGY

Myth-Busting Deep Energy Retrofits

May 8, 2011

11:15 - 12:30 PM

U.S. DEPARTMENT OF ENERGY

Myth: **BUSTED**

"Deep energy retrofits are too complex and too expensive for my buildings."

Overview and Agenda

- Deep Energy Retrofits: Mythbusting Secrets
  1. Pursue the right steps in the right order
  2. Deep Triggers
  3. Focused analysis: Technical Potential and Bundle measures
  4. Define business-as-usual expenditures
  5. Quantify the value beyond energy cost savings
- One Affordable Multi-Family Building: Castle Square
  - *Castle Square has utilized the most advanced building science to guide the renovation of a 500-unit, affordable-housing complex in one of Boston's premier neighborhoods.*
- Walmart's Portfolio Approach
  - *Assemble a diverse group of Subject Matter Experts (SMEs), explain the objectives, outline the lim*its & boundaries, provide them the tools they need…and let them go.
- Question & Answer

Today's Presenters

Name	Organization
Mike Bendewald	Rocky Mountain Institute
Darien Crimmin	WinnCompanies Energy savings goal = 65% over 174,000 sf.
Jim McClendon	Walmart Stores, Inc. Reduce the kWh/sf 20% by 2020

Michael Bendewald
Senior Associate
Rocky Mountain Institute

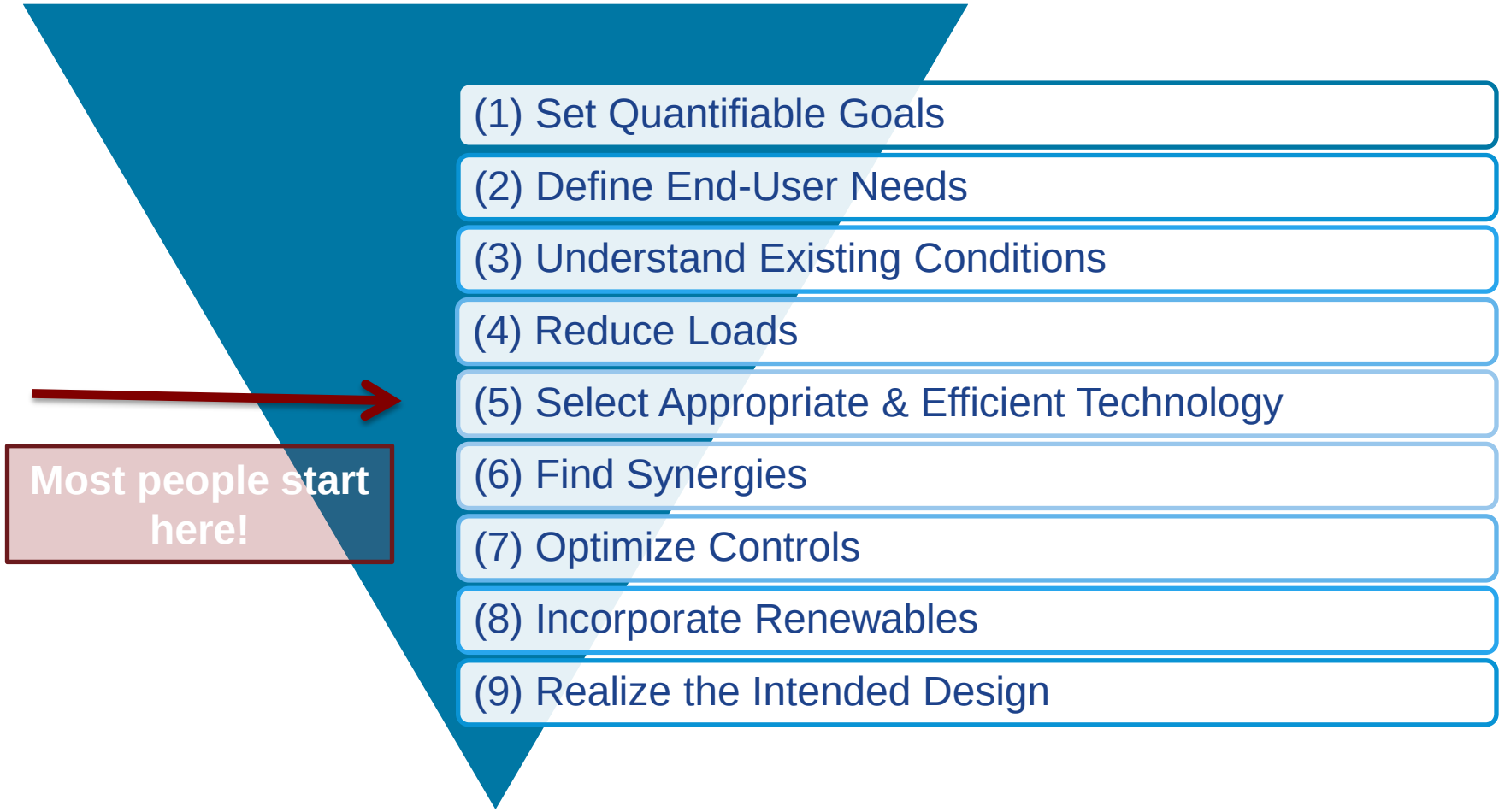
U.S. DEPARTMENT OF ENERGY

Not incremental, but a new class of product

Trade Secrets for Cost Effective Deep Retrofits

1. Pursue the right steps in the right order
2. Deep Triggers
3. Focused analysis: Technical Potential and Bundle measures
4. Define business-as-usual expenditures
5. Quantify the value beyond energy cost savings

#1: Pursue the Right Steps in the Right Order

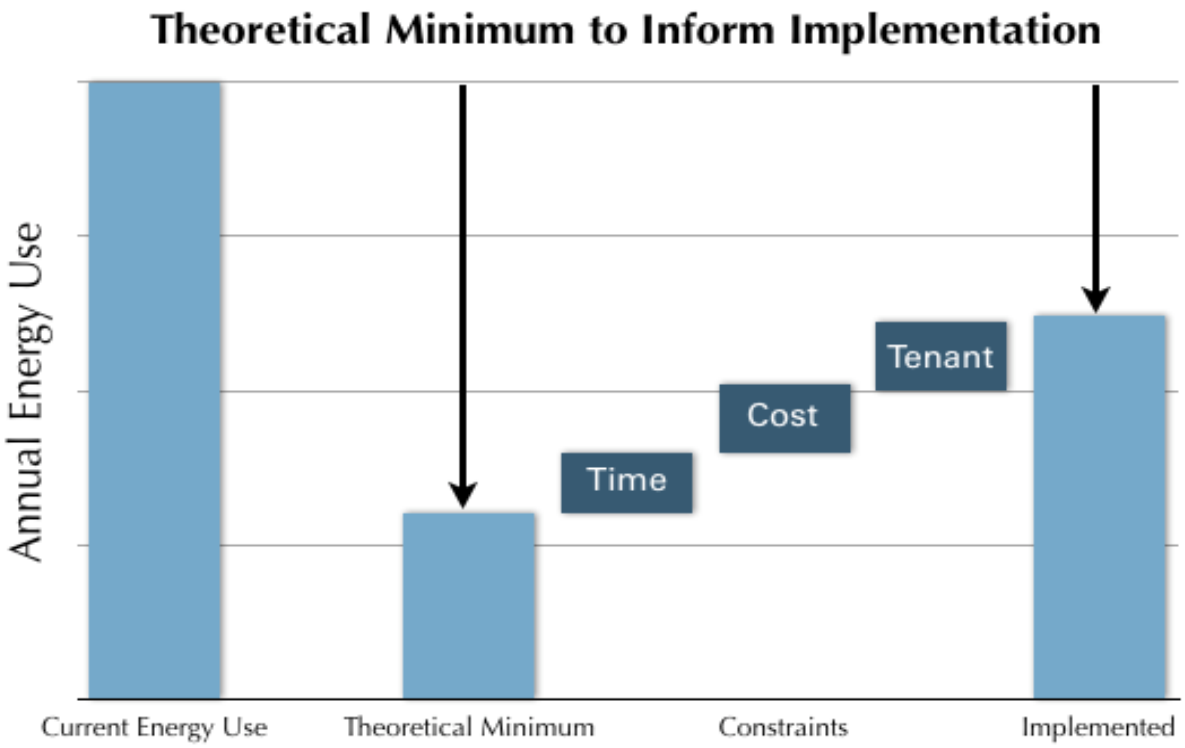


#2: Deep Triggers

1. Planned capital improvement
2. Major system replacement
3. Code upgrades
4. New owner / refinancing
5. New use / occupancy type
6. Building greening
7. Large utility incentives
8. Mitigating an “energy hog”

#3a: Technical Potential

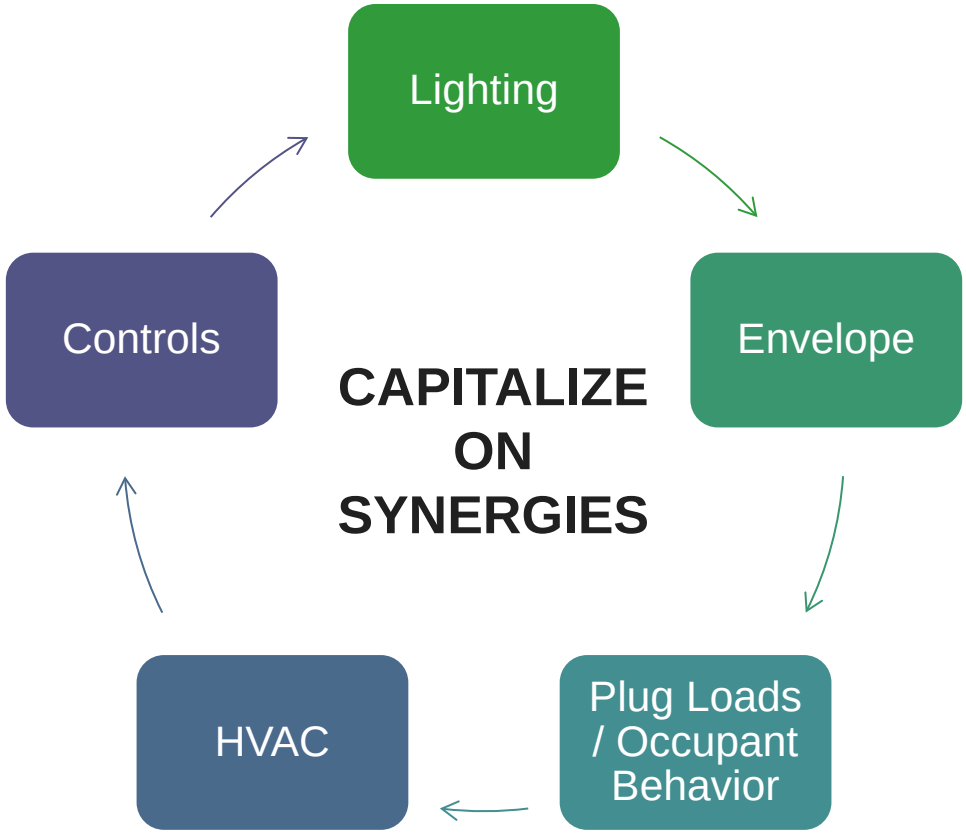
Maximum level of savings possible given today's technology



WHY DO WE CARE?

- Challenges conventional thinking
- Not limited by industry benchmarks/norms
- Leads to more aggressive design targets
- Explicitly determines where ground has been lost

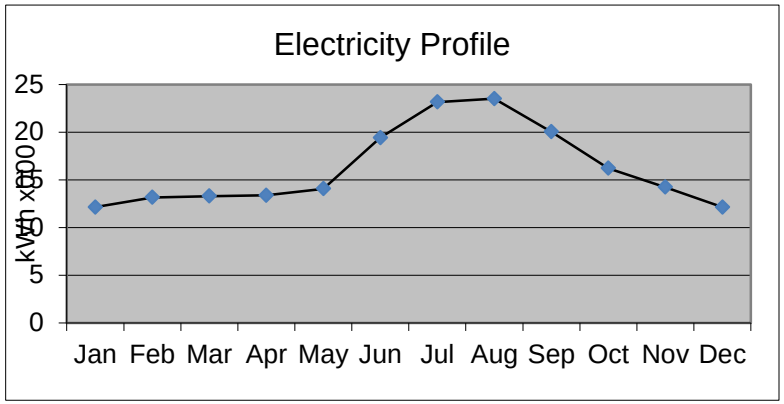
#3b: Bundle measures



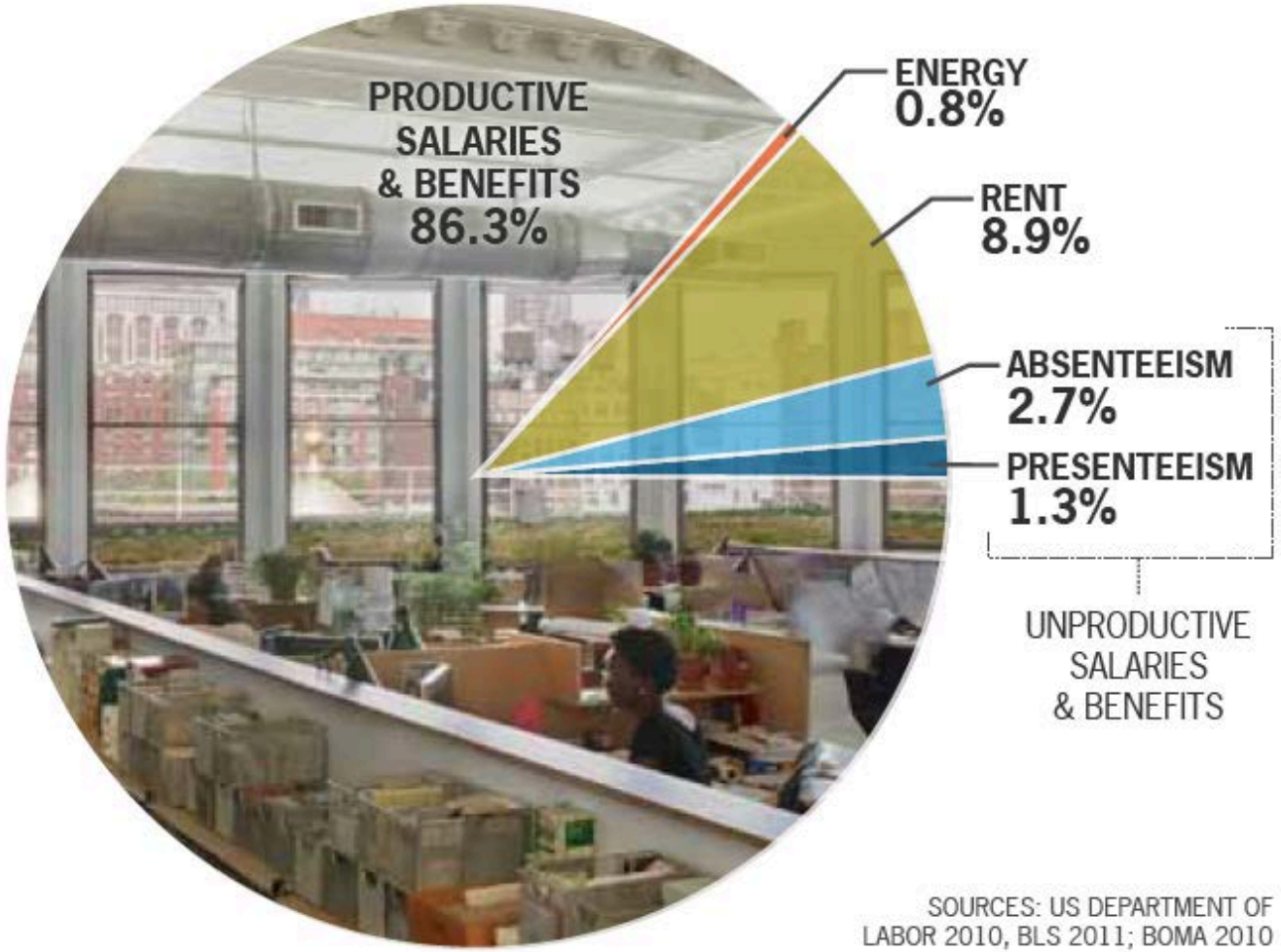
- Downsizing or eliminating mechanical and other systems - and therefore avoiding capital costs
- Adding square footage due to reduced mechanical space
- Allowing for more cost-effective measures to “finance” measures that that provide value beyond energy cost savings (VBECS)

#4: Estimate the Cost of Business as Usual

- Utility bills
- Maintenance/operation costs
- Replacements
- Incremental upgrades
- Code requirements
- Energy/carbon pricing
- Interruption



#5: Include the Values Beyond Energy Cost Savings



#5 The Value Framework

Value	This value is created through…
Reduction in Costs	▪ Lower costs to maintain & replace equip. ▪ Lower health cost (absenteeism, health care) ▪ Lower employee recruiting and churn costs
Revenue Growth	▪ Higher occupancy and rent rates ▪ Increased employee productivity ▪ Improved marketing & sales
Improved Reputation and Leadership	▪ Recruiting best employees or tenants ▪ Employee/tenant satisfaction and retention ▪ Public relations/brand management
Compliance with Internal & External Initiatives	▪ Meeting the needs of Corporate Social Responsibility, Carbon Disclosure Project, etc ▪ Meeting responsible investment fund requirements
Reduced Risk to Future Earnings	▪ Reduced risk to reputation ▪ Limit exposure to energy/water price volatility ▪ Reduced legal risks – sick building syndrome, mold claims, etc

Results from 50 Deep Retrofits

Integrated design & multiple measures are more critical to low-energy buildings than any given technology.

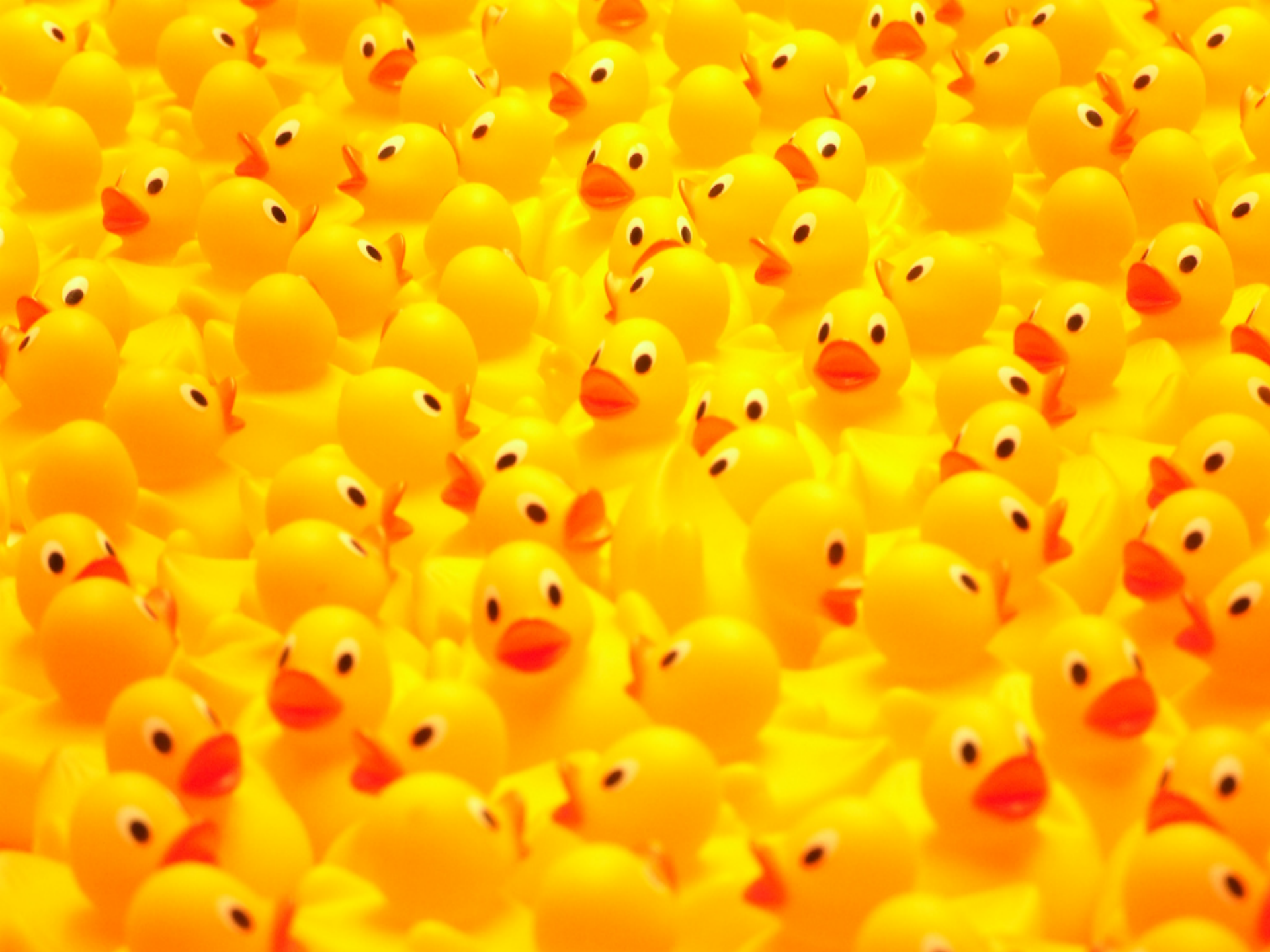
Major renovations offer a major opportunity for deep savings. **Re-positioning existing buildings** is currently an attractive real estate move.

Readily available technologies/strategies were used to create these deep energy retrofits. **Performance feedback** is key.

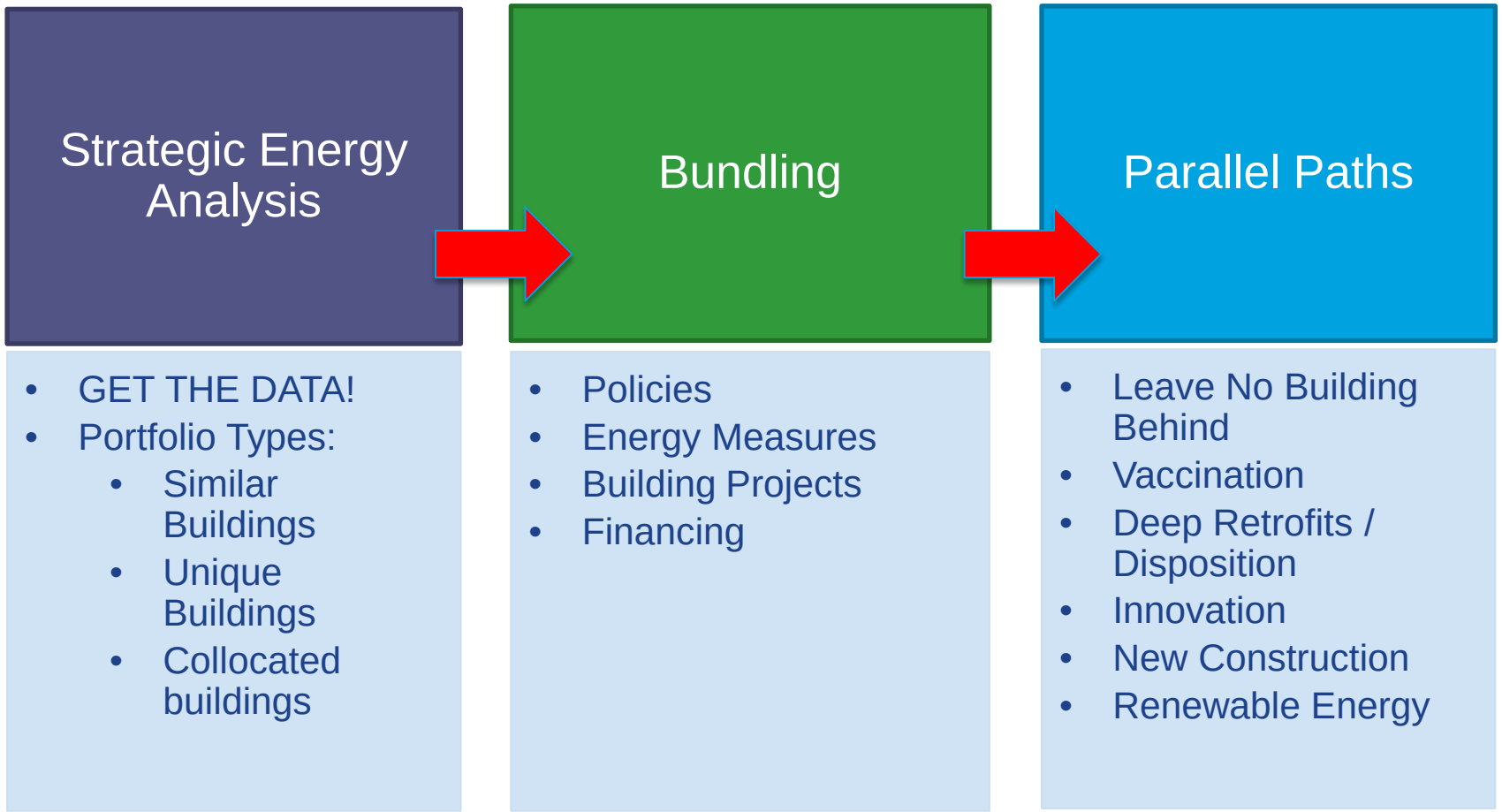
Building ratings, labels, champions and recognition were a strong influence on increased efficiency.

Source: NBI

http://newbuildings.org/meta-report-search-deep-energy-savings



Crafting a Building Portfolio Efficiency Strategy



"We can do some of the measures in all of the buildings, and we can do all of the measures in some of the buildings." – Blake Herrschaft, Engineer

Castle Square Apartments

Affordable Housing Deep Energy Retrofit

Darien Crimmin
Vice President of Energy & Sustainability

WinnCompanies
Development | Residential | Military

CASTLESQUARE

APARTMENTS AVAILABLE ON AN OPEN OCCUPANCY BASIS

EQUAL HOUSING OPPORTUNITY

"AN EQUAL OPPORTUNITY DEVELOPMENT"

U.S. DEPARTMENT OF HOUSING AND URBAN DEVELOPMENT

U.S. DEPARTMENT OF ENERGY

MASSHOUSING

Bank of America

Boston Redevelopment Authority

National Grid

NSTAR ELECTRIC

Building AMERICA U.S. Department of Energy

Enterprise

THE KRESGE FOUNDATION

Boston, MA

Boston, MA

1960s

2008

7 Stories

192 Affordable Apartments

174,424 Gross Square Feet

OCCUPIED Rehab – Low Income

- Resident goals
- Insulation
- Air sealing
- Ventilation
- New Equipment
- Efficiency
- Green Materials
- LEED Platinum

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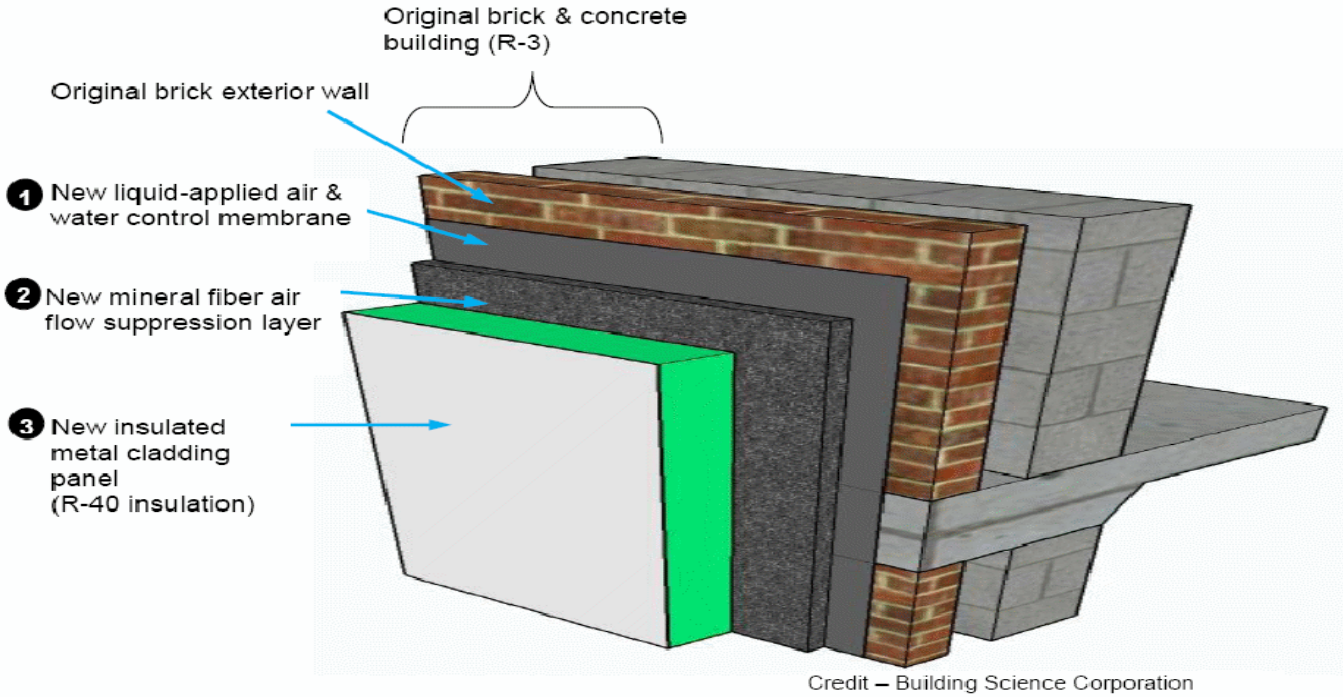
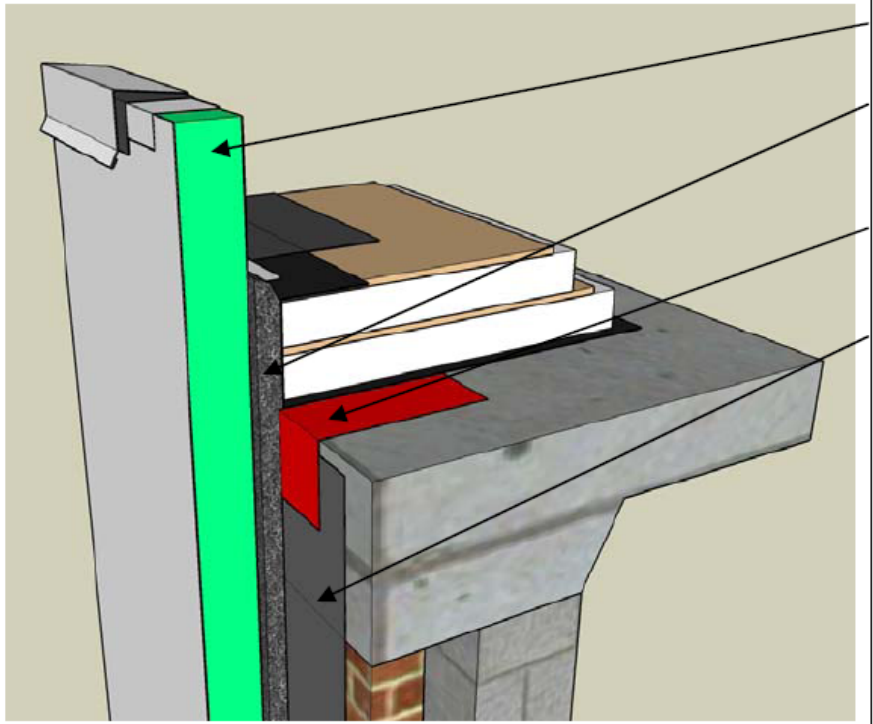


Figure 1 - Castle Square Insulated Exterior Wall System

- Resident goals
- Insulation
- Air sealing
- Ventilation
- New Equipment
- Efficiency
- Green Materials
- LEED Platinum



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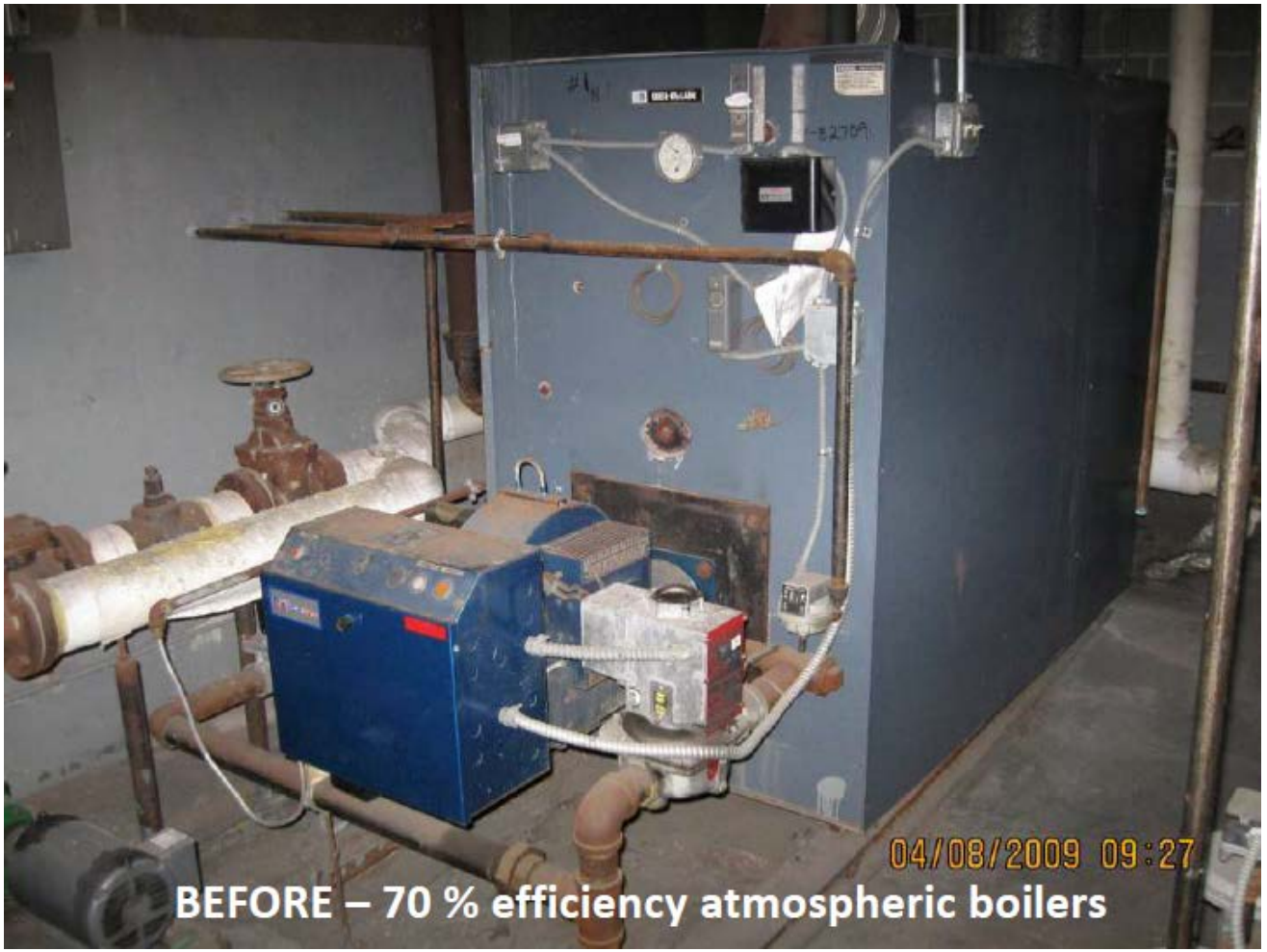

- Resident goals
- Insulation
- Air sealing
- Ventilation
- New Equipment
- Efficiency
- Green Materials
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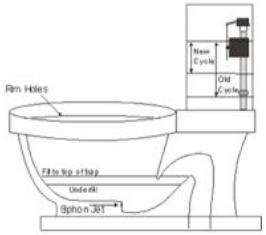
Water



1.5 gallon per minute

Kitchen = 1.5 GPM
Bath = .5 GPM

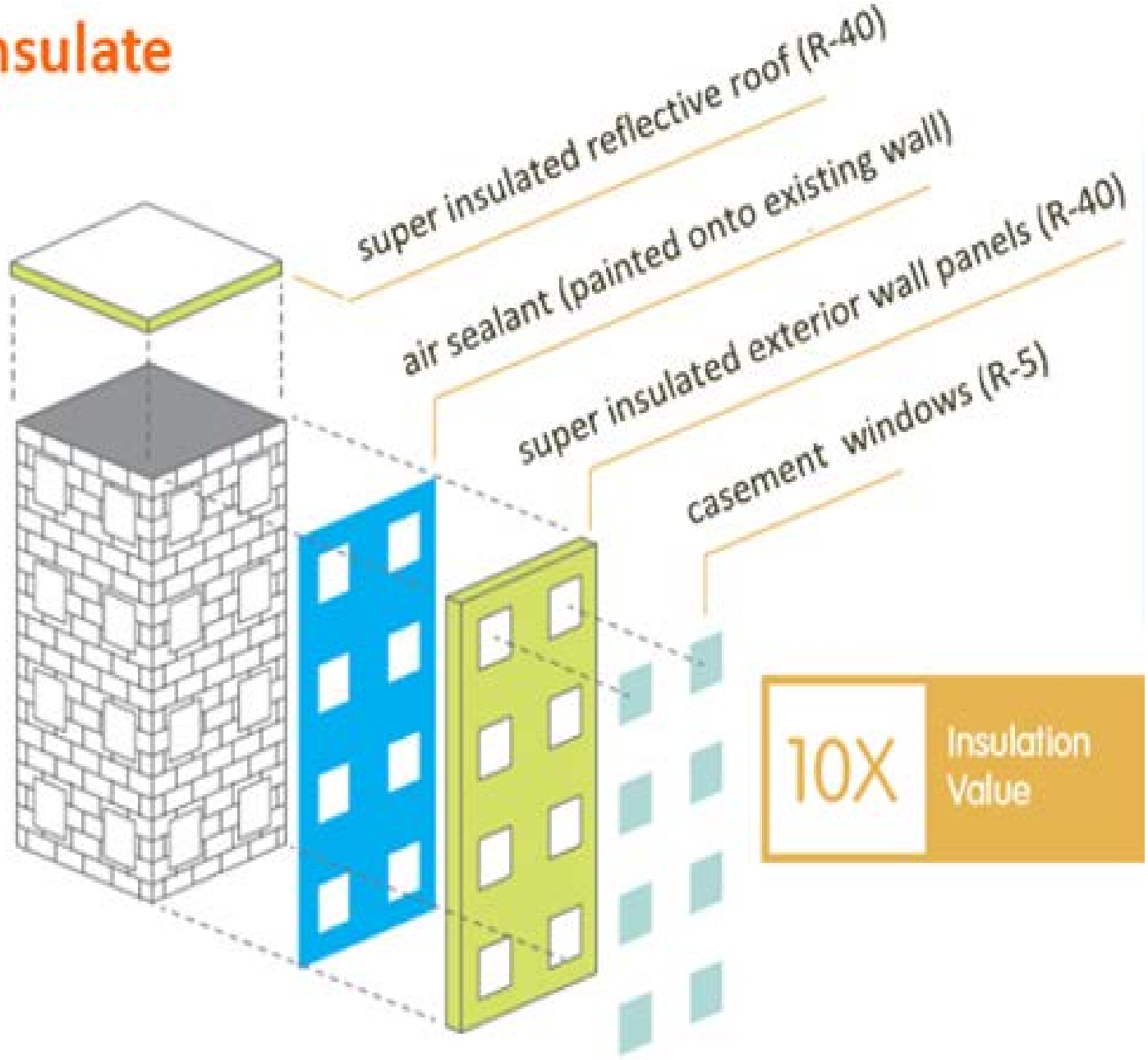
Electrical

Ventilation

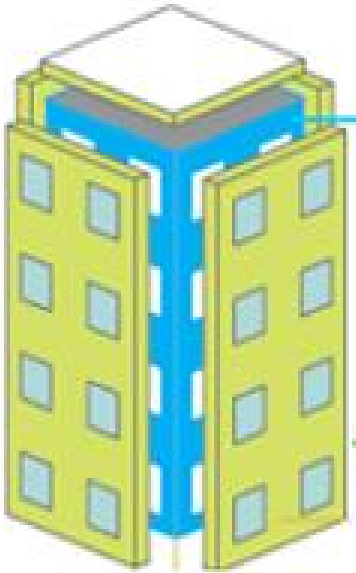
- Resident goals
- Insulation
- Air sealing
- Ventilation
- New Equipment
- Efficiency
- **Green Materials**
- LEED Platinum


CASTLE SQUARE

1 super insulate



2 air seal



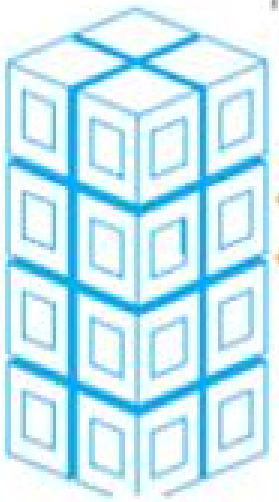
air sealant
(windbreaker)

+

insulation
(sweater)

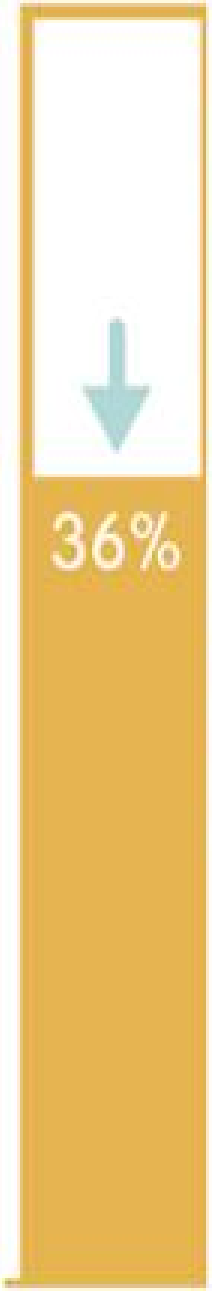
air sealing
between
apartments &
outdoors

compartmentalization



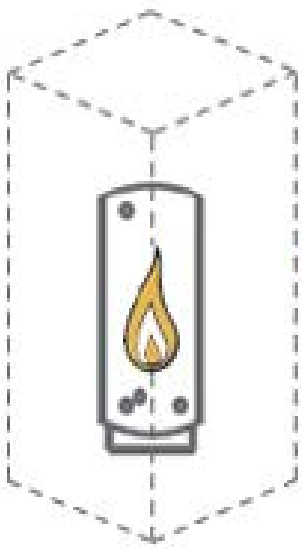
reduced
stack
effect

air sealing
between
apartments &
each other

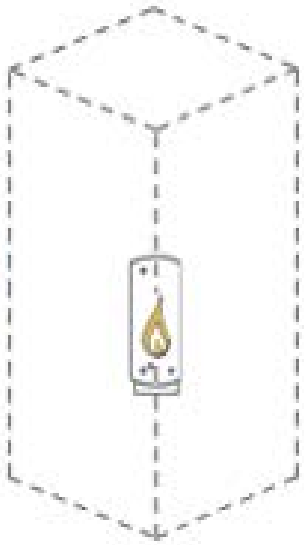


total building energy savings

3 scale down heating & cooling equipment

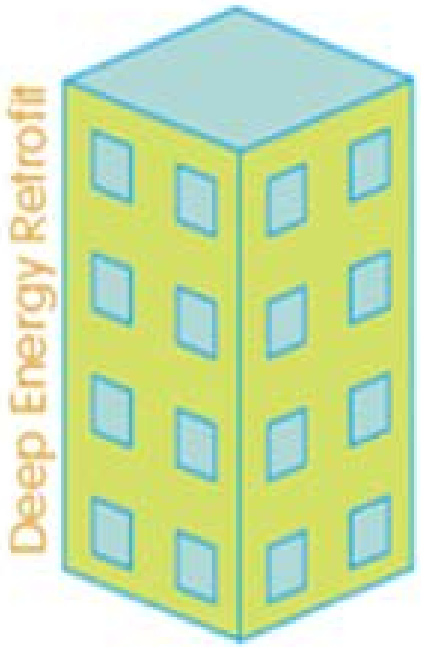


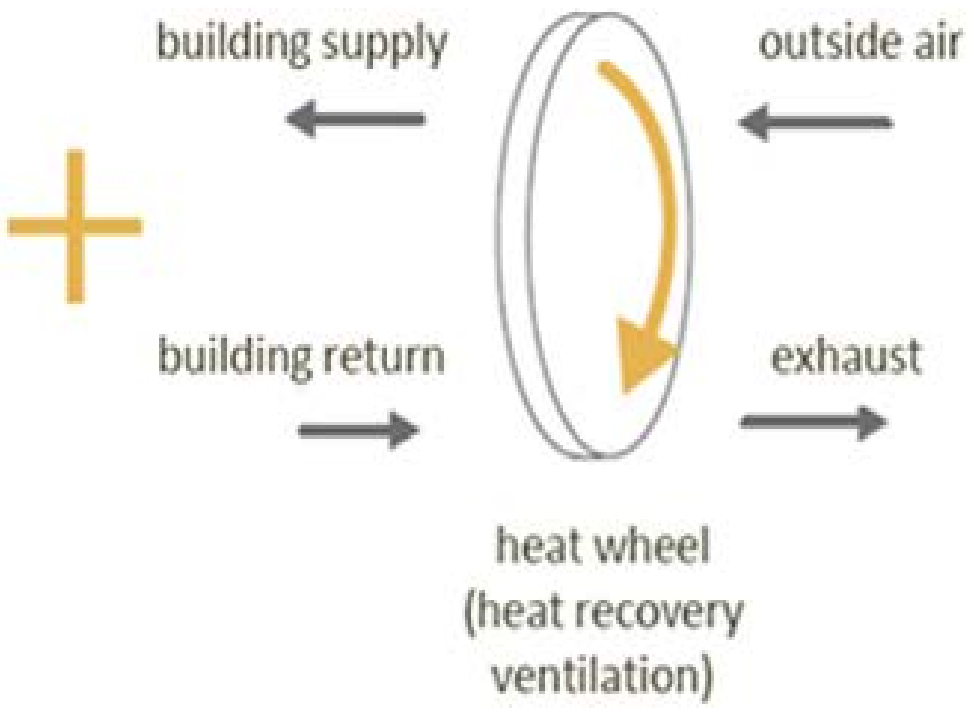
monster inefficient heating & cooling equipment



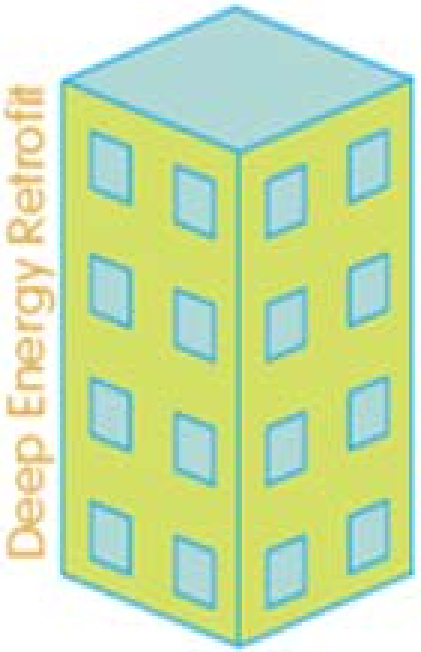
tiny efficient heating & cooling equipment

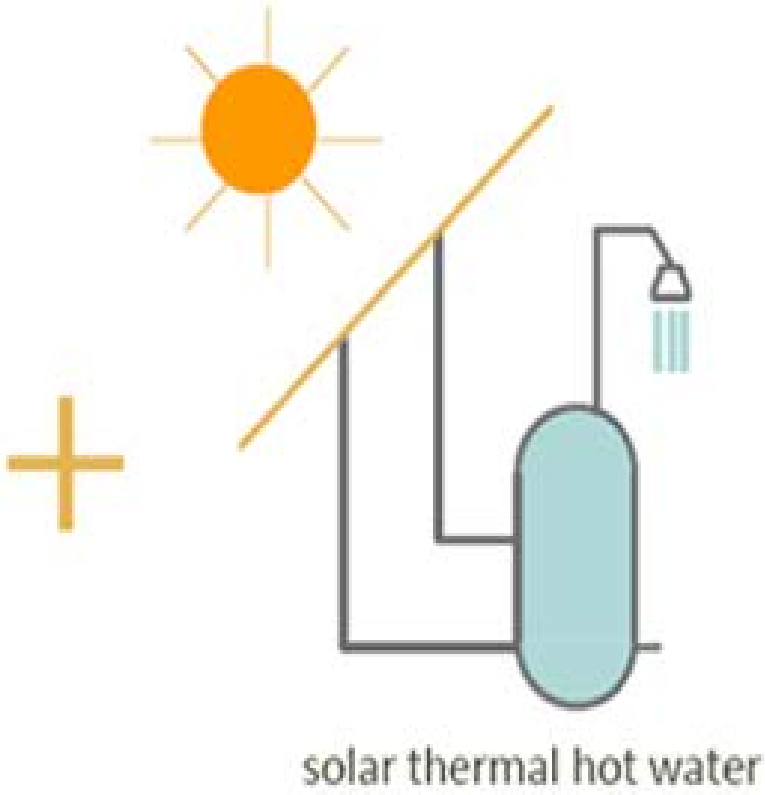
4 improve indoor air quality





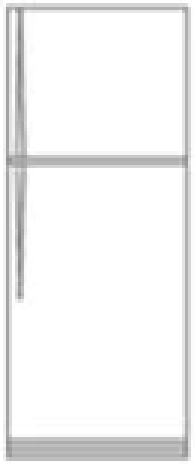
5 harness the sun





6 reduce plug load

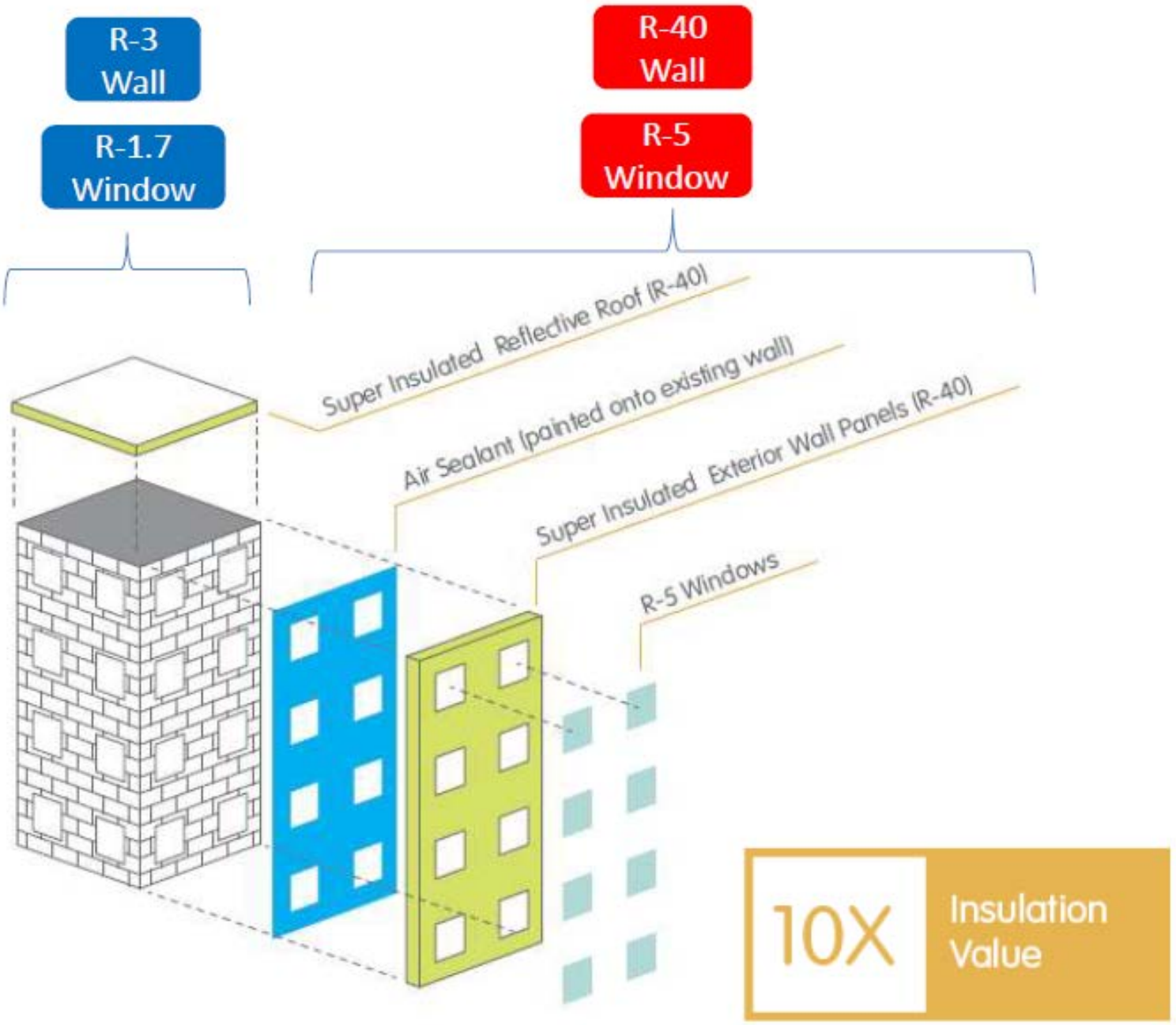
+

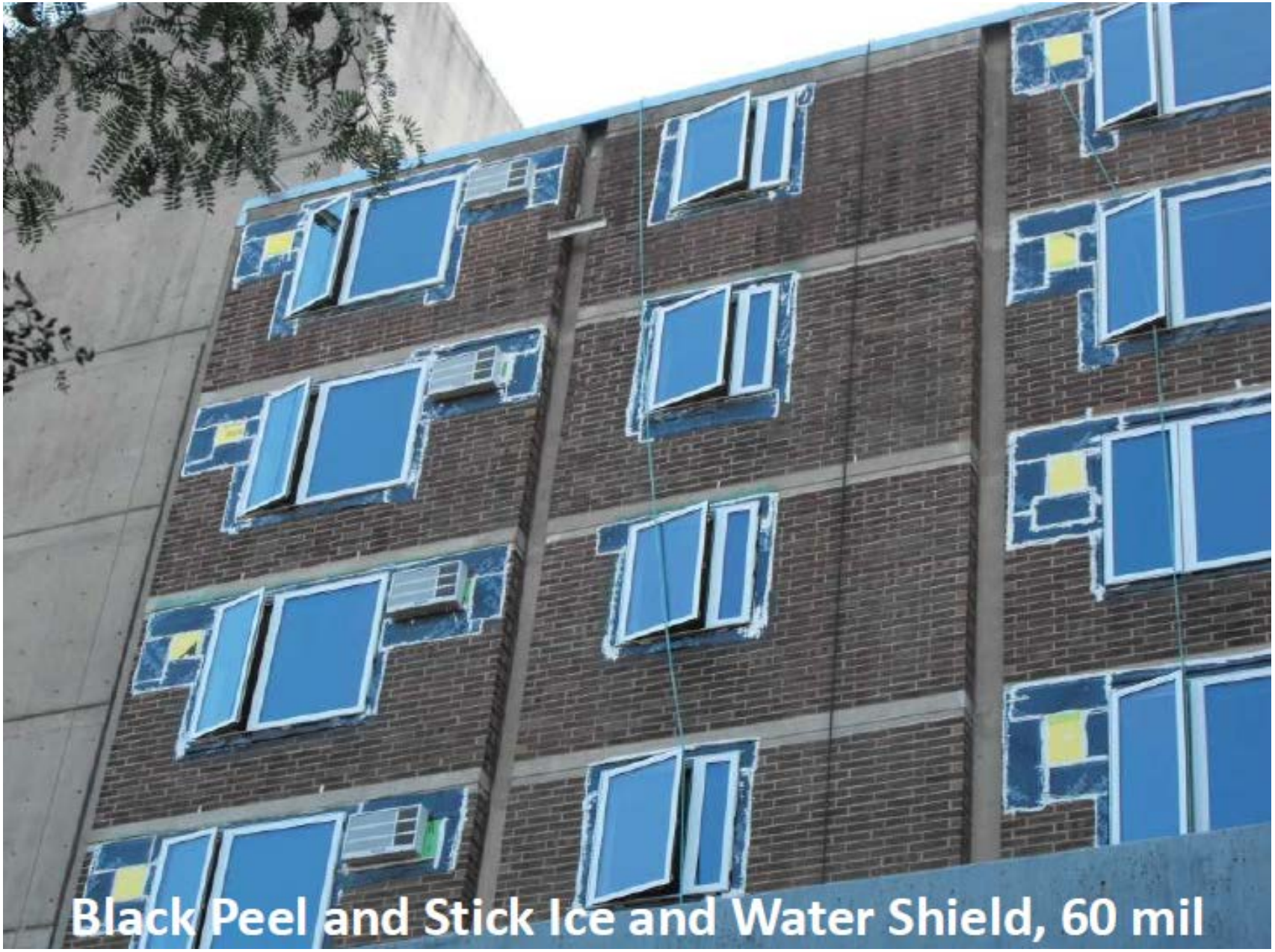


high efficiency appliances

&

high efficiency lighting


R-3
Wall
R-1.7
Window
R-40
Wall
R-5
Window
Super Insulated Reflective Roof (R-40)
Air Sealant (painted onto existing wall)
Super Insulated Exterior Wall Panels (R-40)
R-5 Windows
10X
Insulation
Value


Black Peel and Stick Ice and Water Shield, 60 mil


AFTER – 96% condensing boilers (Viessmann)


Mineral Wool – Air Flow Suppression Layer

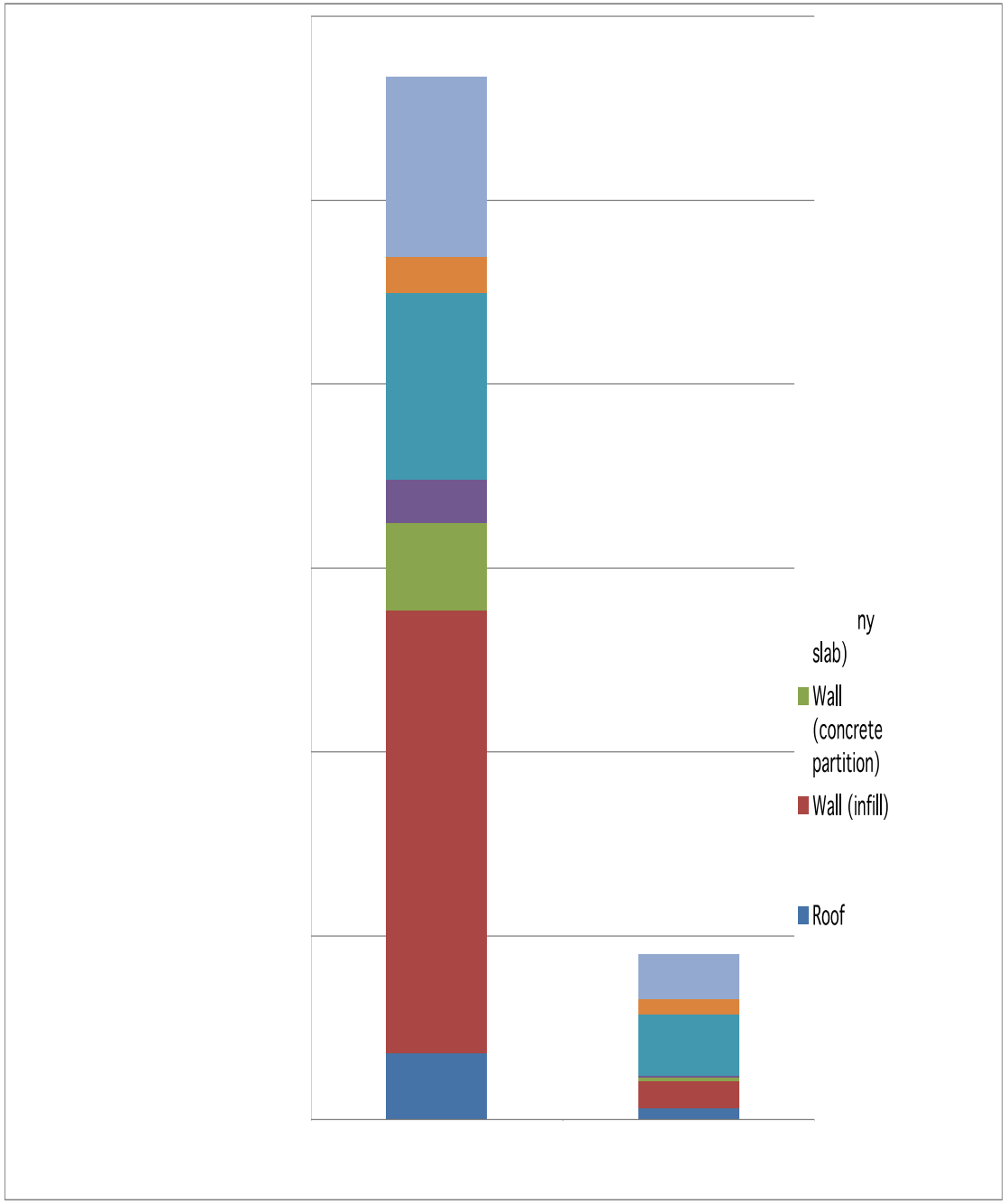

CASTLE SQUA


CASTLE SQUAR
E.BERKELEY

71 % decrease in natural gas for heating
56% decrease in natural gas for hot water
60% decrease in electric usage

10,791 MMBTU Savings Per Year
Avoids Emission of 1,506,120 lbs of CO_2 Per Year

Walls	R-3 → R-40
Roof	R-20 → R-40
Windows	R-1.7 → R-5



GAS SAVINGS PROJECTIONS

	MIDRISE Buildings (192 units)		
	Therms	MMBTU	$
TOTAL Baseline Gas Usage (2008)	126,744	12,674	$193,918
Current Heating Energy Use Baseline	78,024	7,802	$119,377
Savings from Enclosure	47,654	4,765	$72,911
Mechanical Savings	8,016	802	$12,264
TOTAL Heating Savings	55,670	5,567	$85,175
TOTAL Heating Savings as a Percentage of Baseline	**71%**		
Current Hot Water Use Baseline	48,720	4,872	$74,542
Savings from Water Heating System Upgrade	20,061	2,006	$30,693
Solar Thermal Savings	7,164	716	$10,961
Total Hot Water Savings	27,225	2,723	$41,654
Total Hot Water Savings as a Percentage of Baseline	**56%**		
			$0
TOTAL Gas Savings (Scenario I - With Solar Thermal)	82,895	8,290	$126,829
Scenario I: Post Improvement Gas Usage (with Solar Thermal)	43,849		$67,089

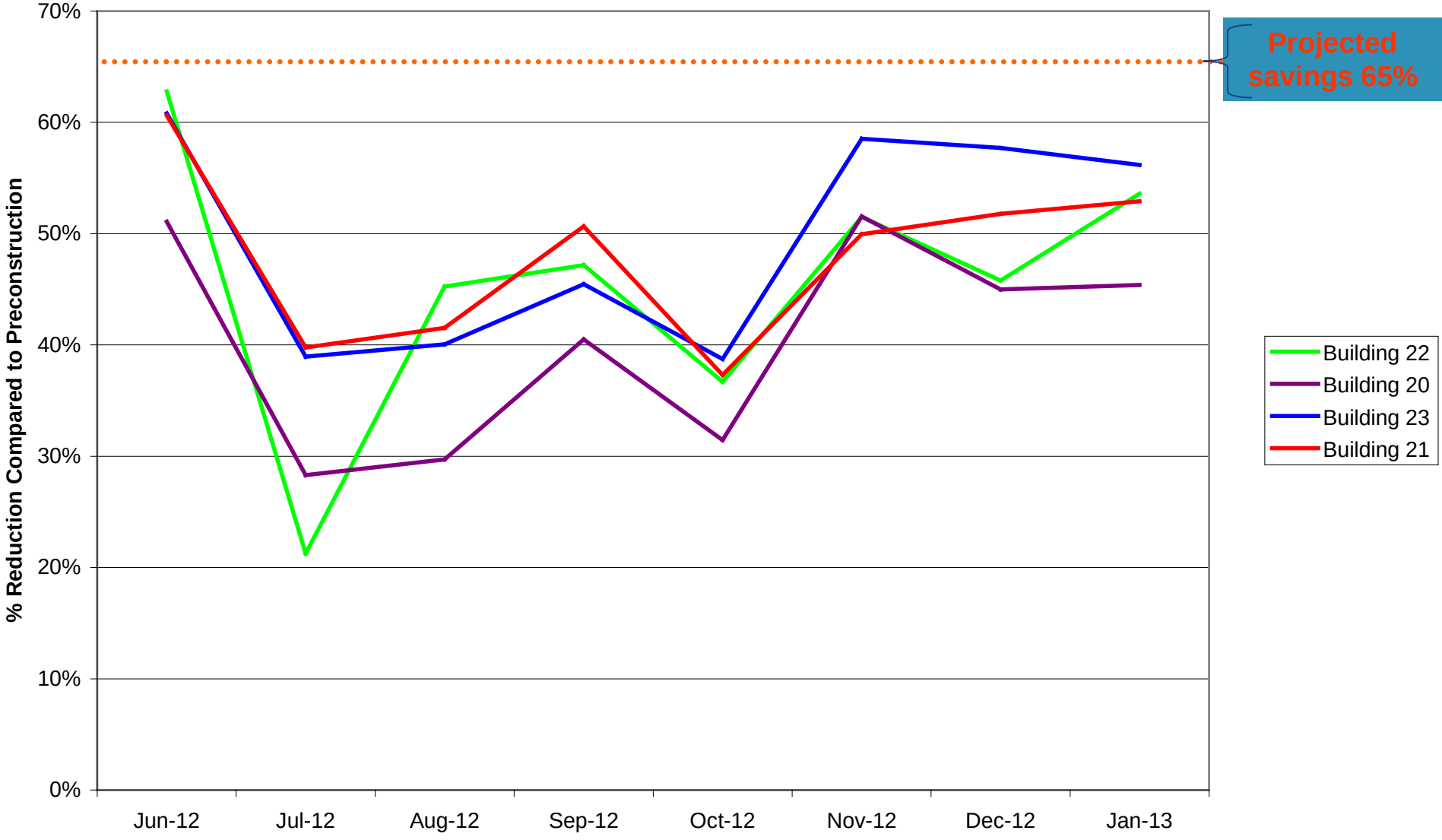
Total Heat and Hot Water Savings	**65%**

48% - 62%

29% - 45%

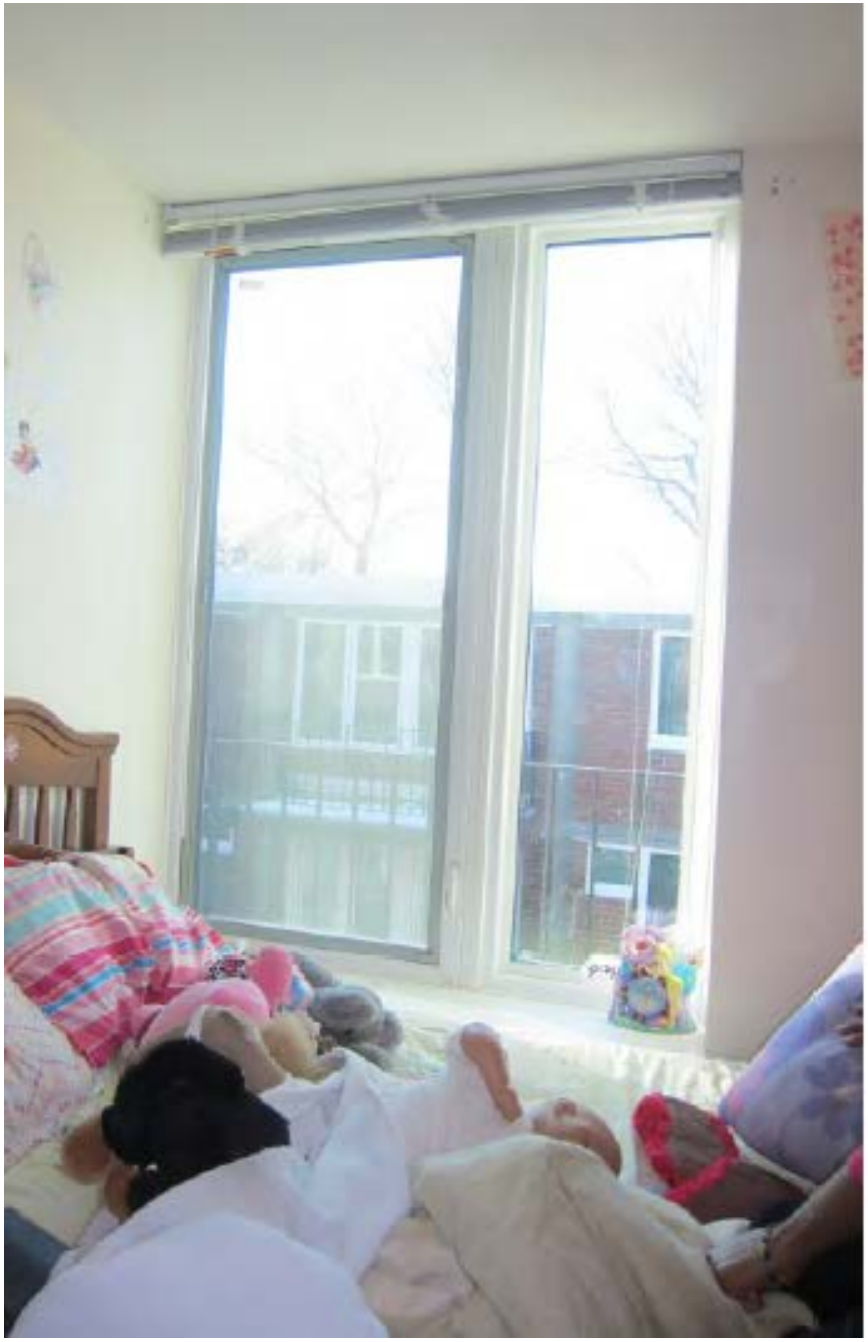
39% - 59%

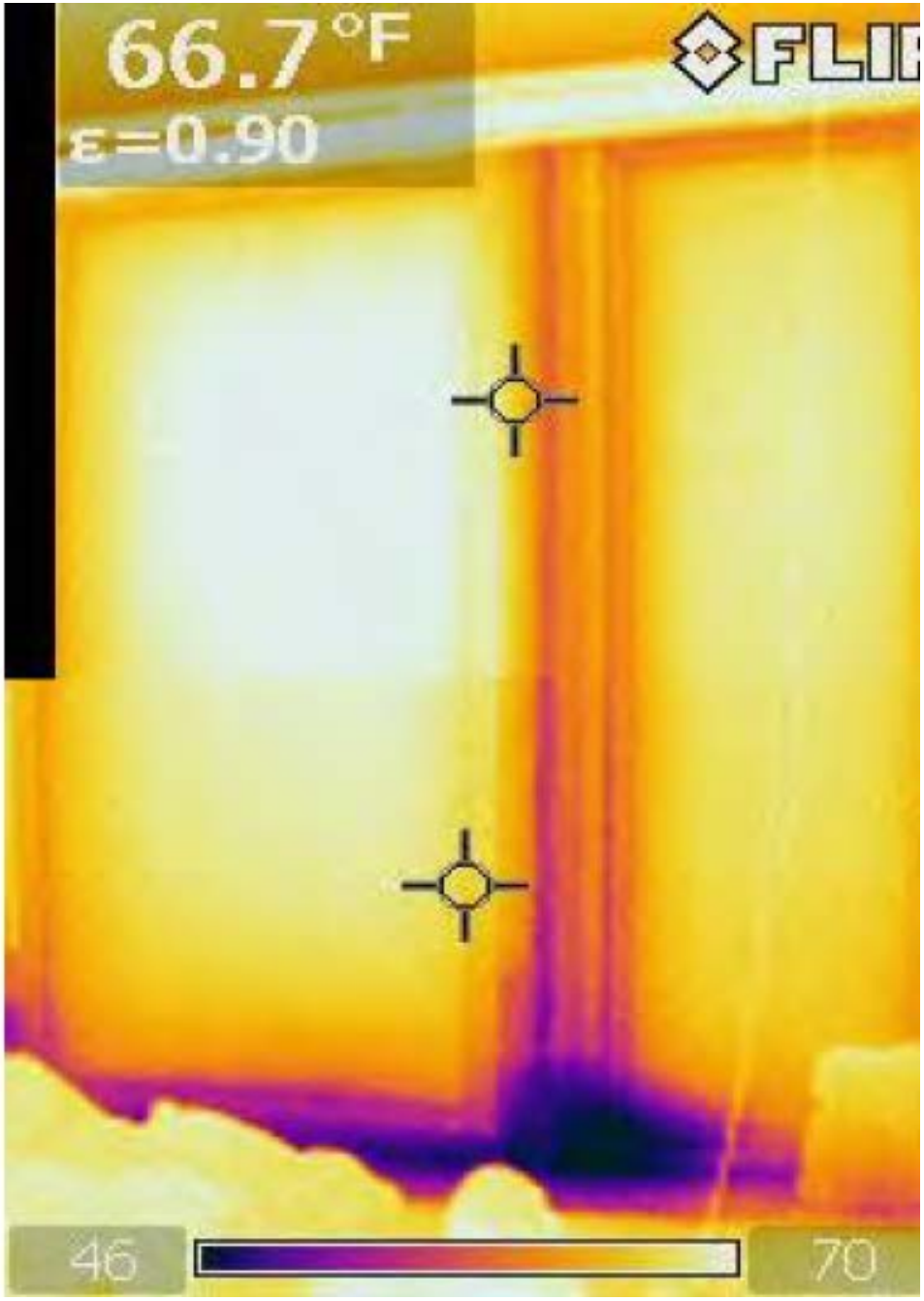
Reduction in Heating and Hot Water Usage - Post Construction
Compared to 2007-2010



Deep Energy Retrofit	Incremental Cost
Roof insulation	$45,000
Exterior wall insulation (72,000 square feet wall area)	$2,200,000
Glazing (13,000 square feet of glazing)	$74,000
Apartment Air Sealing	$160,000
Mechanical-Heat/Hot Water	$254,000
Ventilation	$132,000
Solar thermal	$600,000
TOTAL Incremental Cost	**$3,460,000**

Total cost: $8,100,000 or $42,500 per apartment




66.7°F
ε=0.90
FLIR
46
70

Resident behavior impacts performance!

The most efficient buildings in the world can still waste energy if people in the buildings are not conserving.

www.castledeepenergy.com

Large Scale Energy Reductions
Walmart 2020 Energy Goal

Jim McClendon
Walmart Design

07May2014

Formats & Footprint

Quick Stats:

>1 Billion SF
>200 Million Cust/Wk
>2 Million Associates
>10,000 Stores/Clubs
16 Countries

Walmart
Save money. Live better.

Background Goal

2005 GHG Goal

'Reduce the greenhouse gases at our existing store, club and DC base around the world by 20% over the next 7 years'

Design and build a new prototype that is 20% more efficient and produces 25% fewer greenhouse gases that our 2005 prototype

DEVELOPMENT TIMELINE

Walmart
Save money. Live better.

FIRST TEST
LED Parking Lot Lights
NHM #3497 detailed Full

PROTO
LED light for produce

Green signage is **Proto**

Green & White LED signage Testing; Red is **Proto**

LED Case Lights **Proto**

DOE

FIRST SUP TEST
LED Parking Retrofit#5260 Rogers, #359 Fayetteville, #3828 Longview

FIRST INSTALL
McKinney , TX
Gen-1 LED Case Lts

FIRST INSTALL
#26 Leavenworth SC
New LED parking

PROTO
LED Parking Lot

White signage is **Proto**

CBP

DOE

Red LED signage Testing

1st Full Store LED
#5990 Wichita

2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012

Energy Efficiency Projects → 8000 Projects

Concept Development

McKinney, TX #206
Experimental Project
Open

Aurora, CO #5334
Experimental Project
Open

DOE

1st CO2 Refrigeration TEST
Sam's #8202 Sandfly, GA

HE.1 Projects
4553-Kansas City, MO
#3837 Rockton, IL
#4240 Highland Village, TX
Grand Open

HE.2 Projects GO
#4531 Romeoville, IL
#3731 Bernalillo, NM
#4321 Wichita, KS
#1800 Garland, TX

HE.3 Projects
#1954 Sanford, ME
#3860 Liberty, OH
#1151 Kansas City, KS
Grand Open

HE.6 Projects
#2735 Sacramento, CA
#6622 Sacramento, CA
#5134 Bakersfield, CA
Grand Open

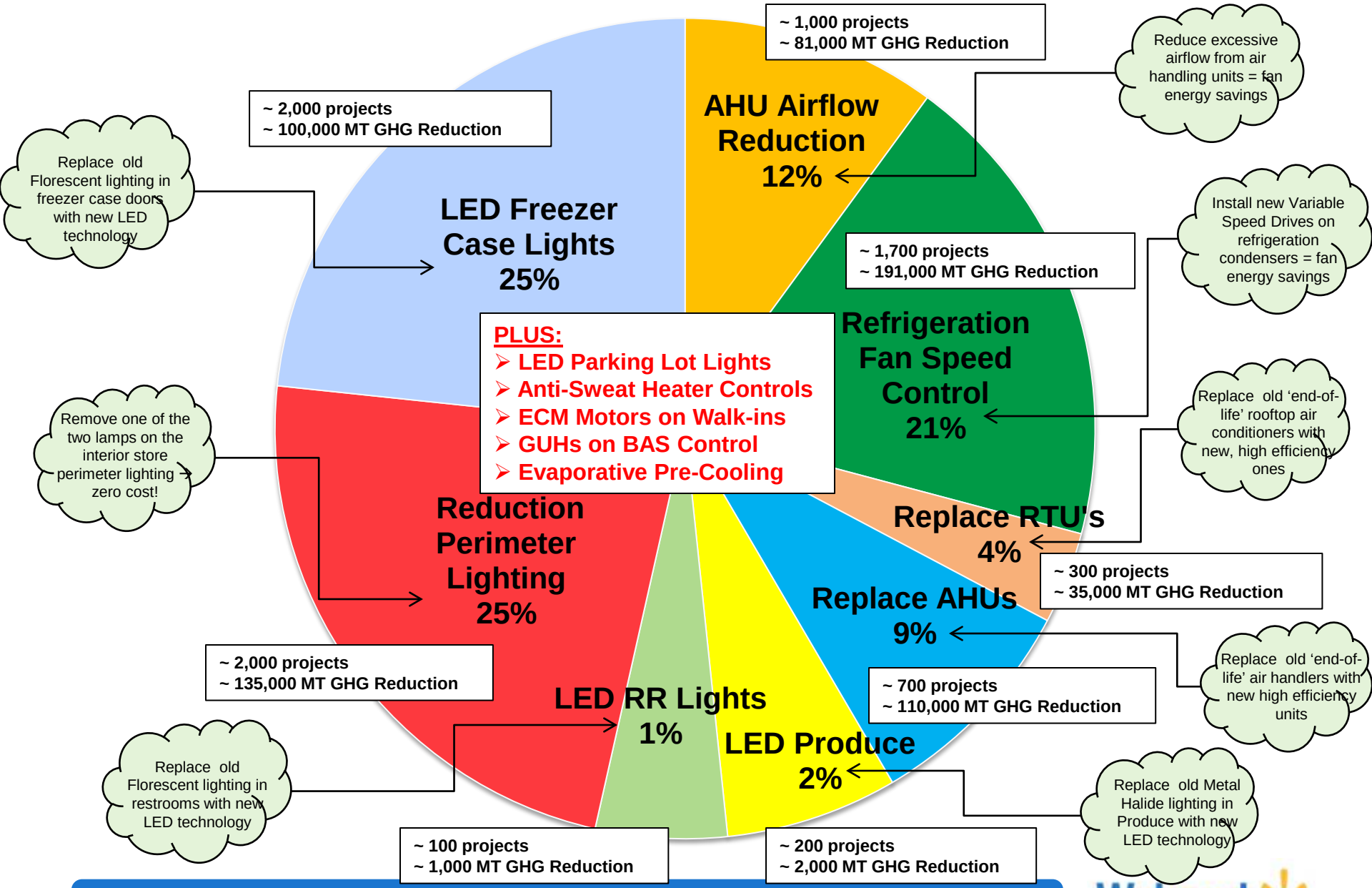
HE Proto Pilots

1st 100% LED SUP
So Euclid, OH

DOE

PROTO CO2 Refrigeration

~8,000 Projects Completed (2005 – 2011):



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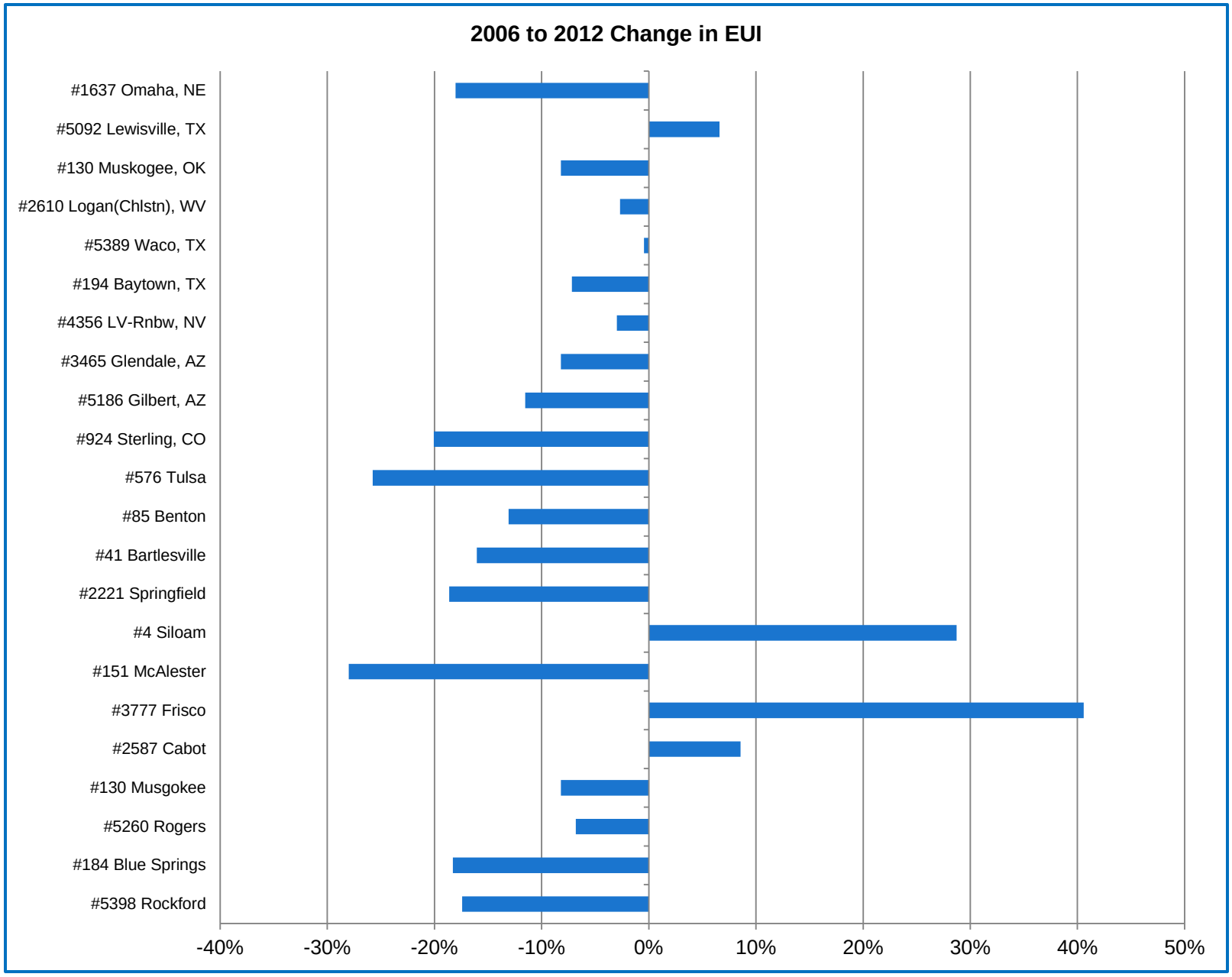

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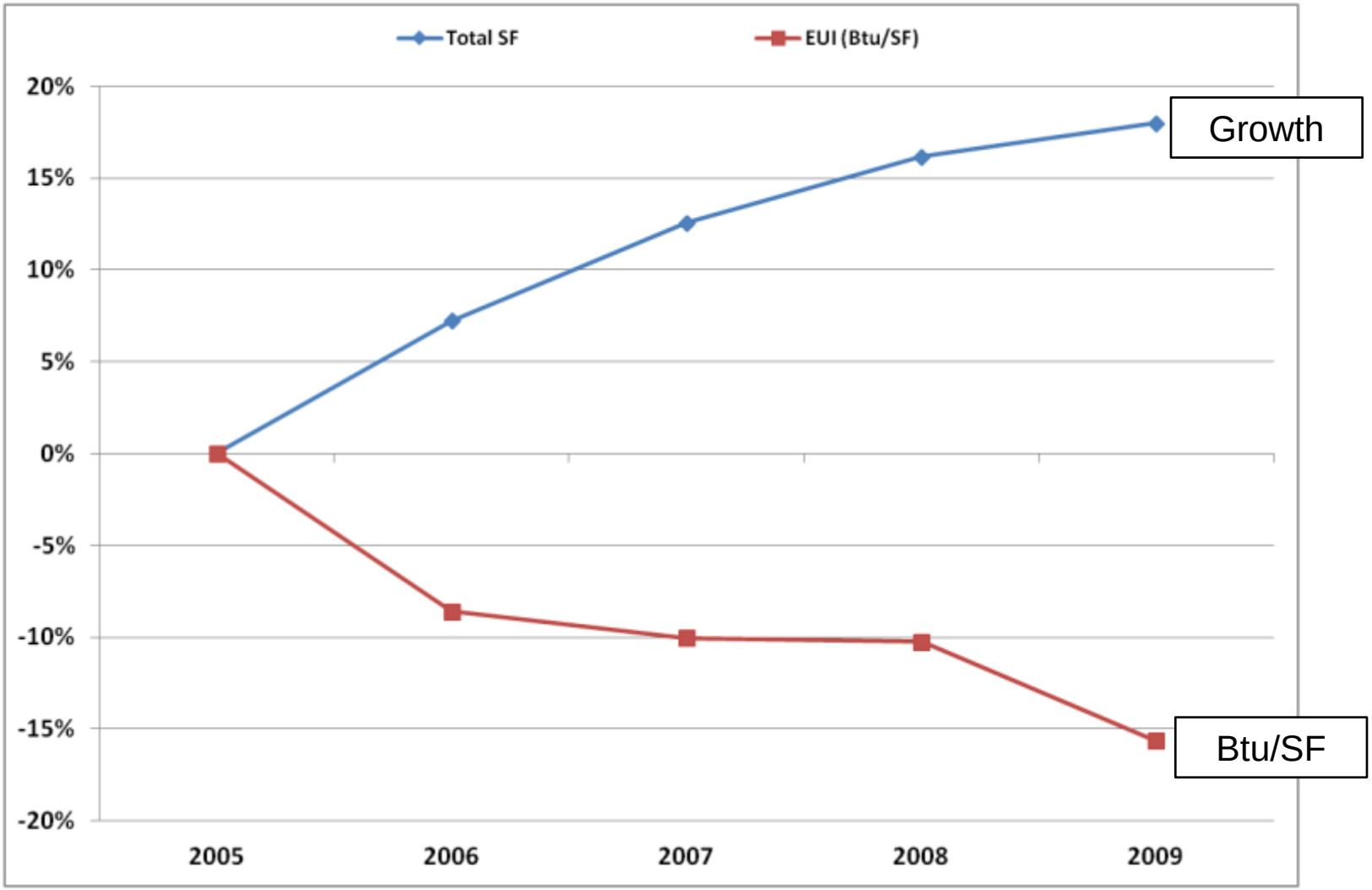
Energy Achievements
(US Only)



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On April 15, 2013 we announced two new corporate energy goals for 2020

Walmart is on the path to being supplied by 100% renewable energy.

We will take a two tiered approach by both increasing renewable energy usage and increasing energy efficiency with the following commitments:

Commitment 1: scale renewables

Public Goal

Drive the production or procurement of 7 billion kWh of renewable energy globally by December 31, 2020—an increase of over 600% versus 2010

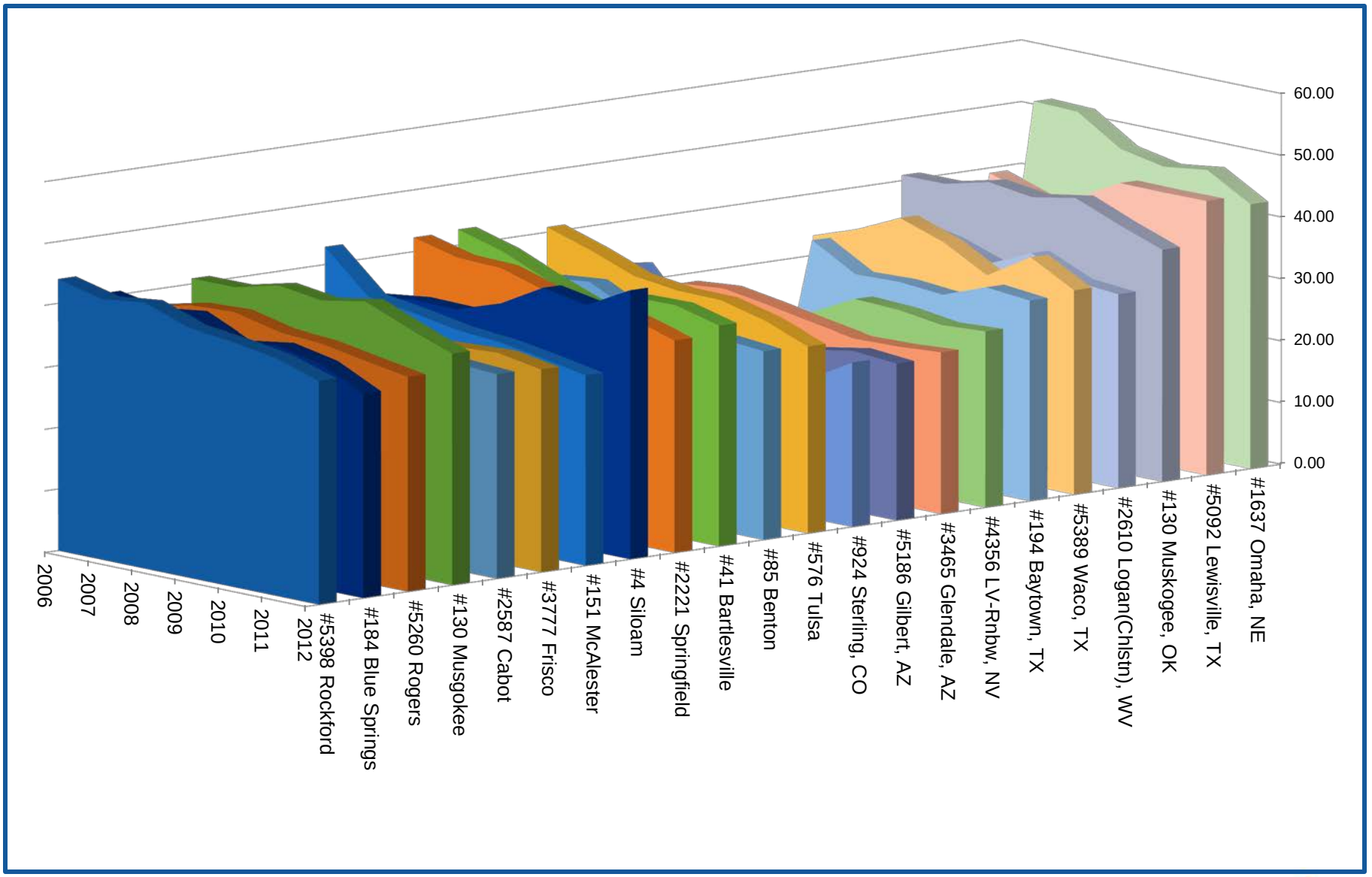
Commitment 2: accelerate efficiency

Public Goal

By December 31, 2020, reduce the kwh/sq.ft. energy intensity required to power our buildings around the world by 20% versus 2010

Walmart
Save money. Live better.

2020 Energy Goal → Starting Where We Left Off



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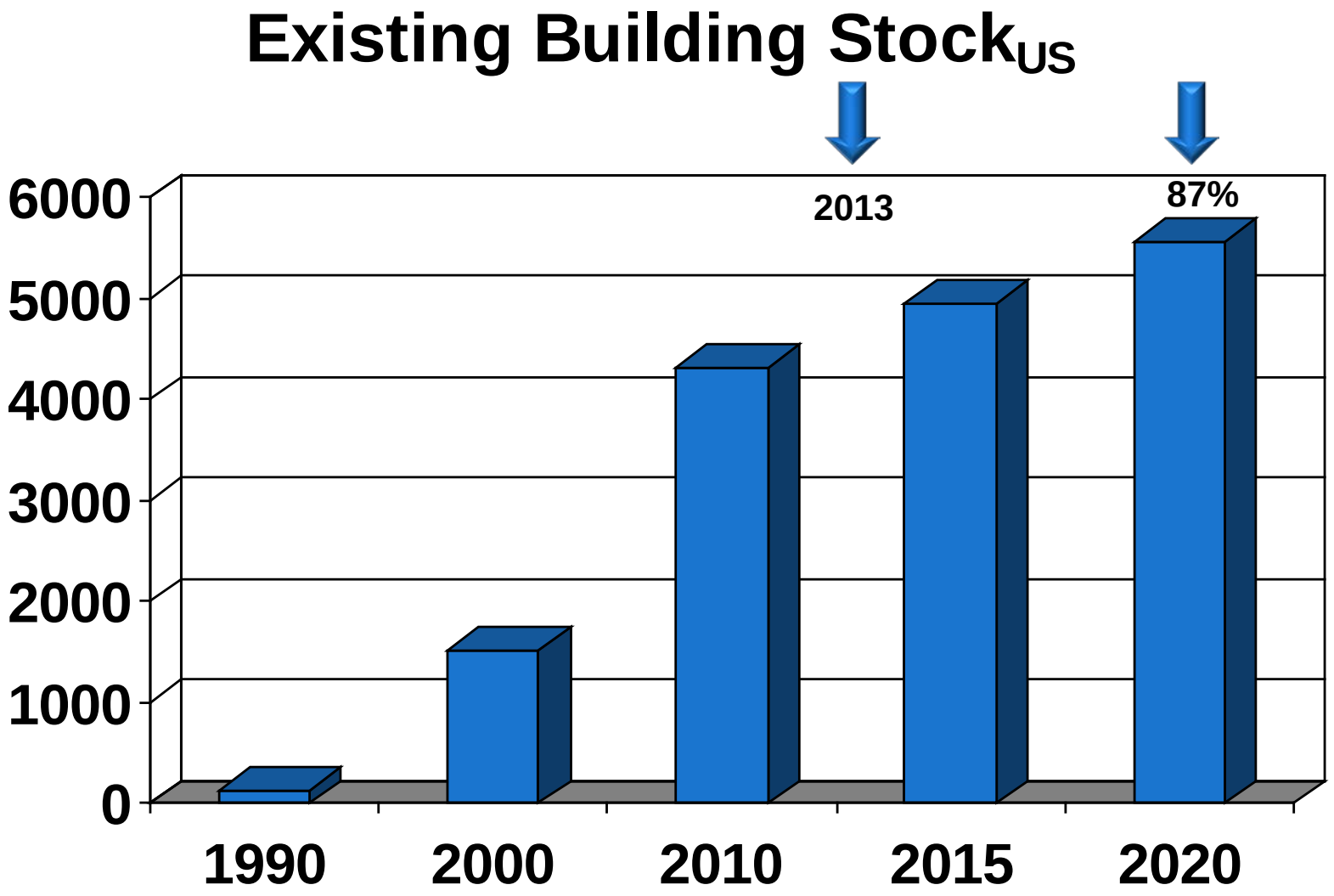
Goal is Based in the Existing Footprint



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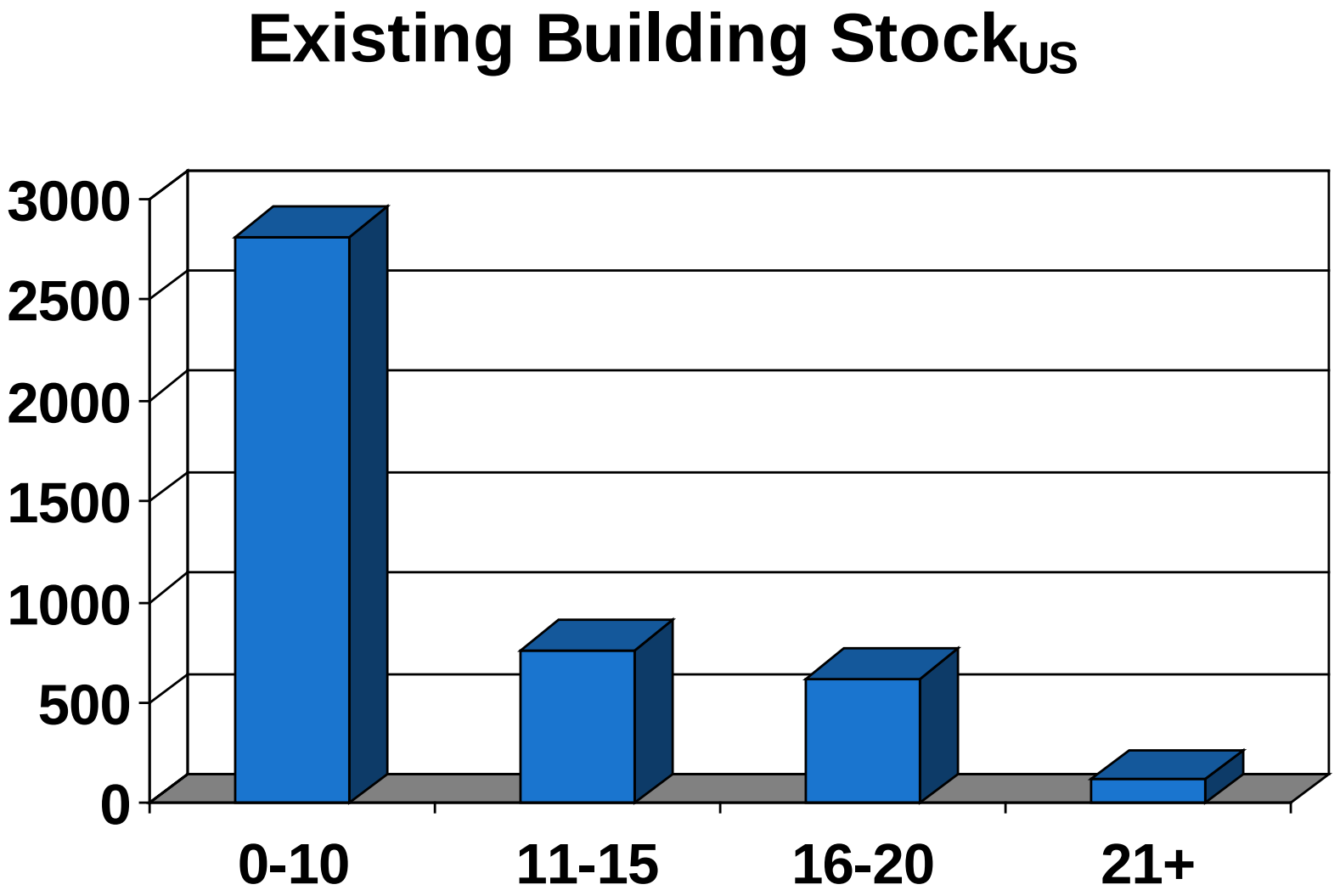
Goal is Based in the Existing Footprint



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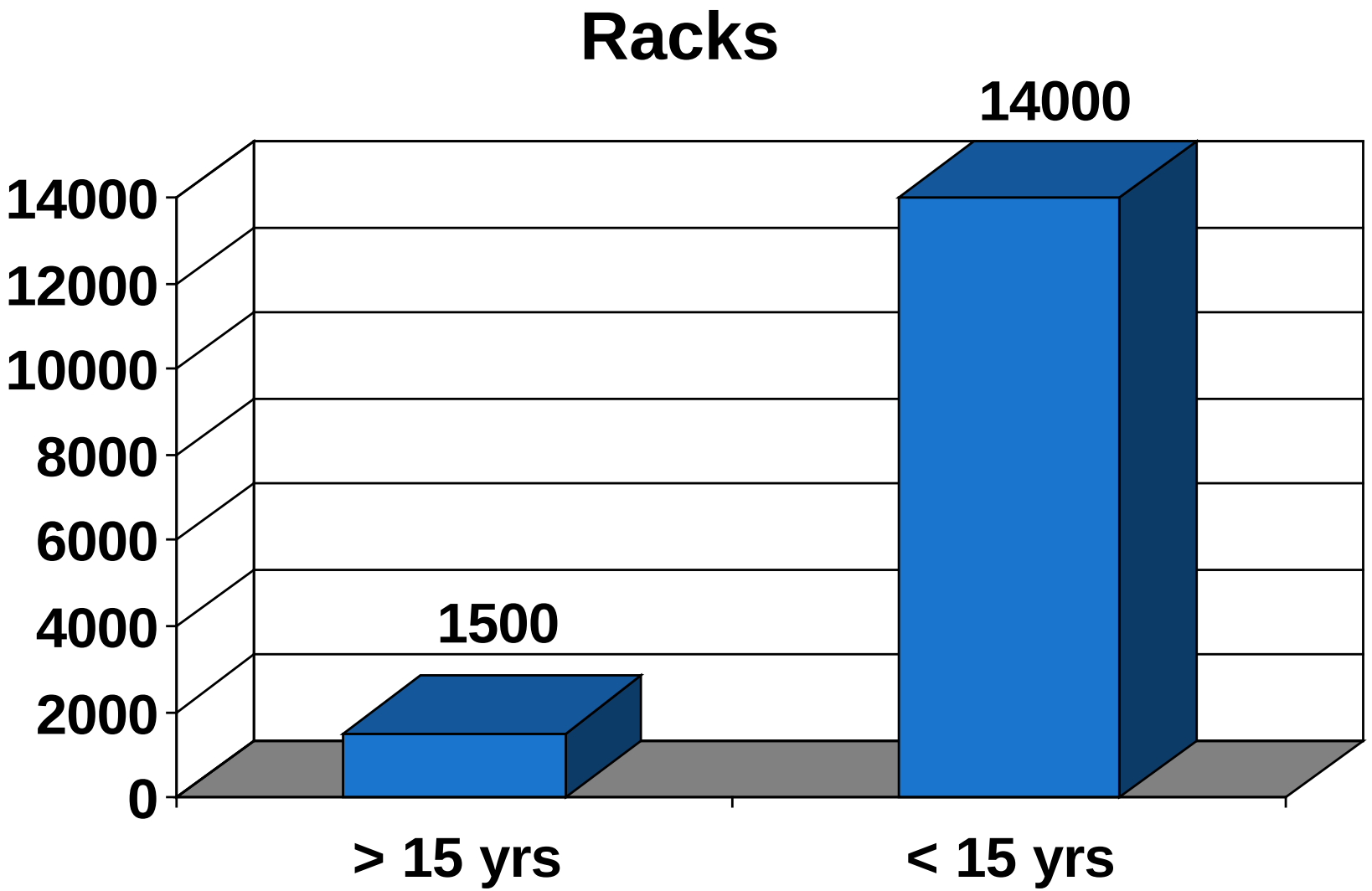
Footprint Opportunities



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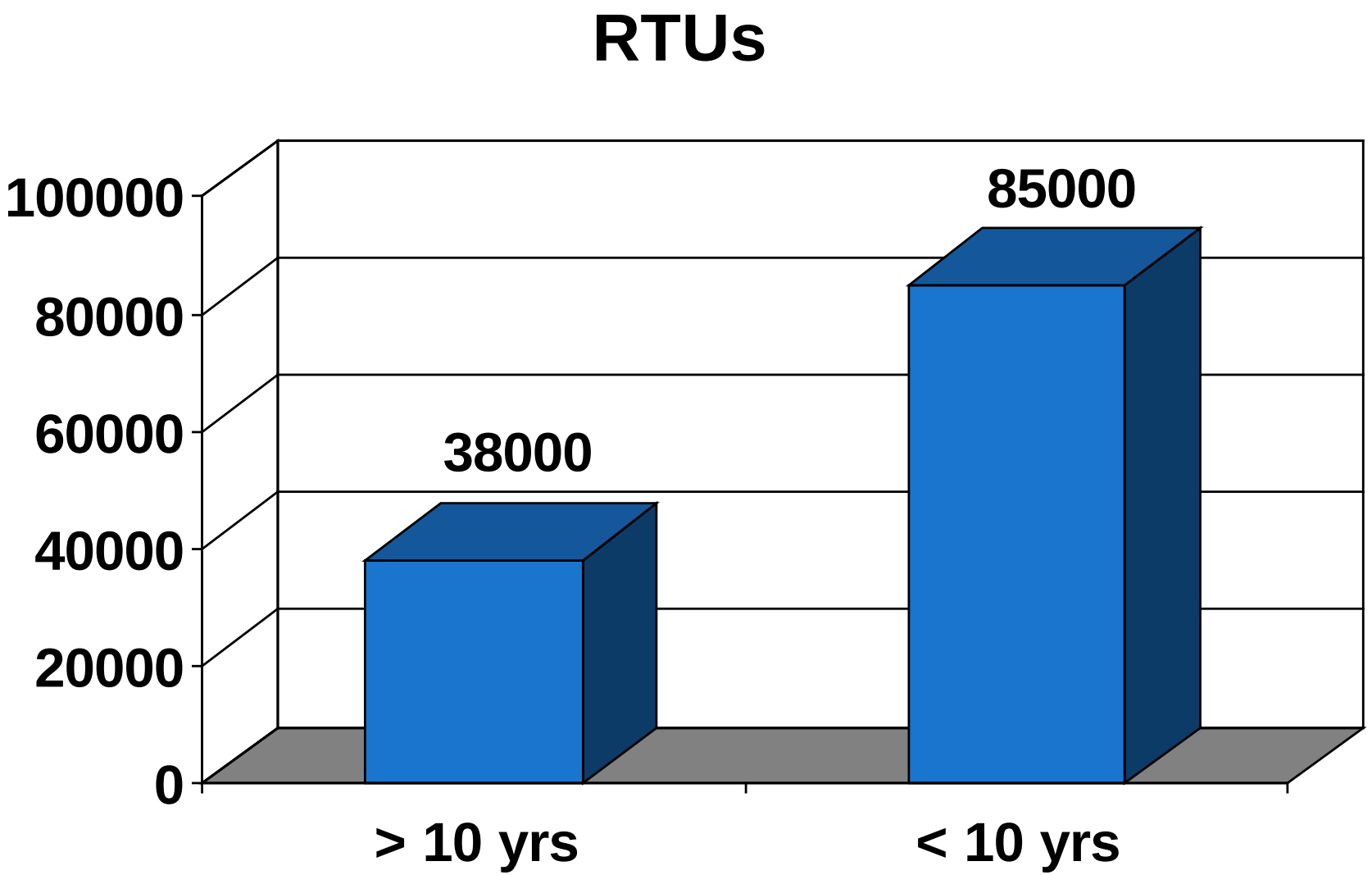
Footprint Opportunities



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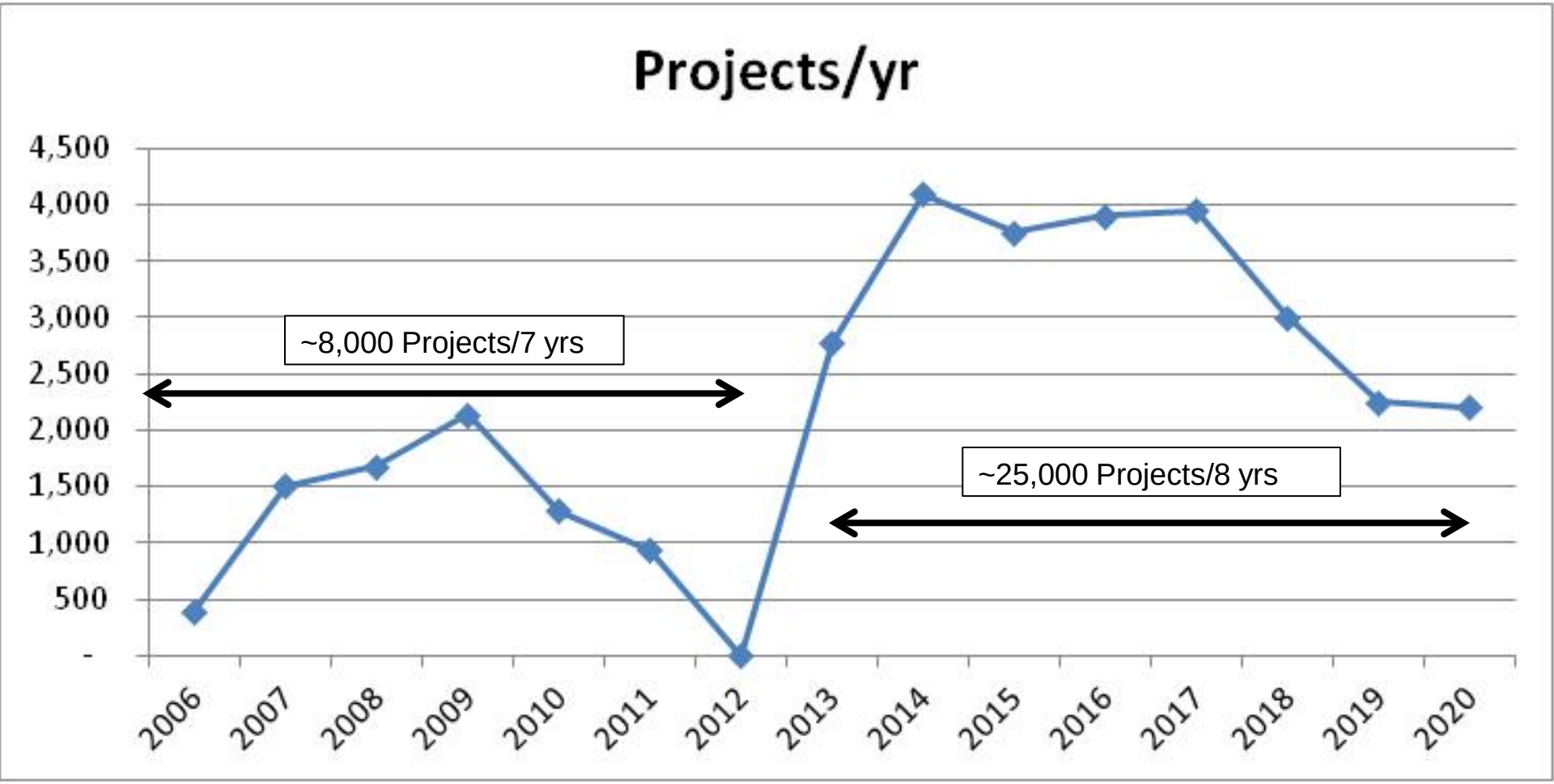
EE Projects Opportunities Example → 2005 Goal vs 2020 Goal



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APPROACH

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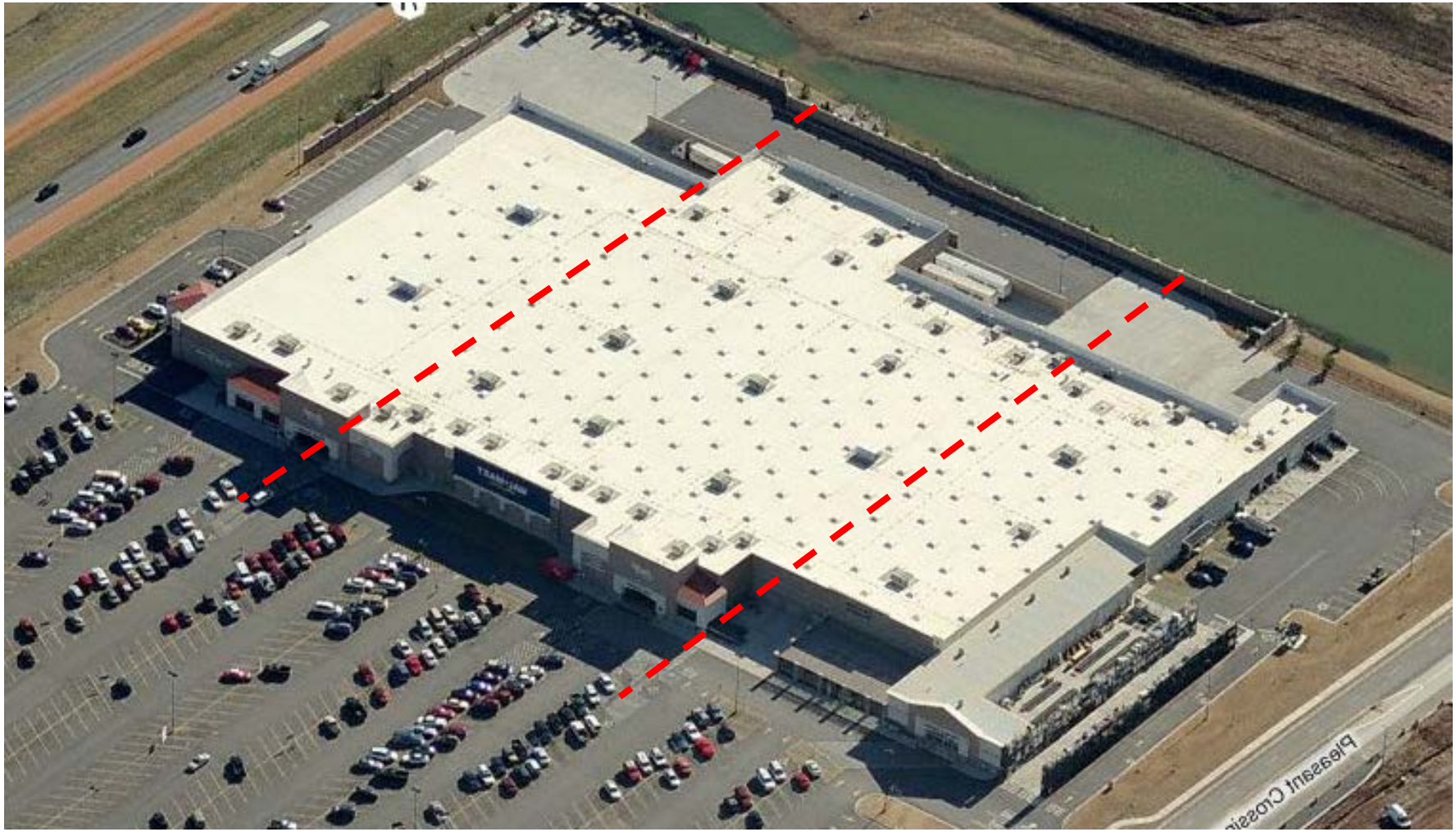

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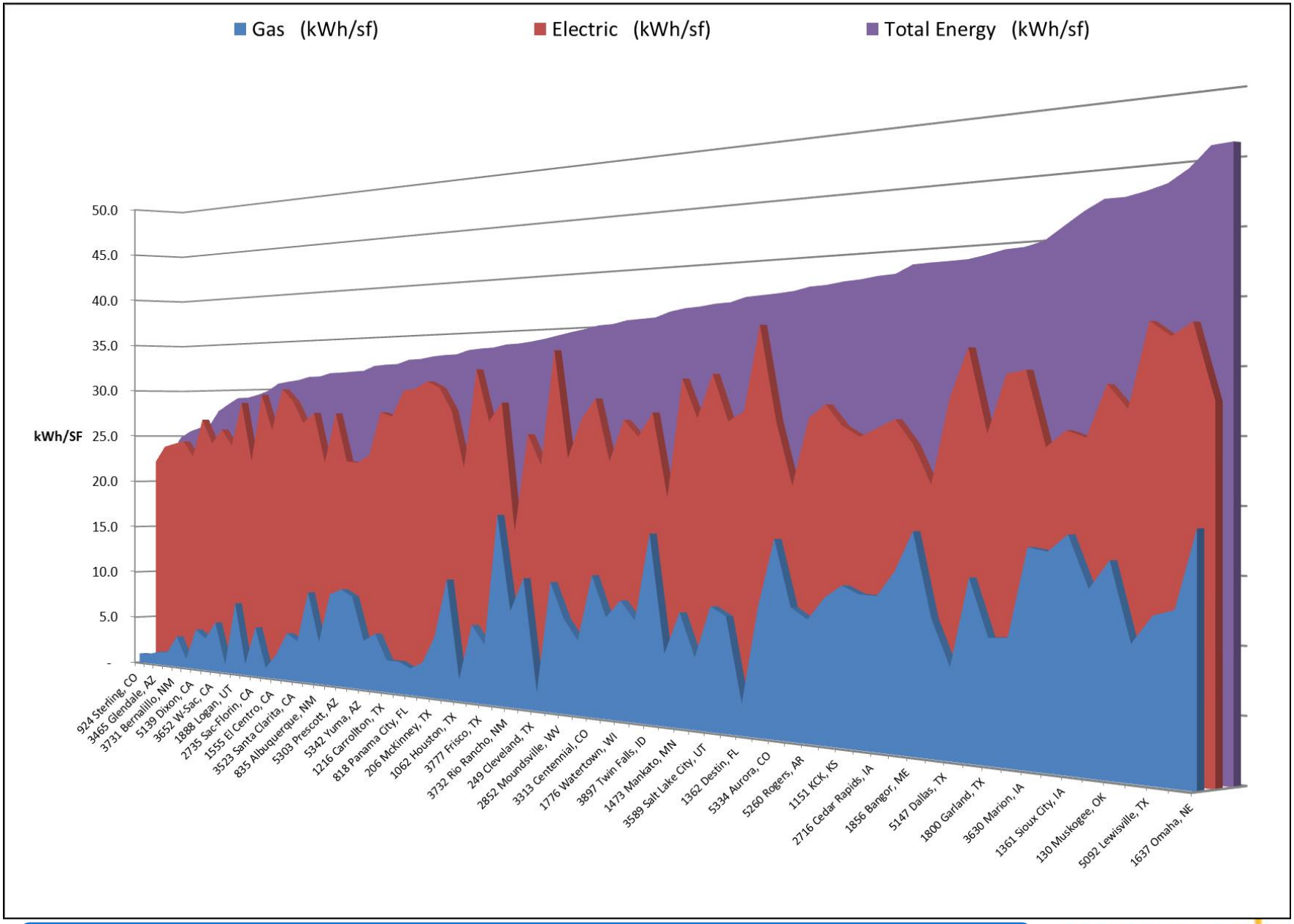
2020 Energy Goal Strategy

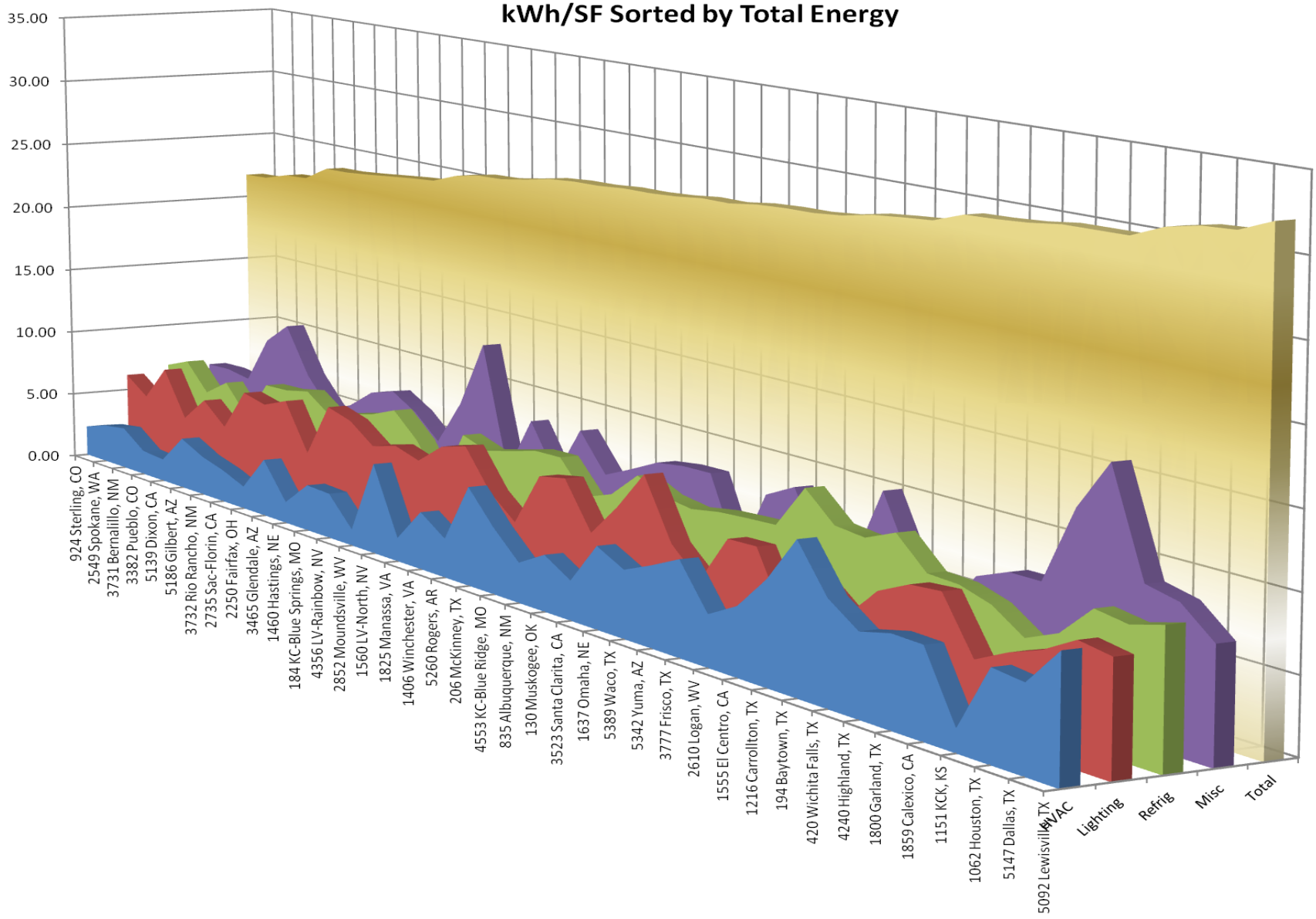
Large scale, portfolio wide energy efficiency project identification;

- *Understand the footprint*
  - *Monthly Utility data at minimum / submeter data is better*
  - *All energy forms; electric, gas, other*
  - *Sort by format, region, operation*

- *Look for patterns & trends → establish 'normal' and identify the outliers*
  - *Range of deviations*
  - *Best / worst performers*
  - *What's right – what's wrong*

- *Initiative Ideation*
  - *Int/Ext SMEs, Utilities, NGOs, GO's, Formal/Informal…*
  - *Sort by; 1) Load Reduction, 2) Free Energy, 3) Efficiency*
  - *Filter by; 1) OTS-ROTS-NT, 2) Return on Investment, 3) Resources*

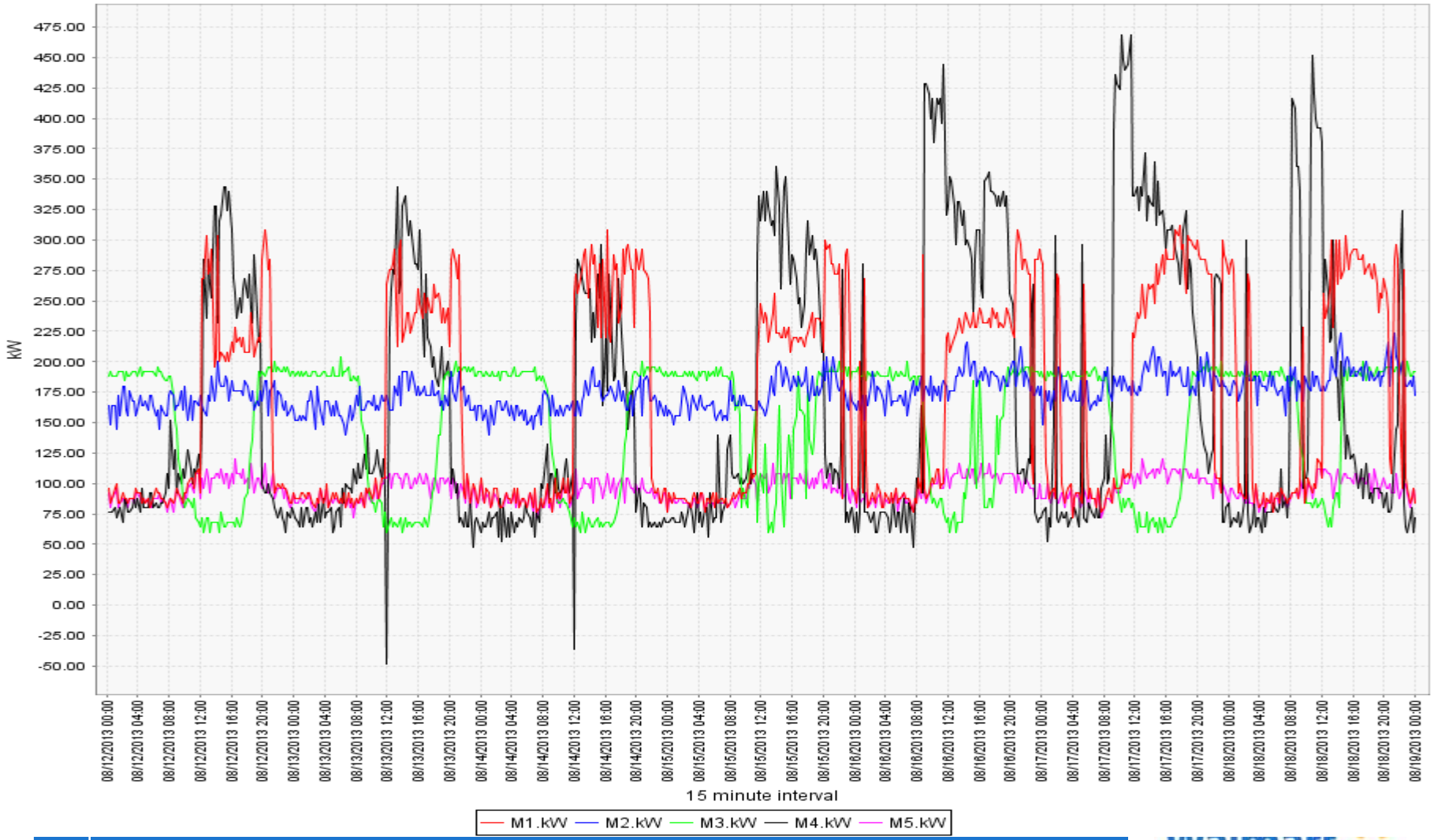




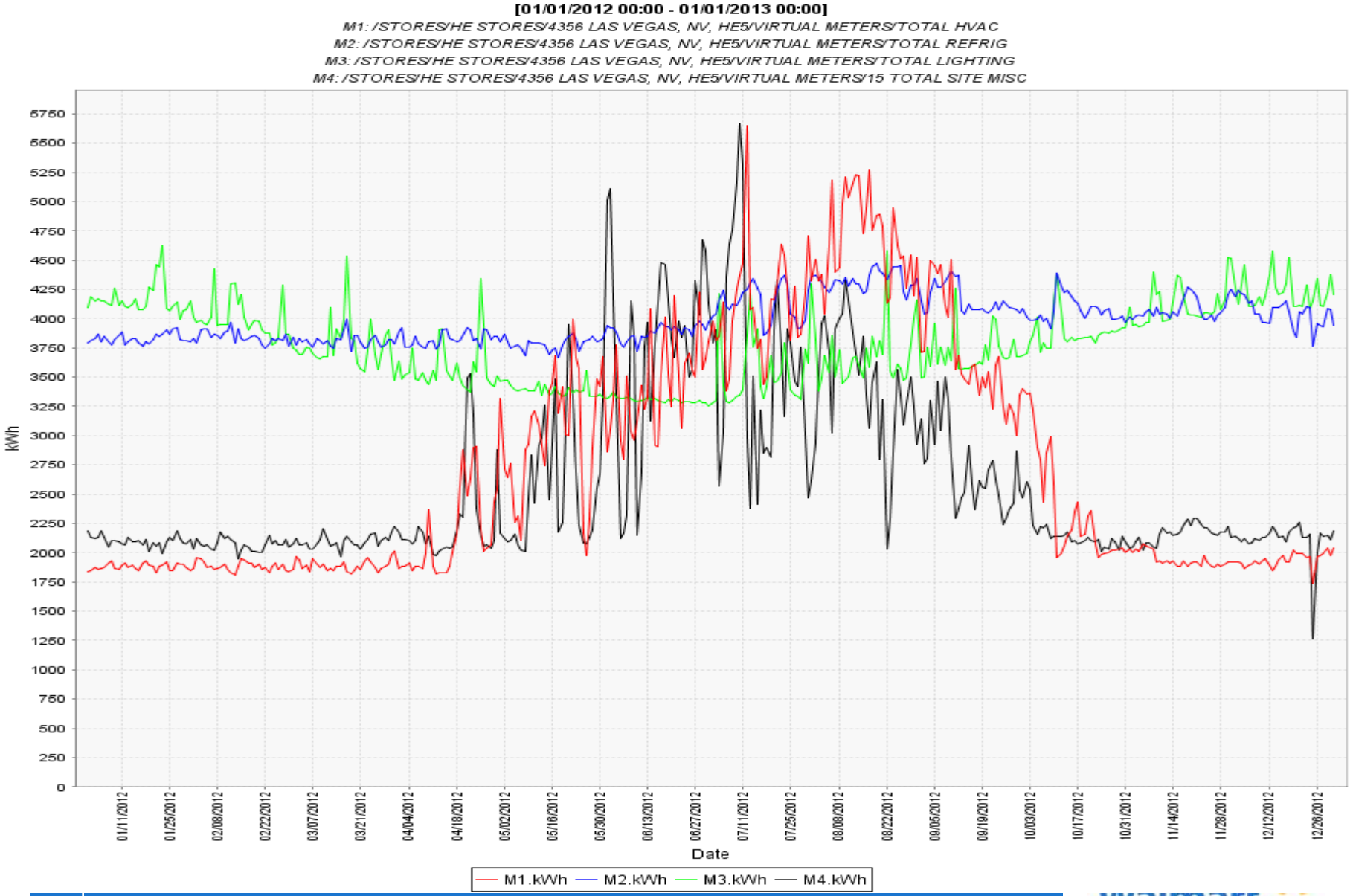
4356, Las Vegas, NV
Previous Week (kW), 15min interval Reading

[08/12/2013 00:00 - 08/19/2013 00:00]

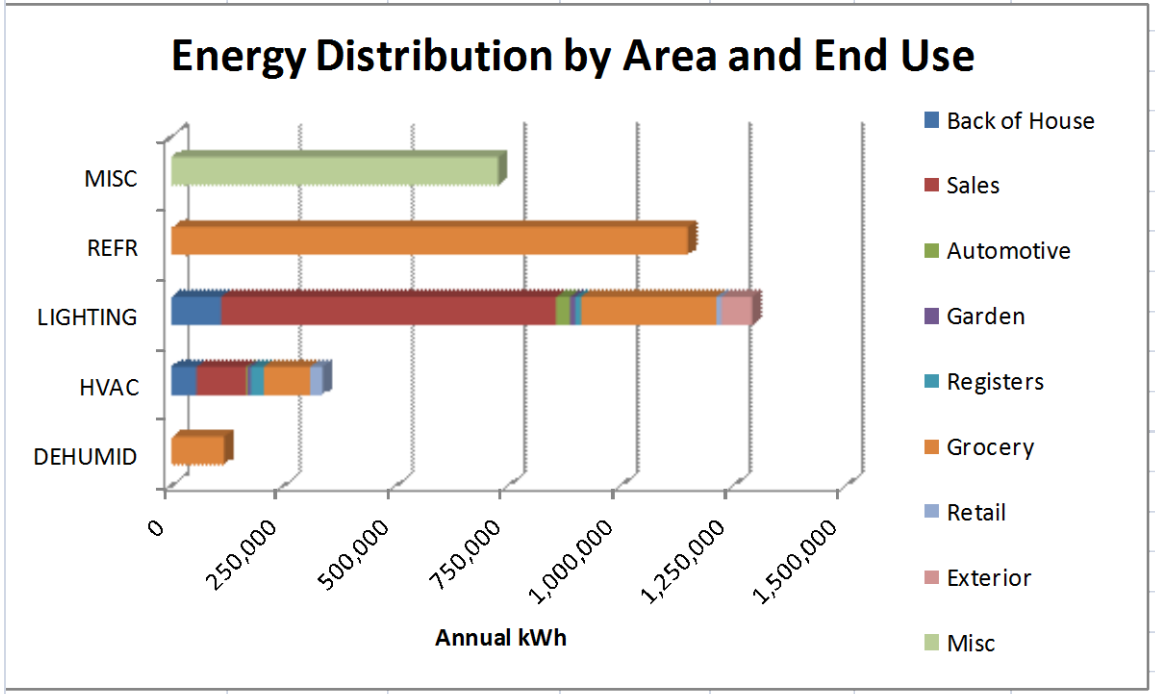
M1: /STORES/HE STORES/4356 LAS VEGAS, NV, HE5/VIRTUAL METERS/TOTAL HVAC
M2: /STORES/HE STORES/4356 LAS VEGAS, NV, HE5/VIRTUAL METERS/TOTAL REFRIG
M3: /STORES/HE STORES/4356 LAS VEGAS, NV, HE5/VIRTUAL METERS/TOTAL LIGHTING
M4: /STORES/HE STORES/4356 LAS VEGAS, NV, HE5/VIRTUAL METERS/15 TOTAL SITE MISC
M5: /STORES/HE STORES/4356 LAS VEGAS, NV, HE5/VIRTUAL METERS/04 TOTAL DEHUMID

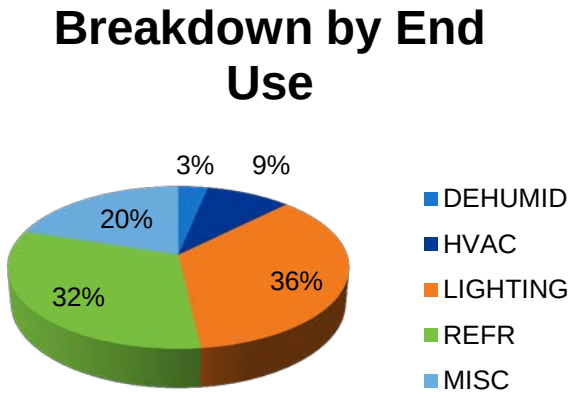


4356, Las Vegas, NV
Previous Year (kWh), 24hr interval reading (bad dehumid reading)

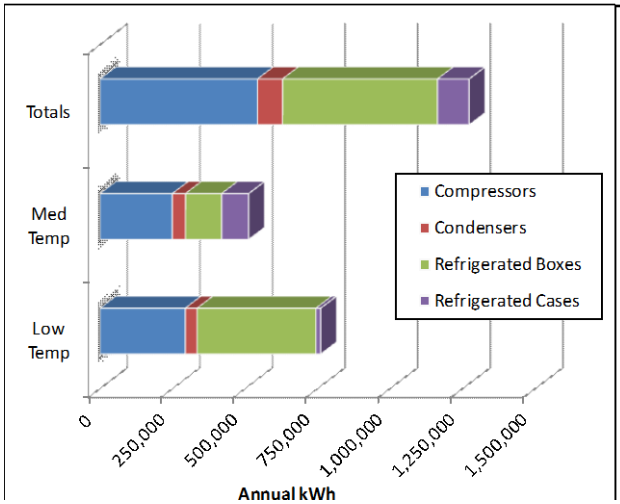


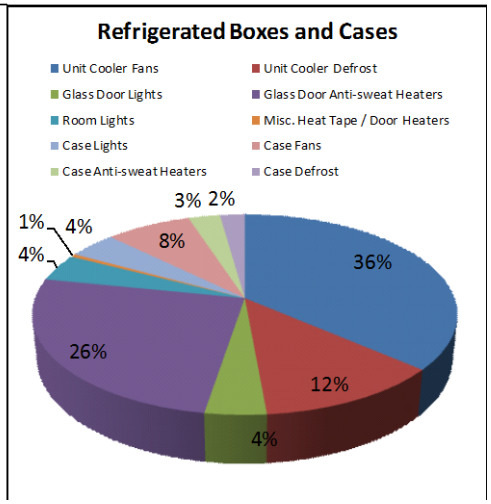
#924 Sterling Super Center kWh/Year Breakdown by Store Area						
	DEHUMID	HVAC	LIGHTING	REFR	MISC	TOTAL
Back of House		55,624	110,177			165,800
Sales		110,536	745,664			856,200
Automotive		3,487	31,098			34,585
Garden		6,928	10,732			17,660
Registers		28,750	13,642			42,392
Grocery	117,667	103,510	300,359	1,148,693		1,670,229
Retail		27,421	11,520			38,941
Exterior			68,039			68,039
Misc					727,055	727,055
Total	117,667	336,256	1,291,231	1,148,693	727,055	3,620,901
Gas (Therms)						79,800





Sam's Club #6549 Pueblo, Colorado				
End Use		Annual kWh Consumption		
		Low Temperature	Medium Temperature	Totals
Compressors	Compressors	293,556	249,057	542,613
Condensers	Condenser Fans	40,849	45,279	86,128
Refrigerated Boxes	Unit Cooler Fans	166,871	67,117	233,988
	Unit Cooler Defrost	72,898	5,612	78,510
	Glass Door Lights	13,937	11,818	25,755
	Glass Door Anti-sweat Heaters	145,324	19,248	164,572
	Room Lights	7,353	20,760	28,113
	Misc. Heat Tape / Door Heaters	3,223	0	3,223
	Walk-In Box Subtotal	409,606	124,555	534,161
Refrigerated Cases	Case Lights	1,429	26,118	27,547
	Case Fans	2,557	46,504	49,061
	Case Anti-sweat Heaters	11,022	7,147	18,169
	Case Defrost	891	13,342	14,233
	Case Subtotal	15,899	93,111	109,010
	All Total	759,910	512,002	1,271,912





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Objective :

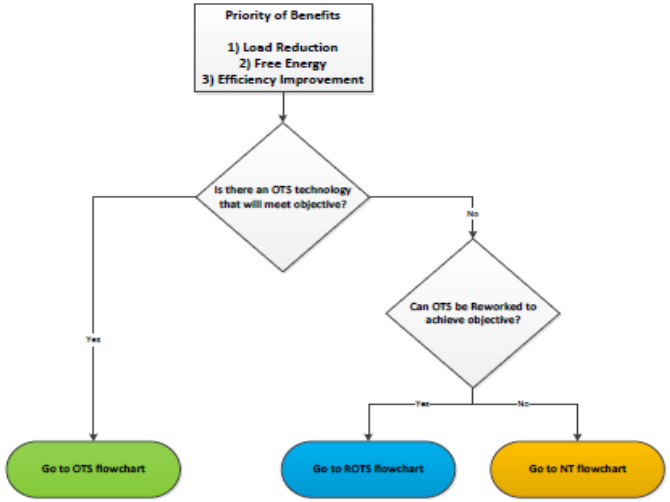
- Define the Objective; ‘Reduce the kWh/sf 20% by 2020’

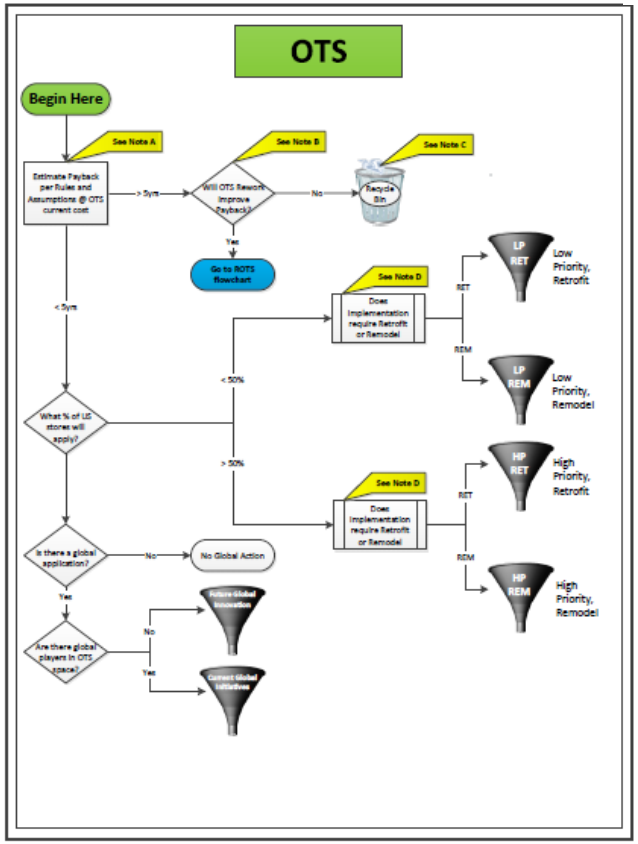
- Need to ‘Fill the Funnel’…with EE projects that make economic sense → FOCUS ON EXISTING BUILDINGS

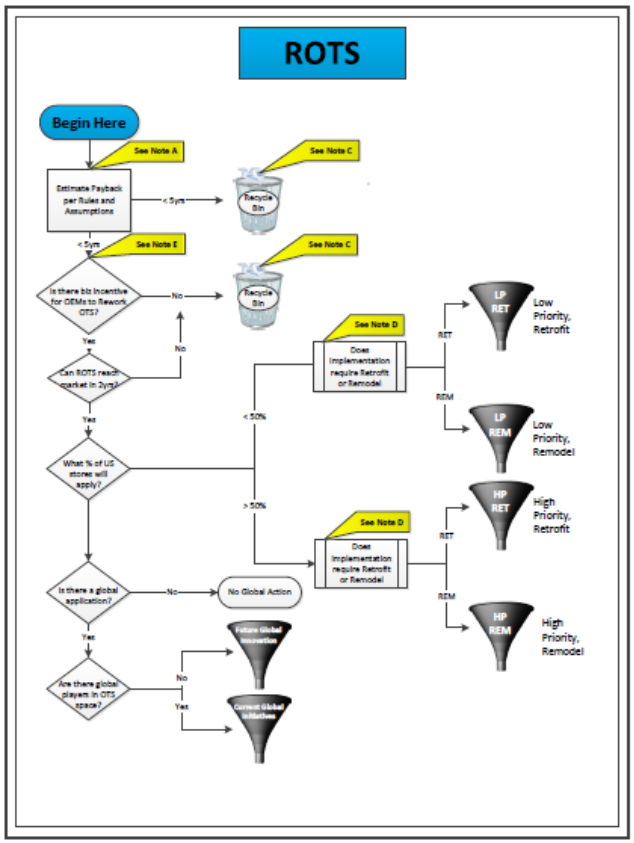
- Basic Concept;
  - *Assemble a diverse group of Subject Matter Experts (SMEs), explain the objectives, outline the limits & boundaries, provide them the tools they need…and let them go.*

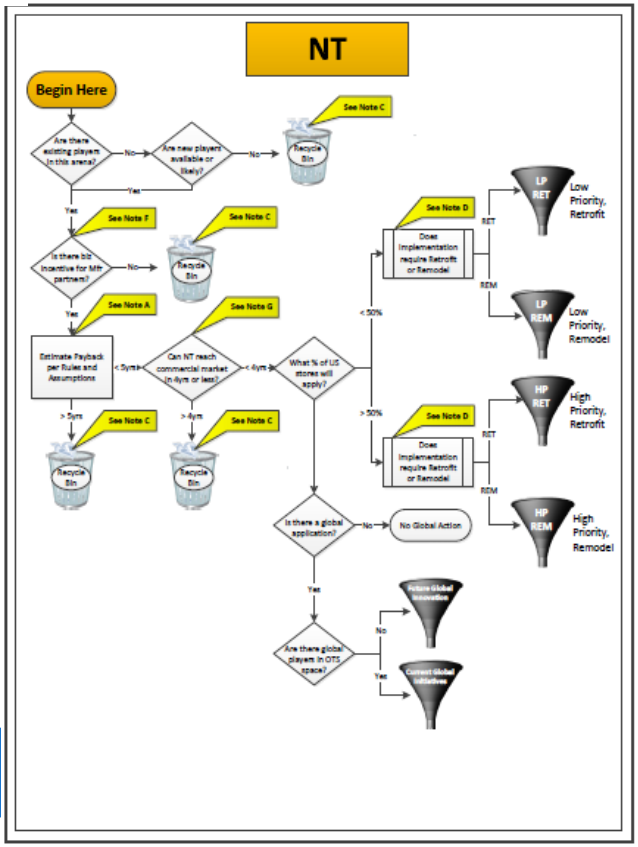
- Know your SME’s;
  - Internal, Consultants, Utilities, DOE, Universities

Strategy Discussion Path









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Thank You

Questions?

U.S. DEPARTMENT OF ENERGY