BIGGEST BANG FOR THE BUCK

How to improve building performance in affordable multifamily buildings

Housing Washington – October 7, 2015

Introduction

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Moderating on behalf of the
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Solutions Affinity Group

HOUSING
DEVELOPMENT
consortium

Presenters

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Walsh Construction WA

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360 Analytics

Richard Loo,

Bellwether Housing

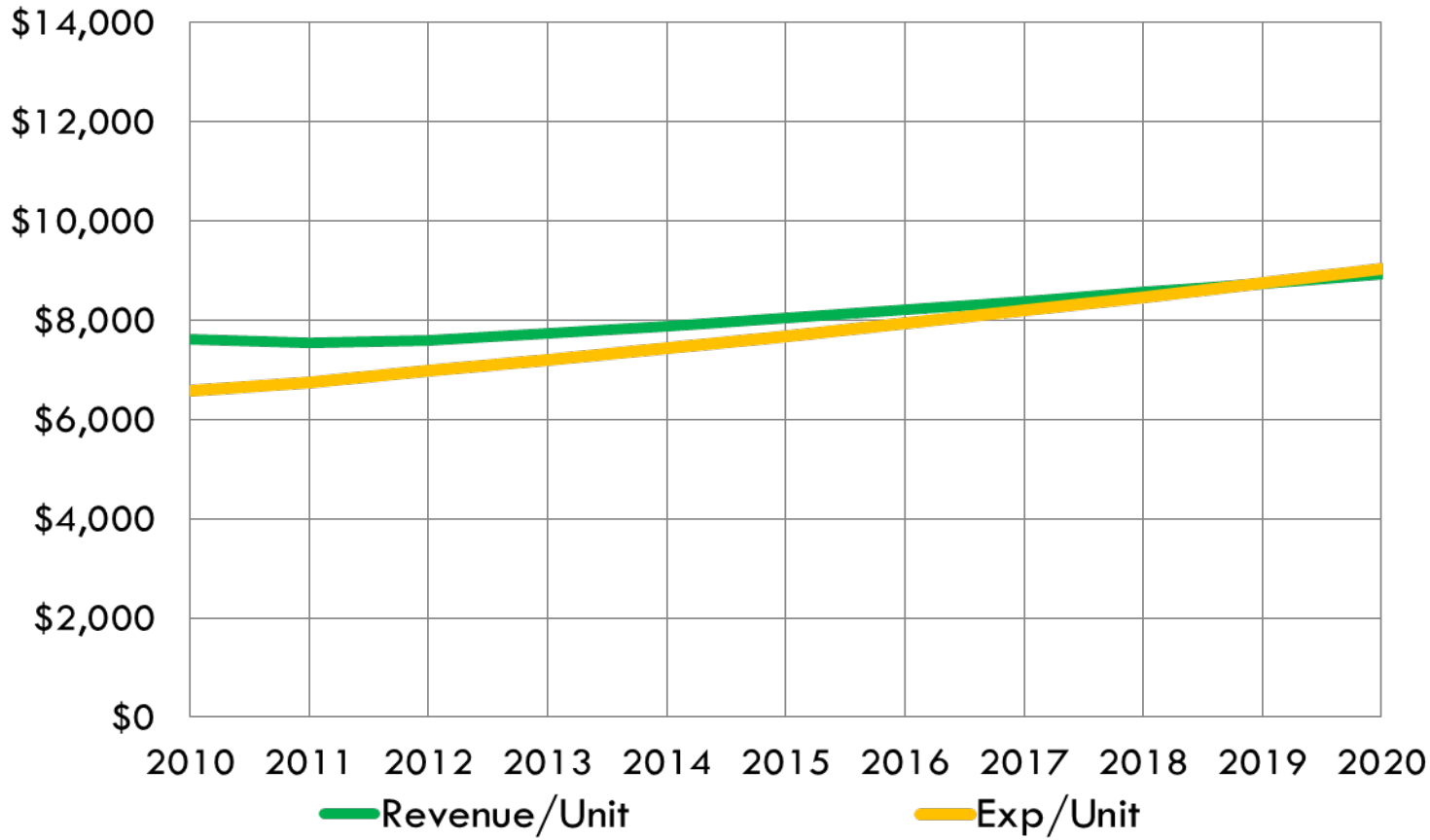
Background

King County HDC Practical Development Solutions

Information sessions held related to energy, specifically:

- Building Envelope
- Lighting and Controls
- Heating & Water Heating
- Renewables
- Resident Behavior

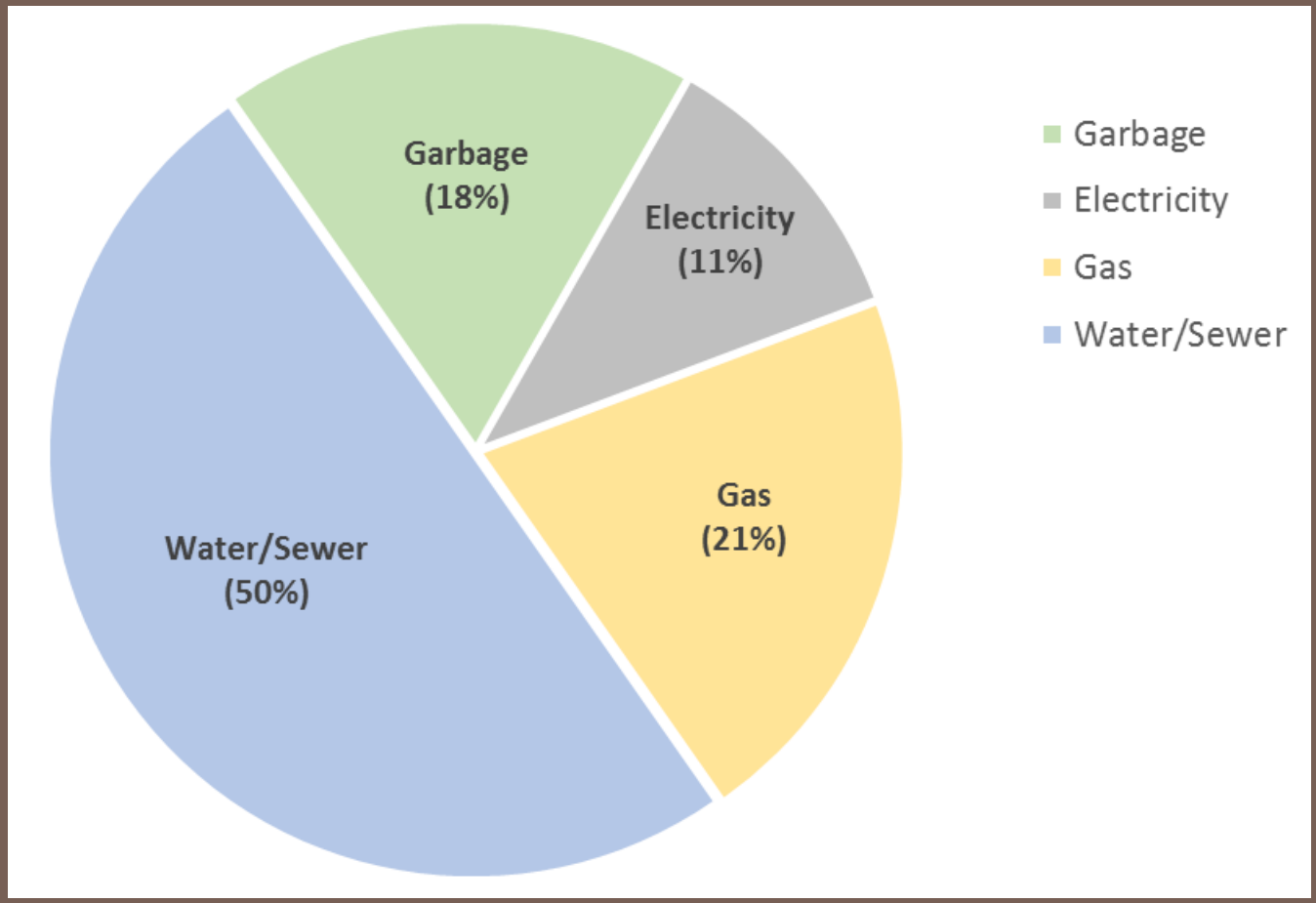
Why Utilities Are Important for Affordable Housing Projects



The Crossover – Revenues vs. Expenses

Why Utilities Are Important for Affordable Housing Projects

Bellwether Housing Annual common area utilities not paid by tenant



Energy ~1/3 of House Annual Utility Costs

Why Energy is Important for Affordable Housing Projects

Owners and funding community want to improve building performance to manage utility costs and increase efficiency.

Therefore, we're expanding our toolkit…

- integrated design with up front energy modeling & cost-benefit analysis
- benchmarking, audits & monitoring

Improved Energy Performance equates to:

- Asset longevity = preservation of affordable housing
- Reduce operating expenses = greater debt capacity
- Avoid the "cross-over" line = less demand on public resources

Energy and Affordable Housing

Goals for today

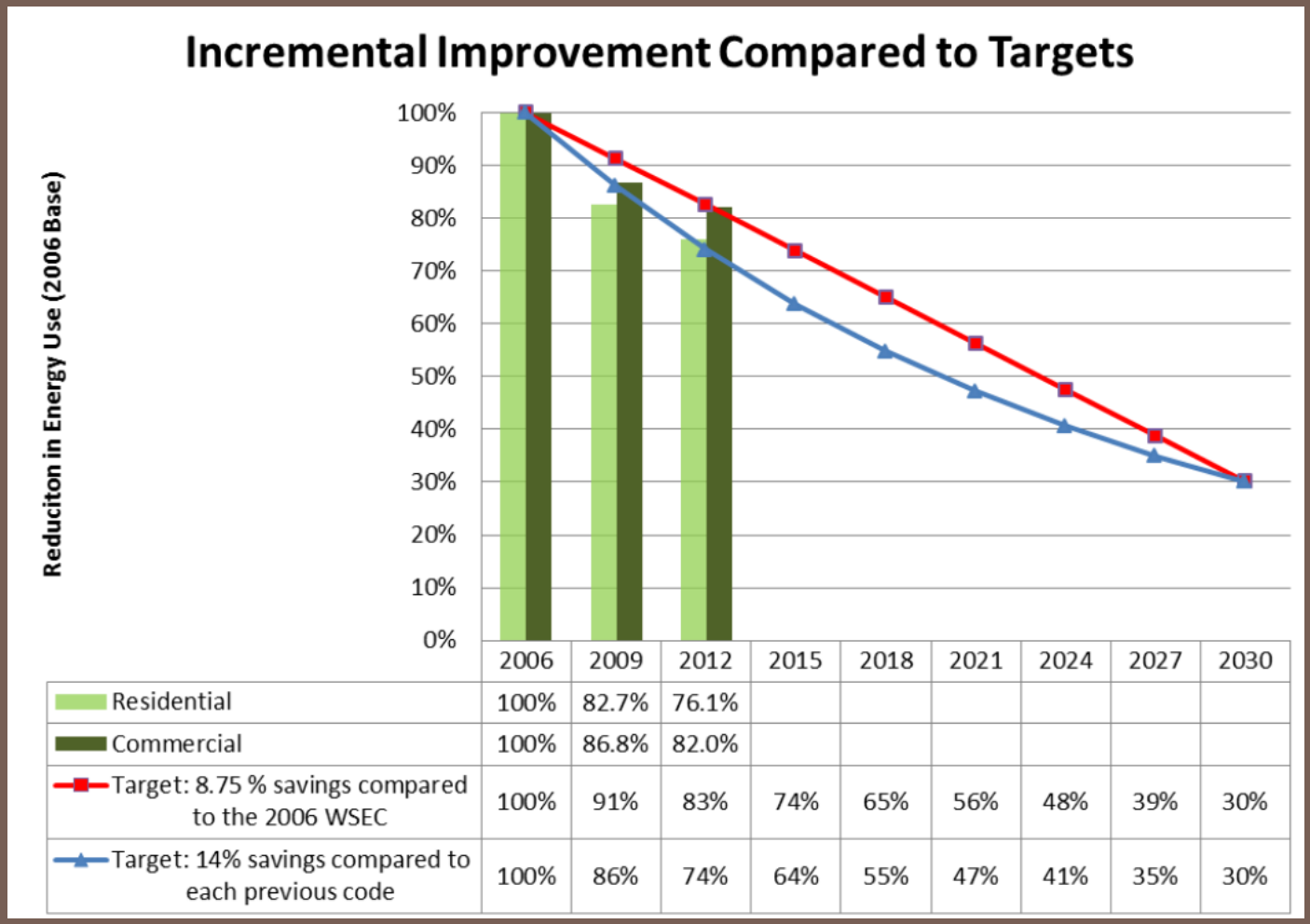
1. What are some of the current best practices with regards to improving energy performance in your new or existing building?
2. Which components of your buildings offer the biggest opportunity for improvement?

What's the Baseline?

Advancing energy code and ESDS

Washington State Energy Code

Energy codes will continue to get more stringent…



	2006	2009	2012	2015	2018	2021	2024	2027	2030
Residential	100%	82.7%	76.1%						
Commercial	100%	86.8%	82.0%						
Target: 8.75 % savings compared to the 2006 WSEC	100%	91%	83%	74%	65%	56%	48%	39%	30%
Target: 14% savings compared to each previous code	100%	86%	74%	64%	55%	47%	41%	35%	30%

What is the Baseline?

2015 Washington State Energy Code

Anticipated adoption 7/1/2016

RESIDENTIAL (Single Family and Multifamily <=3 stories)

- Ductless heat pumps (DHPs) in townhomes with electric heat*
- Increased number of required energy credits*
- All DHW piping must be insulated and HPWHs for >55gal

COMMERCIAL (Including Multifamily > 3 stories)

- 20+% lower lighting power allowances
- Additional efficiency packages*
- DHW pipe insulation and demand recirculation controls

What's The Baseline?

ESDS v3.0 Mandatory Energy

Multifamily >3 stories, choose

1 of 4 Options:

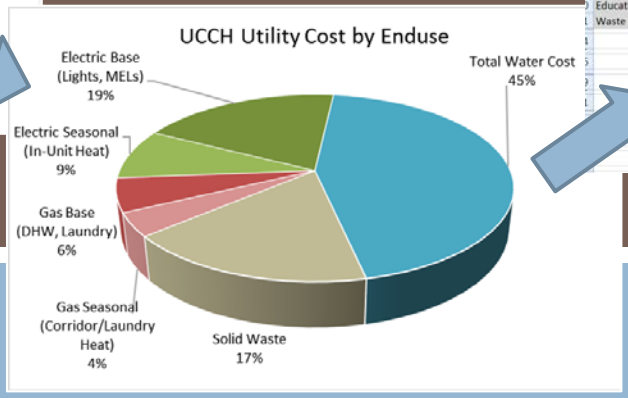
- Building Envelope –> Target UA calculation w/ ESDS mods
- Ventilation –> Air leakage and maximum ventilation rates
- Water Heating –> In-unit or central **heat pump** water heating
- Performance –> Energy modeling, XX% less than standard

Also, 90% of lighting must be LED

What's The Baseline?

The AMP Approach

How did we get here?



Areas	Resource Conservation Measure	COA 1	COA 2	COA 3	FINAL TARGET
Building Envelope		$ -	$ 242,225	$ 492,869	$ 295,853
	Residential (Non-metal) Windows/Glazed Doors	$ -	$ -	$ 62,210	$ 62,210
	Above-Grade Walls (Type V)	$ -	$ 154,558	$ 253,855	$ 154,558
	Roofs	$ -	$ 33,786	$ 49,487	$ 49,487
	Slab-on-Grade Floors	$ -	$ 10,872	$ 33,167	$ -
Air Leakage	Testing	$ -	$ -	$ 8,414	$ 8,414
Lighting	LED Lighting	$ -	$ 57,000	$ 94,000	$ 94,000
Appliances		$ -	$ (15,805)	$ (3,815)	$ -
Controls		$ -	$ -	$ 128,000	$ -
Plumbing	Low Flow Toilets & Fixtures	$ -	$ 49,715	$ 23,635	$ 23,635
Res HVAC	Cove Heaters	$ -	$ 67,102	$ 387,102	$ 67,102
CA HVAC		$ -	$ -	$ -	$ -
Renewables	Photovoltaics	$ 26,767	$ 51,825	$ 174,032	$ 51,825
Metering	Oversight/Management	$ -	$ 25,800	$ 25,800	$ 25,800
Feedback, Engagment, Education	Capture and Display Building Performance	$ -	$ 50,213	$ 70,157	$ 50,213
Waste & Recycle	Solid Waste	$ -	$ (36,874)	$ 1,826	$ (36,874)
	Premium ($)		$ 491,201	$ 1,402,020	$ 579,968
	Premium (%)		2.44%	7.23%	2.91%
	Estimated Incentives		$ (74,876)	$ (152,543)	$ (86,734)
	Annual Operational Savings				$ 76,720
	Simple Payback (including incentives)				6.43
	Internal Rate of Return (15 yrs)				18.70%

Challenges

- What's the baseline?
- Evaluating opportunities earlier in design
- Evaluating a broad spectrum of options
- Real cost estimates
- Coordination among consultants and contractors

Opportunity

Compare multiple Courses Of Action (Levels of Design) that seeks the optimum solution - construction premium vs. operational savings.

COA 1	Good	Baseline, ESDS, Code Compliant, Legal
COA 2	Better	Substantially Better than Code
COA 3	Best	Maximum Efficiency, Asks the Question What if?

Advantages

- Focused on optimum design.
- Builds the Baseline
  - Includes the Good, the Bad, and the Ugly.
  - Provides an understanding of the opportunities within
- Data Driven with tangible numbers
- Compares savings & costs
- Valued Engineering is part of the process

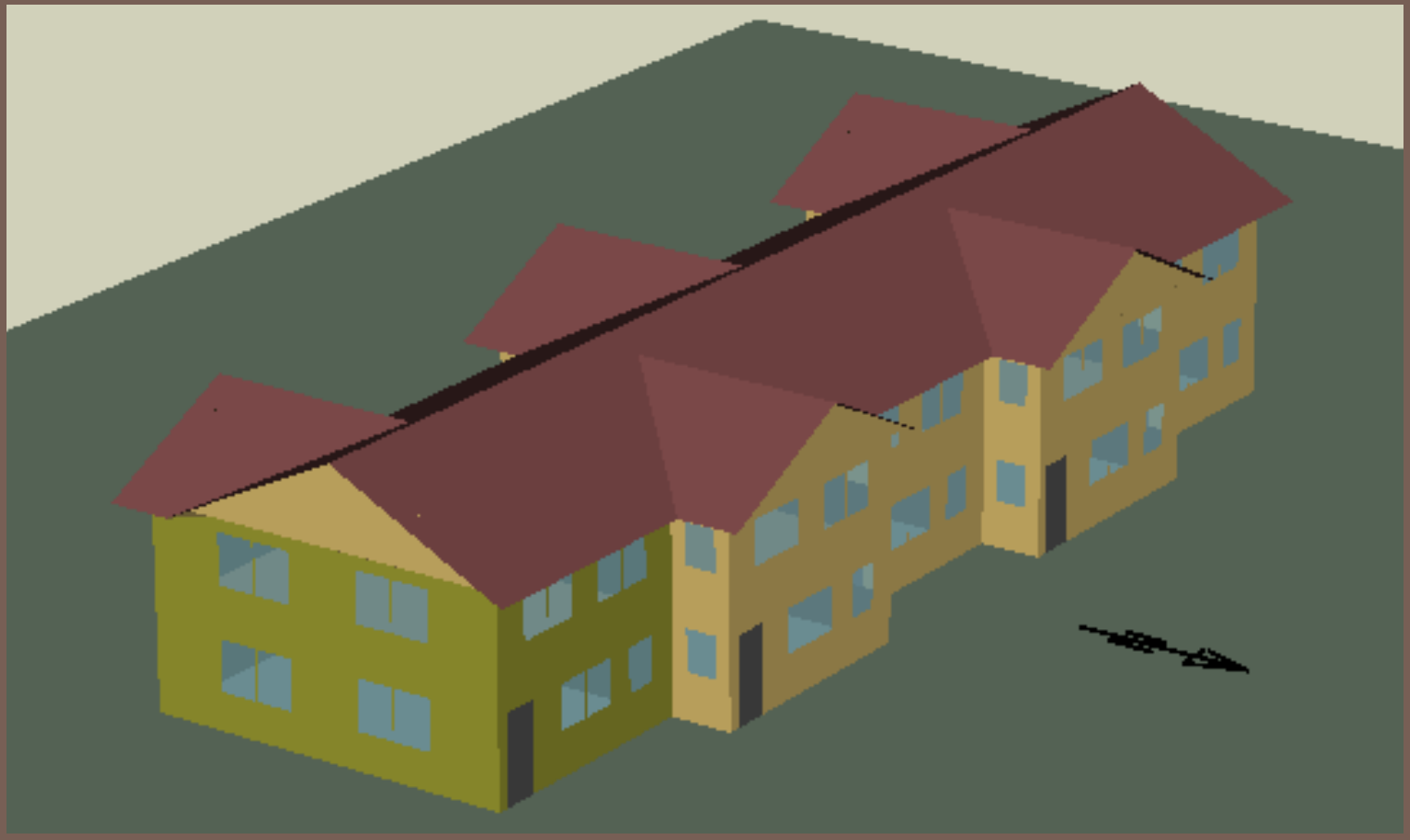
Challenges and Opportunities

Recommended best practices based on AMP and other HDC presenter experience

Building Orientation and Form

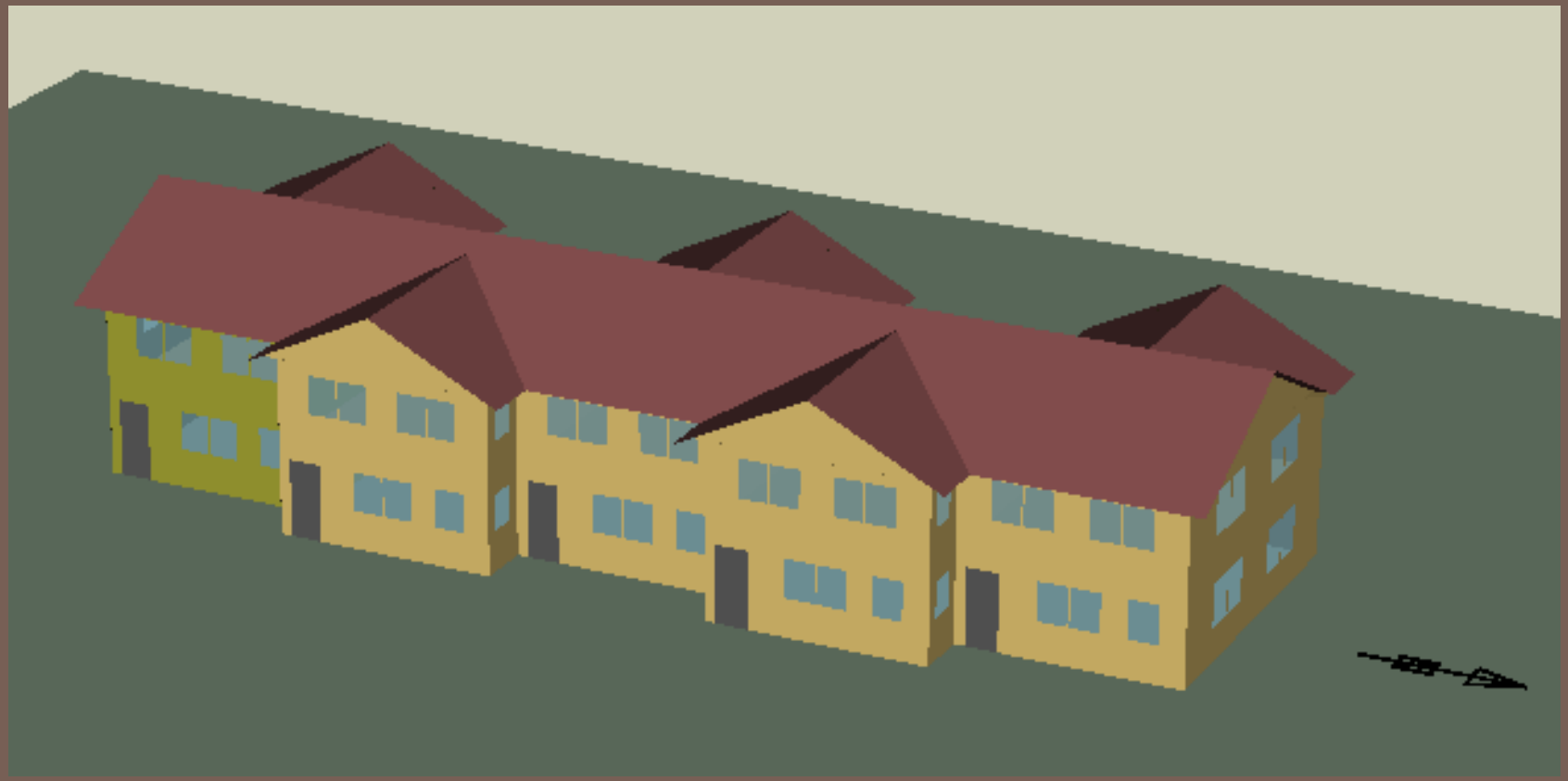
Challenges

East-West…



Challenges

East-West vs. North-South?



Challenge

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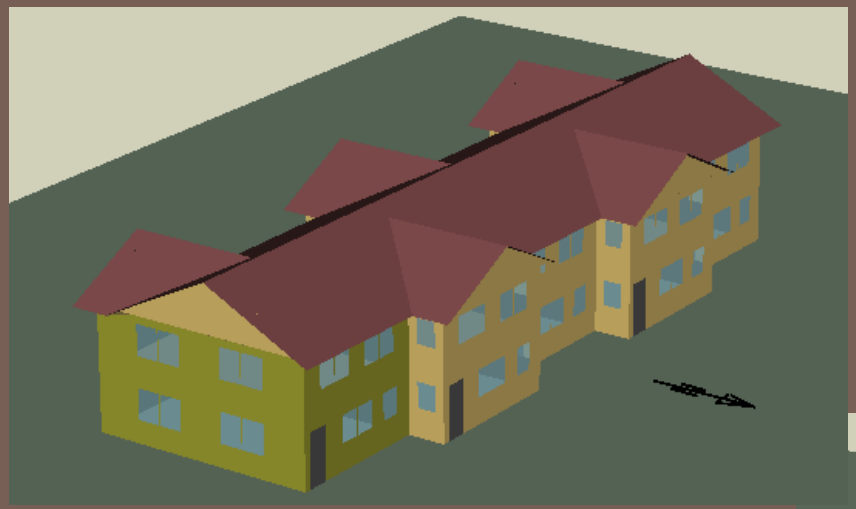
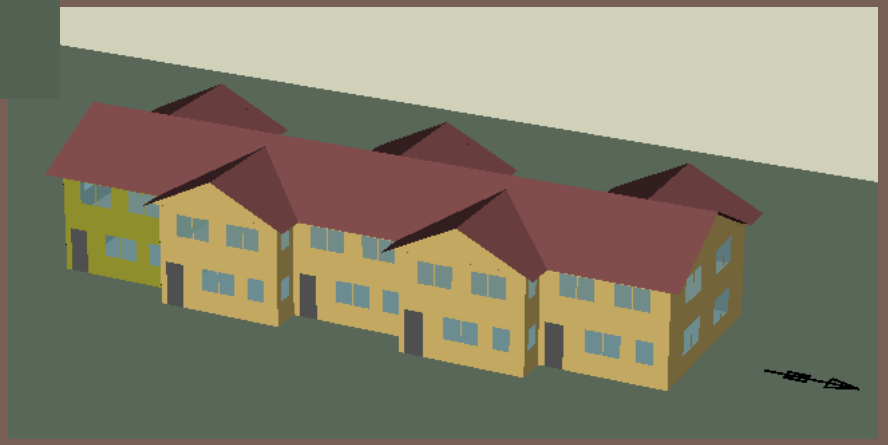
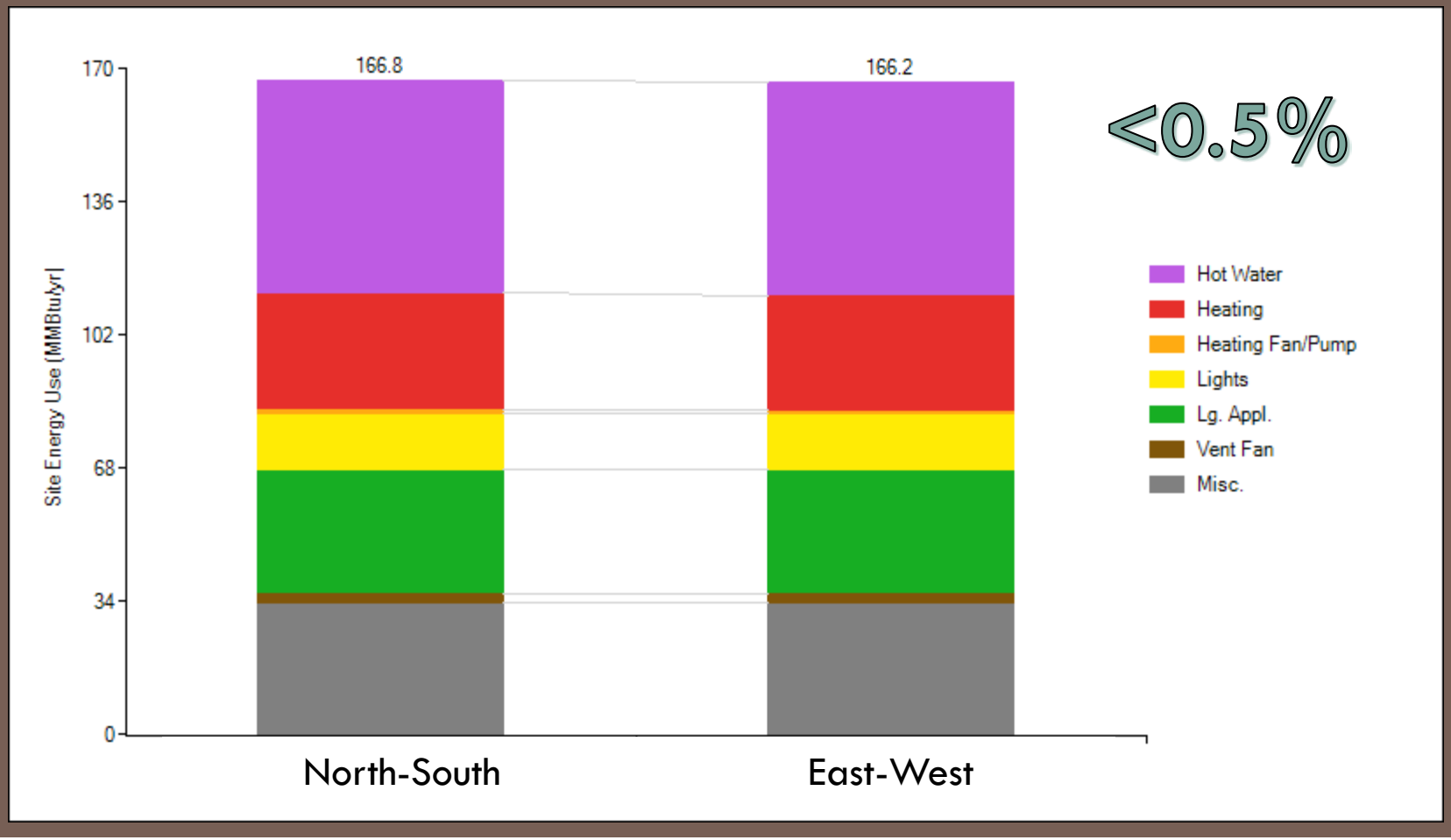


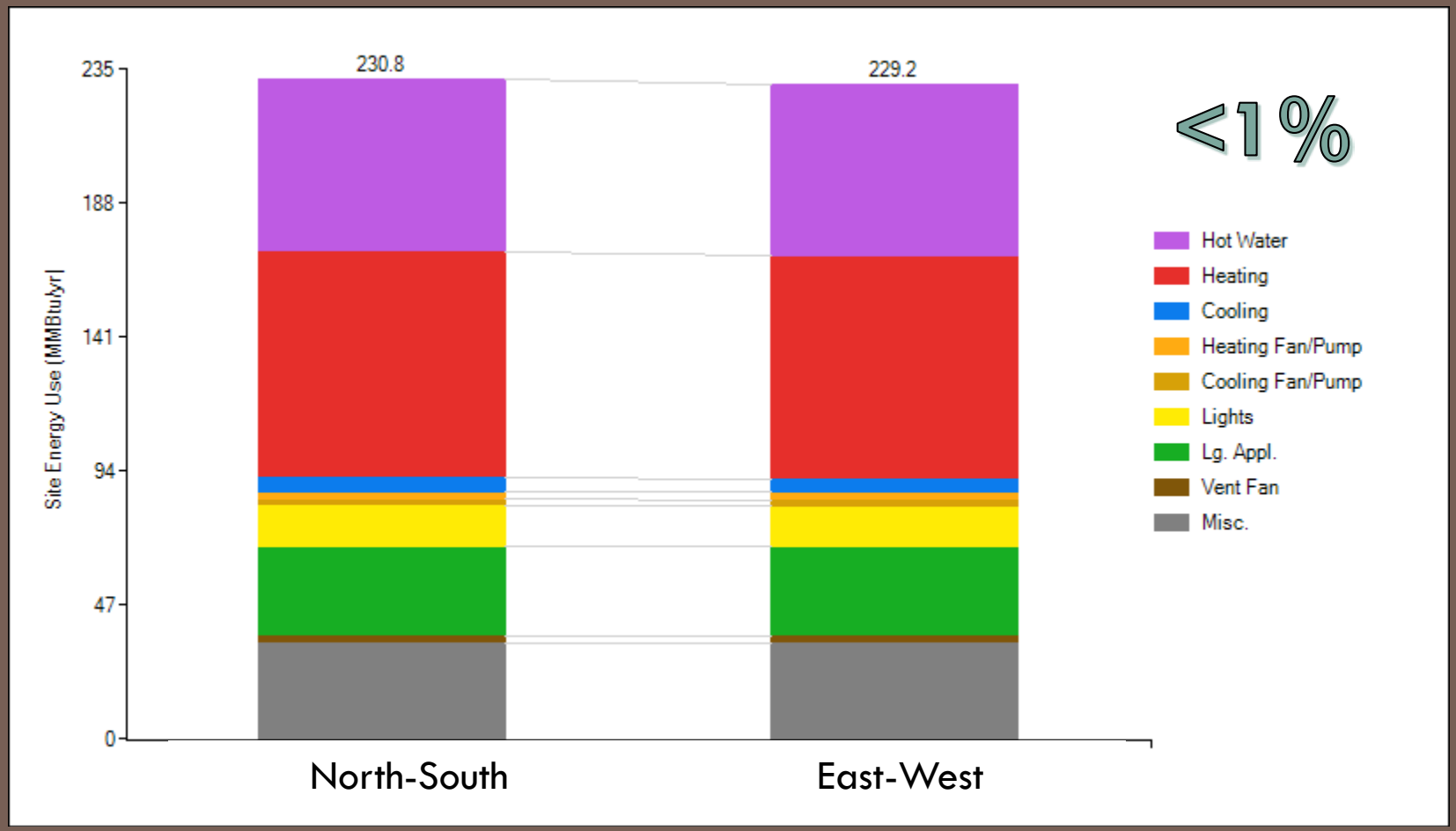


Seattle



Building Orientation and Form

Spokane



Building Orientation and Form

Orientation

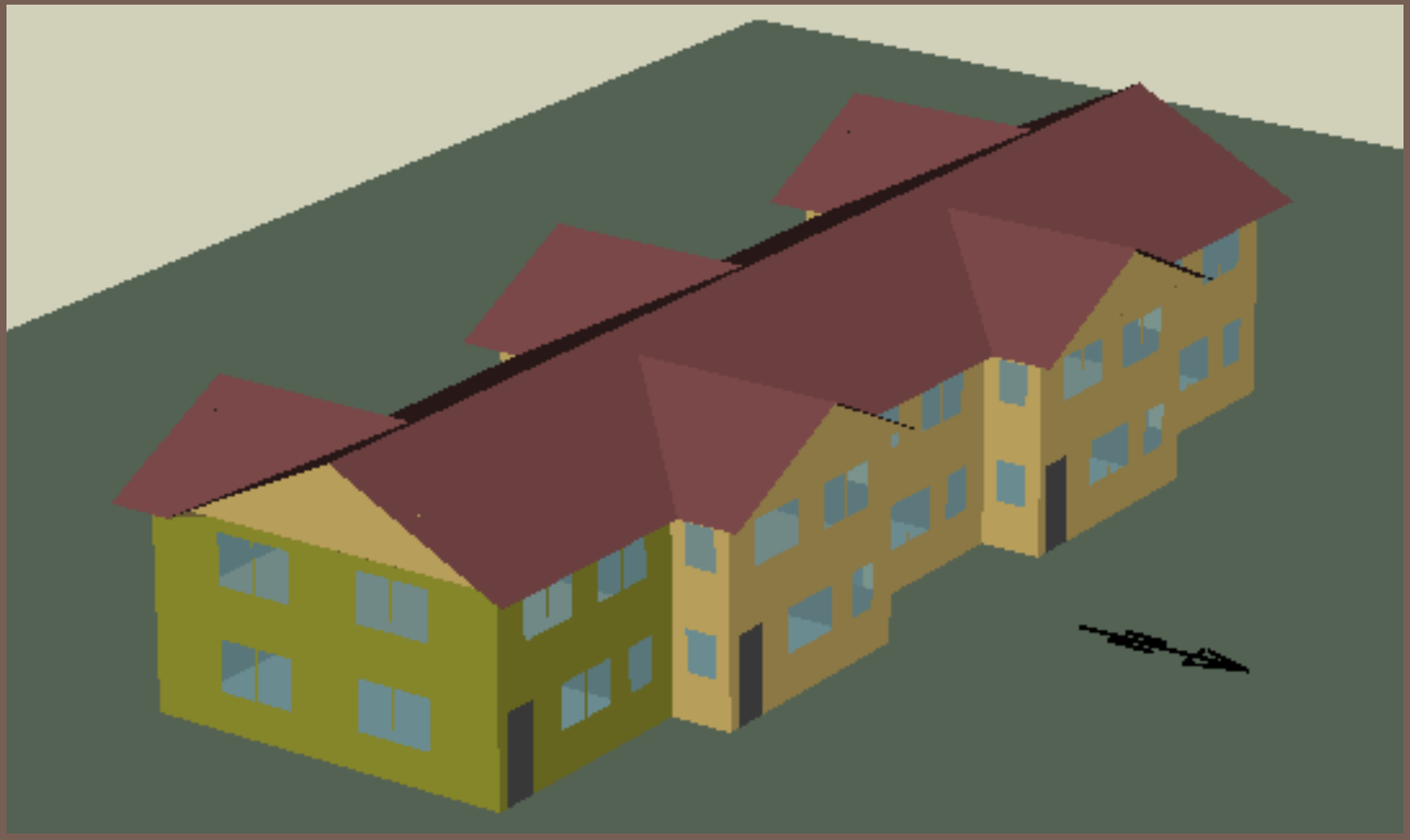
Small impact, but generally better to orient along N-S axis.

BUT… More important when:

- Glazing % increases
- Low energy or net-zero buildings
- Smaller buildings
- Balance heating and cooling

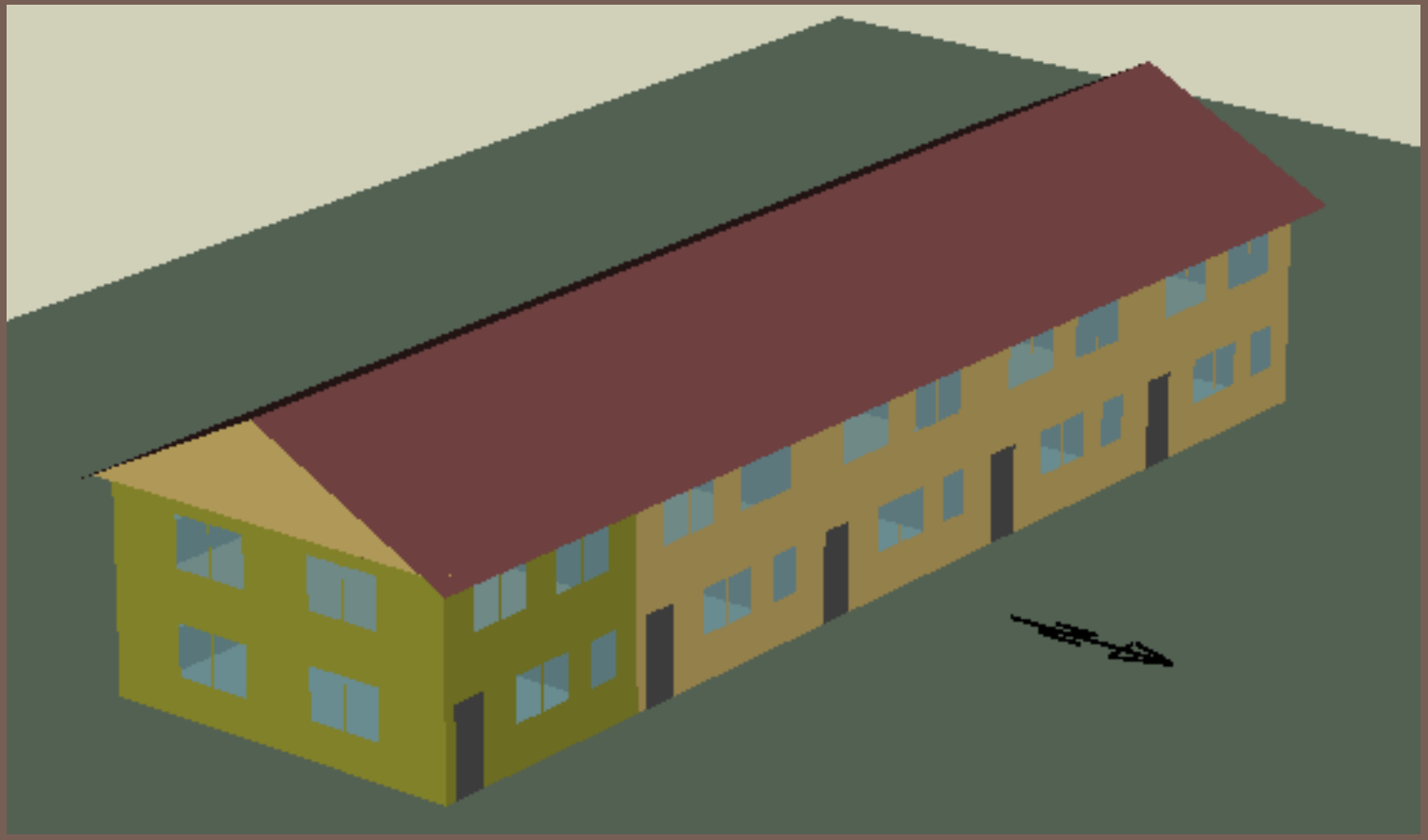
Challenges

Modulation



Challenges

Modulation vs. No Modulation?



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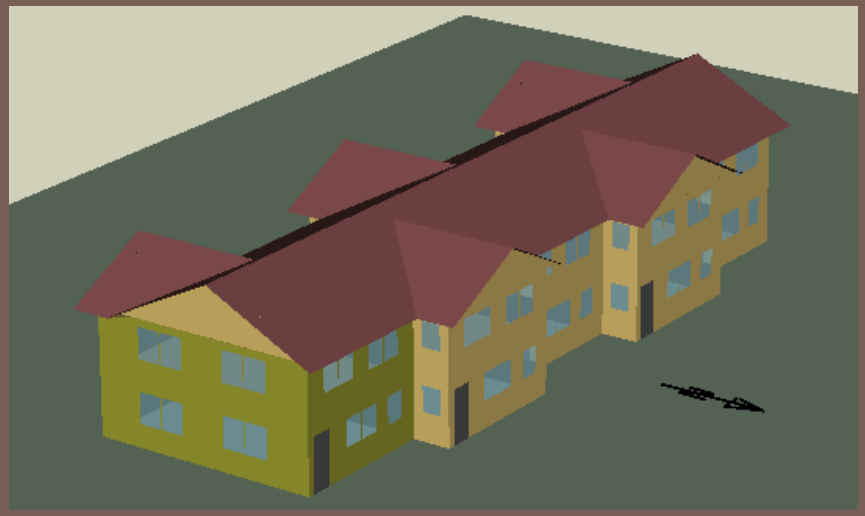

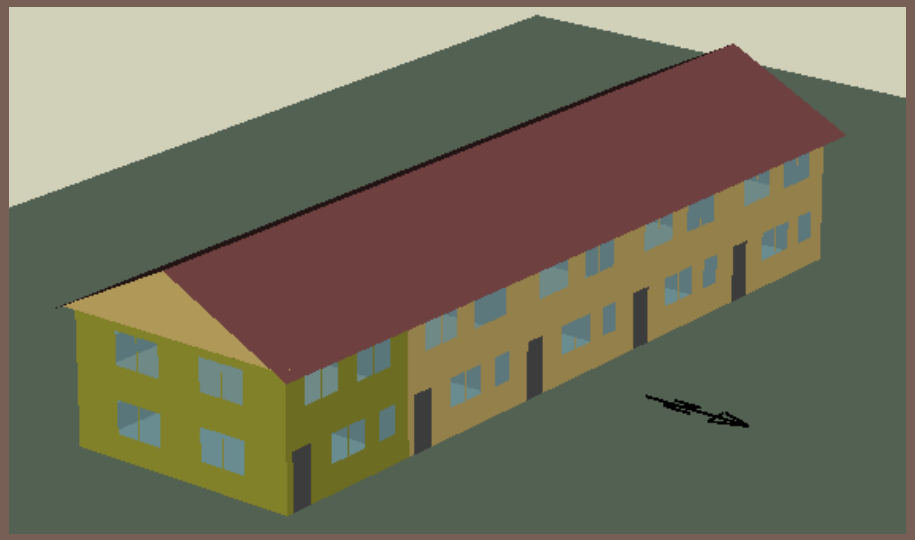

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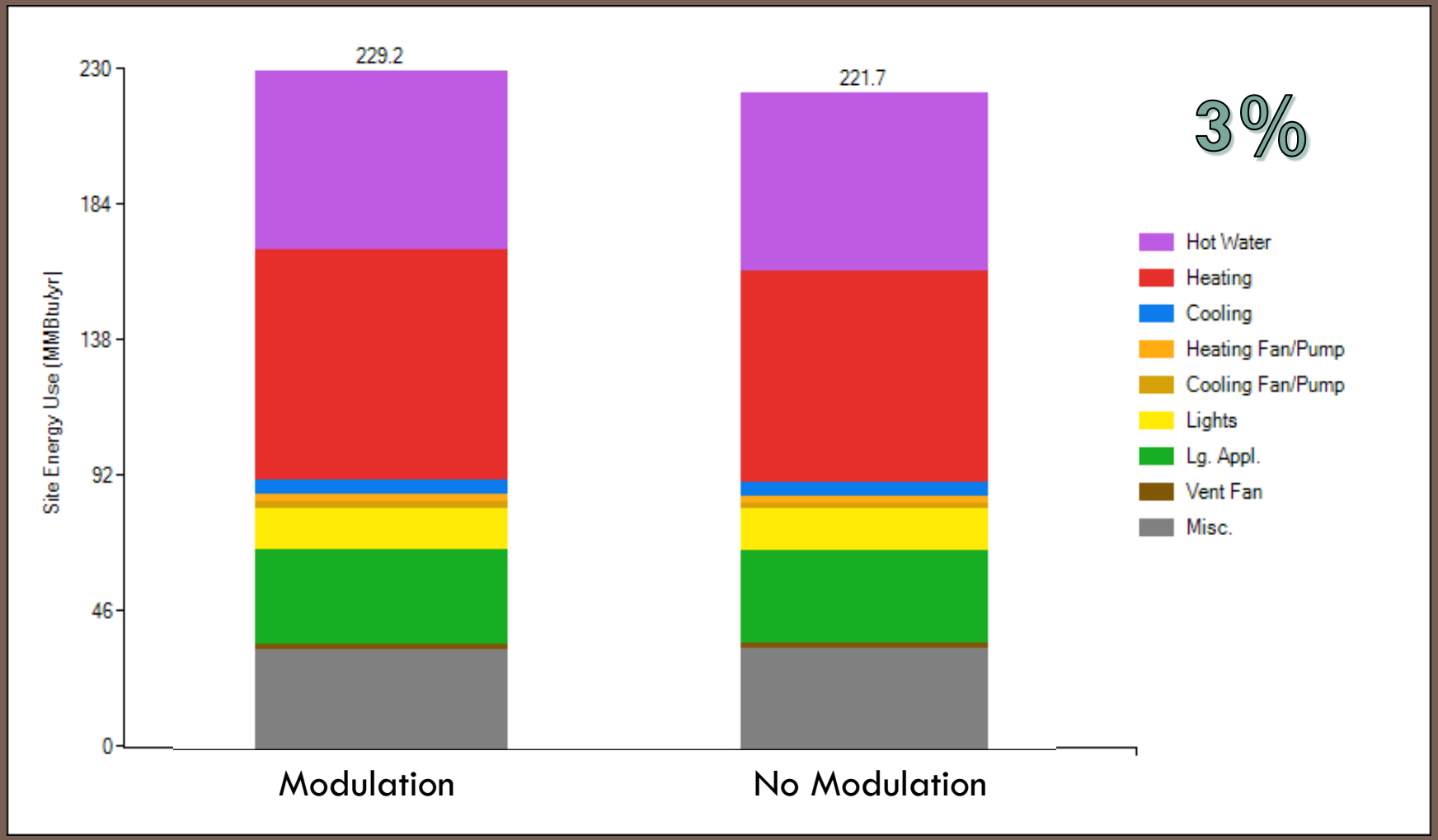
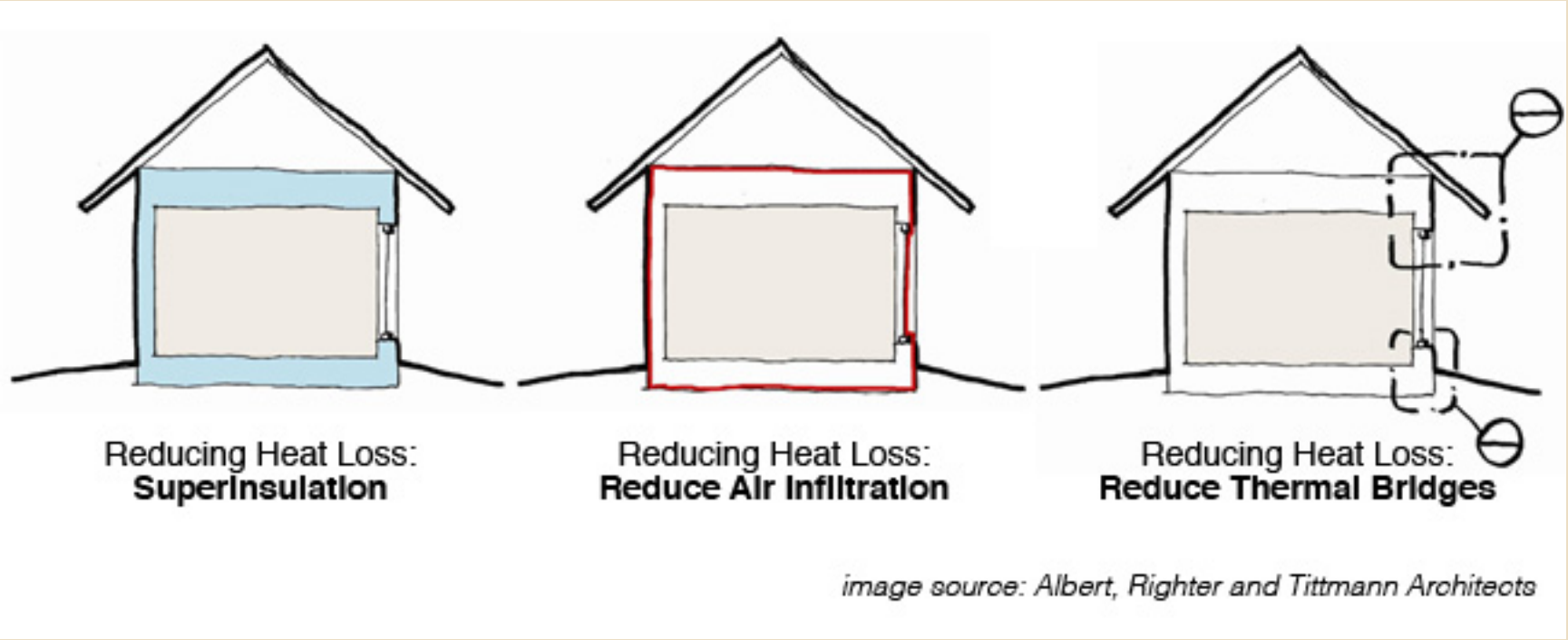


Modulation vs. No Modulation?

Generally, less modulation is better.

- Lower heating/cooling loads
- Can simplify air barrier and waterproofing details
- Lower building cost
- TRADE-OFF: Aesthetics?

Building Envelope



Challenges

- Strong Vision (1 chance to get it right)
- Durability trumps energy performance
- Air Tightness delivers more Bang for the Buck than increased levels of insulation.
  - But Be Reasonable (0.6ACH at 50PA vs. 1ACH at 50PA)
- Collaborate. No one has all the answers.
- Beware of the Bleeding Edge of Technology
  - Innovate and Evaluate

Challenges

What does Performance Mean?

- Does Not - Fall down, Blow Over, Crack, Burn Down, **Rot or Corrode**
- Provides Security
- Controls Noise
- Provides Day lighting
- Provides Views
- Provides Comfort
- Reduces heating / cooling loads

Details that Perform

- Continuity (WSS, WRB, TB, AB, VB)
- Redundancy – 2 lines of Defense
- Accommodation of Movement,
- Accommodation of Service Life
- Accomodation of Tolerances
- Economy of Means – Simple & Fewer

Building Envelope

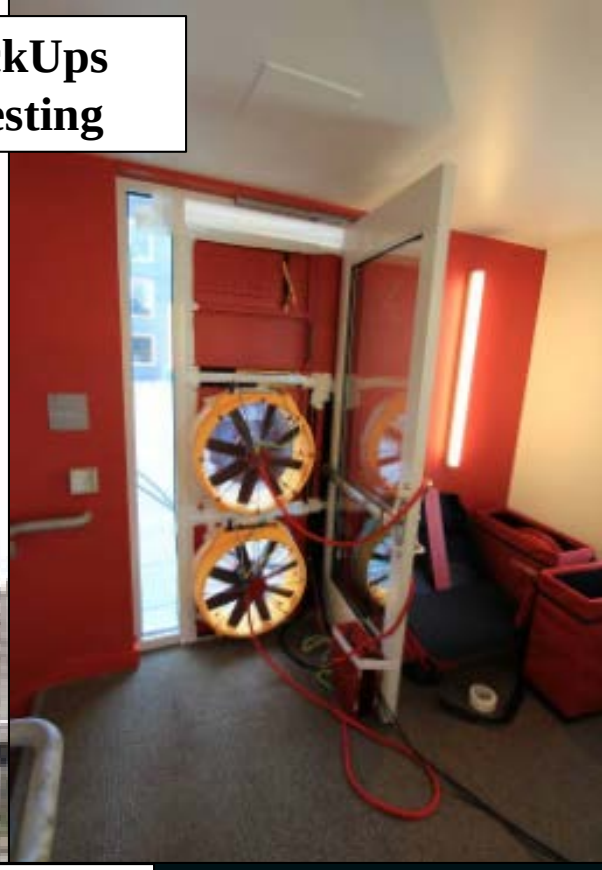
Challenges

Building Envelope

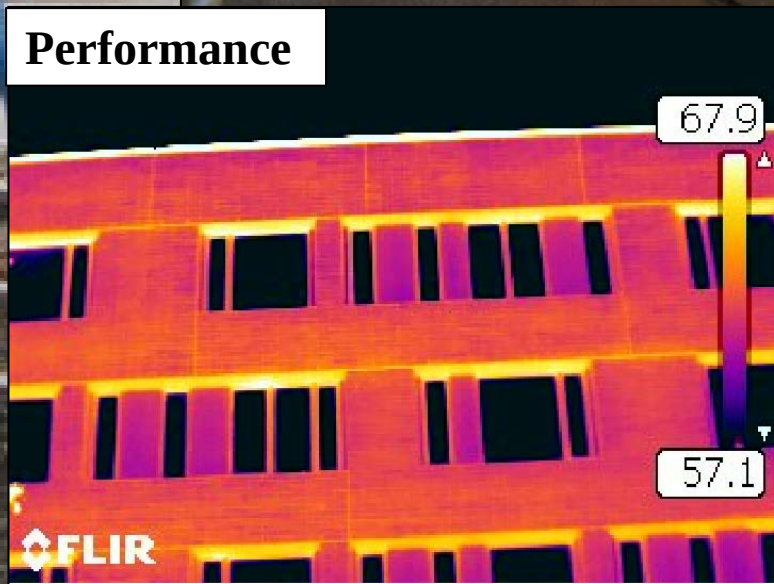
Challenges

MockUps &Testing

Quality Control



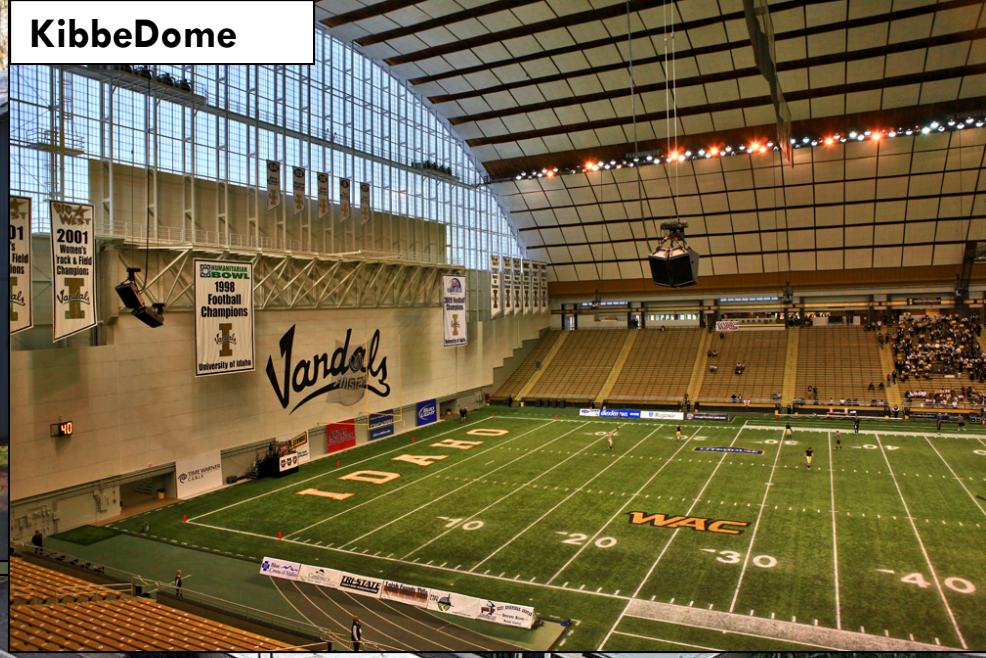
Performance



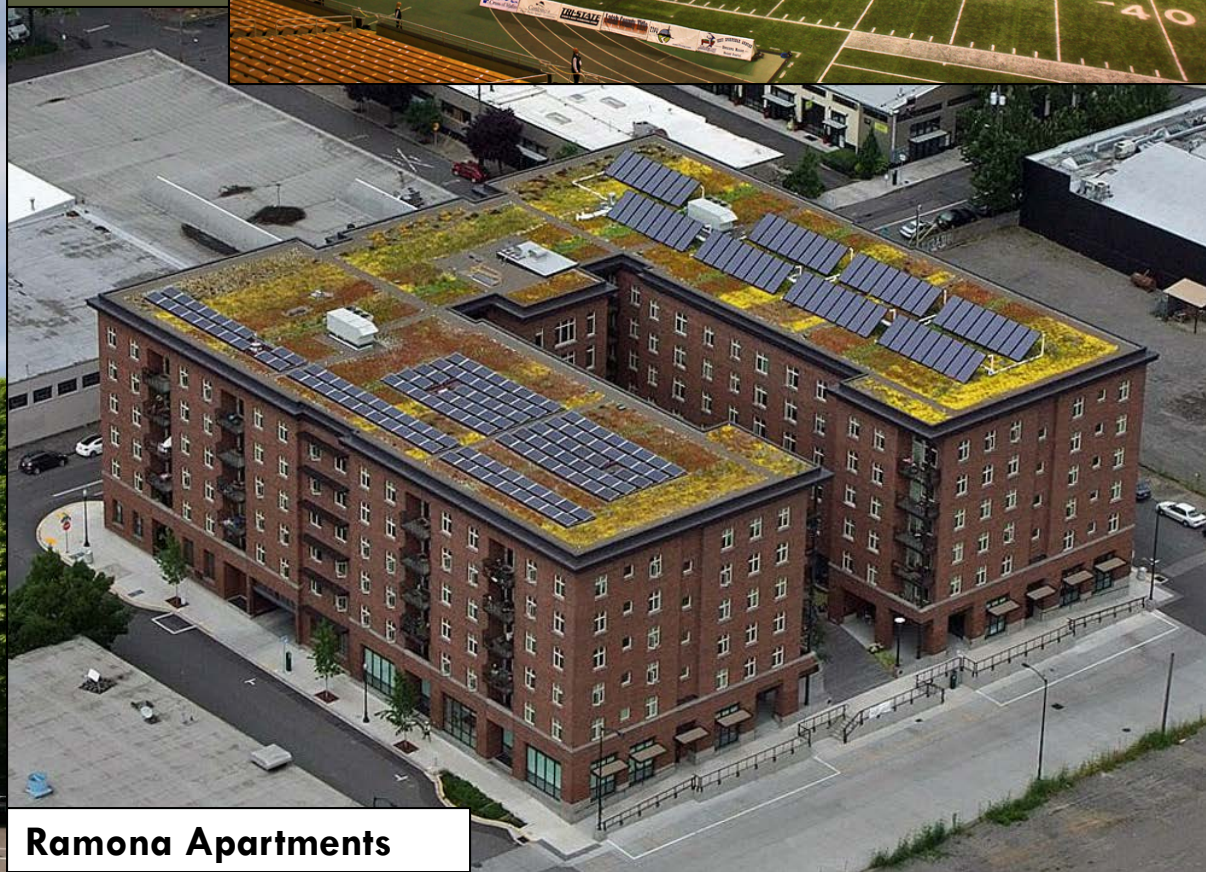
Challenges

Winfield Apartments

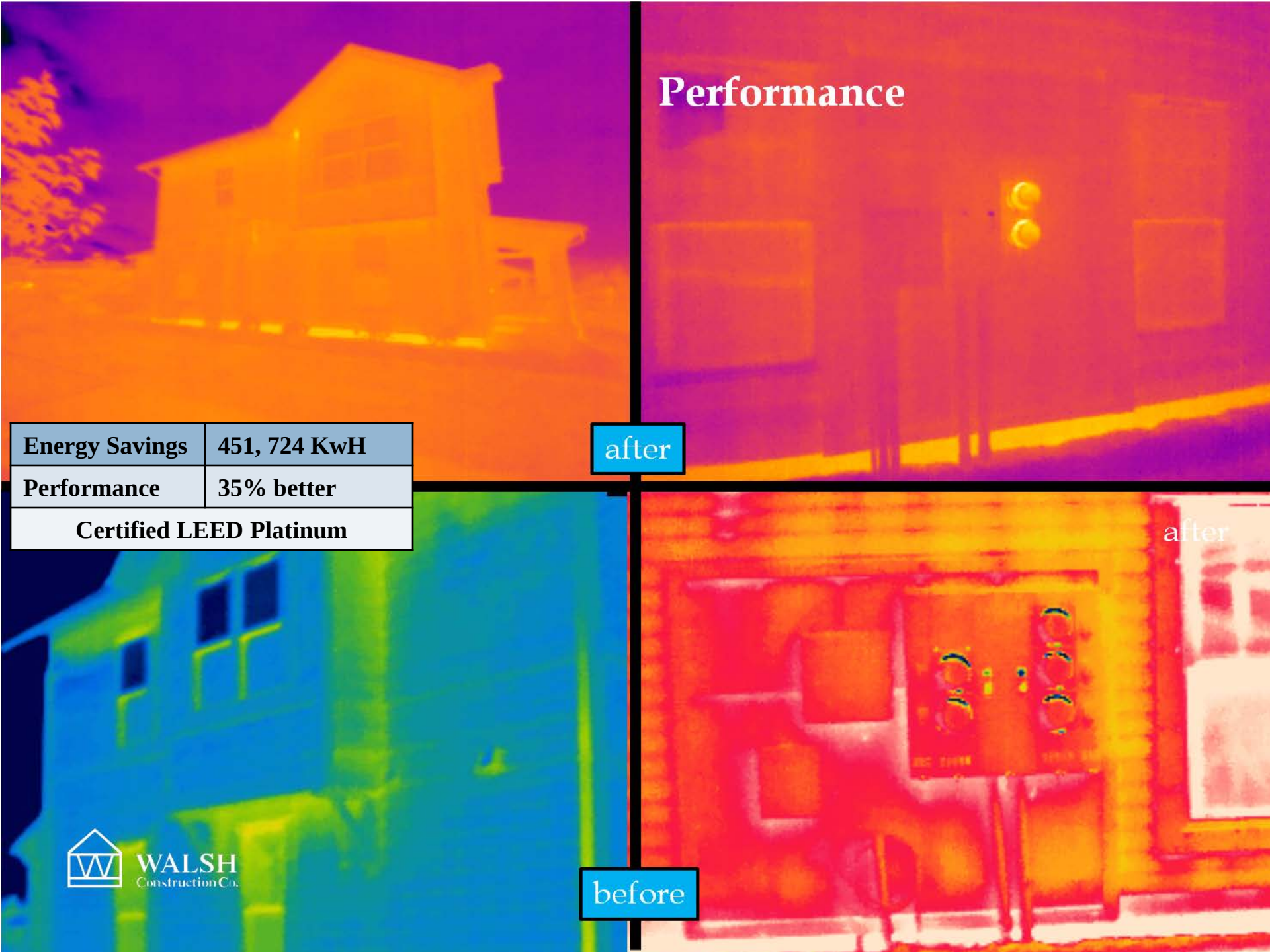
KibbeDome



Hatfield



Ramona Apartments



Energy Savings	**451, 724 KwH**
Performance	**35% better**
Certified LEED Platinum	

Opportunities

- Preconstruction
  - Products, Specs and Details
  - Owner, Architect, BEC, GC, Subs, Suppliers, Manufacturers
- Construction
  - Mock-Ups & Testing
  - FMI
- Post Construction
  - Oversight, Manage, Inspect, Maintain, Evaluate

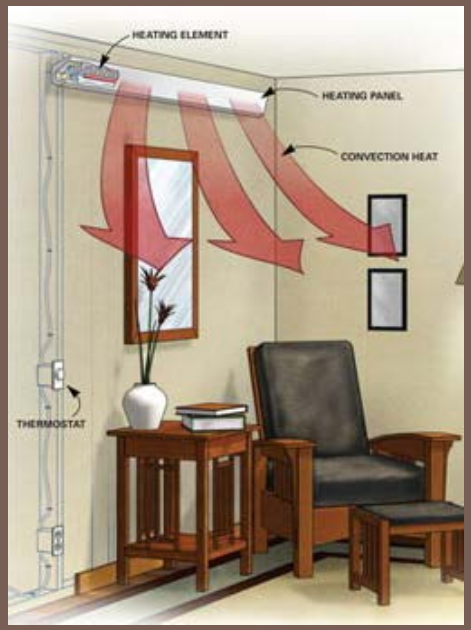
AMP Comparison

COA 1	Good	2x6 framing	R-21 BIB, insulated headers, Commercial Tyvek w/air Barrier details	$0
COA 2	Better	2x8 cavity	R31 BIB, insulated headers, Commercial Tyvek w/air barrier details **and Sealed Sheathing**	$ 154,558
COA 3	Best	2x10 framing	R45.3 (R38 BIB, insulated headers, Commercial Tyvek w/air barrier details, **Sealed Sheathing** 1.5" Ext Insulation)	$ 379,127

HVAC and Water Heating

Opportunities

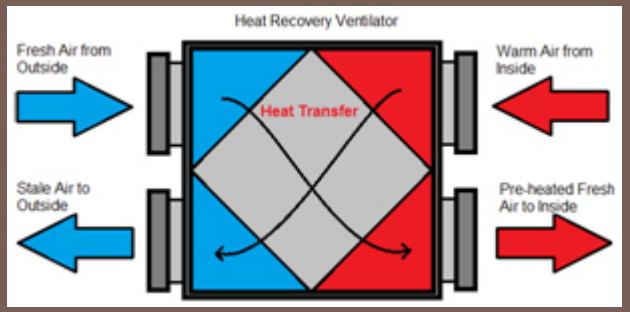
- Smaller units: Building envelope first
- Larger units: Improve envelope + heat pumps
- Cove heaters and radiant panels
- CONTINUOUS DC motor whole house fans + sensors
- Mitigate summer over-heating (low-SHGC glass, exterior shades)
- Properly account for envelope in heater sizing
- Continue to evaluate heat recovery ventilators



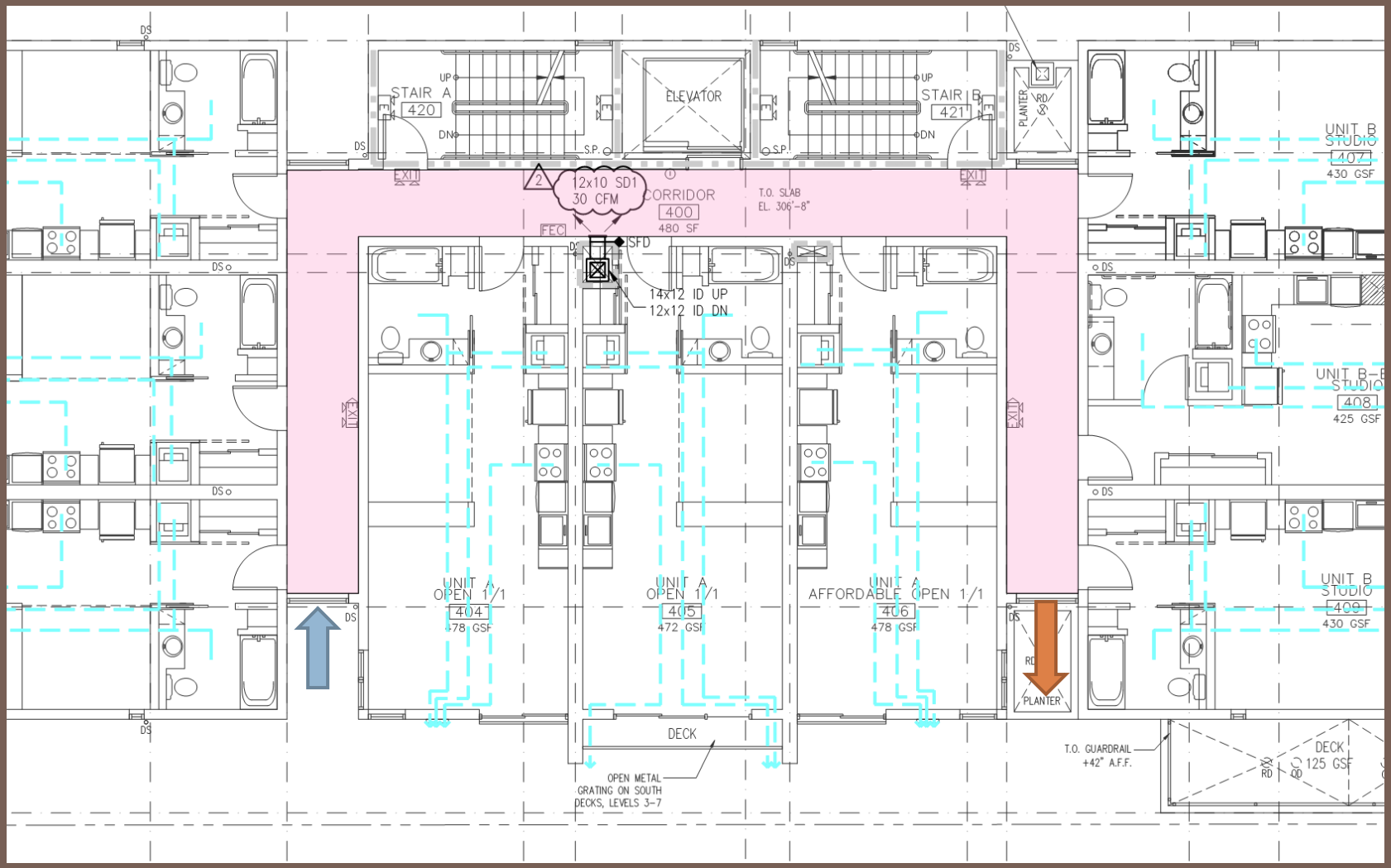
In-Unit HVAC

Opportunities

- Don’t over-ventilate, or design for variable flow
- Properly design air distribution systems
- Properly balance and commission systems
- Investigate heat recovery ventilation options



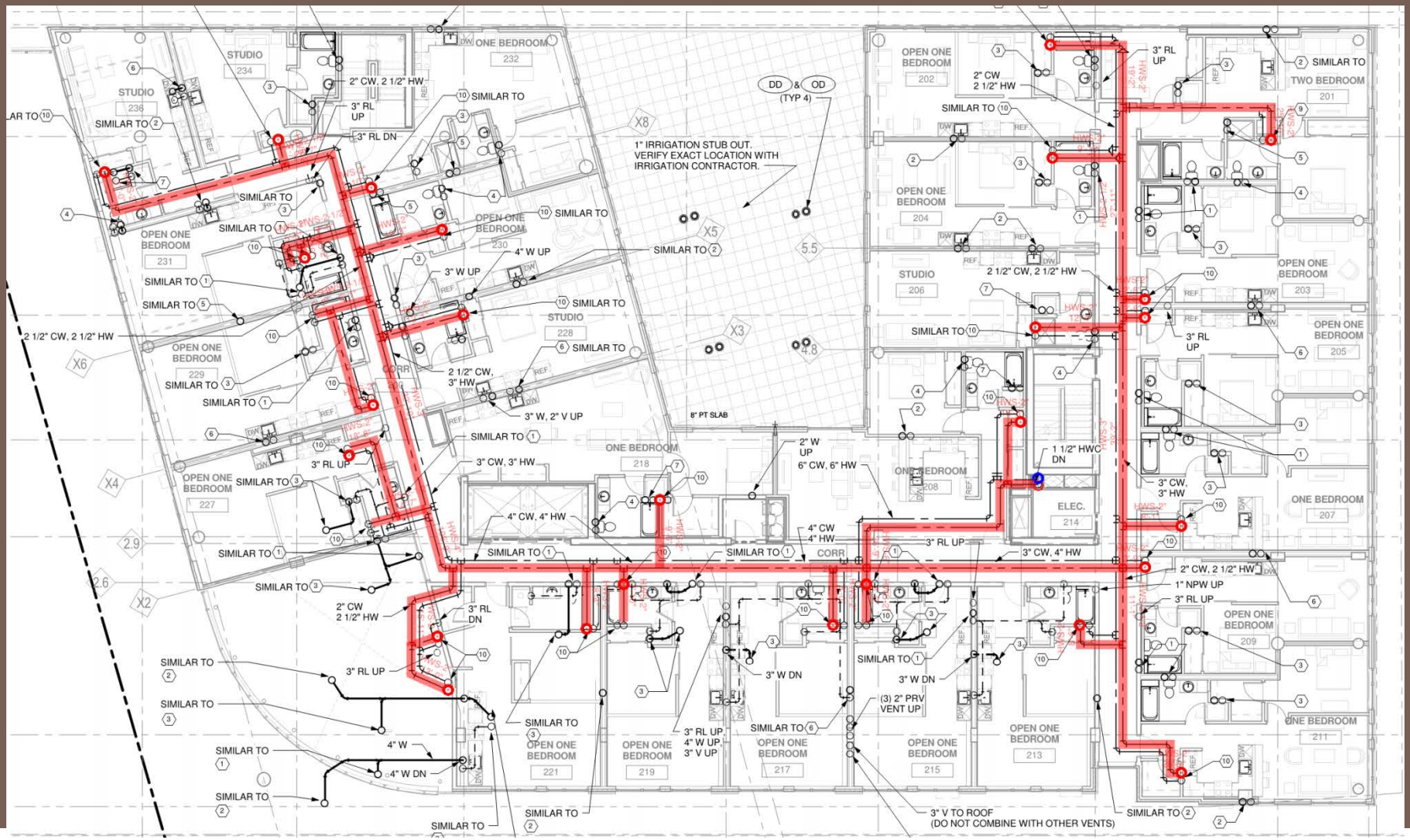
Opportunities



Common Area HVAC

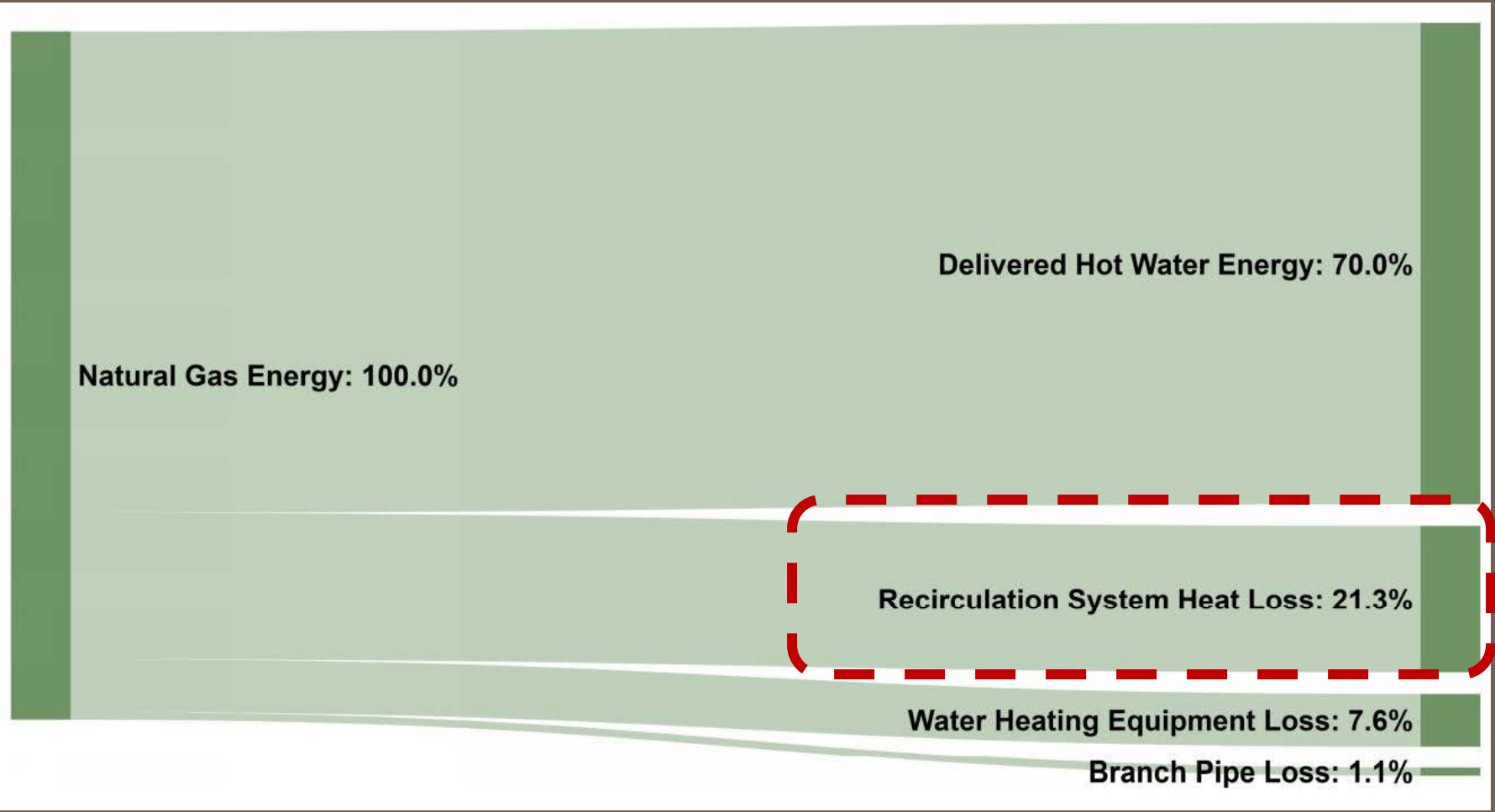
Water Heating

Challenges



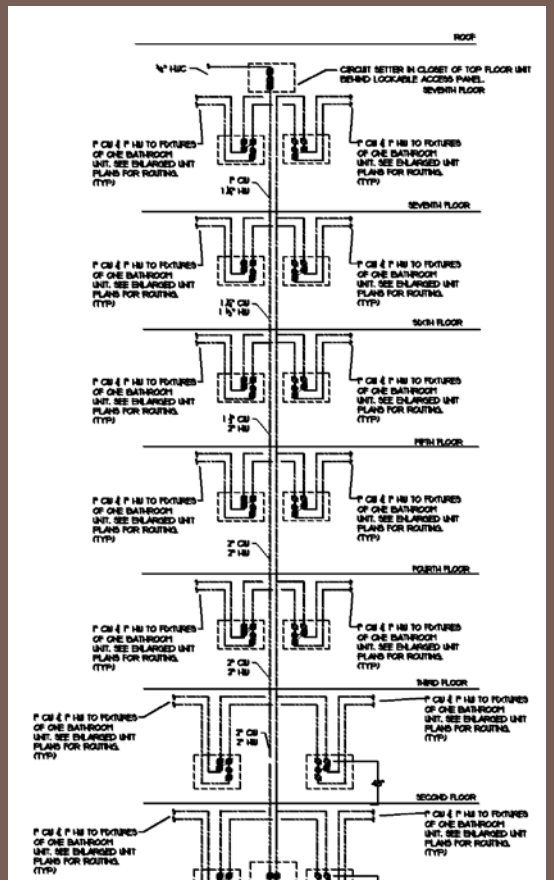
Water Heating

Challenges



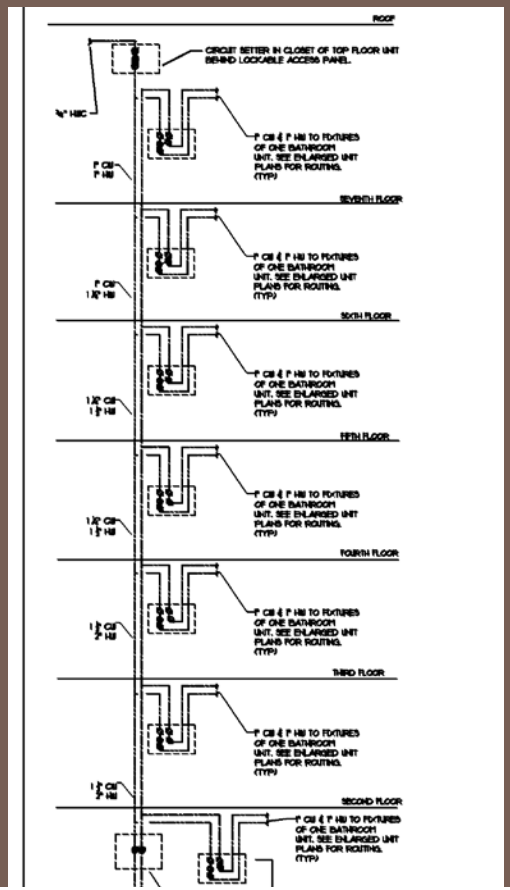
Water Heating

Opportunities



GOOD PRACTICE

Two units/floor each riser



NOT IDEAL

One unit/floor each riser

Water Heating

Opportunities

- Reduce number of risers by planning unit designs with this in mind
- Consider branch pipe lengths (keep dead runs short)
- Pipe sizing (low flow fixtures and available pressure)
- Pipe insulation
- Heat pump water heating!

Lighting and Electrical

Opportunities

- Optimize lighting levels
- Occupancy sensors for corridors (dimming or 50/50)
- Daylight stairwells and corridors
- Use correct lamps/ballasts!

Lighting and Controls

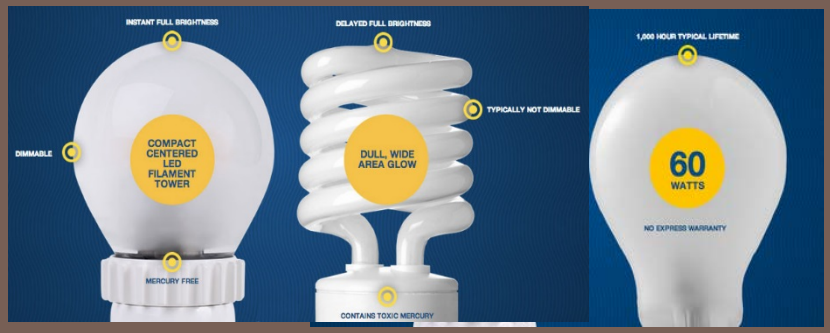
Lighting and Controls

Perception: Premium is low enough that it's the smarter choice every time.

Truth: Premium for LED over Fluorescent is approximately 35%, but dropping

Fluorescent Drum Fixture: $95

LED: ADD $25



Premium can be mitigated by:

- Fixture Selection and Design
- Replacement Cost (3 years vs 10+ life)

Recommended Uses: Corridors, stairwells, parking garages, exterior, unit kitchens and bathrooms

LED vs Fluorescent

AMP Comparison

COA 1	Good	SEC Code Maximum: Corridors – 0.6 W/ft2	$0
COA 2	Better	Corridors – 0.40 W/ft2 Stairwells: - 0.40/ft2 + bi-level control	$ 42,000
COA 3	Best	Corridors 50% LPD reduction (0.33 W/ft2) + accent lighting at elevator lobby, daylight sensors at exterior window areas, no unit entry lights Stairwells: 40% LPD reduction (0.36 W/ft2) + bi-level occupancy sensors	$ 47,000

Renewables

Challenges

- Big incentive not available to nonprofits
- 3rd Party Ownership?
- Production credit

Opportunties

- Optimize the system to maximize incentives?
- Cost?
- Benefit?
- Maintain the system?
- Payback?

Opportunties

Photovoltaic - System of Quotes

	Lease	Incentive	Incentive	Incentive
	Option 1	**Option 2**	**Option 3**	**Option 4**
	Standard - Made in USA	**Standard - Made in USA**	**Standard - Made in WA**	**Standard - Made in WA**
Module Details	SolarWorld 290W	SolarWorld 290W	Itek Energy 280W	Itek Energy 280W
	Qty: 80	**Qty: 80**	**Qty: 80**	**Qty: 46**
System Size	**23200 Watts**	**23200 Watts**	**22400 Watts**	**12880 Watts**
Module mount type	All tilt-up	All tilt-up	All tilt-up	All tilt-up
Inverter type	central	central	central	central
Inverter details	Fronius 11400W (qty: 2)	Fronius 11400W (qty: 2)	Itek Solectria 6600W (qty: 3)	Itek Solectria 6600W (qty: 2)
Estimated Production	**23944 kWh/yr**	**23944 kWh/yr**	**23119 kWh/yr**	**13293 kWh/yr**
System Price	$78,088.58	$79,112.58	$85,088.80	$54,065.70
Dollars per Watt	*$3.37*	*$3.41*	*$3.80*	*$4.20*
Sales Tax	$7,418.42	$7,515.70	$8,083.44	$5,136.24
Total Installed Cost	**$85,507.00**	**$86,628.28**	**$93,172.24**	**$59,201.94**
30% Federal Tax Credit	($25,652.10)	$0.00	$0.00	$0.00
State Sales Tax Partial Refund (75%)	($5,563.81)	($5,636.77)	($6,062.58)	($3,852.18)
5 year accelerated Depreciation at 30%	($22,119.20)			
Net Cost After Tax & Credit(s) etc	$32,171.89	$80,991.50	$87,109.66	$55,349.76
Initial Production Incentive, $/kWh	$0.00	$0.11	$0.38	$0.38
Annual Incentive Payment	**$0.00**	**($2,633.84)**	**($5,000.00)**	**($5,000.00)**
Estimated Total Incentive thru Jun 2020	$0.00	($10,613.13)	($22,295.08)	($21,202.82)
Effective Net Metering rate* in Year 1:	$0.0799/kWh	$0.0799/kWh	$0.0799/kWh	$0.0799/kWh
Estimated Net Metering, rest of Year 1	($1,865.17)	($1,865.17)	($1,800.91)	($1,035.49)
Year 2	($2,011.16)	($2,011.16)	($1,941.87)	($1,116.54)
:	:	:	:	:
2020	($2,228.52)	($2,228.52)	($2,151.74)	($1,237.21)
Total Net Metering thru 2020	**($10,339.59)**	**($10,339.59)**	**($9,983.33)**	**($5,740.23)**
Avg Monthly Incentive+Net Metering	($173.75)	($352.10)	($542.42)	($452.76)
% of Installed Cost paid back by 2020	74.5%	30.7%	41.2%	52.0%
Net (residual) cost, end of 2020	**$21,832.30**	**$60,038.79**	**$54,831.24**	**$28,406.70**
Payback Time (years)	**12**	**23.8**	**22.7**	**21.7**
Module Warranty Period (years)	25	25	25	25
Net PROFIT at end of warranty	$58,244.55	$9,424.93	$13,813.60	$10,157.47
ROI (net gain) at end of warranty	68.1%	10.9%	14.8%	17.2%

*** Each produced kWh earns this amount in avoided bills.**

Assumptions: 1.) Constant usage & production within a season. 2.) 74% of PV production occurs in Apr-Sep. 3.) 4% annual utility cost escalation.

Residents & Staff Engagement

Challenges

- Residents and staff are not operating systems efficiently or appropriately
- Systems not properly commissioned or not commissioned
- Tracking of resident behavior in regards to utility usage
- Information is not institutionalized
- Residents don't understand or care
- Language barriers

Building level controls to make systems work better
apartment-level controls to reduce consumption

- Participation of property management and maintenance staff during design phase leads to better understanding and “buy-in”
- Hand-off post construction with GC, development team, design professionals, property management and maintenance staff
- Resident engagement cards part of manual and posted in common area
- One year post occupancy follow-up with project team

Resident and Staff Engagement

Education and Incentives

- Sub-metering of both hot and cold water will pin-point issues
- Observation of the opened windows during heating season
- Incentive system for tenants to use utilities efficiently
- Training for recycling/composting/trash
- Explanation to tenants that their behavior directly affects the availability of affordable housing

Component # 5– Residents and staff

Tips for Greener Laundry

Detergents

Buy detergents that are:
- concentrated
- biodegradable
- phosphate-free
- Avoid bleach!
- To whiten clothes, use hydrogen peroxide, or white distilled vinegar

Washing Tips

Only wash full loads of laundry

Use only the recommended amount of detergent. Using too much may leave residue on clothes and in the washing machine

Save Energy

Use the COLD WATER setting for all general laundry

Use the HOT WATER setting for bedding and soiled or stained clothes

KNOW THIS!
Phosphates and other chemicals in detergent can pollute our waterways.

90% of energy used to wash clothes is used to HEAT WATER!

Save $150/year by washing in cold water!

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Save Energy & Money Drying Clothes

Drying Clothes
- Clean the lint filter after every use!
- Extend the life of your clothes by not over-drying!

- Use low heat when possible!
- Check the spin cycle on your washer – you could reduce drying time by 30% if you use a more powerful cycle!

Avoid Dryer Sheets

Dryer sheets contain chemicals that can transfer from your clothes to your skin. They can also pollute the air. Instead of dryer sheets use natural, biodegradable fabric softener or vinegar when you wash your clothes!

Hang your clothes to dry!

Save more than $1 per load when you don't use your dryer!

Helpful Hints:

Fragrance Free

Look for fabric softener that is fragrance free instead of dryer sheets.

If you must use dryer sheets, select fragrance free dryer sheets.

bellwether

Control Your Energy Use

Turn it off!
Turn lights off when you don't need them and when you leave a room.

Let the sunshine in!
Open blinds and curtains to let natural light in your home.

Use only what you need...
Use a small task light instead of overhead lights when you can.

What's a Watt?
A watt tells you how much power a device uses.

Add it up!
Just turning off three 60 watt bulbs and using daylight can save an average of $70 per year!

Save Money!

bellwether

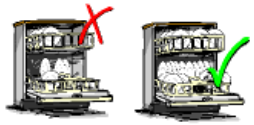
Save Hot Water and Energy, Too!

If you hand wash dishes

Keep the water off while you soap up!

If you use a dishwasher

Run only full loads of dishes in the dishwasher, and turn OFF the dry cycle!

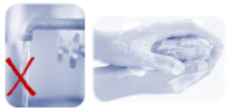


Shower Quickly!

Take shorter showers (5-10 minutes!)

Turn off the faucet

When soaping up!



Save Time, Water, Energy, and Money!

Do you take 20-minute showers?

- **Cut showers to 10 minutes:** You'll save up to 25 gallons of water PER shower!
- **Cut showers to 5 minutes:** You'll save up to 38 gallons of water PER shower!

You could save **10,000** gallons/year!

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Resident Engagement Cards

Example: University District Apartments

Bellwether Housing – University District Apartments

Asset Management Preservation – A Better Process

- Integrated design process combined with data driven analysis guides a team towards making the best and most cost-effective decisions.
- Answers questions and compares tangible results.
- A Complete Team early on is essential.
- Bellwether Housing's University District Apartments serves as the basis for this presentation.

Project Directives

- Build the Baseline
- Technology that is “tried and proven”
- Lower Maintenance
- Increased Durability
- Operational Savings vs. Construction Costs

Areas	Resource Conservation Measure	COA 1	COA 2	COA 3	FINAL TARGET
Building Envelope		$ -	$ 242,225	$ 492,869	$ 295,853
	Residential (Non-metal) Windows/Glazed Doors	$ -	$ -	$ 62,210	$ 62,210
	Above-Grade Walls (Type V)	$ -	$ 154,558	$ 253,855	$ 154,558
	Roofs	$ -	$ 33,786	$ 49,487	$ 49,487
	Slab-on-Grade Floors	$ -	$ 10,872	$ 33,167	$ -
Air Leakage	Testing	$ -	$ -	$ 8,414	$ 8,414
Lighting	LED Lighting	$ -	$ 57,000	$ 94,000	$ 94,000
Appliances		$ -	$ (15,805)	$ (3,815)	$ -
Controls		$ -	$ -	$ 128,000	$ -
Plumbing	Low Flow Toilets & Fixtures	$ -	$ 49,715	$ 23,635	$ 23,635
Res HVAC	Cove Heaters	$ -	$ 67,102	$ 387,102	$ 67,102
CA HVAC		$ -	$ -	$ -	$ -
Renewables	Photovoltaics	$ 26,767	$ 51,825	$ 174,032	$ 51,825
Metering	Oversight/Management	$ -	$ 25,800	$ 25,800	$ 25,800
Feedback, Engagment, Education	Capture and Display Building Performance	$ -	$ 50,213	$ 70,157	$ 50,213
Waste & Recycle	Solid Waste	$ -	$ (36,874)	$ 1,826	$ (36,874)
	Premium ($)		$ 491,201	$ 1,402,020	$ 579,968
	Premium (%)		2.44%	7.23%	2.91%
	Estimated Incentives		$ (74,876)	$ (152,543)	$ (86,734)
	Annual Operational Savings				$ 76,720
	Simple Payback (including incentives)				6.43
	Internal Rate of Return (15 yrs)				18.70%

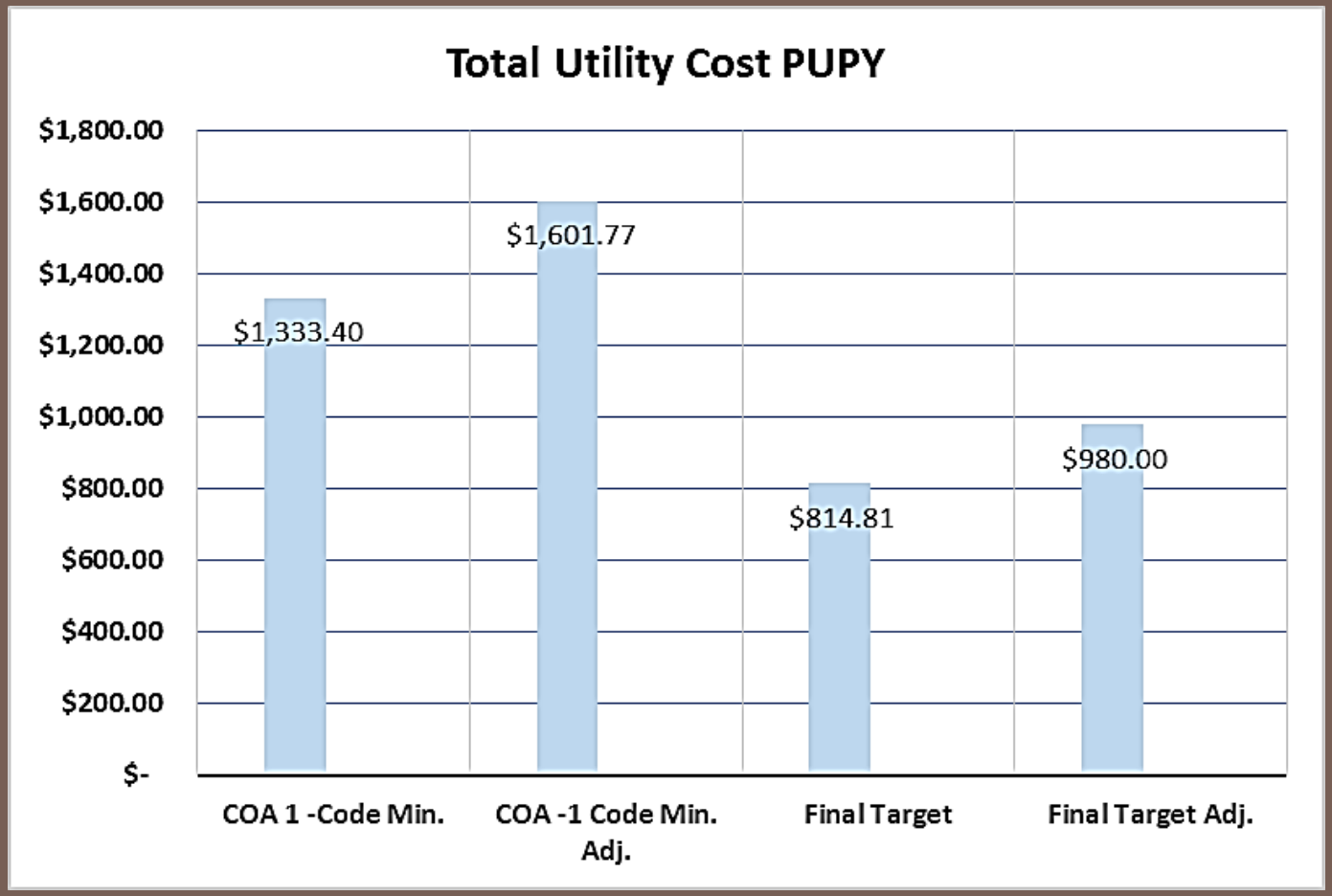
Example - AMP Comparison Chart

Conclusions

	COA 1 - Code Minimum	Final Target - Advanced Performance		COA3 - Passive House	
Units	128	128		128	
Occupancy	320	320		320	
			% Difference		% Difference
Estimated EUI *(kBtu/ft2)*	44.9	29.50	-34%	24.34	-46%
Power *(kWh)*	720,499	530,438	-26%	440,736	-39%
Gas *(Therms)*	25,316	13,892	-45%	11,193	-56%
Water Consumption *(Gallons)*	5,033,350	3,612,934	-28%	3,612,934	-28%
Solid Waste *($)*	$ 38,066	$ 14,691		$ 14,691	
Total Cost *($)*	$ 226,425	$ 149,705	-34%	$ 125,528	-45%
Total Savings *($)*	-	$ 76,720		$ 100,897	

Example - AMP Comparison Chart

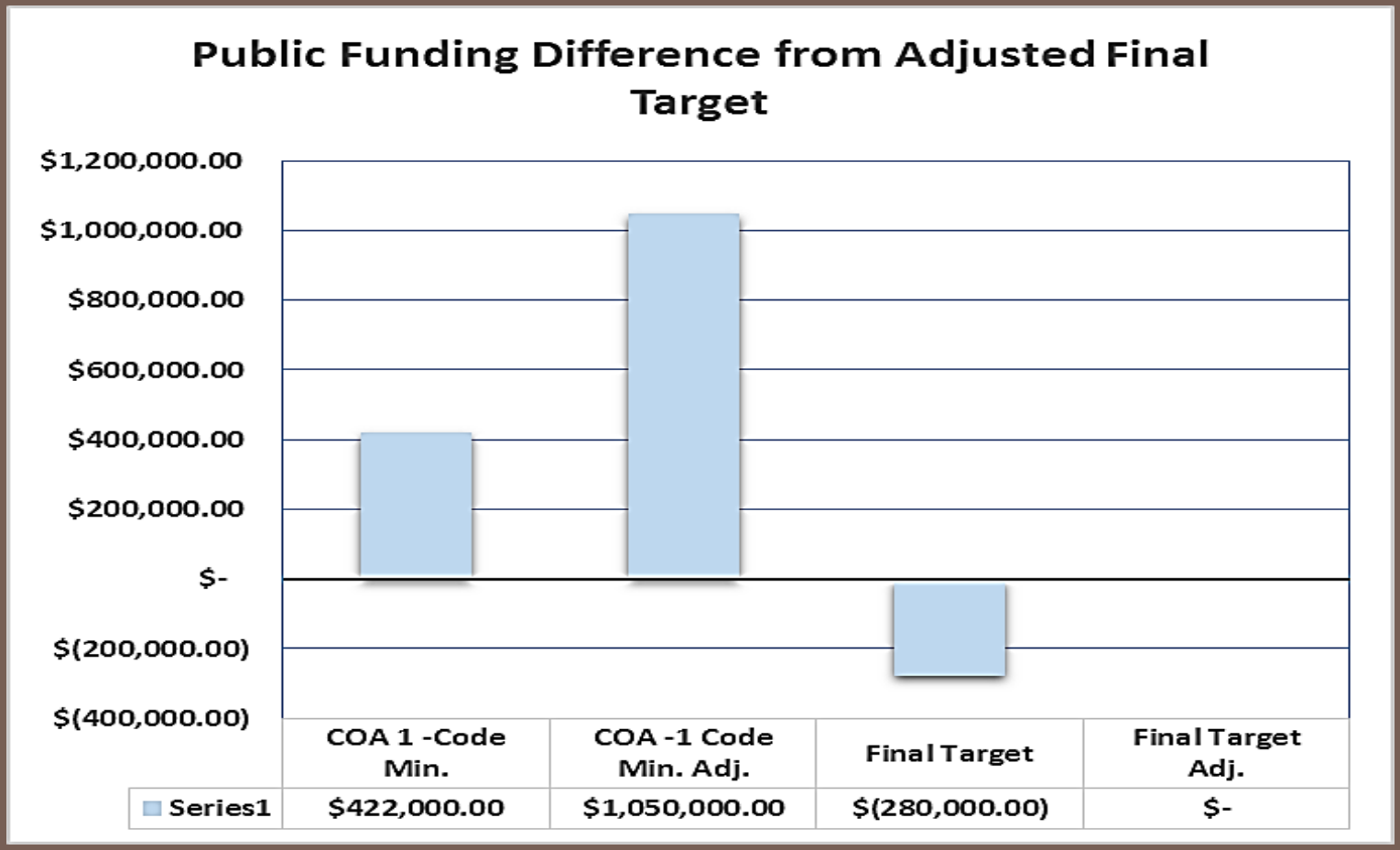
Conclusions



Utility Costs ⟶ NOI ⟶ DEBT ⟶ GAP

Example - Utilities Usage and Public Funding

Conclusions



Utility Costs ⟶ NOI ⟶ DEBT ⟶ GAP

Example - Utilities Usage and Public Funding

Thank You for Listening!

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