LIGHT ON ENERGY LIGHT ON THE PLANET HIGH ON EFFICIENCY

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Boston's Castle Square Super Insulated Deep Retro Fit

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Castle Square Apartments are a 540,000-square-foot mixed-use property comprised of 500 affordable apartment units and 20,000 square feet of retail space.

Castle Square Development Team

The Team: Building Science Corporation (BSC) as the enclosure specialists; Elton + Hampton Architects; Portsmouth, Petersen Engineering Inc.; Biome Studio - a zero-energy and sustainability consulting group; and Pinck and Co. as owner's representative.

Development Process

Create an Responsive Design Team

Engage the stakeholders early

- Tenants Board
- Winn Management
- Staff/Residents

Green Workshops and Planning Charrettes

Listen to and then Set Priorities:

- Regional
- Neighborhood
- Buildings/Occupants/Maintenance

Create a Road Map

Make it Easy to get it Right

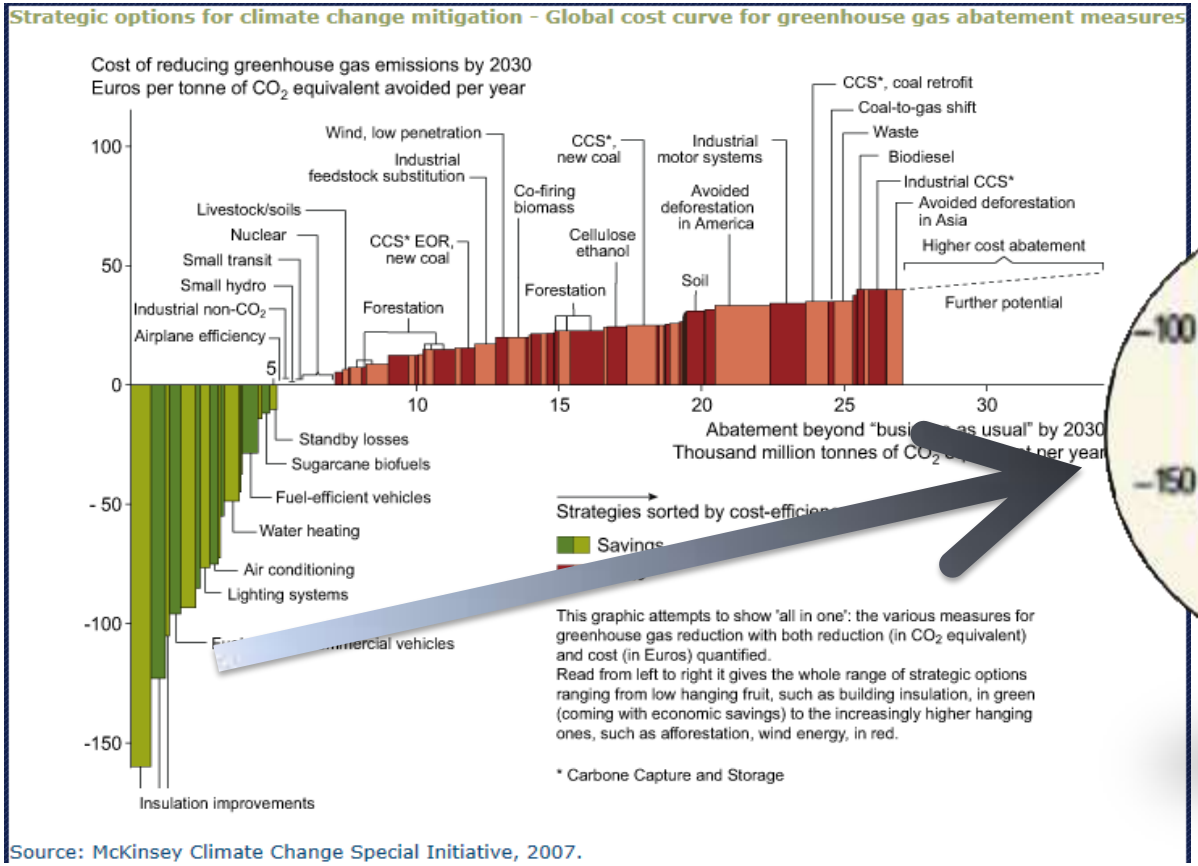
What was heard:

Kitchens from 1960
Bathrooms
Old flooring
Lighting
Windows
Paint
Sidewalks
Handicap Access
Laundry
Playgrounds
Energy/Comfort
Ventilation
Tired old look
Community Space
Budget

Castle Square DEEP RETROFIT Design Principles

1. Super Insulate
2. Air Seal
3. Scale down Heating & Cooling Equipment
4. Improve Indoor Air Quality
5. Harness the Sun
6. Reduce Plug Load

Energy Efficiency Payback



Building Insulation provides the largest energy & cost savings allowing for the shortest payback period

Commercial & Industrial: Castle Square Deep Energy Retrofit

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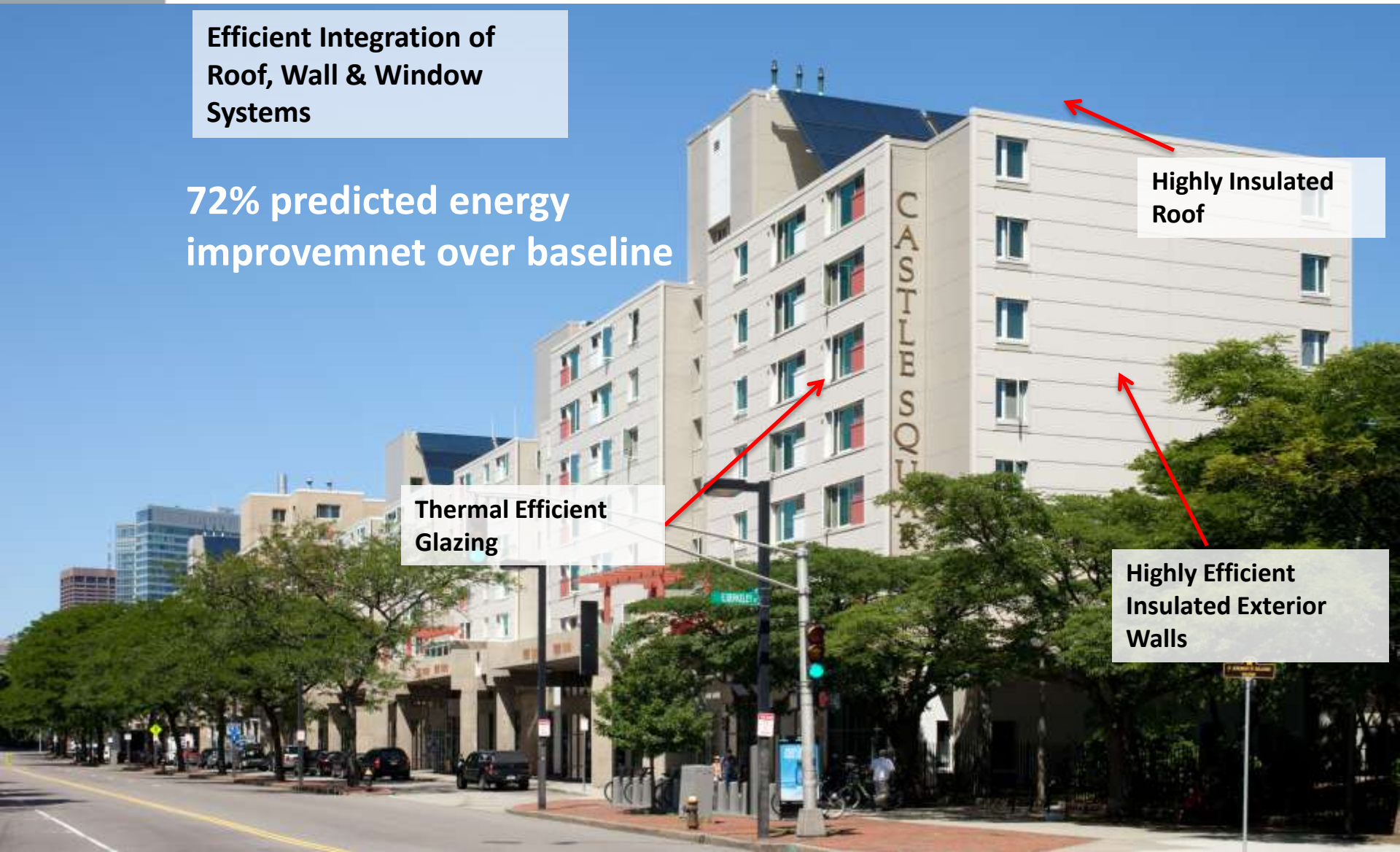
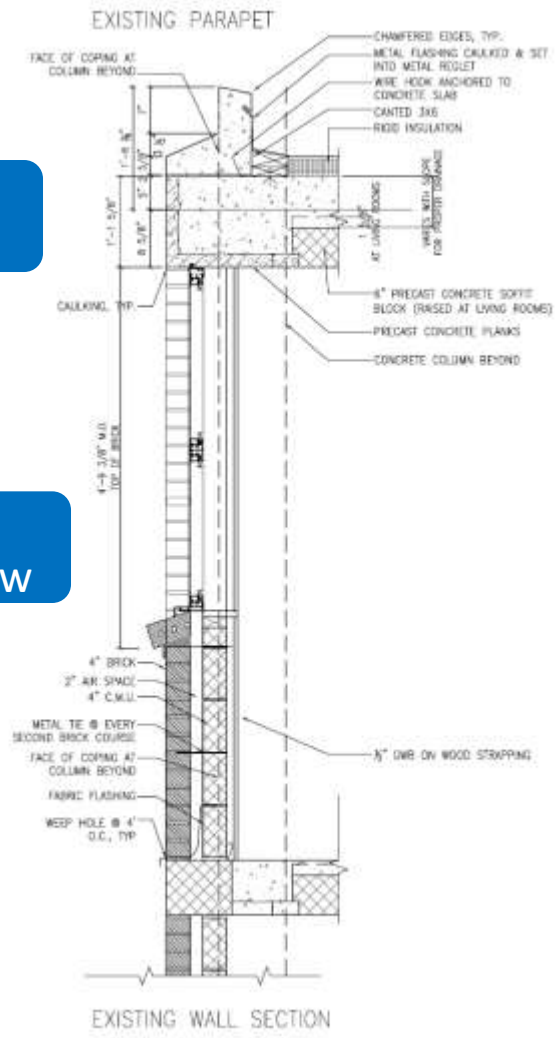


Super Insulated Metal Exterior

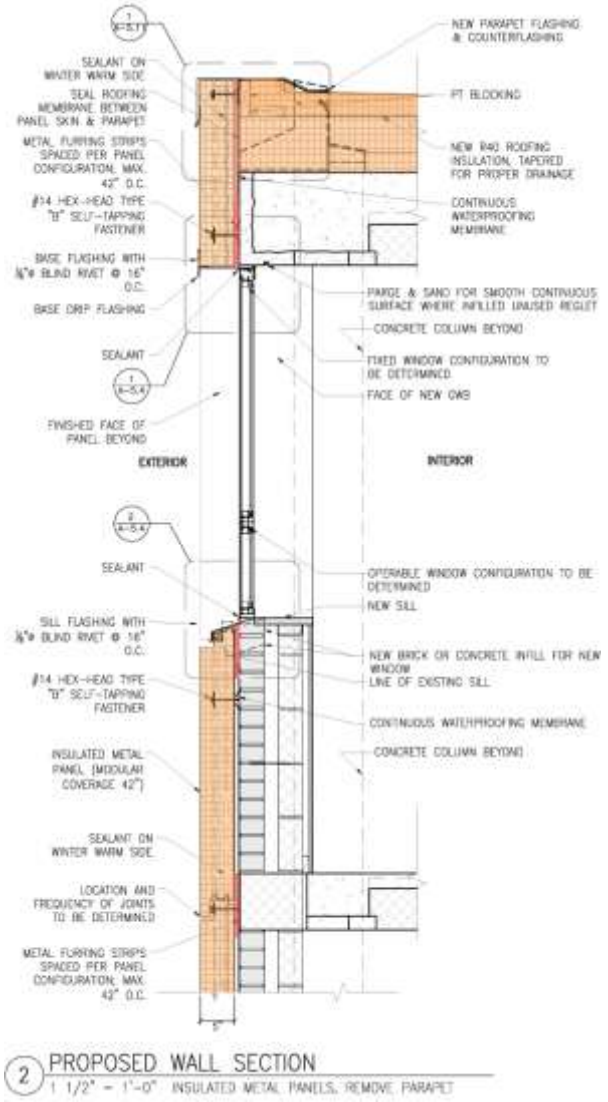
R-3 Wall

R-1.7 Window

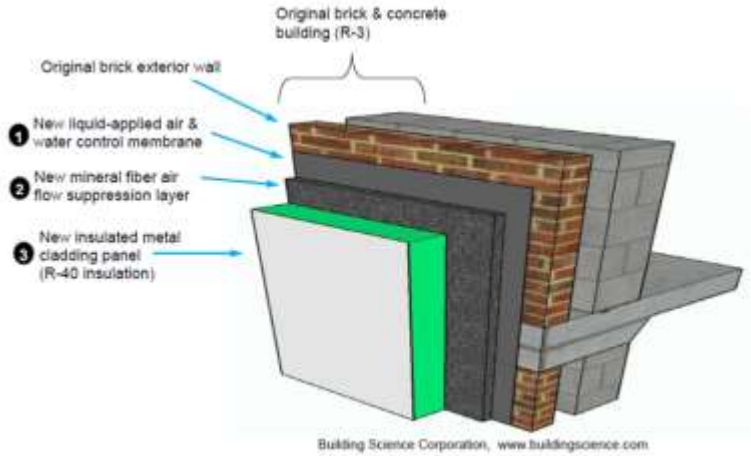


R-40 Wall

R-5 Window



Super Insulated Metal Panel Exterior



Roof and Solar

Roof area	Existing Insulation	New Overlay Insulation	Attachment method
Mid Rise Upper	2" Exp. Polystyrene	5" Polyisocyanurate	Mech. Fastened
Mid Rise Penthouses	2" Exp. Polystyrene	5" Polyisocyanurate	Mech. Fastened
Mid Rise Plaza Decks	3.2" Polyisocyanurate *	Tapered Polyisocyanurate	Mech. Fastened
Building 26/27	2.8" Polyisocyanurate	5" Polyisocyanurate	Mech. Fastened

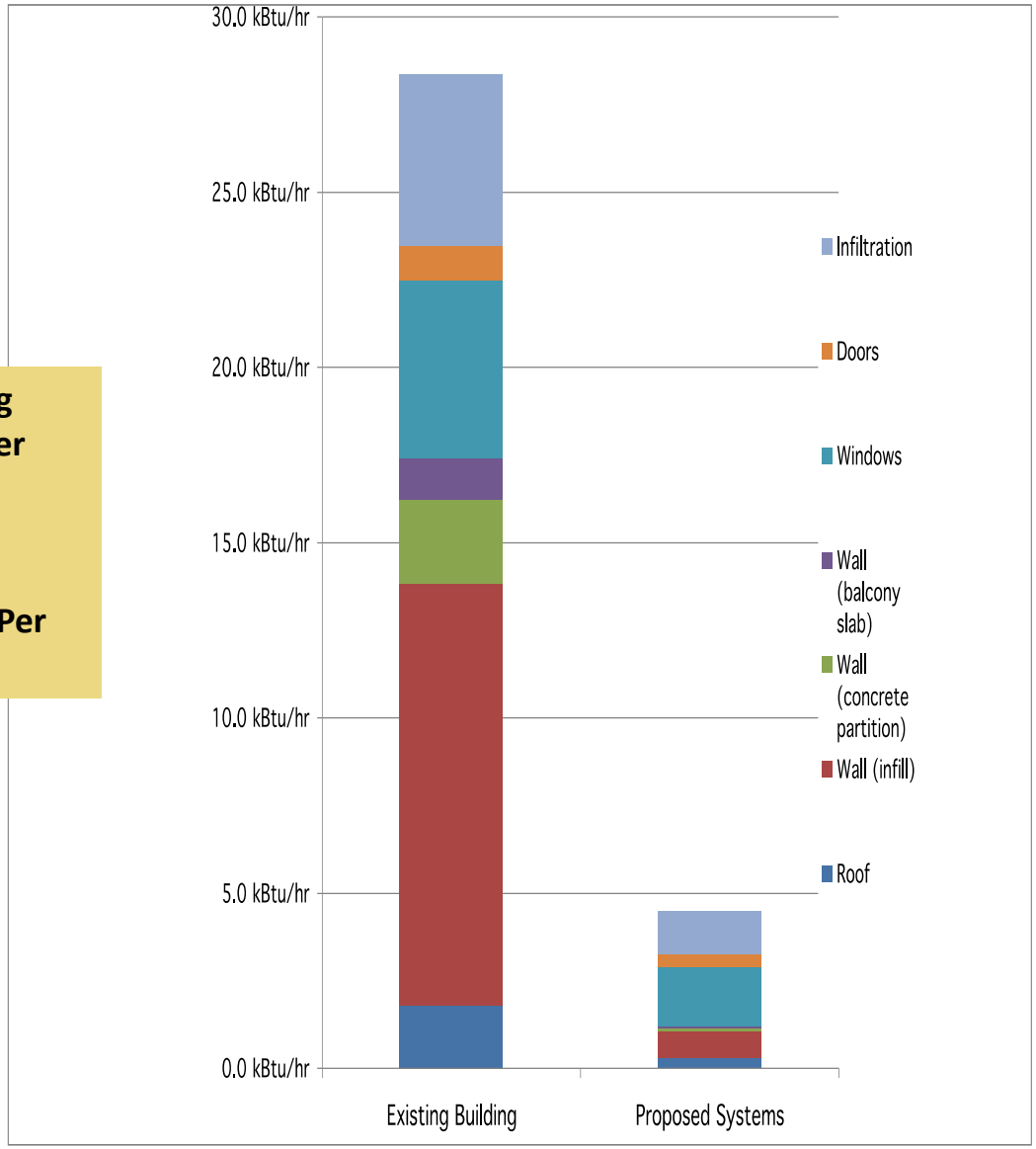
**Removed and replaced with tapered insulation, 1/8" per foot slope.*

Predicted Savings

71 % decrease in natural gas for heating
78% 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 CO2 Per Year

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



Predictive Cost Savings

	Midrise (Deep Energy Retrofit)			Midrise (No Shell)		
Gas		Therms	$1.53		Therms	$1.53
Baseline Gas Consumption - Heating (2008)		**78,024**	**$119,377**		**78,024**	**$119,377**
Savings from Enclosure	**60%**	**47,654**	**$72,911**	**23%**	**18,514**	**$28,326**
Roof Insulation	3%	2,591	$3,964	3%	2,591	$3,964
Exterior Super Insulation	33%	26,018	$39,808	0%		
Air Sealing (Air sealing provides two benefits 1) energy savings and 2) eliminates smells between units. Energy benefit shown here results mainly from the exterior shell in the midrise. (No Shell scenario, some of air sealing benefit is not achievable)	8%	6,245	$9,555	4%	3,123	$4,777
Windows	14%	11,167	$17,086	14%	11,167	$17,086
Doors	2%	1,633	$2,498	2%	1,633	$2,498
Savings from Mechanical (Due to efficiency improvements)		**8,016**	**$12,264**		**7,744**	**$11,849**
Ventilation		5,300	$8,109		5,300	$8,109
Heating System Upgrade (Boilers can't run in condensing mode as often in the no shell scenario which reduces overall heating efficiency)		2,716	$4,155		2,444	$3,740
TOTAL Heating Savings (Gas)	**71%**	**55,670**	**$85,175**	**34%**	**26,258**	**$40,175**

Cost of the Super Insulated Metal Panel Shell

	Total Costs	Costs per Sq.Ft.	Costs per Apartment
Total Cost – Super Insulated Shell 72,00 Sq. Ft. – wall area	$2,499,000	$34.71	$13,016
Cost Breakdown			
Air Vapor Barriers	$125,000	$1.74	$652
Metal Panel Furring - Materials	$145,000	$2.01	$755
Metal Panels Furring Labor	$175,000	$2.44	$915
Mineral Wool Suppression - Materials	$108,000	$1.50	$563
Mineral Wool Suppression - Labor	$72,000	$1.00	$376
Metal Panel Systems - Materials	$1,040,000	$14.44	$5,417
Metal Panel Systems - Installation	$620,000	$8.61	$3,229
Note: Avoided Masonry Repairs	- $300,000		

Heading

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Table 2. MIDRISE GAS PROJECTIONS

REALITY

	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%-64%

55%

53%

Graph 1. MIDRISE

One Year of Performance

- Analysis is ongoing
  - Currently projected between 65-68%
- Commissioning did not occur until after 1 year
- Solar was not functioning properly
- Modeling data inaccuracy
- Rebounding effect