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Distributed Energy Alternatives to Electrical Distribution Grid Expansion in Consolidated Edison Service Territory

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Distributed Energy Alternatives to Electrical Distribution Grid Expansion in Consolidated Edison Service Territory

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EXECUTIVE SUMMARY

The nation's power grid, specifically the New York region, faces burgeoning energy demand and suffers from congested corridors and aging equipment that cost New York consumers millions of dollars. Compounding the problem is high-density buildup in urban areas that limits available space to expand grid capacity. Coincidently, these urban areas are precisely where additional power is required.

DER in this study refers to combined heat and power (CHP) technology, which simultaneously generates heat and electricity at or near the point where the energy will be consumed. There are multiple CHP options available that, combined with a portfolio of other building energy efficiency (EE) strategies, can help achieve a more efficient supply-demand balance than what the grid can currently provide. As an alternative to expanding grid capacity, CHP and EE strategies can be deployed in a flexible manner at virtually any point on the grid to relieve load. What's more, utilities and customers can install them in a variety of potentially profitable applications that are more environmentally friendly.

Under the auspices of the New York State Energy Research and Development Authority (NYSERDA) and the Oak Ridge National Laboratory representing the Office of Electricity of the U.S. Department of Energy, Gas Technology Institute (GTI) conducted this study in cooperation with Consolidated Edison to help broaden the market penetration of EE and DER. This study provides realistic load models and identifies the impacts that EE and DER can have on the electrical distribution grid; specifically within the current economic and regulatory environment of a high load growth area of New York City called Hudson Yards in Midtown Manhattan. These models can be used to guide new policies that improve market penetration of appropriate CHP and EE technologies in new buildings. The following load modeling scenarios were investigated:

- 1. Baseline: All buildings are built per the Energy Conservation Construction Code of New York State (No CHP applied and no EE above the code)
- 2. Current Policy: This is a business-as-usual (BAU) scenario that incorporates some EE and DER based on market potential in the current economic and regulatory environment
- 3. Modified Rate 14RA: This economic strategy is meant to decrease CHP payback by removing the contract demand from, and adding the delivery charge to the Con Edison Standby Rate PSC2, SC14-RA
- 4. Carbon Trade at \$20/metric tonne (mt): This policy establishes a robust carbon trading system in NY that would allow building owners to sell the carbon reduction resulting from CHP and EE

As can be seen in Figure 1 and Figure 2, under a business-as-usual scenario EE and CHP have the potential to reduce the Hudson Yards peak demand by only about 6% and the carbon footprint by only about 3%. Peak demand for the Hudson Yards redevelopment area can be reduced by up to 20% (almost 50MW) and the carbon footprint reduced by about 10% (equivalent to removing approximately 10,000 cars) with some individual policy changes.



Figure 2 - Carbon Footprint for Business-as-Usual and High Market Penetrations



Figure 1 - Hudson Yards Predicted Peak Demands for Business-as-Usual and High Market Penetrations

Conclusion #1: Customer adoption rates of EE and CHP decrease exponentially with increasing simple payback. As such, CHP market penetration rates are limited in Hudson Yards due to simple paybacks in the range of 7 to 10 years even with current subsidies at \$600/kW (capped at \$2 million).

Conclusion #2: Under a business-as-usual scenario EE and CHP have the potential to reduce the Hudson Yards peak demand by only about 6% and the carbon footprint by only about 3%.

Conclusion #3: Peak demand for the Hudson Yards redevelopment area can be reduced by up to 20% (almost 50MW) and the carbon footprint reduced by about 10% (equivalent to removing approximately 10,000 cars) with some individual policy changes.

Conclusion #4: Carbon credits, fixed capacity payments in addition to current variable payments, and a pro-CHP tariff structure are all effective policy tools to reduce peak demand and emissions (including carbon footprint). Combining these policy tools would generate significantly higher peak demand and emissions reductions than individual policy changes.

Conclusion #5: CHP alone can be more effective at reducing peak demand, source energy and emissions (including carbon footprint) than high-efficiency building envelope material and high-efficiency mechanical equipment combined.

Recommendation #1: Adopt the following policies and actions that appropriately value or reduce the cost of EE and CHP:

- Provide a fixed 25 year capacity payment in the range of \$150/kW/yr
- Establish a robust carbon trading system in NY that would allow building owners to sell the carbon reduction resulting from CHP and EE
- Accelerate the completion of the ConEd system upgrades for Hudson Yards to provide for synchronous interconnection of CHP, thereby reducing CHP system first costs by up to \$600/KW. (about the same as the current NYSERDA incentive for CHP)

Recommendation #2: Consider changing the focus of incentive requirements from high efficiency to carbon reduction.

- Option A: Instead of requiring that CHP systems meet a minimum efficiency, establish a minimum carbon reduction percentage, and/or;
- Option B: Reduce the minimum CHP system efficiency from 60% to 50% to allow for larger CHP systems in commercial buildings. This may only apply to certain building types.

Observation #1: Electric chillers 20% more efficient than required by the Energy Conservation Construction Code of New York City could be economically attractive energy efficiency measures for all buildings modeled in this study.

Observation #2: Ice-on-Coil thermal storage systems sized conservatively to accommodate 15% to 25% of the total cooling capacity may be economically attractive peak demand reduction measures for office buildings modeled in this study.

Observation #3: Pending reductions to output-based emissions requirements could increase the first and operating costs of CHP, thereby reducing market penetration rates and potential for peak demand and emissions reductions.

Observation #4: Growing pressure for building owners to obtain Energy Star building certification could increase CHP and EE penetration rates. Improving the overall building energy efficiency increases the Energy Star rating.

Observation #5: Current NOx and SO2 cap and trade policies in New York do not allow building owners to obtain credit for their NOx and SO2 reductions associated with reducing building electricity consumption via EE and CHP. Reductions in electricity at the point of use are not factored into the overall state/region NOx and SO2 cap. This issue will need to be addressed if a carbon trading program is to be established. The carbon trading program should assign carbon credits to building owners that reduce electricity consumption so that building owners can be rewarded for their efficiency efforts.

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BACKGROUND

Under the auspices of the New York State Energy Research and Development Authority (NYSERDA) and the Oak Ridge National Laboratory representing the Office of Electricity of the U.S. Department of Energy, Gas Technology Institute (GTI) conducted this technology transfer study to help broaden the market penetration of building energy efficiency (EE) and distributed energy resources (DER). This study provides realistic models of the impacts that building EE and DER can have on the electrical distribution grid within the current economic and regulatory environment in New York. These models can be used to guide policies that improve market penetration of appropriate energy efficiency strategies.

Case Study

A high-growth area called Hudson Yards in Midtown Manhattan was selected to conduct a case study that shows which EE and DER technologies can be deployed to successfully reduce grid capacity demand. Hudson Yards is a 360 acre underutilized area proposed in 2003 by the New York Department of City Planning and Economic Development to be redeveloped within the next 20 years.ⁱ Hudson Yards is bounded roughly by West 42nd Street and West 30th Street, Eighth Avenue to the Hudson River. In 2005, the New York City Council adopted an amendment to the New York City Zoning Resolution that rezoned much of the manufacturing zone in the area to commercial and residential uses and allows for mixed-use developments and increased densities in sections of the area.ⁱⁱ

The study area for this project was limited to an area defined as the "Special Hudson Yards District" as shown in Figure 3. The Special Hudson Yards District excludes atypical areas like the Javits Convention Center and the convention and sport center expansions, the Garment Center Blocks, which have specific preservation requirements, and the 42nd Street Corridor, which is essentially planned as a theatre district.



Figure 3 - Hudson Yards and Special Hudson Yards District Map

The amended zoning map for the Special Hudson Yards District can accommodate roughly 57 new buildings with various floor area ratios and land-use designations. Along with the zoning map, GTI researched ongoing development efforts and worked with several real estate developers in the area to devise a dozen representative building prototypes. The prototype buildings were used to develop various energy models that were then used to develop aggregate electric distribution load models. The various load models can be used by the city and policy makers to help identify and target energy efficiency strategies.

Utility Infrastructure

To ensure reliable power for customers in the Manhattan area, Con Edison built network systems that distribute power through a complex web of power lines that connect to individual customers through multiple paths. Substations provide multiple feeders to multiple interconnected networks that are quilted throughout the city blocks. As such, load analysis restricted to individual feeders, networks or substations is insufficient because power load can be transferred across the systems. This study concentrates on the Special Hudson Yards District because it has significant potential for peak load reduction. The Hudson Yards redevelopment area is currently served by the Pennsylvania electric network, which serves a total load of approximately 240 MW in midtown Manhattan. This network is supplied by the West 42nd Street No. 1 substation. In 2005, Con Edison prepared an Energy Infrastructure Master Plan (EIMP) for the Hudson Yards redevelopment area.ⁱⁱⁱ As part of the plan, Con Edison conducted analyses to determine the need for load relief actions, including transfer of loads to nearby substations, expansion of existing substation capacities, and establishment of new substations. The net demand growth associated with the Hudson Yards redevelopment was predicted by Con Edison to be about 81 MW by 2010 and 310 MW by 2025. To accommodate the load growth Con Edison projected the following staged electric infrastructure upgrades:

To accommodate the 81 MW of load growth by 2010, Con Edison's plan would be to transfer load between substations and upgrade a substation. The cost associated with that load growth is approximated at \$280/kW. To accommodate the 310 MW of load growth by 2025, Con Edison's plan is expanded to add two new substations, a new switching station, and associated feeders and distribution infrastructure. The total cost associated with the entire 20-year load growth is approximated at \$2375/kW.

The Hudson Yards District is in an area of Con Edison's electric grid that still requires fault mitigation for synchronous distributed generation. Fault current limiters have been installed across a majority of Manhattan Island and are planned for the Hudson Yards District.

Con Edison's EIMP indicates that the gas system appears to have adequate capacity to support a large amount of distributed generation with only minimal reinforcements. Reinforcements could include extension of gas mains and installation/upgrade of gas regulating stations.

Con Edison's EIMP also indicates that extension of the steam system to serve Hudson Yards would be very costly and would also require construction of new steam generating capacity. These costs would exceed the savings that would be realized in electric and gas infrastructure if steam were utilized. This study is based on electric and gas infrastructure.

PROGRAM OBJECTIVES

Load Models

The primary objective of this study was to build energy load models to predict load growth in the selected area and determine the impacts of building EE and DER strategies on the load growth. The energy load models include:

- 1. A Baseline load growth model that is an aggregate of all foreseen new buildings in the Special Hudson Yards District built to the Energy Conservation Construction Code of New York State
- 2. A Business as Usual (BAU) load growth model that incorporates some EE and DER based on the current economic and regulatory environment
- 3. Alternative load growth models that incorporate more EE and DER than the BAU case due to improved economic and regulatory environments

EE and DER Strategies

Various EE and DER strategies were analyzed for the BAU and alternative cases. Each of the strategies improves upon the ECCC and is based on currently available technology and cost. The following categories were evaluated:

- 1. Energy Star -rated appliances for residential spaces
- 2. Reflective roofs (Cool Roofs)
- 3. High efficiency domestic hot water heating
- 4. High efficiency glazing (windows)
- 5. High efficiency space heating
- 6. High efficiency cooling
- 7. High efficiency lighting
- 8. Improved roof insulation
- 9. Improved wall insulation
- 10. Thermal storage in the form of ice-on-coil air conditioning
- 11. Building cooling heating and power DER systems that use waste heat for heating domestic hot water, space heating and absorption chillers for cooling

There are many assumptions associated with the building prototypes, the energy models, and the EE and DER strategies. Appendix A is a summary of the assumptions used to meet the objectives of this study.

MODELING AND METHODOLOGY

Building Prototypes

The Special Hudson Yards District is divided into zoning districts and potential development lots as shown in Figure 4. Each of the potential development lots is classified by a zoning district that identifies the primary land use and the target floor area ratios (FARs). The zoning district also requires ground floor retail development for the entire area. Through research and discussions with real estate developers, GTI identified key building characteristics such as planned use, square footage, and number of stories for some of the buildings already being built or planned to be built. Known building characteristics are highlighted grey in the proposed new buildings list in Figure 5. Otherwise, multiplying the lot sizes (square feet) by the zoning FARs, determines the allowable building floor areas and approximate stories.



Figure 4 - Special Hudson Yards District Development Lots

Proposed New Building List								
Site	Туре	Total Sq-ft	GF Sq-ft	Stories				
	Office	3,420,000	93,000	46				
Eastern Rail Yard	Residential	1,710,000	79,000	27				
	Residential	1,140,000	57,000	25				
705A	Office	1,500,000	45,000	42				
705B	Office	1,914,000	43,000	56				
1000	Residential	436,000	11,000	51				
706A	Mixed	2,000,000	45,000	55				
706B	Office	2,500,000	89,000	35				
1005	Residential	416,000	14,000	36				
707A	Hotel	1,250,000	47,000	33				
707B	Office	1,146,000	36,000	40				
	Residential	395,000	12,000	41				
708A	Office	1,846,000	58,000	40				
708B	Residential	264,000	8,000	44				
	Residential	398,000	14,000	36				
709A	Office	1,008,000	32,000	40				
	Residential	396,000	16,000	31				
709B	Residential	534,000	19,000	36				
	Residential	354,000	10,000	44				
710A	Dilice	960,000	34,000	30				
	Residential	431,000	17,000	36				
710B	Residential	332,000	0,000	44				
711Δ	Office	736,000	28,000	33				
711R	Residential	347,000	11 000	30				
	Office	1.314.000	41,000	40				
1069A	Residential	516.000	21.000	31				
40504	Office	172.000	17.000	13				
1050A	Residential	199,000	17,000	15				
733A	Residential	651,000	23,000	35				
734A	Residential	446,000	23,000	24				
735A	Residential	873,000	45,000	24				
	Hotel	257,000	18,000	18				
	Hotel	257,000	18,000	18				
Block 763	Hotel	257,000	18,000	18				
	Hotel	192,000	13,000	18				
	Hotel	192,000	13,000	18				
Hell's Kitchen	Residential	650,000	45,000	18				
	Residential	67.000	10.000	18				
	Residential	07,000	25,000	0				
	Residential	220,000	22,000	0				
Hell's Kitchen and	Residential	314 000	22,000	0				
Ninth Avenue Corridor	Residential	314,000	22,000	10				
Nintin Avenue Comuor	Residential	81 000	13 000	8				
	Residential	38,000	6,000	8				
	Residential	80,000	13,000	8				
	Residential	186.000	19,000	12				
34th Street Cooridor	Residential	73.000	8.000	12				
	Residential	218,000	23,000	12				
728A	Office	362,000	21,000	22				
720.4	Office	1,686,000	64,000	33				
129A	Residential	1175000	64,000	23				
729B	Office	1839000	64,000	36				
729C	Office	2,115,000	102,000	26				
	Residential	851,000	34,000	31				
Development rights	Residential							
transterred from	or	1,100,000	120,000	58				
Farley Post Office	Residential							

Figure 5 - Special Hudson Yards District Development Proposed New Buildings

For the purpose of this study, 12 building prototype models were developed along with ground-floor models for corner retail shops, internal retail shops with only one external wall, and corner restaurant space. Furthermore, buildings greater than 20 stories were modeled as frame-wall type with structural steel interior frame and exterior unitized curtain wall systems. Buildings 20 stories or less were modeled as mass-wall type structural steel frame with pre-cast concrete exterior wall systems. All of the building prototype details are defined in Appendix A. The building models are summarized in Table 1:

Prototype	Туре	Construction	Stories	Area (ft ²)	Ground-floor Area (ft ²)	Quantity
1	High Rise Office	Frame-wall	56	1,914,000	43,000	1
2	High Rise Office	Frame-wall	41	1,706,000	51,000	6
3	High Rise Office	Frame-wall	34	1,544,000	56,000	5
4	Mid Rise Office	Mass-wall	20	883,000	47,000	3
5	High Rise Hotel	Frame-wall	33	1,250,000	47,000	1
6	Mid Rise Hotel	Mass-wall	18	231,000	16,000	5
7	High Rise Residential	Frame-wall	55	768,000	65,000	2
8	High Rise Residential	Frame-wall	43	336,000	10,000	4
9	High Rise Residential	Frame-wall	34	504,000	19,000	10
10	High Rise Residential	Frame-wall	25	1,069,000	54,000	5
11	Mid Rise Residential	Mass-wall	12	186,000	19,000	14
12	Mixed Use	Frame-wall	55	2,000,000	45,000	1
Common	Corner Retail	Frame-wall	-	-	2,000	-
Common	Internal Retail	Frame-wall	-	-	2,000	-
Common	Restaurant	Frame-wall	-	-	7,400	-
Common	Corner Retail	Mass-wall	-	-	2,000	-
Common	Internal Retail	Mass-wall	-	-	2,000	-
Common	Restaurant	Mass-wall	-	-	7,400	-

Table 1- Special Hudson Yards District Prototype Model Summary

The distribution of prototypes across the Special Hudson Yards District can be found in Appendix A. The resulting land use percentages are shown in Figure 6.



Figure 6 - Special Hudson Yards District Prototype Use by Square Footage

Building energy models for the Special Hudson Yards District were calibrated by comparing their energy use to that of several Manhattan buildings that were built in the late 60's and early 70's. Annual hourly energy data (8,760) were acquired from the owners for each of these buildings and used for calibrating each of the prototype models. The prototype calibrations can be found in Appendix B. Building use, square footage, and number of stories were known for each of the existing Manhattan buildings used for calibration. However, details of the mechanical equipment were very limited.

It was apparent that most of the energy consumption data came from buildings that had some degree of steam-driven cooling, and all of them were heated with central steam. New buildings in the Hudson Yards District will be heated with dedicated gas-fired boilers and cooled with electric chillers. Therefore, the building prototypes were first calibrated assuming central steam heating and 50% steam-driven cooling. The central steam heating and steam-driven cooling were then replaced with dedicated gas-fired boilers and electric chillers for the analyses.

The 13 buildings that data were acquired for are primarily office buildings. Data were acquired for one residential building, but no hotels. As such, typical hotel data within the computer energy modeling software were used to develop the hotel prototypes. They were then compared to the residential data. Typical data were also used to develop the retail and restaurant models.

Building Energy Modeling

Building Energy Analyzer (BEA) computer energy modeling software was used to generate hourly loads for each of the buildings.^{iv} The coincident hourly loads for the individual buildings are then summed to produce aggregate load duration curves (load curves) for the entire area. BEA consists of hour-by-hour computer simulation models for various building types, heat and power generation equipment, and HVAC equipment. Within the BEA models, equipment (e.g. lighting, HVAC, etc.) and building parameters (e.g. wall material, window designs, roofing, etc.), energy rates, and geographical weather data can be defined for specific applications.

BEA forecasts and reports annual hour-by-hour heat and power loads along with hour-byhour fuel requirements. Additionally, the software allows for the aggregation of multiple building loads for energy impact analyses.

BEA uses weather data from the typical meteorological year (TMY2) data sets derived from the 1961-1990 National Solar Radiation Data Base (NSRDB).^v The load models generated from the 8760 building model data streams are typical for weather during the TMY2 time span for New York City.

Aggregate Energy Load Modeling

In August 2007 the New York State Department of State Division of Code Enforcement and Administration published the Energy Conservation Construction Code of New York State (ECCC).^{vi} The code is intended to regulate the design and construction of newly built residential and commercial buildings for the effective use of energy. The baseline load model for this study is an aggregate of building load models that meet, but do not exceed, the ECCC standards. As such, the baseline load model does not include DER in any of the buildings. The load model is intended to show the potential electric load with zero market penetration of EE and DER strategies.

The National Energy Modeling System (NEMS) has formulated a market penetration curve for energy efficiency strategies based on payback years.^{vii} The curve is defined by Equation 1, which demonstrates that when a given EE measure generates positive cash flow within one year, roughly 48% of the market will adopt the measure. This is considered the maximum market penetration rate. The rate of adoption decays exponentially as the payback increases, as shown in Figure 7.

Equation 1: Market penetration
$$= \frac{1.1 \times penparm}{e^{(0.24 \times PCF)}}$$

where:

penparm = penetration parameter, NEMS uses 50%

PCF = number of years to positive cash flow (approximately half the simple payback period)



Figure 7 – NEMS Market Penetration Curve

Based on the NEMS market penetration curve, the Business as Usual (BAU) energy load model was developed. For each building model all of the EE and DER strategies defined in the objectives were applied individually. Using BEA, the energy cost savings were calculated and simple paybacks were determined based on the total cost of the EE or DER measure. Simple paybacks were then changed to *PCF's* and used in Equation 1 to determine BAU market adoption of the EE or DER measures.

A series of alternative energy load models were then developed that incorporate more EE and DER than the BAU case due to an improved economic and regulatory environment.

The increase in adoption of EE and DER strategies occurs as a result of the following parameter changes:

- 1. Decreasing simple payback, thus *PCF* in Equation 1. This can happen by way of an improved economic environment.
- 2. Increasing *penparm* in Equation 1. This is fundamentally the same as increasing the maximum market penetration to be greater than 48% and can happen by way of an improved regulatory environment.

To address each of these alternative approaches, multiple energy load models were developed that implement the following economic and regulatory strategies.

- Decrease simple payback, thus *PCF*, by implementing a carbon cap and trade policy. NYC issued PlanNYC which calls for a 30% reduction in global warming emissions.^{viii} The carbon cap and trade policy fundamentally decreases *paybacks* for EE and DER strategies that reduce carbon emissions. Energy load sensitivities were generated for \$5 to \$20 incrementally at \$5 per metric tonne (\$/mt) of CO2 emitted. At the time of this report, the Chicago Climate Exchange (CCX) was actively trading CO2 in the North America's at about \$6/mt.^{ix} The European Climate Exchange (ECX), launched by CCX, is the leading exchange operating in the European Union Emissions Trading Scheme. At the time of this report ECX was actively trading CO2 in Europe at about EUR25/mt; the USD equivalent is \$38/mt. The trading values of CO2 for both CCX and ECX, have been steadily increasing in 2008.
- 2. Con Edison's applicable rate without CHP is PSC9, SC4, Rate II and has a delivery energy charge component of 0.58 cents per kWh in addition to their commodity energy charge. Con Edison's Standby Rate PSC2, SC14-RA does not include the delivery energy charge. Instead, the standby rate applies a contract demand charge of \$8.02/kW to offset the nonexistent delivery charge and to account for standby demand. This economic strategy is meant to decrease simple payback, thus *PCF*, by removing the contract demand of \$8.02/kW from, and adding the delivery charge of approximately 0.58 cents per kWhr to the commodity energy charge of Con Edison Standby Rate PSC2, SC14-RA.
- 3. Increase *penparm* from about 50% to 90% in increments of 10 percentage points through regulatory policy. This results in calculated market penetration rates for a one-year simple payback of 48%, 58%, 68%, 77% and 87%.

Results, including tables, charts, and conclusions in this report refer to the incremental increases to the maximum market penetration rates (penparm) as follows:

<u>Low</u> Market Penetration: 48% (this is business-as-usual <u>BAU</u>) <u>Mid-Low</u> Market Penetration: 58% <u>Mid</u> Market Penetration: 68% <u>Mid-High</u> Market Penetration: 77% <u>Hiah</u> Market Penetration: 87%

These percentages represent the market penetration rate when the simple payback is one year.

Other Acronyms used in the results are:

Baseline All buildings built per ECCC (No CHP applied and no EE above the ECCC) EE All energy efficiency strategies, including cold storage, except CHP CHP Building Cooling, Heating, and Power Modified Con Edison Standby rate PSC2, SC14-RA, Rate II 14RA CCT5 Carbon Cap & Trade policy at \$5/mt of CO2 *CCT10* Carbon Cap & Trade policy at \$10/mt of CO2 Carbon Cap & Trade policy at \$15/mt of CO2 *CCT15 CCT20* Carbon Cap & Trade policy at \$20/mt of CO2

ANALYSIS RESULTS

Summary of Results

The results in this section are a series of load curves and bar charts that show the annual energy load profiles, totals, and corresponding annual CO2, SO2, and NOx emissions. The load curves are developed by sorting the 8,760 hourly loads in descending order so that the highest demands for the year are at the far left of the graph. Bar charts for energy and emissions are provided with the contributions from gas and electric shown stacked. Bar charts showing the collective energy and emissions contributions from gas and electric are also provided with greater resolution so that the total impacts can be seen well.

Table 2 summarizes the scenarios as assembled in the graphs and charts in Figure 12 through Figure 29. The tables in Appendix C show which and how many EE and DER strategies are adopted based on the various scenarios. Table 3 shows the ranges of predicted reductions in peak electric demand and associated emissions given BAU and High market penetrations. Table 4 shows the ranges of predicted reductions in peak electric demand and High market penetrations and a carbon cap and trade policy at \$5 to \$20/mt. Finally, Table 5 through Table 10 show the levels of CHP adoption on a kW basis for the various scenarios.

To clarify the nomenclature used in Table 5 through Table 10, in Table 5 there are six Prototype 02 buildings that could each install a total of 5,500 kW of CHP. However, applying the market penetration rates for the BAU scenario, only one out of the six installs a total of 5,500 kW of CHP (i.e. 5,500 x 1).

Table 2 – Summary of Graphs, Charts and Tables Showing Results with Parametric Variations Compared to the Baseline Case

		Held (Constant			
Figures	Tables	Market penetration	Measures Applied	Varied Parametrically		
8,9	11,24	-	EE and CHP	Market penetration rates: BAU, Mid-low, Mid, Mid-High, and High		
10,11	12,24	BAU	-	Measures applied: EE only, CHP only, CHP and EE, CHP only with modified 14RA		
12,13	13,25	BAU	EE and CHP	Carbon Cap and Trade Policy: none, CCT5, CCT10, CCT15, and CCT20		
14,15	14,26	Mid-Low	-	Measures applied: EE only, CHP only, CHP and EE, CHP only with modified 14RA		
16,17	15,26	Mid-Low	EE and CHP	Carbon Cap and Trade Policy: none, CCT5, CCT10, CCT15, and CCT20		
18,19	16,27	Mid	-	Measures applied: EE only, CHP only, CHP and EE, CHP only with modified 14RA		
20,21	17,27	Mid	EE and CHP	Carbon Cap and Trade Policy: none, CCT5, CCT10, CCT15, and CCT20		
22,23	18,28	Mid-High	-	Measures applied: EE only, CHP only, CHP and EE, CHP only with modified 14RA		
24,25	19,28	Mid-High	EE and CHP	Carbon Cap and Trade Policy: none, CCT5, CCT10, CCT15, and CCT20		
26,27	20,29	High	-	Measures applied: EE only, CHP only, CHP and EE, CHP only with modified 14RA		
28,29	21,29	High	EE and CHP	Carbon Cap and Trade Policy: none, CCT5, CCT10, CCT15, and CCT20		

Table 3 – Predicted Reductions from Baseline due to the Implementation of EE and CHP for a range of Market Penetrations levels from BAU to High

Measure	Peak Demand	CO2 Emitted	SO2 Emitted	NOx Emitted
EE	3% to 6%	1% to 2%	1% to 2%	1% to 2%
СНР	4% to 7%	2% to 4%	6% to 11%	3% to 5%
EE+CHP	7% to 13%	3% to 6%	7% to 12%	4% to 7%
CHP 14RA	7% to 15%	3% to 8%	10% to 22%	4% to 10%

		· ·			
Measure	ССТ	Peak Demand	CO2 Emitted	SO2 Emitted	NOx Emitted
EE+CHP	\$0	7% to 13%	3% to 6%	7% to 12%	4% to 7%
EE+CHP	\$5	7% to 18%	3% to 9%	7% to 19%	4% to 11%
EE+CHP	\$10	9% to 18%	5% to 9%	10% to 20%	5% to 10%
EE+CHP	\$15	9% to 20%	5% to 10%	10% to 23%	5% to 12%
EE+CHP	\$20	9% to 21%	5% to 10%	11% to 24%	5% to 12%

Table 4 - The Range of Predicted Reductions fromBaseline Due to the Implementation of CHP and EE withMarket Penetrations Varied from BAU to High and CCTPolicy Varied from \$5 to \$20/mt

Table 5 – Predicted CHP Adoption Levels by Buildingwhere Rate 14RA is Unmodified and there is no CarbonCap and Trade Policy

Prototype	Bldgs Qty	BAU	Mid-Low	Mid	Mid-High	High
01	1	0	0	0	0	0
02	6	5,500 x 1				
03	5	0	4,500 x 1	4,500 x 1	4,500 x 1	4,500 x 1
04	3	0	0	0	0	0
05	1	0	0	0	0	0
06	5	400 x 1	400 x 1	400 x 1	400 x 1	400 x 2
07	2	0	0	0	0	0
08	4	0	0	0	750 x 1	750 x 1
09	10	850 x 2	850 x 2	850 x 2	850 x 3	850 x 3
10	5	1,500 x 1				
11	14	250 x 1	250 x 1	250 x 2	250 x 2	250 x 2
12 Office	1	0	0	0	0	0
12 Res	1	0	0	0	0	0
Totals	57	9,350	13,850	14,100	15,700	16,100

Prototype	Bldgs Qty	BAU	Mid-Low	Mid	Mid-High	High
01	1	0	0	0	0	0
02	6	5,500 x 1	5,500 x 1	5,500 x 2	5,500 x 2	5,500 x 2
03	5	4,500 x 1	4,500 x 1	4,500 x 1	4,500 x 2	4,500 x 2
04	3	0	0	3000 x 1	3000 x 1	3000 x 1
05	1	0	0	0	0	0
06	5	400 x 1	400 x 1	400 x 1	400 x 2	400 x 2
07	2	0	0	0	0	0
08	4	0	750 x 1	750 x 1	750 x 1	750 x 1
09	10	850 x 2	850 x 3	850 x 3	850 x 4	850 x 4
10	5	1,500 x 1	1,500 x 1	1,500 x 1	1,500 x 2	1,500 x 2
11	14	250 x 2	250 x 3	250 x 3	250 x 4	250 x 5
12 Office	1	0	0	0	0	0
12 Res	1	0	0	0	0	0
Totals	57	14,100	15,950	24,450	31,950	32,200

Table 6 - Predicted CHP Adoption Levels by Buildingwhere Rate 14RA is Modified and there is no Carbon Capand Trade Policy

Table 7 - Predicted CHP Adoption Levels by Buildingwhere Rate 14RA is Unmodified and there is a CarbonCap and Trade Policy at \$5/mt

Prototype	Bldgs Qty	BAU	Mid-Low	Mid	Mid-High	High
01	1	0	0	0	0	0
02	6	5,500 x 1				
03	5	0	4,500 x 1	4,500 x 1	4,500 x 1	4,500 x 1
04	3	0	0	0	0	3000 x 1
05	1	0	0	0	0	0
06	5	400 x 1	400 x 1	400 x 1	400 x 1	400 x 2
07	2	0	0	0	0	0
08	4	0	0	750 x 1	750 x 1	750 x 1
09	10	850 x 2	850 x 2	850 x 3	850 x 3	850 x 3
10	5	1,500 x 1	1,500 x 1	1,500 x 1	1,500 x 1	1,500 x 2
11	14	250 x 1	250 x 2	250 x 2	250 x 3	250 x 3
12 Office	1	0	0	0	0	0
12 Res	1	0	0	0	0	0
Totals	57	9,350	14,100	15,700	15,950	20,850

Prototype	Bldgs Qty	BAU	Mid-Low	Mid	Mid-High	High
01	1	0	0	0	0	0
02	6	5,500 x 1	5,500 x 1	5,500 x 1	5,500 x 2	5,500 x 2
03	5	4,500 x 1				
04	3	0	0	0	3000 x 1	3000 x 1
05	1	0	0	0	0	0
06	5	400 x 1	400 x 1	400 x 1	400 x 2	400 x 2
07	2	0	0	0	0	0
08	4	0	750 x 1	750 x 1	750 x 1	750 x 1
09	10	850 x 2	850 x 2	850 x 3	850 x 3	850 x 4
10	5	1,500 x 1	1,500 x 1	1,500 x 1	1,500 x 2	1,500 x 2
11	14	250 x 2	250 x 2	250 x 3	250 x 3	250 x 4
12 Office	1	0	0	0	0	0
12 Res	1	0	0	0	0	0
Totals	57	14,100	14,850	15,950	26,350	27,450

Table 8 - Predicted CHP Adoption Levels by Buildingwhere Rate 14RA is Unmodified and there is a CarbonCap and Trade Policy at \$10/mt

Table 9 - Predicted CHP Adoption Levels by Buildingwhere Rate 14RA is Unmodified and there is a CarbonCap and Trade Policy at \$15/mt

Prototype	Bldgs Qty	BAU	Mid-Low	Mid	Mid-High	High
01	1	0	0	0	0	0
02	6	5,500 x 1	5,500 x 1	5,500 x 1	5,500 x 2	5,500 x 2
03	5	4,500 x 1	4,500 x 1	4,500 x 1	4,500 x 1	4,500 x 2
04	3	0	0	0	3000 x 1	3000 x 1
05	1	0	0	0	0	0
06	5	400 x 1	400 x 1	400 x 1	400 x 2	400 x 2
07	2	0	0	0	0	0
08	4	0	750 x 1	750 x 1	750 x 1	750 x 1
09	10	850 x 2	850 x 3	850 x 3	850 x 4	850 x 4
10	5	1,500 x 1	1,500 x 1	1,500 x 1	1,500 x 2	1,500 x 2
11	14	250 x 2	250 x 3	250 x 3	250 x 4	250 x 4
12 Office	1	0	0	0	0	0
12 Res	1	0	0	0	0	0
Totals	57	14,100	15,950	15,950	27,450	31,950

Prototype	Bldgs Qty	BAU	Mid-Low	Mid	Mid-High	High
01	1	0	0	0	0	0
02	6	5,500 x 1	5,500 x 1	5,500 x 2	5,500 x 2	5,500 x 2
03	5	4,500 x 1	4,500 x 1	4,500 x 1	4,500 x 1	4,500 x 2
04	3	0	0	3000 x 1	3000 x 1	3000 x 1
05	1	0	0	0	0	0
06	5	400 x 1	400 x 1	400 x 2	400 x 2	400 x 2
07	2	0	0	0	0	0
08	4	0	750 x 1	750 x 1	750 x 1	750 x 1
09	10	850 x 2	850 x 3	850 x 3	850 x 4	850 x 4
10	5	1,500 x 1	1,500 x 1	1,500 x 1	1,500 x 2	1,500 x 2
11	14	250 x 2	250 x 3	250 x 3	250 x 4	250 x 5
12 Office	1	0	0	0	0	0
12 Res		0	0	0	0	0
Totals	57	14,100	15,950	24,850	27,450	32,200

Table 10 - Predicted CHP Adoption Levels by Buildingwhere Rate 14RA is Unmodified and there is a CarbonCap and Trade Policy at \$20/mt

Business as Usual – Low Market Penetration



Figure 8 - Hudson Yards Aggregate Annual Electric Load Curves - Impact of Varying the Market Penetration Rates of EE and CHP

Table 11 – Percentages of Peak Demand Reduction from
Baseline - Impact of Varying the Market Penetration
Rates of EE and CHP

Measure	Peak Demand
BAU	6.9%
Mid-Low	9.9%
Mid	10.2%
Mid-High	11.8%
High	12.8%



Figure 9 - Hudson Yards Aggregate Annual Energy **Consumption and Emissions - Impact of Varying the Market Penetration Rates of EE and CHP**

0.524

0.522



Table 12 - Peak Demand Reduction from Baseline - Impactof Varying the Measures Applied to Achieve LoadReductions under a BAU Market Penetration Rate

Measure	Peak Demand
BAU EE	2.6%
BAU CHP	4.3%
BAU 14RA	6.4%
BAU CHP+EE	6.9%

BAU Market Penetration Rate 16 13.6 14 13.5 12 13.4 Trillions of Btu Trillions of Btu 10 13.3 8 13.2 6 Gas 13.1 4 ■ Electric 13.0 2 12.9 0 BAU 12.8 Baseline BAU EE BAU CHP BAU 14RA CHP+EE BAU Baseline BAU EE BAU CHP BAU 14RA CHP+EE Gas 2.804 2.736 3.068 3.218 3.000 Total 13,587 13,447 13,201 12,993 13.061 Electric 10.783 10.712 10.133 9.775 10.062 700 600 600 Thousands of Tonnes CO2 595 500 Thousands of Tonnes CO2 400 590 300 Gas 585 200 Electric 100 580 0 BAU 575 Baseline BAU EE BAU CHP BAU 14RA BAU CHP+EE Baseline BAU EE BAU CHP BAU 14RA CHP+EE Gas 142.8 139.3 160.2 170.0 156.7 Total 597.4 590.9 585.1 578.6 578.6 Electric 454.6 451.5 424.9 408.6 421.9 2.00 1.90 1.80 Thousands of Tonnes SO2 1.60 1.85 Thousands of Tonnes SO2 1.40 1.20 1.80 1.00 0.80 Gas 1.75 0.60 Electric 0.40 1.70 0.20 0.00 BAU 1.65 Baseline BAU EE BAU CHP BAU 14RA CHP+EE BAU BAU CHP BAU 14RA Baseline BAU EE CHP+EE Gas 0.001 0.001 0.001 0.001 0.001 Total 1.895 1.883 1.776 1.711 1.764 Electric 1.894 1.882 1.776 1.710 1.763 0.80 0.700 0.70 Thousands of Tonnes NOx 0.695 0.60 Thousands of Tonnes NOx 0.690 0.50 0.685 0.40 0.680 0.30 🗆 Gas 0.675 0.20 Electric 0.670 0.10 0.665 0.00 BAU 0.660 BAU 14RA Baseline BAU EE BAU CHP CHP+EE BAU BAU EE Baseline BAU CHP BAU 14RA CHP+EE Gas 0.112 0.109 0.130 0.140 0.127 Total 0.697 0.690 0.678 0.668 0.672 Electric 0.585 0.581 0.548 0.528 0.545

Figure 11 - Hudson Yards Aggregate Annual Energy Consumption and Emissions – Impact of Varying the Measures Applied to Achieve Load Reductions under a BAU Market Penetration Rate

Figure 12 - Hudson Yards Aggregate Annual Electric Load Curves – Impact of Varying the Carbon Cap and Trade Price under a BAU Market Penetration Rate for CHP & EE



Table 13 - Peak Demand Reduction from Baseline – Impact of Varying the Carbon Cap and Trade Price under a BAU Market Penetration Rate for CHP & EE

Measure	Peak Demand
BAU CHP+EE	6.9%
BAU CHP+EE CCT5	6.9%
BAU CHP+EE CCT10	9.1%
BAU CHP+EE CCT15	9.1%
BAU CHP+EE CCT20	9.2%



Figure 13 - Hudson Yards Aggregate Annual Energy Consumption and Emissions – Impact of Varying the Carbon Cap and Trade Price under a BAU Market Penetration Rate for CHP & EE

Improved Market Penetration Rate – Mid-Low Market Penetration



Figure 14 - Hudson Yards Aggregate Annual Electric Load Curves – Impact of Varying the Measures Applied to Achieve Load Reductions under a Mid-Low Market Penetration Rate



Measure	Peak Demand
Mid-Low EE	3.5%
Mid-Low CHP	6.3%
Mid-Low 14RA	7.3%
Mid-Low CHP+EE	9.9%

Mid-Low Market Penetration Rate 16 13.6 14 13.5 12 13.4 Trillions of Btu Trillions of Btu 10 13.3 8 13.2 6 13.1 Gas 13.0 4 ■ Electric 12.9 2 12.8 0 Mid-Low Mid-Low Mid-Low Mid-Low 12.7 Baseline Mid-Low Mid-Low Mid-Low EE CHP 14RA CHP+EE Mid-Low Baseline CHP+EE CHP 14RA EE 2.717 Gas 3.104 2.804 3.191 3.238 Total 13.59 12,90 12.81 13.41 12,98 Electric 10.783 10.695 9.791 9.702 9.666 700 600 600 595 Thousands of Tonnes CO2 500 Thousands of Tonnes CO2 590 400 585 300 580 Gas 200 Electric 575 100 570 0 Mid-Low Mid-Low Mid-Low Mid-Low 565 Baseline Mid-Low Mid-Low Mid-Low Mid-Low EE CHP 14RA CHP+EE Baseline CHP 14RA CHP+EE Gas 142.8 138.4 163.8 EE 168.2 171.4 Total 597.4 589.3 577.5 575.0 569.4 Electric 454.6 450.8 409.3 403.6 405.6 2.00 1.90 1.80 Thousands of Tonnes SO2 1.60 1.85 Thousands of Tonnes SO2 1.40 1.20 1.80 1.00 0.80 Gas 1.75 0.60 Electric 0.40 1.70 0.20 0.00 Mid-Low Mid-Low Mid-Low Mid-Low 1.65 Baseline CHP 14RA CHP+EE Mid-Low Mid-Low Mid-Low Mid-Low EE Baseline EE СНР 14RA CHP+EE Gas 0.001 0.001 0.001 0.001 0.001 Total 1.895 1.880 1.714 1.691 1.698 Electric 1.894 1.879 1.713 1.690 1.697 0.80 0.70 0.70 0.70 Thousands of Tonnes NOx 0.69 0.60 Thousands of Tonnes NOx 0.69 0.50 0.68 0.40 0.68 0.30 🗆 Gas 0.67 0.20 Electric 0.67 0.66 0.10 0.00 0.66 Mid-Low Mid-Low Mid-Low Mid-Low 0.65 Baseline EE CHP 14RA CHP+EE Mid-Low Mid-Low Mid-Low Mid-Low Baseline EE CHP 14RA CHP+EE Gas 0.112 0.108 0.138 0.142 0.135 Total

Figure 15 - Hudson Yards Aggregate Annual Energy **Consumption and Emissions – Impact of Varying the** Measures Applied to Achieve Load Reductions under a

Electric

0.585

0.581

0.529

0.522

0.524

0.697

0.689

0.667

0.664

0.659
Figure 16 - Hudson Yards Aggregate Annual Electric Load Curves – Impact of Varying the Carbon Cap and Trade Price under a Mid-Low Market Penetration Rate for CHP & EE



Table 15 - Percentages of Peak Demand Reduction fromBaseline – Impact of Varying the Carbon Cap and TradePrice under a Mid-Low Market Penetration Rate for CHP& EE

Measure	Peak Demand
Mid-Low CHP+EE	9.9%
Mid-Low CHP+EE CCT5	10.0%
Mid-Low CHP+EE CCT10	10.6%
Mid-Low CHP+EE CCT15	10.7%
Mid-Low CHP+EE CCT20	10.7%



Figure 17 - Hudson Yards Aggregate Annual Energy Consumption and Emissions – Impact of Varying the Carbon Cap and Trade Price under a Mid-Low Market Penetration Rate for CHP & EE

Improved Market Penetration Rate – Mid Market Penetration



Figure 18 - Hudson Yards Aggregate Annual Electric Load Curves - Impact of Varying the Measures Applied to Achieve Load Reductions under a Mid Market Penetration Rate

Table 16 - Percentages of Peak Demand Reduction from	
Baseline - Impact of Varying the Measures Applied to	
Achieve Load Reductions under a Mid Market Penetratio	n
D - 4-	

Rate

Measure	Peak Demand
Mid EE	3.8%
Mid CHP	6.4%
Mid 14RA	11.1%
Mid CHP+EE	10.2%



Figure 19 - Hudson Yards Aggregate Annual Energy Consumption and Emissions - Impact of Varying the Measures Applied to Achieve Load Reductions under a Mid Market Penetration Rate

Figure 20 - Hudson Yards Aggregate Annual Electric Load Curves - Impact of Varying the Carbon Cap and Trade Price under a Mid Market Penetration Rate for CHP & EE



 Table 17 - Percentages of Peak Demand Reduction from

 Baseline - Impact of Varying the Carbon Cap and Trade

 Price under a Mid Market Penetration Rate for CHP &

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Measure	Peak Demand
Mid CHP+EE	10.2%
Mid CHP+EE CCT5	10.2%
Mid CHP+EE CCT10	10.5%
Mid CHP+EE CCT15	10.5%
Mid CHP+EE CCT20	14.6%



Figure 21 - Hudson Yards Aggregate Annual Energy Consumption and Emissions - Impact of Varying the Carbon Cap and Trade Price under a Mid Market Penetration Rate for CHP & EE

Improved Market Penetration Rate – Mid-High Market Penetration



Figure 22 - Hudson Yards Aggregate Annual Electric Load Curves - Impact of Varying the Measures Applied to Achieve Load Reductions under a Mid-High Market Penetration Rate



Measure	Peak Demand
Mid-High EE	4.7%
Mid-High CHP	7.2%
Mid-High 14RA	14.6%
Mid-High CHP+EE	11.9%



Figure 23 - Hudson Yards Aggregate Annual Energy Consumption and Emissions - Impact of Varying the Measures Applied to Achieve Load Reductions under a Mid-High Market Penetration Rate

Figure 24 - Hudson Yards Aggregate Annual Electric Load Curves - Impact of Varying the Carbon Cap and Trade Price under a Mid-High Market Penetration Rate for CHP & EE



Table 19 - Percentages of Peak Demand Reduction fromBaseline - Impact of Varying the Carbon Cap and TradePrice under a Mid-High Market Penetration Rate for CHP& EE

Measure	Peak Demand
Mid-High CHP+EE	11.9%
Mid-High CHP+EE CCT5	12.0%
Mid-High CHP+EE CCT10	16.7%
Mid-High CHP+EE CCT15	17.3%
Mid-High CHP+EE CCT20	17.3%



Figure 25 - Hudson Yards Aggregate Annual Energy Consumption and Emissions - Impact of Varying the Carbon Cap and Trade Price under a Mid-High Market Penetration Rate for CHP & EE

Improved Market Penetration Rate – High Market Penetration



Figure 26 - Hudson Yards Aggregate Annual Electric Load Curves - Impact of Varying the Measures Applied to Achieve Load Reductions under a High Market Penetration Rate

Table 20 - Percentages of Peak Demand Reduction fromBaseline - Impact of Varying the Measures Applied toAchieve Load Reductions under a High MarketPenetration Rate

Measure	Peak Demand
High EE	5.5%
High CHP	7.3%
High 14RA	14.7%
High CHP+EE	12.8%



Figure 27 - Hudson Yards Aggregate Annual Energy Consumption and Emissions - Impact of Varying the Measures Applied to Achieve Load Reductions under a High Market Penetration Rate



Figure 28 - Hudson Yards Aggregate Annual Electric Load Curves - Impact of Varying the Carbon Cap and Trade Price under a High Market Penetration Rate for CHP & EE

Table 21 - Percentages of Peak Demand Reduction fromBaseline - Impact of Varying the Carbon Cap and TradePrice under a High Market Penetration Rate for CHP &EE

Measure	Peak Demand
High CHP+EE	12.8%
High CHP+EE CCT5	17.6%
High CHP+EE CCT10	18.2%
High CHP+EE CCT15	20.3%
High CHP+EE CCT20	20.5%



Figure 29 - Hudson Yards Aggregate Annual Energy Consumption and Emissions - Impact of Varying the Carbon Cap and Trade Price under a High Market Penetration Rate for CHP & EE

ANALYSIS DISCUSSION

Overall Capacity, Source Energy, and Emissions Impacts

The Hudson Yards redevelopment presents challenging electric demand growth with potentially difficult in-city power, transmission, and distribution siting and financing issues. As such, reducing demand capacity is critical. Furthermore, developers are increasingly being pressured to reduce their carbon footprints. In fact, over 52 cities in New York, including New York City, have joined the Cool Cities initiative, committing to reduce carbon emissions to 1990 levels.^x The results of this report provide key insights toward the impact that energy efficiency strategies and CHP can have on the rising electricity demand and associated emissions in New York City. Figure 30 provides a range of results based on market penetration rates from BAU to High market penetrations for the following scenarios:

- 1. Baseline All buildings built per code with no market penetration of CHP or energy efficiency strategies above code
- 2. Current Policy Potential market as it exists today without modifications to energy rates or implementation of carbon trading policies
- 3. Modified Rate 14RA Replace the contract demand of \$8.02/kW with a delivery charge of approximately 0.58 cents per kWhr in Con Edison Cogeneration Standby Rate PSC2, SC14-RA
- 4. Carbon Trade at \$20/mt Implement a carbon trading policy that puts a value on carbon at \$20/mt

The charts shown in Figure 30 show that there is significant potential to reduce demand capacity, source energy, and associated emissions in Hudson Yards if improved market penetration rates are achieved. Up to 30MW of capacity can be eliminated while saving a trillion BTU's of source energy, thereby reducing the annual carbon footprint by 36,000 tonnes. That reduction in carbon footprint is equivalent to removing about 6,000 cars from the road at 12,000 mi/yr and 21 mpg.

The charts in Figure 30 also show that modifying Con Edison's Standby rate has about the same effect as implementing a carbon trade policy at \$20/mt. Almost 50MW of capacity can be eliminated while saving 1.7 trillion BTU's of source energy, thereby reducing the annual carbon footprint by over 60,000 tonnes. That reduction in carbon footprint is equivalent to removing over 10,000 cars from the road at 12,000 mi/yr and 21 mpg. Proportional reductions in SO2 and NOx are also possible as reflected in the charts.

Reducing electric energy consumption from load growth reduces new utility revenue. However, reducing electric capacity from load growth reduces utility capital expense. Lost revenue from load growth could be as high as \$23 million per year, which represents considerably less than one half percent of Con Edison's annual revenue from electric sales. With Con Edison's predicted long-term cost for capacity at \$2,375/kW, a 50 MW drop in capacity represents almost \$120 million in reduced capital investment.

Figure 30 – Capacity, Source Energy, and Emissions Charts - Impacts due to the Implementation of EE and CHP for a range of Market Penetrations levels from BAU to High



Energy Efficiency vs. CHP Impacts

The charts in Figure 31 show the contribution in reductions to capacity, source energy, and emissions from CHP and EE. The charts down the left side show the results based on current NEMS maximum market penetration rate of about 50%. The charts down the right side show the results based on an improved maximum market penetration rate of about 90%. It is clear from these charts that adopted CHP plays a larger role in reductions than all of the adopted EE measures combined. This is more evident in source energy and emissions reductions than in capacity reductions. However, CHP is still the dominant factor in capacity reduction as well.

As an example, the upper left pie chart shows the capacity (MW) savings for the BAU market penetration. CHP reduces the capacity by 10.3 MW, from 226 MW to about 216 MW. EE reduces the capacity by 6.4 MW, from 226 MW to about 220 MW.

Figure 31 – Energy Efficiency and CHP Charts - Impacts due to the Implementation of EE and CHP for a range of Market Penetrations levels from BAU to High



Energy Efficiency Measures

Impacts on the aggregate Hudson Yards load from individual EE measure were not analyzed. However, the building-by-building analyses reveal some useful results (Reference Table 24 through Table 29 in Appendix C). For example, some of the more attractive EE measures with respect to adoption include:

- 1. Space cooling chiller efficiency that is 20% better than ECCC requirements for office, residential, and hotel buildings
- 2. Space cooling unitary air conditioning that is 20% better than ECCC requirements for retail and restaurant space
- 3. Ice-on-Coil thermal storage systems sized conservatively to accommodate 15% to 25% of the total cooling capacity for office buildings
- 4. Boilers with efficiency levels at 85% as opposed to 80% for hotel and residential buildings
- 5. Individual gas-fired, warm air furnaces with AFUE levels at 94% as opposed to 78% for retail and restaurant spaces
- 6. Gas-fired instantaneous water heaters as opposed to gas-fired storage water heaters for retail spaces

Some of the EE measures that performed exceptionally poor with respect to adoption include:

- 1. Boilers with efficiency levels at 85% as opposed to 80% for office buildings
- 2. Energy Star rated appliances for individual dwellings in residential buildings
- 3. Lighting efficiencies better than ECCC requirements for both hotel and residential buildings (ECCC requirements are already relatively stringent)
- 4. Ice-on-Coil thermal storage systems for large residential buildings

CHP Measures

Current deployment of CHP in New York City lags far below the significant potential as defined by the current market penetration for this study; and there are many well-documented factors that influence the current deployment situation. A recent study by Columbia University's Urban Energy Program identifies three of the key obstacles to CHP deployment as:^{xi}

- 1. The mechanics of connecting to the Consolidated Edison grid (adds cost)
- 2. A complex policy environment and approval process (adds cost)
- 3. Project economics (Items 1 and 2 contribute to this)

The study also suggests that while there is a clear role for CHP to play in filling the supply gap, CHP's potential will only be realized to the extent that a pro-CHP policy environment can be implemented within New York City.^{xi} The authors recommend that research be conducted into new market structures and regulatory systems that more systematically incentivize CHP interconnections with the local grid. To achieve desirable market penetration rates, it is clear that the three key obstacles mentioned above must be

addressed. In fact, the cost for CHP in this study was set unusually high at \$3,000/kW to account for the additional costs.

This study addresses CHP with respect to project economics and policy environment by analyzing the impacts of a more CHP-friendly tariff structure (modified 14RA) and carbon crediting that can incentivize CHP interconnections. Table 22 shows a breakdown of the economic scenarios for 6.5MW of CHP in building prototype 1 (56-story highrise office), including the annual costs and simple payback calculations. The business-as-usual CHP scenario for prototype 1 results in a 9.1-yr simple payback and a predicted market penetration rate of 17% across the 20-yr study period. Providing carbon credit (for CHP alone) reduces the simple payback to 8.2 years but that only increases the penetration rate to 19%. It is important to note that Table 22 reflects the results of CHP only. Other EE measures that may have been adopted for building prototype 1 are not included so that the results for CHP alone can be seen.

Upon further observation of the cost breakdowns for the building with CHP and without CHP, it can be seen that the energy cost components (i.e. electric energy plus metered gas) are within about 10% of one another. In contrast, the demand savings from CHP are over 500%. In effect, all of the electric savings from CHP can be attributed to lowering the buildings on-peak demand charges because the CHP system operates during the entire on-peak period. However, Con Edison applies a standby contract demand charge in return for backup power service during peak periods. The contract demand accounts for almost 15% of the total annual energy bill and cuts the demand savings by well over half (i.e. 500% to 210%). The Columbia University study suggests that policymakers and Con Edison would both benefit from an independent assessment of Con Edison's fundamental approach toward distributed generation. The assessment would examine whether their approach is excessively cautious, or whether it is entirely appropriate give the need to maintain high levels of system reliability. Clearly from the aggregate results, reducing the paybacks for CHP under a modified rate 14RA has a positive impact on capacity, source energy, and emissions reductions. Reducing the payback for CHP in building Prototype 1 from 9.1 yrs to 6.4 yrs, as shown in Table 22 increases the penetration rate for that building type to almost 25%. Furthermore, combining carbon credits with standby relief would increase the penetration rates for building Prototype 1 to over 25%.

Annual Cost Component	No CH	Р	CHP		CHP 14RA		CHP CCT20		CHP 14RA+CCT20	
Electric Energy	\$4,455,205	54%	\$1,541,960	24%	\$1,645,832	30%	\$1,541,960	25%	\$1,645,832	31%
Electrc Demand	\$3,399,367	41%	\$668,294	11%	\$668,294	12%	\$668,294	11%	\$668,294	12%
14RA Contract Demand	\$0	0%	\$905,042	14%	\$0	0%	\$905,042	15%	\$0	0%
Fixed Electricity Charge	\$672	0%	\$13,632	0%	\$13,632	0%	\$13,632	0%	\$13,632	0%
Metered Gas	\$422,954	5%	\$2,819,378	44%	\$2,819,378	51%	\$2,819,378	46%	\$2,819,378	53%
CHP Carbon Credit*	\$0	0%	\$0	0%	\$0	0%	-\$202,000	-3%	-\$202,000	-4%
CHP System O&M	\$0	0%	\$403,272	6%	\$403,272	7%	\$403,272	7%	\$403,272	8%
Total Annual Energy \$	\$8,278,198	100%	\$6,351,578	100%	\$5,550,408	100%	\$6,149,578	100%	\$5,348,408	100%
Total CHP System Cost			\$19,520,836	-	\$19,520,836	-	\$19,520,836	-	\$19,520,836	-
Incentive Capped at \$2M			\$2,000,000	10%	\$2,000,000	10%	\$2,000,000	10%	\$2,000,000	10%
Total Capital Cost	NA		\$17,520,836	90%	\$17,520,836	90%	\$17,520,836	90%	\$17,520,836	90%
Annual Savings			\$1,926,620	10%	\$2,727,790	14%	\$2,128,620	11%	\$2,929,790	15%
Simple Payback			9.1		6.4		8.2		6.0	

Table 22 – BAU CHP Cost Breakdowns for Prototype 1with Modified 14RA and CCT

* Carbon Credit from CHP only, no EE measures

Suppose Con Edison's fundamental approach toward distributed generation is appropriate given the need to maintain system reliability, and that eliminating the standby charges is inappropriate; an alternative could be for New York electricity markets to provide ancillary payments for CHP services in the form of variable or fixed capacity payments. Current variable capacity payments are down from \$12/kW/mo a year ago to \$6/kW/mo according to NY ISO.^{xii} For Prototype 1 above, the total annual payments would be about \$468,000 at \$6/kW/mo. These payments would compensate building owners for providing much needed capacity in New York City.

New York's surging peak demand will necessitate the building of new central generation, transmission, and distribution, unless EE and CHP penetration rates are improved. New central generation plant costs have risen dramatically over the past three years with coal plant costs exceeding \$2,500/KW, not including the T&D needed to carry this generation to a building.^{xiii} While the NY ISO is providing a small variable capacity payment, policy makers should consider also providing a fixed capacity payment that would provide a performance based incentive for new on-site capacity. An annual capacity payment equal to the cost of spending \$2,500/KW up front for new generation is about \$150/KW/yr across 25 years at a discount rate of 3%. A fixed capacity payment at about \$150/KW/yr would increase annual payments from about \$468,000 to \$975,000.

Another way for New York to increase CHP deployment is to accelerate the completion of the Con Edison network system upgrades that will allow parallel interconnection of synchronous generators in Hudson Yards and other locations. Older network protectors installed in Con Edison's territory require a disconnect from the grid in approximately one quarter cycle or less in the presence of a fault current. Otherwise, the network protector can be damaged and cause outages. Newer network protectors do not have such stringent disconnect requirements. Though some smart fuses can disconnect within one quarter cycle, they require a fault current much higher than what Con Edison currently allows. Inverters downstream of synchronous generators can be used to meet the disconnect requirement, but add up to \$600 per kW installed to the project.^{xiv} The installed costs include the cost of the inverters, additional electrical wiring and special chilled water circuits for cooling the inverters. These costs were factored in to the costs for the CHP analyses in this study.

Con Edison is in the process of upgrading the network protectors. The Hudson Yards District is scheduled to be upgraded in 2012. If this schedule can be accelerated so that the fault current protection is not required, the installed CHP costs can be reduced by approximately 15%.

The installed cost for CHP as defined in the assumptions was \$3,000/kW with a \$600/kW subsidy capped at \$2M. Considering the subsidy and the cost of inverters, the total installed cost for 6.5MW of CHP in building prototype 1 can be \$19.5M (without subsidy), \$17.5M (with subsidy) and \$16.7M (with subsidy and no inverters).

Table 1 shows the effects of various policies on paybacks for CHP in building prototype 1 at the various costs.

	CHP without Subsidy First Cost = \$19,500,000		CHP with \$2M \$ First Cost = \$17	Subsidy 7,500,000	CHP w/ \$2M Subsidy & no Inverters First Cost = \$16,700,000		
Policy Scenarios	Annual Savings	Payback	Annual Savings	Payback	Annual Savings	Payback	
BAU	\$1,900,000	10.3	\$1,900,000	9.1	\$1,900,000	8.8	
Modified 14RA	\$2,700,000	7.2	\$2,700,000	6.4	\$2,700,000	6.2	
Variable Capacity	\$2,368,000	8.2	\$2,368,000	7.4	\$2,368,000	7.1	
+Fixed Capacity	\$3,343,000	5.8	\$3,343,000	5.2	\$3,343,000	5.0	
+Carbon CCT 20	\$4,143,000	4.7	\$4,143,000	4.2	\$4,143,000	4.0	

Table 23 - CHP Cost Breakdowns for Prototype 1 with
Capacity Payments and CCT

The BAU CHP scenario for prototype 1 results in a 9.1-yr simple payback and a predicted market penetration of 17%. The market penetration drops to 15% without the subsidy and jumps to 33% with a 4-yr payback if variable capacity, fixed capacity, and CCT20 policies are collectively implemented. At High market penetration rates, the market penetration for a 4-yr CHP payback is 60%.

Other market factors that could increase market penetration include:

 Building certification requirements such as LEED and Energy Star are now being considered by many building owners. In addition, some large cities including New York City are considering requiring building certification. CHP can have a major impact on a building's Energy Star rating. This is because Energy Star converts energy consumptions from site energy to source energy. Source energy represents the total amount of raw fuel that is required to operate the building. It incorporates all transmission, delivery, and production losses, thereby enabling a complete and equitable assessment of energy efficiency in a building. Source-site energy ratios are applied to convert each Btu of energy used on site into the total Btu of equivalent source energy consumed. The source to site ratio for electricity is 3.34. As a result, CHP reduces the total Btu's, thereby increasing a building Energy Star rating. Preliminary modeling of a large office building with and without CHP using the Energy Star on line program revealed that CHP could increase Energy Star rating by as much as 8 points.^{xv}

Other factors that could decrease penetration rates include:

1. The New York environmental board is proposing new emissions rules that would lower the current output based emission limits to 0.9 lb/MWh. Pending changes

to output-based emissions requirements could increase the first and operating costs of CHP, thereby reducing penetration rates.

CHP Performance Requirements

NYSERDA's Commercial/Industrial Performance Program is designed to financially incentivize CHP systems that provide at least 500 kW of summer on-peak demand reduction. Additionally, the program requires that the system demonstrates a minimum annual fuel conversion efficiency of 60% at design. Building Prototype 1 has a predicted summer peak demand of about 10 MW. Given the thermal loads and mechanical arrangement of the building, the appropriate system size to only just meet the 60% efficiency requirement is about 6.5 MW. Coincidently, 6.5 MW is also the optimal size for best economics. However, in some cases the system size has to be reduced because lower heating and cooling requirements in the shoulder months prevent the systems thermal output from being fully utilized, even with an absorption chiller. As a result, the NYSERDA minimum efficiency requirement incentivizes building owners to put in smaller systems than would otherwise be optimal for meeting the electrical demand requirements of the building and maximizing the economics. The reduction in size would make an even bigger impact on the economics if capacity payments were considered. As such, the minimum efficiency policy can reduce CHP market penetration, peak load reduction, and CO2 reduction in some cases.

During periods of high peak loads on the grid, less efficient and higher CO2-producing generators are brought on line as electricity prices increase during the peak periods. Modern engines used in CHP plants typically produce less CO2 than smaller, less efficient peaker plants. Since the NYSERDA requirements, in some cases, ultimately incentivize smaller plants, more power from the less efficient plants will be produced. It is understood that NYSERDA's goal is to promote energy efficient plants. In light of the needs in New York City to reduce peak demand and reduce CO2, NYSERDA should consider modifying the requirements to also give credit for demand reduction and CO2 reduction as well as efficiency. NYSERDA does have an incentive program for demand reduction but this does not currently include CHP plants as they are not considered permanent load reduction.

CONCLUSIONS, RECOMMENDATIONS, OBSERVATIONS

The following conclusions, recommendations and observations can be drawn from the results of this study:

Conclusion #1: Customer adoption rates of EE and CHP decrease exponentially with increasing simple payback. As such, CHP market penetration rates are limited in Hudson Yards due to simple paybacks in the range of 7 to 10 years even with current subsidies at \$600/kW (capped at \$2 million).

Conclusion #2: Under a business-as-usual scenario EE and CHP have the potential to reduce the Hudson Yards peak demand by only about 6% and the carbon footprint by only about 3%.

Conclusion #3: Peak demand for the Hudson Yards redevelopment area can be reduced by up to 20% (almost 50MW) and the carbon footprint reduced by about 10% (equivalent to removing approximately 10,000 cars) with some individual policy changes.

Conclusion #4: Carbon credits, fixed capacity payments in addition to current variable payments, and a pro-CHP tariff structure are all effective policy tools to reduce peak demand and emissions (including carbon footprint). Combining these policy tools would generate significantly higher peak demand and emissions reductions than individual policy changes.

Conclusion #5: CHP alone can be more effective at reducing peak demand, source energy and emissions (including carbon footprint) than high-efficiency building envelope material and high-efficiency mechanical equipment combined.

Recommendation #1: Adopt the following policies and actions that appropriately value or reduce the cost of EE and CHP:

- Provide a fixed 25 year capacity payment in the range of \$150/kW/yr
- Establish a robust carbon trading system in NY that would allow building owners to sell the carbon reduction resulting from CHP and EE
- Accelerate the completion of the ConEd system upgrades for Hudson Yards to provide for synchronous interconnection of CHP, thereby reducing CHP system first costs by up to \$600/KW. (about the same as the current NYSERDA incentive for CHP)

Recommendation #2: Consider changing the focus of incentive requirements from high efficiency to carbon reduction.

- Option A: Instead of requiring that CHP systems meet a minimum efficiency, establish a minimum carbon reduction percentage, and/or;
- Option B: Reduce the minimum CHP system efficiency from 60% to 50% to allow for larger CHP systems in commercial buildings. This may only apply to certain building types.

Observation #1: Electric chillers 20% more efficient than required by the Energy Conservation Construction Code of New York City could be economically attractive energy efficiency measures for all buildings modeled in this study.

Observation #2: Ice-on-Coil thermal storage systems sized conservatively to accommodate 15% to 25% of the total cooling capacity may be economically attractive peak demand reduction measures for office buildings modeled in this study.

Observation #3: Pending reductions to output-based emissions requirements could increase the first and operating costs of CHP, thereby reducing market penetration rates and potential for peak demand and emissions reductions.

Observation #4: Growing pressure for building owners to obtain Energy Star building certification could increase CHP and EE penetration rates. Improving the overall building energy efficiency increases the Energy Star rating.

Observation #5: Current NOx and SO2 cap and trade policies in New York do not allow building owners to obtain credit for their NOx and SO2 reductions associated with reducing building electricity consumption via EE and CHP. Reductions in electricity at the point of use are not factored into the overall state/region NOx and SO2 cap. This issue will need to be addressed if a carbon trading program is to be established. The carbon trading program should assign carbon credits to building owners that reduce electricity consumption so that building owners can be rewarded for their efficiency efforts.

APPENDIX A - ASSUMPTIONS

Construction Types

For the purposes of this study, the following two construction types apply unless otherwise noted.

- Type I: Frame wall Structural steel interior frame with exterior unitized curtain wall system (prefabricated panels). The curtain wall system is comprised of aluminum framing; double glazed insulating glass units; single-pane opacified spandrel glass or equivalent panel coverings (e.g. granite panels); insulation is placed within metal back-pans behind the spandrel glass; gypsum board is used for the interior. Roofs are low-slope structural concrete decks with parapets. Continuous tapered insulation is placed over the concrete and modified bitumen membrane is placed over the insulation.
- Type II: Mass Wall Structural steel interior frame with pre-cast concrete exterior wall system; double glazed insulating glass; cavity insulation is placed within a metal-stud back-up wall assembly behind the concrete; gypsum board is used for the interior. Roofs are low-slope structural concrete decks with parapets. Continuous tapered insulation is placed over the concrete and modified bitumen membrane is placed over the insulation.

Building Prototypes

For classification purposes, although in many cases more than one type of construction may be used, a single construction type for each prototype was selected. The construction types are intended to meet the 2007 Energy Conservation Construction Code of New York State (NYS ECCC) but be specific to this study.

Corner Retail Shops and Restaurants are modeled with two adiabatic walls each and adiabatic roofs. Internal Retail Shops are modeled with three adiabatic walls each and adiabatic roofs. The Mixed Use Residential is modeled with an adiabatic floor and the Mixed Use Office is modeled with an adiabatic roof.

High Rise Office Buildings – Prototypes 1-3

Prototypes 1-3 are Type I construction with an unconditioned basement below grade. The ground floor includes a 7,400 sqft corner restaurant and individual retail shops at approximately 2,000 sqft each. All but one floor above the ground floor are occupied by offices. The remaining floor is used for mechanical equipment and is unconditioned. The floor-to-floor height for all levels is 13'-6".

<u>Prototype 1, High Rise Office Building</u>; Approximately 1,914,000 sqft 56-story building with approximately 43,000 sqft of commercial space at ground level demised to accommodate 18 individual retail shops and a corner restaurant. Approximately 1,837,000 sqft of conditioned office space including corridors is above the ground floor.

Prototype 2, High Rise Office Building; Approximately 1,706,000 sqft 41-story building with approximately 51,000 sqft of commercial space at ground level demised to

accommodate 22 individual retail shops and a corner restaurant. Approximately 1,613,000 sqft of conditioned office space including corridors is above the ground floor.

<u>Prototype 3, High Rise Office Building</u>; Approximately 1,544,000 sqft 34-story building with 56,000 sqft of commercial space at ground level demised to accommodate 24 individual retail shops and a corner restaurant. Approximately 1,443,000 sqft of conditioned office space including corridors is above the ground floor.





Prototype 4 is Type II construction with an unconditioned basement below grade. The ground floor includes a 7,400 sqft corner restaurant and individual retail shops at approximately 2,000 sqft each. All but one floor above the ground floor are occupied by offices. The remaining floor is used for mechanical equipment and is unconditioned. The floor-to-floor height for all levels is 13'-6".

Prototype 4 is an approximately 883,000 sqft 20-story building with approximately 47,000 sqft of commercial space at ground level demised to accommodate 20 individual retail shops and a corner restaurant. Approximately 792,000 sqft of conditioned office space including corridors is above the ground floor.



High Rise Hotel – Prototype 5

Prototype 5 is Type I construction. The hotel lobby, ballrooms, and meeting rooms consume 25% of the total occupied space. The integrated hotel restaurant and laundry areas consume an additional 5% of the total occupied space. The floor-to-floor height for all levels is 13'-6".

Prototype 5 is an approximately 1,250,000 sqft 33-story hotel with 1400 rooms. Approximately 875,000 sqft of space is available for hotel guest rooms at an average 750 sqft per room.



Mid Rise Hotel – Prototype 6

Prototype 6 is Type II construction. The hotel lobby consumes 5% of the total occupied space. The hotel laundry area consumes an additional 5% of the total occupied space. The floor-to-floor height for all levels is 13'-6".

Prototype 6 is an approximately 231,000 sqft 18-story hotel with 233 rooms. Approximately 208,000 sqft of space is available for hotel guest rooms at an average 750 sqft per room.



High Rise Residential Buildings – Prototypes 7-10

Prototypes 7-10 are Type I construction with an unconditioned basement below grade. The ground floor includes a 7,400 sqft corner restaurant and individual retail shops at approximately 2,000 sqft each. All but one floor above the ground floor are occupied by residential units at an average 1,000 sqft per unit. The remaining floor is used for mechanical equipment and is unconditioned. The floor-to-floor height for all levels is 13'-6".

<u>Prototype 7, High Rise Residential Building</u>; Approximately 768,000 sqft 55-story building with approximately 65,000 sqft of commercial space at ground level demised to accommodate 29 individual retail shops and a corner restaurant. Approximately 689,000 sqft of conditioned residential space including corridors is above the ground floor. The residential space is demised to accommodate 588 units at an average 2.7 people per unit.

<u>Prototype 8, High Rise Residential Building</u>; Approximately 336,000 sqft 43-story building with approximately 10,000 sqft of commercial space at ground level demised to accommodate 5 individual retail shops. Approximately 319,000 sqft of conditioned residential space including corridors is above the ground floor. The residential space is demised to accommodate 269 units at an average 2.7 people per unit.

<u>Prototype 9, High Rise Residential Building</u>; Approximately 504,000 sqft 34-story building with approximately 19,000 sqft of commercial space at ground level demised to accommodate 6 individual retail shops and a corner restaurant. Approximately 471,000 sqft of conditioned residential space including corridors is above the ground floor. The residential space is demised to accommodate 397 units at an average 2.7 people per unit.

<u>Prototype 10, High Rise Residential Building</u>; Approximately 1,069,000 sqft 25-story building with approximately 54,000 sqft of commercial space at ground level demised to accommodate 23 individual retail shops and a corner restaurant. Approximately 973,000 sqft of conditioned residential space including corridors is above the ground floor. The residential space is demised to accommodate 820 units at an average 2.7 people per unit.



Mid Rise Residential Building – Prototype 11

Prototype 11 is Type II construction with an unconditioned basement below grade. The ground floor includes individual retail shops at approximately 2,000 sqft each. All but one floor above the ground floor are occupied by residential units. The remaining floor is used for mechanical equipment and is unconditioned. The floor-to-floor height for all levels is 13'-6".

Prototype 11 is approximately 186,000 sqft 12-story building with approximately 19,000 sqft of commercial space at ground level demised to accommodate 9 individual retail shops. Approximately 153,000 sqft of conditioned residential space including corridors is above the ground floor. The residential space is demised to accommodate 129 units at an average 2.7 people per unit.



High Rise Mixed Use Building – Prototype 12

Prototype 12 is Type I construction with an unconditioned basement below grade. The ground floor includes a 7,400 sqft corner restaurant and individual retail shops at approximately 2,000 sqft each. All but one floor above the ground floor are occupied by

residential units and office space. The remaining floor is used for mechanical equipment and is unconditioned. The floor-to-floor height for all levels is 13'-6".

Prototype 12 is approximately 2,000,000 sqft 55-story building with approximately 45,000 sqft of commercial space at ground level demised to accommodate 19 individual retail shops and a corner restaurant. Approximately 869,000 sqft of conditioned residential space and 1,045,000 sqft of conditioned office space including corridors are above the ground floor. The residential space is demised to accommodate 824 units at an average 2.7 people per unit and is above the office space.



The assumed distribution of these prototypical buildings within the Hudson Yards district is shown on the following site plan.



Prototype	Qty
1	1
2	6
3	5
4	3
5	1
6	5
7	2
8	4
9	10
10	5
11	14
12	1

Material Costing

Incremental costs for Baseline vs. Alternative material and equipment were obtained from the California Energy Commission Database for Energy Efficient Resources unless otherwise cited.^{xvi} The database provides well-documented estimates of measure costs and effective useful lives for the measures.

Mechanical Systems and Appliances

Some parameters not defined by the ECCC, such as HVAC ventilation requirements and occupancy loads, were taken from the Mechanical Code of New York State.^{xvii}

Appliance standards not defined by the ECCC, as indicated, were taken from federal appliance and commercial equipment standards.^{xviii}

External Walls

External Window/Wall Assemblies – Type I Construction

Applicable to the following Type I prototypes:	Prototype #
High Rise Office, 56-story and associated Retail and Restaurant Space	1
High Rise Office, 41-story and associated Retail and Restaurant Space	2
High Rise Office, 34-story and associated Retail and Restaurant Space	3
High Rise Hotel, 33-story and associated Retail and Restaurant Space	5
High Rise Residential, 55-story and associated Retail and Restaurant Space	7
High Rise Residential, 43-story and associated Retail and Restaurant Space	8
High Rise Residential, 34-story and associated Retail and Restaurant Space	9
High Rise Residential, 25-story and associated Retail and Restaurant Space	10
High Rise Mixed-use, 55-story and associated Retail and Restaurant Space	12

Scenarios		
NYS ECCC '07	Baseline Model	Alternative (See diagram) ^{xix}
Min cavity insulation: R11 Min continuous insulation: R0 Window Wall Ratio (WWR)	Curtain wall system. All aluminum framing w/ nylon strip at mullion nose for thermal break. Standard double IGU ¼" thick clear glass w/ ½" air gap and aluminum spacer. Spandrel panels are ¼" opacified glass with R11 cavity insulation in metal backpan behind a ¾" air gap. 5/8" gypsum wall board interior.	Same as Baseline Model except reinforced all nylon mullion nose for improved thermal break, and High-performance double IGU ¼" thick Low-E glass w/ ½" Argon gap and nylon spacer, and revised backpan that butts up against the mullion.
Window $U = 0.50$	Window $U = 0.50$	Window $U = 0.26$
U-values Not Available	Window/Wall Assembly U = 0.517	Window/Wall Assembly U = 0.412
Above ground floor WWR: max 50%	Above ground floor: WWR 50%	Above ground floor: WWR 50%
Retail Corner WWR: max 50%	Retail Corner WWR: 24%	Retail Corner WWR: 24%
Retail Internal WWR: max 50%	Retail Internal WWR: 12%	Retail Internal WWR: 12%
Corner Restaurant WWR: max 50%	Corner Restaurant WWR: 24%	Corner Restaurant WWR: 24%

Alternative Incremental Costs (Alternative – Baseline)\$6.50/sqft



<u>Baseline</u>

<u>Alternative</u>

External Walls – Type II Construction

Applicable to the following Type II prototypes:	Prototype #
Midrise Office, 20-story	4
Midrise Hotel, 18-story	6
Midrise Residential, 12-story	11

NYS ECCC '07Baseline ModelAlternativMin cavity insul: R11 Min continuous insul: R04" Pre-cast concrete wall system, R11 cavity insulation within 2x4.16 metal-stud back-up wall assembly behind concrete, 5/8" gypsumSame as Baseline Mode cavity insulation within stud back-up wall	Scenarios		
Min cavity insul: R114" Pre-cast concrete wall system, R11 cavity insulation within 2x4.16 metal-stud back-up wall assembly behind concrete, 5/8" gypsumSame as Baseline Mode cavity insulation within stud back-up wall	ve 1		
board interior.	del, except R19 n 2x6.16 metal- l assembly		
Overall U Not Available Overall U = 0.132 Overall U = 0	0.114		

Alternative Incremental Costs (Alternative – Baseline)	\$0.43/sqft

Roofing Material

Roofing Construction & Insulation – Types I & II Construction

Applicable to the following Type I & II prototypes:	Prototype #
High Rise Office, 56-story	1
High Rise Office, 41-story	2
High Rise Office, 34-story	3
Midrise Office, 20-story	4
High Rise Hotel, 33-story	5
Midrise Hotel, 18-story	6
High Rise Residential, 55-story	7
High Rise Residential, 43-story	8
High Rise Residential, 34-story	9
High Rise Residential, 25-story	10
Midrise Residential, 12-story	11
High Rise Mixed-use, 55-story	12

Scenarios		
NYS ECCC '07	Baseline Model	Alternative
Min continuous insulation: R19	6" low-slope structural concrete deck with continuous 5" R19 tapered expanded polystyrene over the concrete and modified bitumen membrane over the insulation	Same as Baseline except 6" R23 tapered expanded polystyrene over the concrete
U-values Not Available	Overall $U = 0.044$	Overall $U = 0.036$

Alternative Incremental Costs (Alternative – Baseline)\$0.18/sqft
Cool Roof – Types I & II Construction

Applicable to the following Type I & II prototypes:	Prototype #
High Rise Office, 56-story	1
High Rise Office, 41-story	2
High Rise Office, 34-story	3
Midrise Office, 20-story	4
High Rise Hotel, 33-story	5
Midrise Hotel, 18-story	6
High Rise Residential, 55-story	7
High Rise Residential, 43-story	8
High Rise Residential, 34-story	9
High Rise Residential, 25-story	10
Midrise Residential, 12-story	11
High Rise Mixed-use, 55-story (Residential Space Only)	12

Scenarios		
NYS ECCC '07	Baseline Model	Alternative
	No Cool Roof.	Same as Baseline except with White
No Cool Roof Requirements	Standard black exposed modified bitumen	elastomeric reflective coating for modified
	membrane	bitumen membrane
Not Available	Reflectance $= 0.08$	Reflectance $= 0.83$
Not Available	Thermal Emittance $= 0.83$	Thermal Emittance $= 0.83$
Not Available	Absorptance $= 0.90$	Absorptance $= 0.30$

\$0.33/sqft

Alternative Incremental Costs (Alternative – Baseline)

Windows

Windows – Type II Construction

Applicable to the following Type II prototypes:	Prototype #
High Rise Office, 56-story and associated Retail and Restaurant Space	1
High Rise Office, 41-story and associated Retail and Restaurant Space	2
High Rise Office, 34-story and associated Retail and Restaurant Space	3
Midrise Office, 20-story and associated Retail and Restaurant Space	4
High Rise Hotel, 33-story and associated Retail and Restaurant Space	5
Midrise Hotel, 18-story and associated Retail and Restaurant Space	6
High Rise Residential, 55-story and associated Retail and Restaurant Space	7
High Rise Residential, 43-story and associated Retail and Restaurant Space	8
High Rise Residential, 34-story and associated Retail and Restaurant Space	9
High Rise Residential, 25-story and associated Retail and Restaurant Space	10
Midrise Residential, 12-story and associated Retail and Restaurant Space	11
High Rise Mixed-use, 55-story and associated Retail and Restaurant Space	12

Scenarios		
Baseline Model	Alternative	
Standard double IGU ¼" thick clear glass w/ ½" air gap and aluminum spacer.	High-performance double IGU ¼" thick Low-E glass w/ ½" Argon gap and nylon spacer.	
Window $U = 0.50$	Window $U = 0.26$	
Window SHGC $= 0.35$	Window SHGC $= 0.29$	
Above ground floor WWR: 50%	Above ground floor WWR: 50%	
Retail Corner WWR: 24%	Retail Corner WWR: 24%	
Retail Internal WWR: 12%	Retail Internal WWR: 12%	
Corner Restaurant WWR: 24%	Corner Restaurant WWR: 24%	
	Scenarios Baseline Model Standard double IGU ¼" thick clear glass w/½" air gap and aluminum spacer. Window U = 0.50 Window SHGC = 0.35 Above ground floor WWR: 50% Retail Corner WWR: 24% Retail Internal WWR: 12% Corner Restaurant WWR: 24%	

Alternative Incremental Costs (Alternative – Baseline)	\$6.50/sqft

HVAC HVAC Summary

Space	Cooling	Heating
	Central water-cooled, electrically operated,	Central gas-fired hot water boiler
Office	centrifugal chiller w/ economizer and VAV	(No condenser heat recovery for service
Office	fan control,	water heating because facility does not
	dehumidification w/ reheat	operate 24 hours per day)
Control motor cooled alectrically around d		Central gas-fired hot water boiler
Pasidantial	central water-cooled, electrically operated,	(No condenser heat recovery for service
Residential	fan control	water heating because residential units have
	Tan control	individual hot water heaters)
	Control water cooled electrically operated	Central gas-fired hot water boiler w/
Hotal	central water-cooled, electrically operated,	condenser heat recovery for service water
Hotel	fan control	heating as required by
	Tan control	NYS ECCC '07
	Individual electrically operated, air-cooled,	
Retail	unitary air conditioner w/ economizer and	Individual gas-fired, warm air furnace
	CAV fan control	
	Individual electrically operated, air-cooled,	
Restaurant	unitary air conditioner w/ economizer and	Individual gas-fired, warm air furnace
	CAV fan control	

HVAC – Office, Residential, and Hotel Central Cooling Plant

Applicable to the following spaces:	Prototype #
High- and Mid-Rise Office	All
High- and Mid-Rise Residential	All
High- and Mid-Rise Hotel	All

Scenarios		
NYS ECCC '07	Baseline Model	Alternative
Water cooled, electrically operated,	Central water-cooled, electrically operated,	Central water-cooled, electrically operated,
centrifugal chiller	centrifugal chillers	centrifugal chillers
150-300 tons: 0.634 kW/ton	150-300 tons: 0.634 kW/ton	150-300 tons: 0.507 kW/ton
> 300 tons: 0.576 kW/ton	> 300 tons: 0.576 kW/ton	> 300 tons: 0.461 kW/ton
Variable-air-volume	Variable-air-volume	Variable-air-volume
Economizer	Economizer	Economizer
Infiltration: 0.3 cfm/sqft of fenestration	Infiltration: 0.3 cfm/sqft of fenestration	Infiltration: 0.3 cfm/sqft of fenestration
Office Ventilation: 19.75 cfm/person	Office Ventilation: 19.75 cfm/person	Office Ventilation: 19.75 cfm/person
Residential Vent: 17.00 cfm/person	Residential Vent: 17.00 cfm/person	Residential Vent: 17.00 cfm/person
Hotel Ventilation: 31 cfm/room	Hotel Ventilation: 31 cfm/room	Hotel Ventilation: 31 cfm/room
Office max occupant load: 10 people	Office max occupant load: 10 people per	Office max occupant load: 10 people per
per 1000 sqft	1000 sqft	1000 sqft
Residential max occupant load: 2.7	Residential max occupant load: 2.7 people	Residential max occupant load: 2.7 people
people per 1000 sqft	per 1000 sqft	per 1000 sqft
Hotel max occupant load: 20 people per	Hotel max occupant load: 20 people per	Hotel max occupant load: 20 people per
1000 sqft	1000 sqft	1000 sqft

Alternative Incremental Costs (Alternative – Baseline)		
150-300 tons	\$77.07/ton	
> 300 tons	\$83.08/ton	

HVAC – Retail and Restaurant Unitary AC

Applicable to the following spaces:	Prototype #
Corner retail shops	All
Internal retail shops	All but 5 & 6
Corner Restaurants	All but 6 & 11

Scenarios		
NYS ECCC '07	Baseline Model	Alternative
Electrically operated, air-cooled, unitary air conditioner	Individual electrically operated, air-cooled, unitary air conditioners	Individual electrically operated, air-cooled, unitary air conditioners
< 65k Btu/hr: 10 SEER	< 65k Btu/hr: 10 SEER, 9.5 EER	< 65k Btu/hr: 14 SEER, 12.5 EER
Infiltration: 0.3 cfm/sqft of fenestration	Infiltration: 0.3 cfm/sqft of fenestration	Infiltration: 0.3 cfm/sqft of fenestration
Retail Ventilation: 0.30 cfm/sqft	Retail Ventilation: 0.30 cfm/sqft	Retail Ventilation: 0.30 cfm/sqft
Restaurant Vent: 17.25 cfm/person	Restaurant Vent: 17.25 cfm/person + 18 cfm/sqft of hood space	Restaurant Vent: 17.25 cfm/person + 18 cfm/sqft of hood space
Retail max occupant load: Undefined	Retail max occupant load: 29 people per 1000 sqft	Retail max occupant load: 29 people per 1000 sqft
Restaurant max occupant load:	Restaurant max occupant load:	Restaurant max occupant load:
(70 dining, 20 kitchen)	(70 dining, 20 kitchen)	(70 dining, 20 kitchen)
people per 1000 sqft	people per 1000 sqft	people per 1000 sqft

Alternative Incremental Costs (Alternative – Baseline)		
< 65k Btu/hr or 5.4 tons	\$295.82/ton	

HVAC – Office, Residential, and Hotel Central Boiler

Applicable to the following spaces:	Prototype #
High- and Mid-Rise Office	All
High- and Mid-Rise Residential	All
High- and Mid-Rise Hotel	All

Scenarios		
NYS ECCC '07	Baseline Model	Alternative
Gas-fired hot water boiler	Gas-fired hot water boiler	Gas-fired hot water boiler
> 2,500,000 Btu/hr	> 2,500,000 Btu/hr	> 2,500,000 Btu/hr
Combustion Efficiency: 80%	Combustion Efficiency: 80%	Combustion Efficiency: 85%
Hotel: condenser heat recovery for	Hotel: condenser heat recovery for service	Hotel: condenser heat recovery for service
service water neating	water neating	water neating

Alternative Incremental C	Costs (Alternative – Baseline)
> 2,500,000 Btu/hr	\$12.31/kBtu/hr

HVAC – Retail and Restaurant Furnace

Applicable to the following spaces:	Prototype #
Corner retail shops	All but 5 & 6
Internal retail shops	All but 5 & 6
Corner Restaurants	All but 6 & 11

Scenarios		
NYS ECCC '07	Baseline Model	Alternative
Gas-fired, warm air furnace	Individual gas-fired, warm air furnace	Individual gas-fired, warm air furnace
< 225,000 Btu/hr: 78% AFUE	< 225,000 Btu/hr: 78% AFUE	< 225,000 Btu/hr: 94% AFUE

Alternative Incremental Costs (Alternative – Baseline)		
110,000 Btu/hr	\$8.25/kBtu/hr	
115,000 Btu/hr	\$8.15/kBtu/hr	
120,000 Btu/hr	\$8.09/kBtu/hr	
125,000 Btu/hr	\$8.07/kBtu/hr	
140,000 Btu/hr	\$8.19/kBtu/hr	

Appliances

Space	Service Water System
Office	Central gas-fired hot water boiler
Office	(Reference HVAC – Central Boiler)
Desidential	Central gas-fired hot water boiler
Residential	(Reference HVAC – Central Boiler)
Uotal	Central gas-fired hot water boiler
Hotel	(Reference HVAC – Central Boiler)
Poteil	Individual gas-fired, storage water heaters
Ketall	less than 75,000 btuh each
Restaurant	Individual gas-fired, storage water heaters
	less than 75,000 btuh each

Domestic (Service) Hot Water Summary

Domestic (Service) Hot Water – Retail and Restaurant

Applicable to the following spaces:	Prototype #
Corner retail shops	All but 5 & 6
Internal retail shops	All but 5 & 6
Corner Restaurants	All but 6 & 11

Scenarios		
NYS ECCC '07	Baseline Model	Alternative
Gas-fired storage and instantaneous	Individual 50 gallon gas-fired storage water	Individual 50 gallon equivalent gas-fired
water heaters	heaters	Instantaneous water heaters
Storage < 75,000 Btu/hr:	Storage < 75,000 Btu/hr:	
EF = 0.62 - 0.0019V	EF = 0.62-0.0019V = 52.5%	In stantan serve 150,000 Dts /s a
Storage 75,000-155,000 Btu/hr:	Storage 75,000-155,000 Btu/hr: Thermal	The must Efficiency 22.20(
Thermal Efficiency $= 80\%$	Efficiency $= 80\%$	(based on Takagi T M100)
Storage > 155,000 Btu/hr	Storage > 155,000 Btu/hr	(based on Takagi I-M199)
Thermal Efficiency $= 80\%$	Thermal Efficiency $= 80\%$	

Alternative Incremental Costs (Alternative – Baseline)		
150,000 Btu/hr	\$370.64/appliance	

Energy Star^{xx} – Residential Dishwasher, Clothes Washer, Refrigerator

Applicable to the following spaces:	
High- and Mid-Rise Residential	

Prototype # All

Scenarios		
NYS ECCC '07	Baseline Model	Alternative
Dishwasher: No requirement	Typical dishwasher (160 cycles/yr) based on federal regulations EF = 0.46 154 kWh/yr	Energy Star rated dishwasher EF = 0.64 (160 cycles/yr) 111 kWh/yr
Clothes Washer: No Requirement	Typical clothes washer (2.65 cf) based on federal regulations MMEF = 1.26 78.5 kWh/yr	Energy Star rated clothes washer (2.65 cf) MMEF = 2.00 49 kWh/yr
Clothes Drier: No Requirement	Typical clothes drier (416 dry cycles) based on federal regulations EF = 2.67 5.4 MBtu/yr 57 kWh/yr	Energy Star rated clothes drier (416 dry cycles) EF = 2.67 5.4 MBtu/yr 51.3 kWh/yr
Refrigerator: No Requirement	Typical refrigerator based on federal regulations 569 kWh/yr	NA
Gas Range: No Requirement	Typical gas range based on federal regulations 2.4 MBtu/yr	NA

Alternative Incremental Costs (Alternative – Baseline)				
Energy Star Dishwasher	\$133.64/appliance			
Energy Star Clothes Washer	\$131.00/Appliance			
Energy Star Clothes Drier	\$242.26/Appliance			
Total Energy Star Cost	\$506.90/household			

Lighting

Lighting – Residential and Commercial

Applicable to the following spaces:	Prototype #
High- and Mid-Rise Office	All
High- and Mid-Rise Residential	All
High- and Mid-Rise Hotel	All
Corner retail shops	All but 5 & 6
Internal retail shops	All but 5 & 6
Corner Restaurants	All but 6 & 11

Scenarios				
NYS ECCC '07	Baseline Model	Alternative		
Office: 1.1 W/sqft	Primarily area lighting 1.1 W/Sqft	Reduced area lighting plus task lighting 0.9 W/sqft		
Hotel Tenant Area: 1.3 W/sqft Hotel Lobby: 1.1 W/sqft	Mix of 60 LPW screw-in CFL and dimmable incandescent	Replace CFLs w/ 69 LPW recessed fixtures with 4-pin triple tubes		
Hotel Meeting Rooms: 1.3 W/sqft	1.3 W/sqft	1.19 W/sqft		
Multifamily Residential: 0.7 W/sqft	Mix of 60 LPW screw-in CFL and dimmable incandescent 0.700 W/sqft	Replace CFLs w/ 69 LPW recessed fixtures with 4-pin triple tubes 0.675 W/sqft		
Retail Sales: 1.5 W/sqft	Typical fluorescent 1.5 W/sqft	NA		
Restaurant: 1.6 W/sqft	Typical fluorescent 1.6 W/sqft	NA		

Alternative Incremental C	Costs (Alternative – Baseline)
All Spaces	\$2.5/sqft

In most cases, the ECCC requirements are already relatively stringent. Lighting alternatives were derived from the New Buildings Institute Advanced Lighting Guidelines.^{xxi}

On-site Power and Thermal Generation

Each on-site power and thermal generation system is optimized per application

Installed cost for CHP system is defined by:

Engines:

\$3,000/kW^{xxii} \$600/kW (capped at \$2,000,000) NYSERDA incentive^{xxiii} \$2,400/kW with incentive O&M cost for CHP system is \$0.020/kWh^{xxii} CHP system maximum efficiencies are: < 900 kW: Electric = 34%, Total = 76% > 900 kW: Electric = 35%, Total = 77% < 900 kW: Jacket water temp = 215 F, Exhaust temp = 900 F > 900 kW: Jacket water temp = 235 F, Exhaust temp = 850 F

CHP systems recover heat to domestic hot water, space heating, and absorption cooling at the following maximum efficiencies.

Electric Power Jacket Water		Exhaust	Total	
Gen Efficiency Heat Efficiency		Heat Efficiency	Efficiency	
34/35%	26%	16%	76/77%	

CHP system sizes and run-time are optimized and are configured to track electric load with the following part-load correction factors.

	Electric Power	Jacket Water	Exhaust
Load	Gen Efficiency	Heat Efficiency	Heat Efficiency
100%	1.000	1.000	1.000
75%	0.769	0.860	0.760
50%	0.558	0.740	0.520
25%	0.344	0.600	0.250

Absorption Chillers:

Absorption efficiency: 0.70 COP Installed cost for hot water single effect absorption chillers is defined by: < 300 tons: \$520/ton 300 to 500 tons: \$430/ton 500 to 1000 tons: \$365/ton

Installed cost for electric chillers is defined by: < 500 tons: \$340/ton 500 to 1000 tons: \$350/ton

O&M cost for absorption chillers is defined by: Y = $644.61X^{-0.8454}$, where X = refrigeration tons

Thermal Storage^{xxiv}

Ice-on-coil system @ \$70/ton-hr applied to spaces with chillers only Charge during mid- and off-peak periods Serves 15% to 25% of the cooling capacity (optimized on a case-by-case basis) Starting efficiency equals baseline chiller efficiency. Ending efficiency equals approx. 40% lower.

Utility Rates^{xxv}



2007 PSC9, SC4, Rate II Total Daily Summer and Winter Electric Energy Rates

2007 PSC2, SC14-RA, Rate II Total Daily Summer and Winter Electric Energy Rates



Note, this rate is essentially the same as PSC9, SC4, Rate II minus the delivery component of the charge (i.e. commodity charge only).

2007 PSC9, SC4, Rate II Total Daily Summer and Winter Electric Demand Rates



2007 PSC2, SC14-RA, Rate II Total Daily Summer and Winter Electric Demand Rates



A rate sensitivity analysis was performed on PSC2, SC14-RA, Rate II as follows:

- 1. The contract demand of \$8.02/kW was removed
- 2. The energy delivery charge was added making the energy rates equivalent to PSC9, SC4, Rate II energy rates

SC2, Rate II	Summer	Winter	Units	
Up to 90 Therms	1.7529	1.7518	\$/therm	
Up to 3000 Therms	1.5612	1.5601	\$/therm	
Over 3000 Therms	1.4445	1.4434	\$/therm	
Rider H, Rate I	Summer	Winter	Units	
Rider H, Rate I Less than 5 MW	Summer 1.3294	Winter 1.3612	Units \$/therm	
Rider H, Rate I Less than 5 MW	Summer 1.3294	Winter 1.3612	Units \$/therm	
Rider H, Rate I Less than 5 MW Rider H, Rate II	Summer 1.3294 Summer	Winter 1.3612 Winter	Units \$/therm Demand*	Units

2007 Summer and Winter Gas Rates

*Demand equals maximum generator demand in past 12 months 1 therm = 100,000 Btu

Electric Power Generation and Residential Heating Emission Factors^{xxvi}

		Baseload Central Power Plant (lb/MWh of Electricity)	Non-Baseload Central Power Plant (lb/MWh of Electricity)	Gas Heating (Ib/MMBtu of Fuel Use)	CHP (tuned for low Nox) (lb/MMBtu of Fuel Use)
Global Warming	CO2	610	1688.236	117.6	147.6
Acid Rain	SO2	3.476	5.729	0.00059	0.00059
Ozone/Smog	NOX	1.059	1.791	0.092	0.15

Non-Baseload Central Power Plant operation is defined as 8 am to 10 pm weekdays only.

Building energy consumptions are converted from site energy to source energy. Source energy represents the total amount of raw fuel that is required to operate the building. It incorporates all transmission, delivery, and production losses, thereby enabling a complete and equitable assessment of energy efficiency in a building. Source-site energy ratios are applied to convert each Btu of energy used on site into the total Btu of equivalent source energy consumed.^{xxvii} The following ratios were used.

Fuel Type	Source-Site Ratio
Electricity	3.340
Natural Gas	1.047

Energy Efficiency Measure Useful Lives

Database for Energy Efficient Resources DEER^{xvi}

Measure	Useful Life (yrs)
Wall Insulation	50
Roof Insulation	50
Cool Roof	15
Windows	20
Appliances	14
DHW Heater	14
Lighting	12
HVAC	18
CHP	20
Thermal Storage	18

Market Penetration Curves

The following curves apply to all alternative measures, including CHP and Energy Efficiency strategies. The bottom curve is based on the National Energy Modeling System (NEMS) maximum market penetration defined by

Equation 2: Market penetration =
$$\frac{1.1 \times penparm}{e^{(0.24 \times payback)}}$$

where:

penparm = penetration parameter, NEMS uses 50%

payback = number of years to positive cash flow (approximately half the simple payback period)^{vii}

This equation results in a 48% market penetration rate at a 1-yr payback. For sensitivity analysis, the equation was modified by increasing *penparm* to 60%, 70%, 80%, and 90%, thereby increasing the resulting maximum market penetration rate at a 1-yr payback to 58%, 68%, 77%, and 87% respectively.



Payback	Baseline	BAU (Max 50%)	IMPR (Max 60%)	IMPR (Max 70%)	IMPR (Max 80%)	IMPR (Max 90%)
1	0%	48%	58%	68%	77%	87%
2	0%	43%	51%	60%	68%	77%
3	0%	38%	45%	53%	60%	68%
4	0%	33%	40%	46%	53%	60%
5	0%	29%	35%	41%	47%	52%
6	0%	26%	31%	36%	41%	46%
7	0%	23%	27%	32%	36%	41%
8	0%	20%	24%	28%	32%	36%
9	0%	18%	21%	25%	28%	32%
10	0%	15%	18%	22%	25%	28%
11	0%	14%	16%	19%	22%	24%
12	0%	12%	14%	17%	19%	22%
13	0%	11%	13%	15%	17%	19%
14	0%	9%	11%	13%	15%	17%
15	0%	8%	10%	11%	13%	15%
16	0%	7%	9%	10%	11%	13%
17	0%	6%	8%	9%	10%	11%
18	0%	6%	7%	8%	9%	10%
19	0%	5%	6%	7%	8%	9%
20	0%	4%	5%	6%	7%	8%
21	0%	4%	5%	5%	6%	7%
22	0%	3%	4%	5%	5%	6%
23	0%	3%	4%	4%	5%	5%
24	0%	3%	3%	4%	4%	5%
25	0%	2%	3%	3%	4%	4%

Carbon Cap and Trade Analysis

Sensitivity analyses were performed to determine the impact of a carbon cap and trade policy. For the sensitivities, carbon emissions in the form of CO2 can be traded at the following values:

- 1. \$5/ton of CO2 saved
- 2. \$10/ton of CO2 saved
- 3. \$15/ton of CO2 saved
- 4. \$20/ton of CO2 saved

Current voluntary trading in North America through the Chicago Climate Exchange is approximately 6/ton.



Current trading in Europe through the Chicago Climate Exchange is approximately \$38/ton.^{ix}



APPENDIX B – BUILDING CALIBRATIONS

Illustrated below are Manhattan buildings that were built in the late 60's and early 70's. Annual hourly energy data (8,760) were acquired from the owners for each of these buildings and used for calibrating Hudson Yards prototype models. The hourly energy data for each individual building is shown in light gray in the following figures in this appendix. The buildings are used for office, residential, or a mix of both.





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High Rise Office Buildings – Prototypes 1, 2, 3 and 4 Average Electricity for December – March



High Rise Office Buildings – Prototypes 1, 2, 3 and 4 Average Electricity for April – May and October - November



High Rise Office Buildings – Prototypes 1, 2, 3 and 4 Average Electricity for June - September



High Rise Office Buildings – Prototypes 1, 2, 3 and 4 Average Heat for December – March



High Rise Office Buildings – Prototypes 1, 2, 3 and 4 Average Heat for April – May and October – November



High Rise Office Buildings – Prototypes 1, 2, 3 and 4 Average Heat for June – September

High Rise Residential & Hotel Buildings – Prototypes 5, 6, 7, 8, 9, 10 and 11 Average Electricity for December – March





High Rise Residential & Hotel Buildings – Prototypes 5, 6, 7, 8, 9, 10

High Rise Residential & Hotel Buildings – Prototypes 5, 6, 7, 8, 9, 10 and 11 Average Electricity for June – September





High Rise Residential & Hotel Buildings – Prototypes 5, 6, 7, 8, 9, 10 and 11 Average Heat for December – March



High Rise Residential & Hotel Buildings – Prototypes 5, 6, 7, 8, 9, 10 and 11 Average Heat for April – May and October – November



High Rise Residential & Hotel Buildings – Prototypes 5, 6, 7, 8, 9, 10 and 11 Average Heat for June – September

APPENDIX C – DATA

	Efficiency Quantity of Spaces that Adopt Efficiency Measure					asure
	Measure	BAU	Mid-Low	Mid	Mid-High	High
	Appliances	0	0	0	0	0
	CHP	1	2	2	2	2
	14RA (CHP only)	2	2	4	5	5
(9	Cool Roof	1	1	1	3	3
al 1	Water Heating	0	0	0	0	0
ots	Glazing	2	2	2	3	3
Ľ	Space Heating	0	0	0	0	0
ice	Space Cooling	5	6	6	9	9
Qf	Lighting	0	0	1	2	2
	Roof Insulation	1	3	3	4	5
	Thermal Storage	2	4	4	4	6
	Wall Insulation	1	2	2	2	2
	Appliances	0	0	0	0	0
	CHP	1	1	1	1	2
	14RA (CHP only)	1	1	1	2	2
()	Cool Roof	0	0	0	0	0
al 6	Water Heating	0	0	0	0	0
_ot	Glazing	0	0	0	0	0
L (T	Space Heating	1	2	2	2	3
ote	Space Cooling	2	2	3	3	3
Ĭ	Lighting	0	0	0	0	0
	Roof Insulation	0	0	0	0	0
	Thermal Storage	0	1	1	1	1
	Wall Insulation	0	0	0	0	0
	Appliances	0	0	0	0	0
	CHP	4	4	5	7	7
()	14RA (CHP only)	5	8	8	11	12
13	Cool Roof	7	8	9	11	13
ota	Water Heating	0	0	0	0	0
Ē	Glazing	5	7	8	9	11
tial	Space Heating	9	10	13	14	17
eni	Space Cooling	12	15	18	21	23
sid	Lighting	0	0	0	0	0
Re	Roof Insulation	1	3	4	4	5
	Thermal Storage	1	1	1	3	3
	Wall Insulation	5	7	7	9	9
	Appliances	0	0	0	0	0
	CHP	0	0	0	0	0
	14RA (CHP only)	0	0	0	0	0
24)	Cool Roof	0	0	0	0	0
72	Water Heating	44	56	66	74	84
otal	Glazing	75	112	112	127	127
Ľ	Space Heating	33	40	47	53	61
ail	Space Cooling	32	39	48	54	60
Ret	Lighting	0	0	0	0	0
	Roof Insulation	0	0	0	0	0
	Thermal Storage	0	0	0	0	0
	Wall Insulation	75	112	112	127	127
	Appliances	0	0	0	0	0
	CHP	0	0	0	0	0
2	14RA (CHP only)	0	0	0	0	0
4	Cool Roof	0	0	0	0	0
ota	Water Heating	7	10	12	13	15
Ĕ	Glazina	6	8	8	10	10
ant	Space Heating	21	25	28	33	37
nra	Space Cooling	16	19	23	27	30
sta	Lighting	0	0	0	0	0
Re	Roof Insulation	0	0	0	0	0
	Thermal Storage	0	0	0	0	0
	Wall Insulation	6	8	8	10	10
L		-	-	-	. 🗸	. 🗸

Table 24 - Quantity of Spaces that Adopt Efficiency Measures at VariousMarket Penetrations without a Carbon Cap and Trade Policy

[Efficiency	Quantity of Spaces that Adopt Efficiency Measure				
	Measure	No CCT	CCT5	CCT10	CCT15	CCT20
	Appliances	0	0	0	0	0
	СНР	1	1	2	2	2
	Cool Roof	1	1	1	1	1
16)	Water Heating	0	0	0	0	0
tal ,	Glazing	2	2	2	2	2
(To	Space Heating	0	0	0	0	0
ce	Space Cooling	5	5	5	5	5
Offi	Lighting	0	0	0	0	0
-	Roof Insulation	1	1	2	2	3
	Thermal Storage	2	2	2	2	2
	Wall Insulation	1	1	1	1	2
	Appliances	0	0	0	0	0
	СНР	1	1	1	1	1
	Cool Roof	0	0	0	0	0
(9	Water Heating	0	0	0	0	0
tal	Glazing	0	0	0	0	0
ΞĽ	Space Heating	1	1	1	1	1
tel	Space Cooling	2	2	2	2	2
H	Lighting	0	0	0	0	0
	Roof Insulation	0	0	0	0	0
	Thermal Storage	0	0	0	0	0
	Wall Insulation	0	0	0	0	0
	Appliances	0	0	0	0	0
	СНР	4	4	5	5	5
(9	Cool Roof	7	7	7	7	7
al 3	Water Heating	0	0	0	0	0
Tot	Glazing	5	6	6	6	6
al (Space Heating	9	9	9	9	9
enti	Space Cooling	12	12	13	13	13
side	Lighting	0	0	0	0	0
Re	Roof Insulation	1	1	2	2	3
	Thermal Storage	1	1	1	1	1
	Wall Insulation	5	5	5	5	5
	Appliances	0	0	0	0	0
	СНР	0	0	0	0	0
_	Cool Roof	0	0	0	0	0
24)	Water Heating	44	45	45	48	48
al 7	Glazing	75	75	75	75	99
Tot	Space Heating	33	33	33	34	34
ail (Space Cooling	32	33	34	36	36
Ret	Lighting	0	0	0	0	0
	Roof Insulation	0	0	0	0	0
	Thermal Storage	0	0	0	0	0
	Wall Insulation	75	75	75	75	99
Restaurant (Total 47)	Appliances	0	0	0	0	0
	СНР	0	0	0	0	0
	Cool Roof	0	0	0	0	0
	Water Heating	7	9	9	9	9
	Glazing	6	6	6	6	7
	Space Heating	21	21	21	21	21
	Space Cooling	16	16	16	17	18
	Lighting	0	0	0	0	0
	Roof Insulation	0	0	0	0	0
	Thermal Storage	0	0	0	0	0
	Wall Insulation	6	6	6	6	7

Table 25 - Quantity of Spaces that Adopt Efficiency Measures at BAUMarket Penetration with a CCT Policy of \$5 to \$20/MT

MeasureNo CCTCCT10CCT15CCT20GPAppliances00000GP22222Cool Roof11111Image: Cooling00000Glaring222222Space Cooling00000Space Cooling001111Formal Storage4444Wall Insulation22222COR Roof00000CHP11111Cool Roof00000Grading000000Grading000000Grading000000Grading000000Grading000000Grading000000Grading77888Space Cooling15171717Grading7777Grading10101010Grading12112112112Grading13444 <trr>Space Cooling15171717<th></th><th>Efficiency</th><th colspan="6">Quantity of Spaces that Adopt Efficiency Measure</th></trr>		Efficiency	Quantity of Spaces that Adopt Efficiency Measure					
Appliances 0 0 0 0 0 (9) BOU UBUE UBUE UBUE UBUE UBUE UBUE UBUE		Measure	No CCT	CCT5	CCT10	CCT15	CCT20	
CHP 2 2 2 2 2 G0 Cool Roof 1 1 1 1 1 1 Mater Heating 0 0 0 0 0 0 Space Cooling 6 6 6 6 6 Space Cooling 6 6 6 6 6 Roof Insulation 3 3 3 3 3 Thermal Storage 4 4 4 4 4 Wall Insulation 2 2 2 2 2 2 CHP 1 1 1 1 1 1 1 Cool Roof 0 0 0 0 0 0 0 0 Space Cooling 2		Appliances	0	0	0	0	0	
Cool Roof 1 1 1 1 1 Gaing 2 2 2 2 2 2 Space Heating 0 0 0 0 0 Gaing 2 2 2 2 2 2 Space Heating 0 0 1 1 1 1 Roof Insulation 3 3 3 3 3 3 Thermal Storage 4 4 4 4 4 Wall Insulation 2 2 2 2 2 Cool Roof 0 0 0 0 0 Gaing 0 0 0 0 0 0 Space Cooling 2 <t< td=""><td rowspan="3">16)</td><td>СНР</td><td>2</td><td>2</td><td>2</td><td>2</td><td>2</td></t<>	16)	СНР	2	2	2	2	2	
Image: space Heating 0 0 0 0 0 Glazing 2 2 2 2 2 Space Leating 0 0 0 0 0 Space Cooling 6 6 6 6 6 Space Cooling 6 6 6 6 6 Roof Insulation 3 3 3 3 3 3 Thermal Storage 4 4 4 4 4 4 Wall Insulation 2 2 2 2 2 2 Appliances 0 0 0 0 0 0 0 Space Heating 2 <td< td=""><td>Cool Roof</td><td>1</td><td>1</td><td>1</td><td>1</td><td>1</td></td<>		Cool Roof	1	1	1	1	1	
Glazing 2 2 2 2 2 Space Heating 0 0 0 0 0 Space Cooling 6 6 6 6 6 Lighting 0 0 1 1 1 Roof Insulation 3 3 3 3 3 Thermal Storage 4 4 4 4 4 Wall Insulation 2 2 2 2 2 Appliances 0 0 0 0 0 0 Glazing 0 0 0 0 0 0 0 Space Cooling 2 <t< td=""><td>Water Heating</td><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td></t<>		Water Heating	0	0	0	0	0	
Q Space Heating 0 0 0 0 0 Space Cooling 6 6 6 6 6 Lighting 0 0 1 1 1 Roof Insulation 3 3 3 3 3 Thermal Storage 4 4 4 4 4 Wall Insulation 2	tal	Glazing	2	2	2	2	2	
By Control Space Cooling 6 7 8 9 9 9 9	(To	Space Heating	0	0	0	0	0	
E Lighting 0 0 1 1 1 Roof Insulation 3 3 3 3 3 Thermal Storage 4 4 4 4 4 Wall Insulation 2 2 2 2 2 Appliances 0 0 0 0 0 0 CHP 1 1 1 1 1 1 Col Roof 0 0 0 0 0 0 Space Heating 2 2 2 2 2 2 Space Heating 0 0 0 0 0 0 Roof Insulation 0 0 0 0 0 0 Roof Insulation 0 0 0 0 0 0 Roof Insulation 0 0 0 0 0 0 General Col Roof 8 8 8 8	ce	Space Cooling	6	6	6	6	6	
Roof Insulation 3 3 3 3 3 Thermal Storage 4 4 4 4 4 Wall Insulation 2 2 2 2 2 Appliances 0 0 0 0 0 Coll Roof 0 0 0 0 0 Wall Insulation 0 0 0 0 0 Gene Colling 2 2 2 2 2 Space Cooling 2 2 2 2 2 Space Cooling 2 2 2 2 2 2 Space Cooling 1 1 1 1 1 1 Wall Insulation 0 0 0 0 0 0 Gene Gon Roof 8 8 8 8 8 8 8 Gon Insulation 7 7 8 8 8 8 Golazing	Off	Lighting	0	0	1	1	1	
Thermal Storage 4 4 4 4 4 Wall Insulation 2 2 2 2 2 Appliances 0 0 0 0 0 0 CHP 1 1 1 1 1 1 Cool Roof 0 0 0 0 0 0 Gazing 0 0 0 0 0 0 Space Heating 2 2 2 2 2 2 Lighting 0 0 0 0 0 0 Mall Insulation 0 0 0 0 0 0 Mall Insulation 0 0 0 0 0 0 0 George Gazing 7 7 8 8 8 9 Wall Insulation 3 4 4 4 4 4 Thermal Storage 1 1 1 <td></td> <td>Roof Insulation</td> <td>3</td> <td>3</td> <td>3</td> <td>3</td> <td>3</td>		Roof Insulation	3	3	3	3	3	
Wall Insulation 2 2 2 2 2 Appliances 0 0 0 0 0 CHP 1 1 1 1 1 Cool Roof 0 0 0 0 0 General State General State 2 2 2 2 Space Cooling 2 2 2 2 2 Space Cooling 2 2 2 2 2 Mapliances 0 0 0 0 0 Thermal Storage 1 1 1 1 1 Wall Insulation 0 0 0 0 0 0 Cool Roof 8 8 8 8 8 8 9 Water Heating 0 0 0 0 0 0 General Storage 1 10 100 100 100 100 Space Heating 0		Thermal Storage	4	4	4	4	4	
Appliances 0 0 0 0 0 G CHP 1 1 1 1 1 Col Roof 0 0 0 0 0 0 Gazing 0 0 0 0 0 0 Space Heating 2 2 2 2 2 2 Space Cooling 0 0 0 0 0 0 Roof Insulation 0 0 0 0 0 0 Thermal Storage 1 1 1 1 1 1 Walt Insulation 0 0 0 0 0 0 Con Roof 8 8 8 8 9 9 Water Heating 0 0 0 0 Space Con Roof 8 8 8 8 9 9 10 10 10 10 10 10 10 10 10		Wall Insulation	2	2	2	2	2	
CHP 1 1 1 1 1 1 GO ROOF 0 0 0 0 0 0 Water Heating 0 0 0 0 0 0 Space Cooling 2 2 2 2 2 2 Lighting 0 0 0 0 0 0 Roof insulation 0 0 0 0 0 0 Wall Insulation 0 0 0 0 0 0 Gene Color Roof 8 8 8 8 8 8 Space Cooling 15 17 17 17 17 Ughting 0 0 0 0 0 0 Go Insulation 3 4 4 4 4 Thermal Storage 1 1 1 1 1 Space Cooling 15 17 7 7 7		Appliances	0	0	0	0	0	
Cool Roof 0 0 0 0 0 0 Image: Space Heating 0 0 0 0 0 0 Space Heating 2 2 2 2 2 2 Space Cooling 2 2 2 2 2 2 Lighting 0 0 0 0 0 0 Roof Insulation 0 0 0 0 0 0 Wall Insulation 0 0 0 0 0 0 0 Generating 0 0 0 0 0 0		СНР	1	1	1	1	1	
G Water Heating 0 0 0 0 0 0 Gigs Glazing 0 0 0 0 0 0 0 Space Heating 2		Cool Roof	0	0	0	0	0	
Glazing 0 0 0 0 0 0 Space Heating 2	(9	Water Heating	0	0	0	0	0	
E Space Heating 2 2 2 2 2 2 Ighting 0 0 0 0 0 0 0 Roof Insulation 0 0 0 0 0 0 0 Mail Insulation 0 0 0 0 0 0 0 Appliances 0 0 0 0 0 0 0 GE Cool Roof 8 8 8 8 8 8 Space Heating 10 10 10 10 10 10 Space Cooling 15 17 17 17 17 17 Space Heating 0 0 0 0 0 0 0 Space Cooling 15 17 17 17 17 17 Uighting 0 0 0 0 0 0 0 Ge Col Roof 0 0	otal	Glazing	0	0	0	0	0	
Open Space Cooling 2 2 2 2 2 2 Lighting 0 0 0 0 0 0 0 Roof Insulation 0 0 0 0 0 0 0 Wall Insulation 0 0 0 0 0 0 0 CO 0 0 0 0 0 0 0 0 CO Roof Insulation 0	Ĕ	Space Heating	2	2	2	2	2	
Lighting 0 0 0 0 0 Roof Insulation 0 0 0 0 0 Thermal Storage 1 1 1 1 1 Wall Insulation 0 0 0 0 0 Wall Insulation 0 0 0 0 0 Ge Cool Roof 8 8 8 9 Water Heating 0 0 0 0 0 Gazing 7 7 8 8 8 Space Cooling 15 17 17 17 Lighting 0 0 0 0 0 Roof Insulation 3 4 4 4 4 Thermal Storage 1 1 1 1 1 Wall Insulation 7 7 7 7 7 Gool Roof 0 0 0 0 0 Cool Roof	otel	Space Cooling	2	2	2	2	2	
Roof Insulation 0 0 0 0 0 Thermal Storage 1 1 1 1 1 1 Wall Insulation 0 0 0 0 0 0 Appliances 0 0 0 0 0 0 CHP 4 5 6 8 8 9 Water Heating 0 0 0 0 0 0 Ge Tool Roof 8 8 8 8 9 9 Water Heating 10 10 10 10 10 10 Space Cooling 15 17 17 17 17 17 Lighting 0 0 0 0 0 0 0 Roof Insulation 7 7 7 7 7 7 7 Water Heating 56 56 56 56 56 56 56 56 56	Ĩ	Lighting	0	0	0	0	0	
Thermal Storage 1 1 1 1 1 Wall Insulation 0 0 0 0 0 Appliances 0 0 0 0 0 Col Roof 8 8 8 8 9 Water Heating 0 0 0 0 0 Gene Glazing 7 7 8 8 8 Space Cooling 15 17 17 17 17 Space Cooling 15 17 17 17 17 Uighting 0 0 0 0 0 Roof Insulation 3 4 4 4 4 Thermal Storage 1 1 1 1 1 Wall Insulation 7 7 7 7 7 Appliances 0 0 0 0 0 Col Roof 0 0 0 0 0 <		Roof Insulation	0	0	0	0	0	
Wall Insulation 0 0 0 0 0 0 Appliances 0 0 0 0 0 0 0 CHP 4 5 6 8 8 8 8 COR Not 8 8 8 8 9 0 0 0 Glazing 7 7 8 8 8 8 8 Space Heating 10 10 10 10 10 10 Space Cooling 15 17 17 17 17 17 Lighting 0 0 0 0 0 0 Roof Insulation 3 4 4 4 4 4 Thermal Storage 1 1 1 1 1 1 Wall Insulation 7 7 7 7 7 7 Appliances 0 0 0 0 0 0		Thermal Storage	1	1	1	1	1	
Appliances 0 0 0 0 0 0 00 CHP 4 5 6 8 8 8 Cool Roof 8 8 8 8 9 0 0 0 0 Glazing 7 7 8 8 8 8 8 Space Heating 10 10 10 10 10 10 Space Cooling 15 17 17 17 17 Lighting 0 0 0 0 0 0 Roof Insulation 3 4 4 4 4 Thermal Storage 1 1 1 1 1 Walter Heating 56		Wall Insulation	0	0	0	0	0	
CHP 4 5 6 8 8 Cool Roof 8 8 8 8 9 Water Heating 0 0 0 0 0 Glazing 7 7 8 8 8 8 Space Heating 10 10 10 10 10 10 Space Cooling 15 17 17 17 17 17 Lighting 0 0 0 0 0 0 Roof Insulation 3 4 4 4 4 Thermal Storage 1 1 1 1 1 Water Heating 56 56 56 56 56 Gol Roof 0 0 0 0 0 0 Water Heating 56 56 56 56 56 56 56 56 56 56 56 56 56 56 56 56		Appliances	0	0	0	0	0	
Cool Roof 8 8 8 8 9 Water Heating 0 0 0 0 0 Glazing 7 7 8 8 8 Space Heating 10 10 10 10 10 Space Cooling 15 17 17 17 17 Lighting 0 0 0 0 0 0 Roof Insulation 3 4 4 4 4 Thermal Storage 1 1 1 1 Wall Insulation 7 7 7 7 Appliances 0 0 0 0 0 Col Roof 0 0 0 0 0 0 Water Heating 56 56 56 56 56 56 56 Gazing 39 42 42 42 42 42 Ughting 0 0 0		СНР	4	5	6	8	8	
Water Heating 0 0 0 0 0 0 Glazing 7 7 8 8 8 Space Heating 10 10 10 10 10 Space Cooling 15 17 17 17 17 Lighting 0 0 0 0 0 0 Roof Insulation 3 4 4 4 4 Thermal Storage 1 1 1 1 1 Wall Insulation 7 7 7 7 7 Appliances 0 0 0 0 0 Col Roof 0 0 0 0 0 Water Heating 56 56 56 56 56 Glazing 112 112 112 112 112 Space Cooling 39 42 42 42 42 Lighting 0 0 0 0	36)	Cool Roof	8	8	8	8	9	
Glazing 7 7 8 8 8 Space Heating 10 10 10 10 10 Space Cooling 15 17 17 17 17 Lighting 0 0 0 0 0 Roof Insulation 3 4 4 4 Thermal Storage 1 1 1 1 Wall Insulation 7 7 7 7 Appliances 0 0 0 0 0 Col Roof 0 0 0 0 0 0 Water Heating 56 56 56 56 56 56 Glazing 112 112 112 112 112 112 Space Cooling 39 42 42 42 42 Lighting 0 0 0 0 0 Water Heating 10 0 0 0 0	otal	Water Heating	0	0	0	0	0	
Space Heating 10 10 10 10 10 10 Space Cooling 15 17 17 17 17 Lighting 0 0 0 0 0 Roof Insulation 3 4 4 4 4 Thermal Storage 1 1 1 1 1 Wall Insulation 7 7 7 7 7 Appliances 0 0 0 0 0 0 COI Roof 0 0 0 0 0 0 0 Water Heating 56 56 56 56 56 56 56 Glazing 112 112 112 112 112 112 Space Cooling 39 42 42 42 42 42 42 42 42 42 42 42 42 42 42 42 42 42 42 42	(To	Glazing	7	7	8	8	8	
Space Cooling 15 17 17 17 17 Lighting 0 0 0 0 0 0 Roof Insulation 3 4 4 4 4 4 Thermal Storage 1 1 1 1 1 1 Wall Insulation 7 7 7 7 7 Appliances 0 0 0 0 0 CHP 0 0 0 0 0 Colo Roof 0 0 0 0 0 Water Heating 56 56 56 56 56 Glazing 112 112 112 112 112 Space Cooling 39 42 42 42 42 Lighting 0 0 0 0 0 Roof Insulation 112 112 112 112 112 Lighting 0 0 0	itial	Space Heating	10	10	10	10	10	
Lighting 0 0 0 0 0 0 Roof Insulation 3 4 4 4 4 Thermal Storage 1 1 1 1 1 Wall Insulation 7 7 7 7 7 Appliances 0 0 0 0 0 CHP 0 0 0 0 0 Color Roof 0 0 0 0 0 Water Heating 56 56 56 56 56 Glazing 112 112 112 112 112 Space Heating 40 40 40 41 41 Space Cooling 39 42 42 42 42 Lighting 0 0 0 0 0 Roof Insulation 012 012 112 112 112 Wall Insulation 112 1112 1112 112	den	Space Cooling	15	17	17	17	17	
Root Insulation 3 4 4 4 4 4 Thermal Storage 1 1 1 1 1 1 Wall Insulation 7 7 7 7 7 7 Appliances 0 0 0 0 0 0 0 CHP 0 0 0 0 0 0 0 0 Col Roof 0 0 0 0 0 0 0 0 Water Heating 56 56 56 56 56 56 56 Glazing 112 112 112 112 112 112 Space Heating 40 40 40 40 41 41 Space Cooling 39 42 42 42 42 42 42 42 42 42 42 42 42 41 41 11 112 112 112 112	esi	Lighting	0	0	0	0	0	
Inermal storage 1 1 1 1 1 1 Wall Insulation 7 7 7 7 7 7 Appliances 0 0 0 0 0 0 0 CHP 0 0 0 0 0 0 0 0 Cool Roof 0 0 0 0 0 0 0 0 0 Water Heating 56	R	Roof Insulation	3	4	4	4	4	
Wall Insulation 7 <th7< th=""> 1 7</th7<>		Thermal Storage	1	1 7	1	1	1	
Appliances 0 0 0 0 0 0 0 CHP 0 0 0 0 0 0 0 Cool Roof 0 0 0 0 0 0 0 Water Heating 56 56 56 56 56 56 Glazing 112 112 112 112 112 112 Space Heating 40 40 40 41 41 Space Cooling 39 42 42 42 42 Lighting 0 0 0 0 0 Roof Insulation 0 0 0 0 0 Wall Insulation 112 112 112 112 112 Appliances 0 0 0 0 0 Col Roof 0 0 0 0 0 Glazing 8 8 8 8 8 <tr< td=""><td></td><td>Wall Insulation</td><td>/</td><td>/</td><td>/</td><td>/</td><td>/</td></tr<>		Wall Insulation	/	/	/	/	/	
CHP O O O O O O O O Cool Roof 0 0 0 0 0 0 0 0 Water Heating 56 56 56 56 56 56 56 Glazing 112 112 112 112 112 112 Space Heating 40 40 40 41 41 Space Cooling 39 42 42 42 42 Lighting 0 0 0 0 0 Roof Insulation 0 0 0 0 0 Wall Insulation 112 112 112 112 112 Appliances 0 0 0 0 0 0 Col Roof 0 0 0 0 0 0 Glazing 8 8 8 8 8 8 8 Space Heating 2		Appliances	0	0	0	0	0	
K Coor Nool Coor Coor <thcoor< th=""> Coor Coor <t< td=""><td></td><td>Cool Roof</td><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td></t<></thcoor<>		Cool Roof	0	0	0	0	0	
Key Water Heating 36	(4)	Water Heating	56	56	56	56	56	
Brand 112 </td <td>72</td> <td></td> <td>30 112</td> <td>112</td> <td>30 112</td> <td>30 112</td> <td>30 112</td>	72		30 112	112	30 112	30 112	30 112	
Image: base frequency 40 40 40 41 41 Space Cooling 39 42 42 42 42 42 Lighting 0 0 0 0 0 0 0 Roof Insulation 0 0 0 0 0 0 0 Thermal Storage 0 0 0 0 0 0 0 Wall Insulation 112 112 112 112 112 112 Appliances 0 0 0 0 0 0 0 CHP 0 0 0 0 0 0 0 Water Heating 10 10 10 10 10 10 Glazing 8 8 8 8 8 8 8 Space Heating 25 25 25 25 25 25 25 25 25 25 25 25 <t< td=""><td>ota</td><td>Space Heating</td><td>40</td><td>112</td><td>112</td><td>112</td><td> </td></t<>	ota	Space Heating	40	112	112	112	 	
Top Space cooling Space cooling <thspace cooling<="" th=""> Space cooling</thspace>	ГŢ	Space Cooling	20	40	40	41	41	
Arrow Constraint C	etai	Lighting	0	- 42	42	42	42	
Noor maladiant 0	Ř	Roof Insulation	0	0	0	0	0	
Internal storage 0		Thermal Storage	0	0	0	0	0	
Appliances 0 0 0 0 0 0 CHP 0 0 0 0 0 0 0 Cool Roof 0 0 0 0 0 0 0 Water Heating 10 10 10 10 10 10 Glazing 8 8 8 8 8 8 8 Space Heating 25 25 25 25 25 25 Space Cooling 19 20 21 21 21 21 Lighting 0 0 0 0 0 0 0 Wall Insulation 0 0 0 0 0 0 0		Wall Insulation	112	112	112	112	112	
Appliances 0		Annliances	0	0	0	0	0	
Cool Roof 0	ırant (Total 47)	СНР	0	0	0	0	0	
Gradient Construction Construction <td>Cool Roof</td> <td>0</td> <td>0</td> <td>0</td> <td>0</td> <td>0</td>		Cool Roof	0	0	0	0	0	
Glazing 8 8 8 8 8 8 Space Heating 25 25 25 25 25 Space Heating 0 0 0 0 0 Lighting 0 0 0 0 0 Roof Insulation 0 0 0 0 0 Wall Insulation 8 8 8 8 8 8		Water Heating	10	10	10	10	10	
Space Heating 25 25 25 25 25 Space Cooling 19 20 21 21 21 Lighting 0 0 0 0 0 Roof Insulation 0 0 0 0 0 Wall Insulation 8 8 8 8 8		Glazing	8	8	8	8	8	
Space Cooling 19 20 21 21 21 Lighting 0 0 0 0 0 0 Roof Insulation 0 0 0 0 0 0 Thermal Storage 0 0 0 0 0 0 Wall Insulation 8 8 8 8 8 8		Space Heating	25	25	25	25	25	
Lighting 0 0 0 0 0 0 Key Lighting 0		Space Cooling	19	20	21	21	21	
Image: Second	stau	Lighting	0	0	0	0	0	
Thermal Storage 0 0 0 0 0 Wall Insulation 8 8 8 8 8	Res	Roof Insulation	0	0	0	0	0	
Wall Insulation 8 8 8 8 8		Thermal Storage	0	0	0	0	0	
		Wall Insulation	8	8	8	8	8	

Table 26 - Quantity of Spaces that Adopt Efficiency Measures at Mid-
Low Market Penetrations with a CCT Policy of \$5 to \$20/MT

Measure No CCT CCT10 CCT15 CCT20 Appliances 0 0 0 0 0 0 CHP 2 2 2 2 4 Cool Roof 1 1 1 1 1 Water Heating 0 0 0 0 0 Space Heating 0 0 0 0 0 0 Space Cooling 6 6 7 7 7 7 Lighting 1 1 1 2		Efficiency	Quantity of Spaces that Adopt Efficiency Measure				
Appliances 0 0 0 0 0 CHP 2 2 2 2 4 Water Heating 0 0 0 0 0 Glazing 2 2 2 2 2 Space Heating 0 0 0 0 0 Space Cooling 6 6 7 7 7 Roof Insulation 3 3 4 4 4 Wall Insulation 2 2 2 2 2 Appliances 0 0 0 0 0 Gof Insulation 2 2 2 2 2 Space Cooling 3 3 3 3 3 3 Space Heating 2 2 2 2 2 2 Space Cooling 3 3 3 3 3 3 3 Space Cooling 3 3 3		Measure	No CCT	CCT5	CCT10	CCT15	CCT20
CHP 2 2 2 4 Cool Roof 1 1 1 1 1 Garing 2 2 2 2 2 2 Space Heating 0 0 0 0 0 0 Space Cooling 6 6 7 7 7 7 Lighting 1 1 1 2 2 2 Roof Insulation 3 3 4 4 4 Wall Insulation 2 2 2 2 2 Cool Roof 0 0 0 0 0 0 Gaizing 0 0 0 0 0 0 0 Space Heating 2 <td></td> <td>Appliances</td> <td>0</td> <td>0</td> <td>0</td> <td>0</td> <td>0</td>		Appliances	0	0	0	0	0
General Cool Roof 1 1 1 1 1 1 Water Heating 0 0 0 0 0 0 Gazing 2 2 2 2 2 2 2 Space Heating 0 0 0 0 0 0 Space Cooling 6 6 7 7 7 Lighting 1 1 1 2 2 Roof Insulation 3 3 4 4 4 Wall Insulation 2 2 2 2 2 Appliances 0 0 0 0 0 0 Gen Roof 0 0 0 0 0 0 0 Space Heating 2 2 2 2 2 2 2 2 2 Space Coling 3 3 3 3 3 3 3 3 3 <th< td=""><td rowspan="3">16)</td><td>СНР</td><td>2</td><td>2</td><td>2</td><td>2</td><td>4</td></th<>	16)	СНР	2	2	2	2	4
Vater Heating 0 0 0 0 0 Glaing 2 2 2 2 2 Space Leating 0 0 0 0 0 Space Leating 1 1 2 2 Space Looling 6 6 7 7 7 Lighting 1 1 2 2 2 Roof Insulation 3 3 4 4 4 Wall Insulation 2 2 2 2 2 CHP 1 1 1 1 2 Coll Roof 0 0 0 0 0 Space Heating 2 2 2 2 2 Space Heating 0 0 0 0 0 Mult Insulation 0 0 0 0 0 Mol Insulation 0 0 0 0 0 0 Mult Insulat		Cool Roof	1	1	1	1	1
Bit Space Heating Q		Water Heating	0	0	0	0	0
Openet Space Heating O O O O O Space Cooling 6 6 7 7 7 Lighting 1 1 1 2 2 Roof insulation 3 3 4 4 4 Mall insulation 2 2 2 2 2 Appliances O O O O O Gene Color O O O O O Gene Coling 3 3 3 3 3 3 3 Space Cooling 3 3 3 3 3 3 3 3 Wall Insulation O O O O O O Gene Cooling 1 1 1 1 1 1 Wall Insulation O O O O O O Gene Coling 18 18 18 13 <th1< td=""><td>tal</td><td>Glazing</td><td>2</td><td>2</td><td>2</td><td>2</td><td>2</td></th1<>	tal	Glazing	2	2	2	2	2
Space Cooling 6 6 7 7 7 Lighting 1 1 1 2 2 Roof Insulation 3 3 4 4 4 Thermal Storage 4 4 4 4 4 Wall Insulation 2 2 2 2 2 Col Roof 0 0 0 0 0 0 Gazing 0 0 0 0 0 0 0 Space Heating 2	(To	Space Heating	0	0	0	0	0
End Lighting 1 1 1 2 2 Roof Insulation 3 3 4 4 4 Thermal Storage 4 4 4 4 Wall Insulation 2 2 2 2 2 Appliances 0 0 0 0 0 0 Cool Roof 0 0 0 0 0 0 0 Space Cooling 3 3 3 3 3 3 3 Lighting 0 0 0 0 0 0 0 Space Cooling 3 3 3 3 3 3 3 Lighting 0 0 0 0 0 0 0 Roof Insulation 0 0 0 0 0 0 0 Geores Cool Roof 9 10 10 11 11 1 Wall	ice	Space Cooling	6	6	7	7	7
Roof Insulation 3 3 4 4 4 Thermal Storage 4 4 4 4 4 Wall Insulation 2 2 2 2 2 Appliances 0 0 0 0 0 Cool Roof 0 0 0 0 0 Water Heating 0 0 0 0 0 Space Cooling 3 3 3 3 3 3 Lighting 0 0 0 0 0 0 Koof Insulation 0 0 0 0 0 0 Mall Insulation 0 0 0 0 0 0 Col Roof 9 10 10 11 11 Water Heating 0 0 0 0 0 Geo Roof 9 10 10 11 11 Water Heating 0 0 <	Off	Lighting	1	1	1	2	2
Thermal Storage 4 4 4 4 4 Wall Insulation 2 2 2 2 2 Appliances 0 0 0 0 0 0 CHP 1 1 1 2 2 2 2 Galaing 0 0 0 0 0 0 0 Space Heating 2 2 2 2 2 2 2 Space Cooling 3 3 3 3 3 3 3 Lighting 0 0 0 0 0 0 0 Roof Insulation 0 0 0 0 0 0 0 Galaing 8 8 8 9 9 9 3 Space Heating 13 13 13 13 13 13 Bod Insulation 7 8 8 9 9 9 <td></td> <td>Roof Insulation</td> <td>3</td> <td>3</td> <td>4</td> <td>4</td> <td>4</td>		Roof Insulation	3	3	4	4	4
Wall Insulation 2 2 2 2 2 2 Appliances 0 0 0 0 0 0 CHP 1 1 1 1 2 Cool Roof 0 0 0 0 0 George Gaing 0 0 0 0 0 Space Cooling 3 3 3 3 3 3 Lighting 0 0 0 0 0 0 Roof Insulation 0 0 0 0 0 0 Mall Insulation 0 0 0 0 0 0 George Cool Roof 9 10 10 11 11 Wall Insulation 0 0 0 0 0 0 George Gaing 8 8 8 9 9 Space Cooling 18 18 18 19 <		Thermal Storage	4	4	4	4	4
Appliances 0 0 0 0 0 0 CHP 1 1 1 1 2 Cool Roof 0 0 0 0 0 Gaizing 0 0 0 0 0 Space Heating 2 2 2 2 2 Space Cooling 3 3 3 3 3 Lighting 0 0 0 0 0 Roof Insulation 0 0 0 0 0 Thermal Storage 1 1 1 1 1 Water Heating 0 0 0 0 0 0 Gaizing 8 8 8 9 9 9 9 Space Cooling 18 18 18 19 200 0 Gaizing 1 1 1 1 1 1 1 Water Heating 0 <td></td> <td>Wall Insulation</td> <td>2</td> <td>2</td> <td>2</td> <td>2</td> <td>2</td>		Wall Insulation	2	2	2	2	2
CHP 1 1 1 1 1 1 2 Cool Roof 0 0 0 0 0 0 0 Water Heating 0 0 0 0 0 0 0 Space Cooling 3 3 3 3 3 3 3 Lighting 0 0 0 0 0 0 0 Mail Insulation 0 0 0 0 0 0 0 Ge group Appliances 0 0 0 0 0 0 Ge group Ge group Ge group 13 13 13 13 13 Mater Heating 0 0 0 0 0 0 0 Ge group Glazing 8 8 8 9 9 9 Space Cooling 18 18 18 19 20 0 0 0 0 </td <td></td> <td>Appliances</td> <td>0</td> <td>0</td> <td>0</td> <td>0</td> <td>0</td>		Appliances	0	0	0	0	0
Cool Roof 0 0 0 0 0 0 Water Heating 0 0 0 0 0 0 Space Heating 2 2 2 2 2 2 Space Cooling 3 3 3 3 3 3 Lighting 0 0 0 0 0 0 Roof Insulation 0 0 0 0 0 0 Wall Insulation 0 0 0 0 0 0 0 Col Roof 9 10 10 11 11 11 11 Water Heating 0 0 0 0 0 0 0 Generation 13 13 13 13 13 13 13 13 13 Space Cooling 18 18 18 19 20 14 1 1 1 1 1 1 1<		СНР	1	1	1	1	2
General Water Heating 0 0 0 0 0 0 Space Heating 2 2 2 2 2 2 2 Space Cooling 3 3 3 3 3 3 3 Lighting 0 0 0 0 0 0 0 Roof Insulation 0 0 0 0 0 0 0 Walter Heating 0 0 0 0 0 0 0 Water Heating 0 0 0 0 0 0 0 Water Heating 0 0 0 0 0 0 0 General Galazing 8 8 8 9 9 9 Space Heating 13 13 13 13 13 13 Space Cooling 18 18 18 19 20 1 Lighting 0		Cool Roof	0	0	0	0	0
Glazing O O O O O O O Space Heating 2 2 2 2 2 2 2 Space Cooling 3 3 3 3 3 3 Lighting 0 0 0 0 0 0 Roof Insulation 0 0 0 0 0 0 Wall Insulation 0 0 0 0 0 0 Ge G	l 6)	Water Heating	0	0	0	0	0
E Space Heating 2 <	ota	Glazing	0	0	0	0	0
Space Cooling 3 3 3 3 3 3 3 3 Lighting 0 0 0 0 0 0 0 Roof Insulation 0 0 0 0 0 0 0 Wall Insulation 0 0 0 0 0 0 0 CO CHP 5 7 8 8 8 8 Cool Roof 9 10 10 11 11 11 Water Heating 0 0 0 0 0 0 Generating 13 13 13 13 13 13 13 Space Heating 18 18 18 19 20 1 Lighting 0 0 0 0 0 0 0 Roof Insulation 7 8 8 9 9 4 4 4 4 1 1	Ē	Space Heating	2	2	2	2	2
Lighting 0 0 0 0 0 0 Roof Insulation 0 0 0 0 0 0 Thermal Storage 1 1 1 1 1 1 Wall Insulation 0 0 0 0 0 0 Appliances 0 0 0 0 0 0 0 Get The Beating 0 0 0 0 0 0 0 Get The Beating 13 13 13 13 13 13 13 Space Heating 13 13 13 13 13 13 Space Cooling 18 18 18 19 20 Lighting 0 0 0 0 0 0 Roof Insulation 4 4 4 4 5 Thermal Storage 1 1 1 1 1 Wall Insulation 7 </td <td>ote</td> <td>Space Cooling</td> <td>3</td> <td>3</td> <td>3</td> <td>3</td> <td>3</td>	ote	Space Cooling	3	3	3	3	3
Roof Insulation 0 0 0 0 0 0 Thermal Storage 1 1 1 1 1 1 1 Wall Insulation 0 0 0 0 0 0 0 Appliances 0 0 0 0 0 0 0 CHP 5 7 8 8 8 8 8 Generating 0 0 0 0 0 0 0 Generating 8 8 8 9 9 20 11 11 11 11 11 13 13 13 13 13 13 13 13 13 13 13 13 13 13 13 13 14 14 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1	Т	Lighting	0	0	0	0	0
Thermal Storage 1 1 1 1 1 1 Wall Insulation 0 0 0 0 0 0 Appliances 0 0 0 0 0 0 0 CHP 5 7 8 8 8 8 8 Cool Roof 9 10 10 11 11 11 Water Heating 0 0 0 0 0 0 Ge Coling 18 18 18 19 20 13 13 13 13 13 Space Heating 0		Roof Insulation	0	0	0	0	0
Wall Insulation 0 0 0 0 0 0 0 Appliances 0 0 0 0 0 0 0 CHP 5 7 8 8 8 8 Cool Roof 9 10 10 11 11 Water Heating 0 0 0 0 0 Gazing 8 8 8 9 9 Space Heating 13 13 13 13 13 Space Cooling 18 18 18 19 20 Lighting 0 0 0 0 0 0 Roof Insulation 4 4 4 4 5 Thermal Storage 1 1 1 1 1 Wall Insulation 7 8 8 9 9 Appliances 0 0 0 0 0 Cool Roof 0		Thermal Storage	1	1	1	1	1
Appliances 0 0 0 0 0 0 0 GE Cool Roof 9 10 10 11 11 Water Heating 0 0 0 0 0 0 0 Glazing 8 8 8 9 9 Space Heating 13 13 13 13 13 Space Cooling 18 18 18 19 20 Lighting 0 0 0 0 0 0 Roof Insulation 4 4 4 4 5 Thermal Storage 1 1 1 1 1 Wall Insulation 7 8 8 9 9 Appliances 0 0 0 0 0 Col Roof 0 0 0 0 0 Geo Bizing 112 118 118 127 127 Space Heating		Wall Insulation	0	0	0	0	0
CHP 5 7 8 8 8 8 Cool Roof 9 10 10 11 11 Water Heating 0 0 0 0 0 Glazing 8 8 8 9 9 Space Heating 13 13 13 13 13 Space Heating 13 13 13 13 13 Space Cooling 18 18 18 19 20 Lighting 0 0 0 0 0 Roof Insulation 4 4 4 4 5 Thermal Storage 1 1 1 1 1 Water Heating 66 66 66 66 66 Golazing 112 118 118 127 127 Space Heating 47 47 47 47 47 Space Heating 0 0 0 0 <td< td=""><td></td><td>Appliances</td><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td></td<>		Appliances	0	0	0	0	0
Cool Root 9 10 10 11 11 Water Heating 0 0 0 0 0 Glazing 8 8 9 9 Space Heating 13 13 13 13 13 Space Cooling 18 18 19 20 Lighting 0 0 0 0 0 Roof Insulation 4 4 4 4 5 Thermal Storage 1 1 1 1 1 Wall Insulation 7 8 8 9 9 Appliances 0 0 0 0 0 Col Roof 0 0 0 0 0 Water Heating 66 66 66 66 66 Glazing 112 118 118 127 127 Space Coling 48 48 48 50 Lighting 0 <	_	СНР	5	7	8	8	8
Water Heating 0 <	36)	Cool Root	9	10	10		11
Glazing 8 8 9 9 Space Heating 13 13 13 13 13 Space Cooling 18 18 18 19 20 Lighting 0 0 0 0 0 0 Roof Insulation 4 4 4 4 5 Thermal Storage 1 1 1 1 1 Wall Insulation 7 8 8 9 9 Appliances 0 0 0 0 0 Coll Roof 0 0 0 0 0 Water Heating 66 66 66 66 66 Glazing 112 118 118 127 127 Space Cooling 48 48 48 48 50 Lighting 0 0 0 0 0 0 Roof Insulation 0 0 0 0 0 </td <td>otal</td> <td>Water Heating</td> <td>0</td> <td>0</td> <td>0</td> <td>0</td> <td>0</td>	otal	Water Heating	0	0	0	0	0
Space Heating 13 14 14	Ĕ	Glazing	8	8	8	9	9
Space Cooling 18 18 18 19 20 Lighting 0 0 0 0 0 0 Roof Insulation 4 4 4 4 5 Thermal Storage 1 1 1 1 1 Wall Insulation 7 8 8 9 9 Appliances 0 0 0 0 0 CHP 0 0 0 0 0 Cool Roof 0 0 0 0 0 Water Heating 66 66 66 66 66 Glazing 112 118 118 127 127 Space Cooling 48 48 48 50 0 0 0 Lighting 0 0 0 0 0 0 0 Water Heating 112 118 118 127 127 127 Water Heating </td <td>ntial</td> <td>Space Heating</td> <td>13</td> <td>13</td> <td>13</td> <td>13</td> <td>13</td>	ntial	Space Heating	13	13	13	13	13
Lighting 0 112 118 118 127 127 127 127 127 127 127 127 127 127 127 127 127 127 127 127 127 <th1< td=""><td>der</td><td>Space Cooling</td><td>18</td><td>18</td><td>18</td><td>19</td><td>20</td></th1<>	der	Space Cooling	18	18	18	19	20
Root insulation 4 4 4 4 4 4 4 5 Thermal Storage 1 1 1 1 1 1 Wall Insulation 7 8 8 9 9 Appliances 0 0 0 0 0 CHP 0 0 0 0 0 Coll Roof 0 0 0 0 0 Water Heating 66 66 66 66 66 Glazing 112 118 118 127 127 Space Heating 47 47 47 47 47 Space Cooling 48 48 48 48 50 Lighting 0 0 0 0 0 0 Roof Insulation 112 118 118 127 127 Mapliances 0 0 0 0 0 0 CHP	tesi	Lighting	0	0	0	0	0
Intermal storage 1 <th1< th=""> 1 1</th1<>	æ	Root insulation	4	4	4	4	5
Wain instantion 7 8 8 9 9 9 Appliances 0 0 0 0 0 0 0 CHP 0 0 0 0 0 0 0 0 Cool Roof 0 0 0 0 0 0 0 0 Water Heating 66 66 66 66 66 66 66 66 Glazing 112 118 118 127 127 Space Heating 47 47 47 47 47 Space Cooling 48 48 48 48 50 Lighting 0 0 0 0 0 Roof Insulation 112 118 118 127 127 Appliances 0 0 0 0 0 0 CHP 0 0 0 0 0 0 Wall Insulation<		Mall Inculation	1			1	1
Appliances 0			/	°	<u> </u>	9	9
Image: Control of the contro		Снр	0	0	0	0	0
Image: constraint of the second constraint of th			0	0	0	0	0
Key like instant Oo	(4)	Water Heating	66	66	66	66	66
Bit Bit <td>172</td> <td>Glazing</td> <td>112</td> <td>118</td> <td>118</td> <td>127</td> <td>127</td>	172	Glazing	112	118	118	127	127
Image: Construction of the second s	ota	Snace Heating	47	47	47	47	47
Byzec booming No	il (T	Space Cooling	48	48	48	48	50
X Image for a constraint of a constrai	eta	Lighting	0	0	0	0	0
Thermal Storage 0	R	Roof Insulation	0	0	0	0	0
Wall Insulation 112 118 118 127 127 Appliances 0 0 0 0 0 0 CHP 0 0 0 0 0 0 0 Cool Roof 0 0 0 0 0 0 0 Water Heating 12 12 12 12 12 12 Glazing 8 9 9 10 10 10 Space Heating 28 28 30 30 30 30 Space Cooling 23 24 24 24 24 24 Lighting 0 0 0 0 0 0 Roof Insulation 0 0 0 0 0 0		Thermal Storage	0	0	0	0	0
Appliances 0 0 0 0 0 0 CHP 0 0 0 0 0 0 0 Cool Roof 0 0 0 0 0 0 0 Water Heating 12 12 12 12 12 12 Glazing 8 9 9 10 10 Space Heating 28 28 30 30 30 Space Cooling 23 24 24 24 24 Lighting 0 0 0 0 0 Roof Insulation 0 0 0 0 0 Thermal Storage 0 0 0 0 0		Wall Insulation	112	118	118	127	127
CHP 0 0 0 0 0 0 Col Roof 0 0 0 0 0 0 0 Water Heating 12 12 12 12 12 12 12 Glazing 8 9 9 10 10 10 Space Heating 28 28 30 30 30 Space Cooling 23 24 24 24 24 Lighting 0 0 0 0 0 0 Roof Insulation 0 0 0 0 0 0 Thermal Storage 0 0 0 0 0 0		Appliances	0	0	0	0	0
Cool Roof 0 0 0 0 0 0 Water Heating 12 12 12 12 12 12 Glazing 8 9 9 10 10 Space Heating 28 28 30 30 30 Space Cooling 23 24 24 24 24 Lighting 0 0 0 0 0 Roof Insulation 0 0 0 0 0 Thermal Storage 0 0 0 0 0	Restaurant (Total 47)	СНР	0	0	0	0	0
Vater Heating 12 12 12 12 12 Glazing 8 9 9 10 10 Space Heating 28 28 30 30 30 Space Cooling 23 24 24 24 24 Lighting 0 0 0 0 0 Roof Insulation 0 0 0 0 0 Thermal Storage 0 0 0 0 0 0		Cool Roof	0	0	0	0	0
Glazing 8 9 9 10 10 Space Heating 28 28 30 30 30 Space Cooling 23 24 24 24 24 Lighting 0 0 0 0 0 Roof Insulation 0 0 0 0 0 Thermal Storage 0 0 0 0 0		Water Heating	12	12	12	12	12
Space Heating 28 28 30 30 30 Space Cooling 23 24 24 24 24 Lighting 0 0 0 0 0 Roof Insulation 0 0 0 0 0 Thermal Storage 0 0 0 0 0		Glazing	8	9	9	10	10
Space Cooling 23 24 24 24 24 Lighting 0 0 0 0 0 Roof Insulation 0 0 0 0 0 Thermal Storage 0 0 0 0 0		Space Heating	28	28	30	30	30
Lighting 0 0 0 0 0 Roof Insulation 0 0 0 0 0 0 Thermal Storage 0 0 0 0 0 0 0		Space Cooling	23	24	24	24	24
∞ Roof Insulation 0 0 0 0 0 0 Thermal Storage 0 <td< td=""><td>Lighting</td><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td></td<>		Lighting	0	0	0	0	0
Thermal Storage 0 0 0 0 0		Roof Insulation	0	0	0	0	0
		Thermal Storage	0	0	0	0	0
Wall Insulation 8 9 9 10 10		Wall Insulation	8	9	9	10	10

Table 27 - Quantity of Spaces that Adopt Efficiency Measures at MidMarket Penetrations with a CCT Policy of \$5 to \$20/MT

1	Efficiency	Quantity of Spaces that Adopt Efficiency Measure				
	Measure	No CCT	CCT5	CCT10	CCT15	CCT20
	Appliances	0	0	0	0	0
	СНР	2	2	4	4	4
	Cool Roof	3	3	3	3	3
16)	Water Heating	0	0	0	0	0
tal	Glazing	3	3	3	3	3
(Tot	Space Heating	0	0	0	0	0
ce	Space Cooling	9	9	9	9	9
Offi	Lighting	2	2	2	2	2
•	Roof Insulation	4	4	5	5	5
	Thermal Storage	4	4	4	4	4
	Wall Insulation	2	2	2	2	2
	Appliances	0	0	0	0	0
	СНР	1	1	2	2	2
	Cool Roof	0	0	0	0	0
(9	Water Heating	0	0	0	0	0
tal	Glazing	0	0	0	0	0
(To	Space Heating	2	2	2	2	2
tel	Space Cooling	3	3	3	3	3
Ηo	Lighting	0	0	0	0	0
	Roof Insulation	0	0	0	0	0
	Thermal Storage	1	1	1	1	1
	Wall Insulation	0	0	0	0	0
	Appliances	0	0	0	0	0
	СНР	7	8	9	11	11
(9	Cool Roof	11	12	12	12	14
al 3(Water Heating	0	0	0	0	0
Fota	Glazing	9	9	10	11	11
al (T	Space Heating	14	14	14	16	16
ntia	Space Cooling	21	21	21	21	21
side	Lighting	0	0	0	0	0
Res	Roof Insulation	4	5	5	5	5
	Thermal Storage	3	3	3	3	3
	Wall Insulation	9	9	9	9	9
	Appliances	0	0	0	0	0
	СНР	0	0	0	0	0
	Cool Roof	0	0	0	0	0
24)	Water Heating	74	74	74	74	74
al 72	Glazing	127	127	127	127	127
_ota	Space Heating	53	53	54	55	55
ii (]	Space Cooling	54	54	56	56	56
eta	Lighting	0	0	0	0	0
Я	Roof Insulation	0	0	0	0	0
	Thermal Storage	0	0	0	0	0
	Wall Insulation	127	127	127	127	127
	Appliances	0	0	0	0	0
Restaurant (Total 47)	СНР	0	0	0	0	0
	Cool Roof	0	0	0	0	0
	Water Heating	13	13	13	13	15
	Glazing	10	10	10	10	10
	Space Heating	33	33	33	34	34
	Space Cooling	27	27	27	28	28
	Lighting	0	0		0	0
	Roof Insulation	0	0	0	0	0
	Thermal Storage	0	0	0	0	0
	Wall Insulation	10	10	10	10	10
		10	10	10	10	10

Table 28 - Quantity of Spaces that Adopt Efficiency Measures at Mid-High Market Penetratios with a CCT Policy of \$5 to \$20/MT

[Efficiency	Quantity of Spaces that Adopt Efficiency Measure				
	Measure	No CCT	ССТ5	CCT10	CCT15	CCT20
	Appliances	0	0	0	0	0
16)	СНР	2	4	4	5	5
	Cool Roof	3	4	4	4	4
	Water Heating	0	0	0	0	0
tal .	Glazing	3	4	4	4	4
(To	Space Heating	0	0	0	0	0
ce	Space Cooling	9	9	9	9	9
Offi	Lighting	2	2	2	2	2
	Roof Insulation	5	5	5	5	6
	Thermal Storage	6	6	6	6	6
	Wall Insulation	2	2	3	3	3
	Appliances	0	0	0	0	0
	CHP	2	2	2	2	2
	Cool Roof	0	0	0	0	1
(9	Water Heating	0	0	0	0	0
otal	Glazing	0	0	0	0	0
Ĕ	Space Heating	3	3	3	3	3
otel	Space Cooling	3	3	3	3	4
Ĭ	Lighting	0	0	0	0	0
	Roof Insulation	0	0	0	0	0
	Thermal Storage	1	1	1	1	1
	Wall Insulation	0	0	0	0	0
	Appliances	0	0	0	0	0
	СНР	7	9	11	11	12
36)	Cool Roof	13	15	15	15	15
tal	Water Heating	0	0	0	0	0
Ĕ	Glazing	11	11	12	12	12
tial	Space Heating	17	18	18	18	18
den	Space Cooling	23	24	24	24	25
esi	Lighting	0	0	0	0	0
Я	Roof Insulation	5	5	5	5	5
	Thermal Storage	3	3	3	3	3
	Wall Insulation	9	9	11	11	12
	Appliances	0	0	0	0	0
		0	0	0	0	0
4)	COOI ROOI	0	0	0	0	0
72		04 127	127	164	04 164	04 197
otal	Gidzing	61	61	104 61	104 62	187
E)		60	62	62	62	64
etai	Lighting	00	02	02	03	04
Å	Roof Insulation	0	0	0	0	0
	Thermal Storage	0	0	0	0	0
	Wall Insulation	127	127	164	164	187
	Appliances	0	0	104	104	187
Restaurant (Total 47)	СНР	0	0	0	0	0
		0	0	0	0	0
	Water Heating	15	15	16	16	16
	Glazing	10	10	13	13	14
	Snace Heating	37	37	37	37	37
	Space Cooling	30	30	37	37	37
	Lighting	0	0	0	0	0
	Roof Insulation	0	0	0	0	0
	Thermal Storage	0	0	0	0	0
	Wall Insulation	10	10	13	13	14
		10	10	10	-10	- 7

Table 29 - Quantity of Spaces that Adopt Efficiency Measures at High Market Penetrations with a CCT Policy of \$5 to \$20/MT
Prototype 01 – 56-story Highrise Office Data

Category and Measure	Elec Cost	Gas Cost	Total Cost	Alt Cost	Payback
Baseline	\$7,855,243	\$422,954	\$8,278,197	\$0	NA
Baseline + Combined Heat and Power, 6500 kW, 1390 ton absorber	\$3,128,928	\$2,819,377	\$5,948,305	\$17,520,836	9.1
Baseline + Cool Roof, 100% of roof at Abs=0.3	\$7,854,360	\$423,291	\$8,277,651	\$11,022	20.2
Baseline + High Efficiency Glazing, U=0.26, SHGC=0.29	\$7,735,254	\$305,473	\$8,040,727	\$1,764,062	7.4
Baseline + High Efficiency Heating, Boiler Comb Eff = 85%	\$7,855,243	\$398,671	\$8,253,914	\$459,360	18.9
Baseline + High Efficiency Cooling, 0.461 kW/ton Centrifugal Chillers	\$7,580,850	\$422,954	\$8,003,804	\$508,367	1.9
Baseline + High Efficiency Lighting, 0.9 watts/sqft	\$7,430,794	\$434,947	\$7,865,741	\$4,592,517	11.1
Baseline + Envelope Insulation - Roof, 6" R23 XPS	\$7,853,260	\$422,732	\$8,275,992	\$6,012	2.7
Baseline + Thermal Storage, 25% of max load, 23376 ton-hrs	\$7,661,938	\$422,954	\$8,084,892	\$1,636,332	8.5
Baseline + Envelope Insulation - Walls, Reduced thermal bridging	\$7,769,615	\$313,469	\$8,083,085	\$1,764,062	9.0
			. , ,	. , ,	
Category and Measure	Elec kWh	Elec MMBtu	Gas MMBtu	Total MMBtu	MMBtu Diff
Category and Measure Baseline	Elec kWh 38,767,980	Elec MMBtu 441,802	Gas MMBtu 30,348	Total MMBtu 472,150	MMBtu Diff 0
Category and Measure Baseline Baseline + Combined Heat and Power, 6500 kW, 1390 ton absorber	Elec kWh 38,767,980 17,283,500	Elec MMBtu 441,802 196,963	Gas MMBtu 30,348 223,037	Total MMBtu 472,150 420,000	MMBtu Diff 0 52,150
Category and Measure Baseline Baseline + Combined Heat and Power, 6500 kW, 1390 ton absorber Baseline + Cool Roof, 100% of roof at Abs=0.3	Elec kWh 38,767,980 17,283,500 38,774,800	Elec MMBtu 441,802 196,963 441,882	Gas MMBtu 30,348 223,037 30,372	Total MMBtu 472,150 420,000 472,254	MMBtu Diff 0 52,150 -104
Category and Measure Baseline Baseline + Combined Heat and Power, 6500 kW, 1390 ton absorber Baseline + Cool Roof, 100% of roof at Abs=0.3 Baseline + High Efficiency Glazing, U=0.26, SHGC=0.29	Elec kWh 38,767,980 17,283,500 38,774,800 38,248,720	Elec MMBtu 441,802 196,963 441,882 435,887	Gas MMBtu 30,348 223,037 30,372 21,827	Total MMBtu 472,150 420,000 472,254 457,714	MMBtu Diff 0 52,150 -104 14,437
Category and Measure Baseline Baseline + Combined Heat and Power, 6500 kW, 1390 ton absorber Baseline + Cool Roof, 100% of roof at Abs=0.3 Baseline + High Efficiency Glazing, U=0.26, SHGC=0.29 Baseline + High Efficiency Heating, Boiler Comb Eff = 85%	Elec kWh 38,767,980 17,283,500 38,774,800 38,248,720 38,767,980	Elec MMBtu 441,802 196,963 441,882 435,887 441,802	Gas MMBtu 30,348 223,037 30,372 21,827 28,586	Total MMBtu 472,150 420,000 472,254 457,714 470,388	MMBtu Diff 0 52,150 -104 14,437 1,762
Category and Measure Baseline Baseline + Combined Heat and Power, 6500 kW, 1390 ton absorber Baseline + Cool Roof, 100% of roof at Abs=0.3 Baseline + High Efficiency Glazing, U=0.26, SHGC=0.29 Baseline + High Efficiency Heating, Boiler Comb Eff = 85% Baseline + High Efficiency Cooling, 0.461 kW/ton Centrifugal Chillers	Elec kWh 38,767,980 17,283,500 38,774,800 38,248,720 38,767,980 37,746,150	Elec MMBtu 441,802 196,963 441,882 435,887 441,802 430,159	Gas MMBtu 30,348 223,037 30,372 21,827 28,586 30,348	Total MMBtu 472,150 420,000 472,254 457,714 470,388 460,507	MMBtu Diff 0 52,150 -104 14,437 1,762 11,643
Category and Measure Baseline Baseline + Combined Heat and Power, 6500 kW, 1390 ton absorber Baseline + Cool Roof, 100% of roof at Abs=0.3 Baseline + High Efficiency Glazing, U=0.26, SHGC=0.29 Baseline + High Efficiency Heating, Boiler Comb Eff = 85% Baseline + High Efficiency Cooling, 0.461 kW/ton Centrifugal Chillers Baseline + High Efficiency Lighting, 0.9 watts/sqft	Elec kWh 38,767,980 17,283,500 38,774,800 38,248,720 38,767,980 37,746,150 36,913,150	Elec MMBtu 441,802 196,963 441,882 435,887 441,802 430,159 420,666	Gas MMBtu 30,348 223,037 30,372 21,827 28,586 30,348 31,218	Total MMBtu 472,150 420,000 472,254 457,714 470,388 460,507 451,885	MMBtu Diff 0 52,150 -104 14,437 1,762 11,643 20,265
Category and Measure Baseline Baseline + Combined Heat and Power, 6500 kW, 1390 ton absorber Baseline + Cool Roof, 100% of roof at Abs=0.3 Baseline + High Efficiency Glazing, U=0.26, SHGC=0.29 Baseline + High Efficiency Heating, Boiler Comb Eff = 85% Baseline + High Efficiency Cooling, 0.461 kW/ton Centrifugal Chillers Baseline + High Efficiency Lighting, 0.9 watts/sqft Baseline + Envelope Insulation - Roof, 6" R23 XPS	Elec kWh 38,767,980 17,283,500 38,774,800 38,748,720 38,767,980 37,746,150 36,913,150 38,752,680	Elec MMBtu 441,802 196,963 441,882 435,887 441,802 430,159 420,666 441,628	Gas MMBtu 30,348 223,037 30,372 21,827 28,586 30,348 31,218 30,332	Total MMBtu 472,150 420,000 472,254 457,714 470,388 460,507 451,885 471,960	MMBtu Diff 0 52,150 -104 14,437 1,762 11,643 20,265 190
Category and Measure Baseline Baseline + Combined Heat and Power, 6500 kW, 1390 ton absorber Baseline + Cool Roof, 100% of roof at Abs=0.3 Baseline + High Efficiency Glazing, U=0.26, SHGC=0.29 Baseline + High Efficiency Heating, Boiler Comb Eff = 85% Baseline + High Efficiency Cooling, 0.461 kW/ton Centrifugal Chillers Baseline + High Efficiency Lighting, 0.9 watts/sqft Baseline + High Efficiency Storage, 25% of max load, 23376 ton-hrs	Elec kWh 38,767,980 17,283,500 38,774,800 38,248,720 38,767,980 37,746,150 36,913,150 38,752,680 39,421,300	Elec MMBtu 441,802 196,963 441,882 435,887 441,802 430,159 420,666 441,628 449,250	Gas MMBtu 30,348 223,037 30,372 21,827 28,586 30,348 31,218 30,332 30,348	Total MMBtu 472,150 420,000 472,254 457,714 470,388 460,507 451,885 471,960 479,598	MMBtu Diff 0 52,150 -104 14,437 1,762 11,643 20,265 190 -7,448

Prototype 02 – 41-story Highrise Office Data

Category and Measure	Elec Cost	Gas Cost	Total Cost	Alt Cost	Payback
Baseline	\$6,608,378	\$396,177	\$7,004,555	\$0	NA
Baseline + Combined Heat and Power, 5500 kW, 1150 ton absorber	\$2,602,070	\$2,411,465	\$5,013,535	\$14,517,192	8.8
Baseline + Cool Roof, 100% of roof at Abs=0.3	\$6,606,996	\$396,464	\$7,003,460	\$13,307	12.2
Baseline + High Efficiency Glazing, U=0.26, SHGC=0.29	\$6,515,729	\$298,760	\$6,814,490	\$1,409,693	7.4
Baseline + High Efficiency Heating, Boiler Comb Eff = 85%	\$6,608,378	\$373,344	\$6,981,723	\$432,758	19.0
Baseline + High Efficiency Cooling, 0.461 kW/ton Centrifugal Chillers	\$6,393,825	\$396,177	\$6,790,002	\$419,471	2.0
Baseline + High Efficiency Lighting, 0.9 watts/sqft	\$6,243,810	\$408,176	\$6,651,986	\$4,032,506	11.4
Baseline + Envelope Insulation - Roof, 6" R23 XPS	\$6,607,094	\$395,975	\$7,003,069	\$7,259	4.9
Baseline + Thermal Storage, 25% of max load, 15073 ton-hrs	\$6,408,409	\$396,177	\$6,804,586	\$1,055,081	5.3
Baseline + Envelope Insulation - Walls, Reduced thermal bridging	\$6,543,264	\$305,194	\$6,848,458	\$1,409,693	9.0
Category and Measure	Elec kWh	Elec MMBtu	Gas MMBtu	Total MMBtu	MMBtu Diff
Category and Measure Baseline	Elec kWh 32,359,210	Elec MMBtu 368,769	Gas MMBtu 28,406	Total MMBtu 397,176	MMBtu Diff 0
Category and Measure Baseline Baseline + Combined Heat and Power, 5500 kW, 1150 ton absorber	Elec kWh 32,359,210 14,105,440	Elec MMBtu 368,769 160,748	Gas MMBtu 28,406 190,703	Total MMBtu 397,176 351,450	MMBtu Diff 0 45,725
Category and Measure Baseline Baseline + Combined Heat and Power, 5500 kW, 1150 ton absorber Baseline + Cool Roof, 100% of roof at Abs=0.3	Elec kWh 32,359,210 14,105,440 32,363,580	Elec MMBtu 368,769 160,748 368,820	Gas MMBtu 28,406 190,703 28,427	Total MMBtu 397,176 351,450 397,247	MMBtu Diff 0 45,725 -71
Category and Measure Baseline Baseline + Combined Heat and Power, 5500 kW, 1150 ton absorber Baseline + Cool Roof, 100% of roof at Abs=0.3 Baseline + High Efficiency Glazing, U=0.26, SHGC=0.29	Elec kWh 32,359,210 14,105,440 32,363,580 31,921,900	Elec MMBtu 368,769 160,748 368,820 363,786	Gas MMBtu 28,406 190,703 28,427 21,340	Total MMBtu 397,176 351,450 397,247 385,126	MMBtu Diff 0 45,725 -71 12,049
Category and Measure Baseline Baseline + Combined Heat and Power, 5500 kW, 1150 ton absorber Baseline + Cool Roof, 100% of roof at Abs=0.3 Baseline + High Efficiency Glazing, U=0.26, SHGC=0.29 Baseline + High Efficiency Heating, Boiler Comb Eff = 85%	Elec kWh 32,359,210 14,105,440 32,363,580 31,921,900 32,359,210	Elec MMBtu 368,769 160,748 368,820 363,786 368,769	Gas MMBtu 28,406 190,703 28,427 21,340 26,750	Total MMBtu 397,176 351,450 397,247 385,126 395,519	MMBtu Diff 0 45,725 -71 12,049 1,656
Category and Measure Baseline Baseline + Combined Heat and Power, 5500 kW, 1150 ton absorber Baseline + Cool Roof, 100% of roof at Abs=0.3 Baseline + High Efficiency Glazing, U=0.26, SHGC=0.29 Baseline + High Efficiency Heating, Boiler Comb Eff = 85% Baseline + High Efficiency Cooling, 0.461 kW/ton Centrifugal Chillers	Elec kWh 32,359,210 14,105,440 32,363,580 31,921,900 32,359,210 31,611,400	Elec MMBtu 368,769 160,748 368,820 363,786 368,769 360,246	Gas MMBtu 28,406 190,703 28,427 21,340 26,750 28,406	Total MMBtu 397,176 351,450 397,247 385,126 395,519 388,652	MMBtu Diff 0 45,725 -71 12,049 1,656 8,524
Category and Measure Baseline Baseline + Combined Heat and Power, 5500 kW, 1150 ton absorber Baseline + Cool Roof, 100% of roof at Abs=0.3 Baseline + High Efficiency Glazing, U=0.26, SHGC=0.29 Baseline + High Efficiency Heating, Boiler Comb Eff = 85% Baseline + High Efficiency Cooling, 0.461 kW/ton Centrifugal Chillers Baseline + High Efficiency Lighting, 0.9 watts/sqft	Elec kWh 32,359,210 14,105,440 32,363,580 31,921,900 32,359,210 31,611,400 30,726,770	Elec MMBtu 368,769 160,748 368,820 363,786 368,769 360,246 350,166	Gas MMBtu 28,406 190,703 28,427 21,340 26,750 28,406 29,276	Total MMBtu 397,176 351,450 397,247 385,126 395,519 388,652 379,442	MMBtu Diff 0 45,725 -71 12,049 1,656 8,524 17,734
Category and Measure Baseline Baseline + Combined Heat and Power, 5500 kW, 1150 ton absorber Baseline + Cool Roof, 100% of roof at Abs=0.3 Baseline + High Efficiency Glazing, U=0.26, SHGC=0.29 Baseline + High Efficiency Glazing, U=0.26, SHGC=0.29 Baseline + High Efficiency Heating, Boiler Comb Eff = 85% Baseline + High Efficiency Cooling, 0.461 kW/ton Centrifugal Chillers Baseline + High Efficiency Lighting, 0.9 watts/sqft Baseline + Envelope Insulation - Roof, 6" R23 XPS	Elec kWh 32,359,210 14,105,440 32,363,580 31,921,900 32,359,210 31,611,400 30,726,770 32,349,180	Elec MMBtu 368,769 160,748 368,820 363,786 368,769 360,246 350,166 368,653	Gas MMBtu 28,406 190,703 28,427 21,340 26,750 28,406 29,276 28,391	Total MMBtu 397,176 351,450 397,247 385,126 395,519 388,652 379,442 397,044	MMBtu Diff 0 45,725 -71 12,049 1,656 8,524 17,734 132
Category and Measure Baseline Baseline + Combined Heat and Power, 5500 kW, 1150 ton absorber Baseline + Cool Roof, 100% of roof at Abs=0.3 Baseline + High Efficiency Glazing, U=0.26, SHGC=0.29 Baseline + High Efficiency Glazing, Boiler Comb Eff = 85% Baseline + High Efficiency Cooling, 0.461 kW/ton Centrifugal Chillers Baseline + High Efficiency Lighting, 0.9 watts/sqft Baseline + Envelope Insulation - Roof, 6" R23 XPS Baseline + Thermal Storage, 25% of max load, 15073 ton-hrs	Elec kWh 32,359,210 14,105,440 32,363,580 31,921,900 32,359,210 31,611,400 30,726,770 32,349,180 32,826,030	Elec MMBtu 368,769 160,748 368,820 363,786 368,769 360,246 350,166 368,653 374,087	Gas MMBtu 28,406 190,703 28,427 21,340 26,750 28,406 29,276 28,391 28,406	Total MMBtu 397,176 351,450 397,247 385,126 395,519 388,652 379,442 397,044 402,493	MMBtu Diff 0 45,725 -71 12,049 1,656 8,524 17,734 132 -5,317

Prototype 03 – 34-story Highrise Office Data

Category and Measure	Elec Cost	Gas Cost	Total Cost	Alt Cost	Payback
Baseline	\$5,777,791	\$369,041	\$6,146,832	\$0	NA
Baseline + Combined Heat and Power, 4500 kW, 1020 ton absorber	\$2,445,646	\$2,115,914	\$4,561,560	\$11,515,326	8.9
Baseline + Cool Roof, 100% of roof at Abs=0.3	\$5,775,495	\$369,331	\$6,144,825	\$14,430	7.2
Baseline + High Efficiency Glazing, U=0.26, SHGC=0.29	\$5,694,205	\$285,642	\$5,979,848	\$1,211,066	7.3
Baseline + High Efficiency Heating, Boiler Comb Eff = 85%	\$5,777,791	\$347,756	\$6,125,547	\$391,261	18.4
Baseline + High Efficiency Cooling, 0.461 kW/ton Centrifugal Chillers	\$5,594,845	\$369,041	\$5,963,885	\$373,943	2.0
Baseline + High Efficiency Lighting, 0.9 watts/sqft	\$5,452,965	\$381,340	\$5,834,305	\$3,607,511	11.5
Baseline + Envelope Insulation - Roof, 6" R23 XPS	\$5,777,079	\$368,854	\$6,145,933	\$7,871	8.8
Baseline + Thermal Storage, 25% of max load, 16172 ton-hrs	\$5,600,953	\$369,041	\$5,969,993	\$1,132,005	6.4
Baseline + Envelope Insulation - Walls, Reduced thermal bridging	\$5,717,690	\$291,002	\$6,008,692	\$1,211,066	8.8
Category and Measure	Elec kWh	Elec MMBtu	Gas MMBtu	Total MMBtu	MMBtu Diff
Category and Measure Baseline	Elec kWh 28,152,040	Elec MMBtu 320,824	Gas MMBtu 26,438	Total MMBtu 347,261	MMBtu Diff 0
Category and Measure Baseline Baseline + Combined Heat and Power, 4500 kW, 1020 ton absorber	Elec kWh 28,152,040 12,667,300	Elec MMBtu 320,824 144,358	Gas MMBtu 26,438 162,517	Total MMBtu 347,261 306,876	MMBtu Diff 0 40,386
Category and Measure Baseline Baseline + Combined Heat and Power, 4500 kW, 1020 ton absorber Baseline + Cool Roof, 100% of roof at Abs=0.3	Elec kWh 28,152,040 12,667,300 28,147,870	Elec MMBtu 320,824 144,358 320,777	Gas MMBtu 26,438 162,517 26,458	Total MMBtu 347,261 306,876 347,235	MMBtu Diff 0 40,386 27
Category and Measure Baseline Baseline + Combined Heat and Power, 4500 kW, 1020 ton absorber Baseline + Cool Roof, 100% of roof at Abs=0.3 Baseline + High Efficiency Glazing, U=0.26, SHGC=0.29	Elec kWh 28,152,040 12,667,300 28,147,870 27,771,460	Elec MMBtu 320,824 144,358 320,777 316,485	Gas MMBtu 26,438 162,517 26,458 20,388	Total MMBtu 347,261 306,876 347,235 336,873	MMBtu Diff 0 40,386 27 10,388
Category and Measure Baseline Baseline + Combined Heat and Power, 4500 kW, 1020 ton absorber Baseline + Cool Roof, 100% of roof at Abs=0.3 Baseline + High Efficiency Glazing, J=0.26, SHGC=0.29 Baseline + High Efficiency Heating, Boiler Comb Eff = 85%	Elec kWh 28,152,040 12,667,300 28,147,870 27,771,460 28,152,040	Elec MMBtu 320,824 144,358 320,777 316,485 320,824	Gas MMBtu 26,438 162,517 26,458 20,388 24,893	Total MMBtu 347,261 306,876 347,235 336,873 345,717	MMBtu Diff 0 40,386 27 10,388 1,544
Category and Measure Baseline Baseline + Combined Heat and Power, 4500 kW, 1020 ton absorber Baseline + Cool Roof, 100% of roof at Abs=0.3 Baseline + High Efficiency Glazing, U=0.26, SHGC=0.29 Baseline + High Efficiency Heating, Boiler Comb Eff = 85% Baseline + High Efficiency Cooling, 0.461 kW/ton Centrifugal Chillers	Elec kWh 28,152,040 12,667,300 28,147,870 27,771,460 28,152,040 27,530,860	Elec MMBtu 320,824 144,358 320,777 316,485 320,824 313,743	Gas MMBtu 26,438 162,517 26,458 20,388 24,893 26,438	Total MMBtu 347,261 306,876 347,235 336,873 345,717 340,181	MMBtu Diff 0 40,386 27 10,388 1,544 7,081
Category and Measure Baseline Baseline + Combined Heat and Power, 4500 kW, 1020 ton absorber Baseline + Cool Roof, 100% of roof at Abs=0.3 Baseline + High Efficiency Glazing, U=0.26, SHGC=0.29 Baseline + High Efficiency Heating, Boiler Comb Eff = 85% Baseline + High Efficiency Cooling, 0.461 kW/ton Centrifugal Chillers Baseline + High Efficiency Lighting, 0.9 watts/sqft	Elec kWh 28,152,040 12,667,300 28,147,870 27,771,460 28,152,040 27,530,860 26,688,450	Elec MMBtu 320,824 144,358 320,777 316,485 320,824 313,743 304,144	Gas MMBtu 26,438 162,517 26,458 20,388 24,893 26,438 27,330	Total MMBtu 347,261 306,876 347,235 336,873 345,717 340,181 331,474	MMBtu Diff 0 40,386 27 10,388 1,544 7,081 15,788
Category and Measure Baseline Baseline Baseline Baseline + Combined Heat and Power, 4500 kW, 1020 ton absorber Baseline + Combined Heat and Power, 4500 kW, 1020 ton absorber Baseline + Cool Roof, 100% of roof at Abs=0.3 Baseline + High Efficiency Glazing, U=0.26, SHGC=0.29 Baseline + High Efficiency Heating, Boiler Comb Eff = 85% Baseline + High Efficiency Cooling, 0.461 kW/ton Centrifugal Chillers Baseline + High Efficiency Lighting, 0.9 watts/sqft Baseline + Envelope Insulation - Roof, 6" R23 XPS	Elec kWh 28,152,040 12,667,300 28,147,870 27,771,460 28,152,040 27,530,860 26,688,450 28,146,790	Elec MMBtu 320,824 144,358 320,777 316,485 320,824 313,743 304,144 320,764	Gas MMBtu 26,438 162,517 26,458 20,388 24,893 26,438 27,330 26,424	Total MMBtu 347,261 306,876 347,235 336,873 345,717 340,181 331,474 347,188	MMBtu Diff 0 40,386 27 10,388 1,544 7,081 15,788 74
Category and Measure Baseline Baseline + Combined Heat and Power, 4500 kW, 1020 ton absorber Baseline + Cool Roof, 100% of roof at Abs=0.3 Baseline + High Efficiency Glazing, U=0.26, SHGC=0.29 Baseline + High Efficiency Glazing, U=0.26, SHGC=0.29 Baseline + High Efficiency Heating, Boiler Comb Eff = 85% Baseline + High Efficiency Cooling, 0.461 kW/ton Centrifugal Chillers Baseline + High Efficiency Lighting, 0.9 watts/sqft Baseline + Envelope Insulation - Roof, 6" R23 XPS Baseline + Thermal Storage, 25% of max load, 16172 ton-hrs	Elec kWh 28,152,040 12,667,300 28,147,870 27,771,460 28,152,040 27,530,860 26,688,450 28,146,790 28,518,920	Elec MMBtu 320,824 144,358 320,777 316,485 320,824 313,743 304,144 320,764 325,005	Gas MMBtu 26,438 162,517 26,458 20,388 24,893 26,438 27,330 26,424 26,438	Total MMBtu 347,261 306,876 347,235 336,873 345,717 340,181 331,474 347,188 351,443	MMBtu Diff 0 40,386 27 10,388 1,544 7,081 15,788 74 -4,182

Prototype 04 – 20-story Midrise Office Data

Category and Measure	Elec Cost	Gas Cost	Total Cost	Alt Cost	Payback
Baseline	\$2,979,295	\$156,522	\$3,135,817	\$0	NA
Baseline + Combined Heat and Power, 3000 kW, 490 ton absorber	\$959,703	\$1,205,189	\$2,164,892	\$7,207,338	9.0
Baseline + Cool Roof, 100% of roof at Abs=0.3	\$2,977,004	\$156,948	\$3,133,952	\$13,756	7.4
Baseline + High Efficiency Glazing, U=0.26, SHGC=0.29	\$2,944,167	\$128,404	\$3,072,570	\$680,795	10.8
Baseline + High Efficiency Heating, Boiler Comb Eff = 85%	\$2,979,295	\$147,510	\$3,126,805	\$204,826	22.7
Baseline + High Efficiency Cooling, 0.461 kW/ton Centrifugal Chillers	\$2,889,343	\$156,522	\$3,045,865	\$179,037	2.0
Baseline + High Efficiency Lighting, 0.9 watts/sqft	\$2,800,867	\$165,732	\$2,966,599	\$1,979,998	11.7
Baseline + Envelope Insulation - Roof, 6" R23 XPS	\$2,978,638	\$156,099	\$3,134,737	\$7,503	6.9
Baseline + Thermal Storage, 25% of max load, 7818 ton-hrs	\$2,870,071	\$156,522	\$3,026,593	\$547,243	5.0
Baseline + Envelope Insulation - Walls, R19, 2x4.16	\$2,978,441	\$153,788	\$3,132,229	\$45,037	12.6
Category and Measure	Elec kWh	Elec MMBtu	Gas MMBtu	Total MMBtu	MMBtu Diff
Category and Measure Baseline	Elec kWh 14,371,930	Elec MMBtu 163,784	Gas MMBtu 11,065	Total MMBtu 174,848	MMBtu Diff 0
Category and Measure Baseline Baseline + Combined Heat and Power, 3000 kW, 490 ton absorber	Elec kWh 14,371,930 5,542,578	Elec MMBtu 163,784 63,163	Gas MMBtu 11,065 92,572	Total MMBtu 174,848 155,734	MMBtu Diff 0 19,114
Category and Measure Baseline Baseline + Combined Heat and Power, 3000 kW, 490 ton absorber Baseline + Cool Roof, 100% of roof at Abs=0.3	Elec kWh 14,371,930 5,542,578 14,366,120	Elec MMBtu 163,784 63,163 163,717	Gas MMBtu 11,065 92,572 11,096	Total MMBtu 174,848 155,734 174,813	MMBtu Diff 0 19,114 35
Category and Measure Baseline Baseline + Combined Heat and Power, 3000 kW, 490 ton absorber Baseline + Cool Roof, 100% of roof at Abs=0.3 Baseline + High Efficiency Glazing, U=0.26, SHGC=0.29	Elec kWh 14,371,930 5,542,578 14,366,120 14,226,000	Elec MMBtu 163,784 63,163 163,717 162,120	Gas MMBtu 11,065 92,572 11,096 9,032	Total MMBtu 174,848 155,734 174,813 171,153	MMBtu Diff 0 19,114 35 3,696
Category and Measure Baseline Baseline + Combined Heat and Power, 3000 kW, 490 ton absorber Baseline + Cool Roof, 100% of roof at Abs=0.3 Baseline + High Efficiency Glazing, U=0.26, SHGC=0.29 Baseline + High Efficiency Heating, Boiler Comb Eff = 85%	Elec kWh 14,371,930 5,542,578 14,366,120 14,226,000 14,371,930	Elec MMBtu 163,784 63,163 163,717 162,120 163,784	Gas MMBtu 11,065 92,572 11,096 9,032 10,418	Total MMBtu 174,848 155,734 174,813 171,153 174,201	MMBtu Diff 0 19,114 35 3,696 647
Category and Measure Baseline Baseline + Combined Heat and Power, 3000 kW, 490 ton absorber Baseline + Cool Roof, 100% of roof at Abs=0.3 Baseline + High Efficiency Glazing, U=0.26, SHGC=0.29 Baseline + High Efficiency Heating, Boiler Comb Eff = 85% Baseline + High Efficiency Cooling, 0.461 kW/ton Centrifugal Chillers	Elec kWh 14,371,930 5,542,578 14,366,120 14,226,000 14,371,930 14,084,210	Elec MMBtu 163,784 63,163 163,717 162,120 163,784 160,504	Gas MMBtu 11,065 92,572 11,096 9,032 10,418 11,065	Total MMBtu 174,848 155,734 174,813 171,153 174,201 171,568	MMBtu Diff 0 19,114 35 3,696 647 3,280
Category and Measure Baseline Baseline + Combined Heat and Power, 3000 kW, 490 ton absorber Baseline + Cool Roof, 100% of roof at Abs=0.3 Baseline + High Efficiency Glazing, U=0.26, SHGC=0.29 Baseline + High Efficiency Heating, Boiler Comb Eff = 85% Baseline + High Efficiency Cooling, 0.461 kW/ton Centrifugal Chillers Baseline + High Efficiency Lighting, 0.9 watts/sqft	Elec kWh 14,371,930 5,542,578 14,366,120 14,226,000 14,371,930 14,084,210 13,579,380	Elec MMBtu 163,784 63,163 163,717 162,120 163,784 160,504 154,752	Gas MMBtu 11,065 92,572 11,096 9,032 10,418 11,065 11,733	Total MMBtu 174,848 155,734 174,813 171,153 174,201 171,568 166,485	MMBtu Diff 0 19,114 35 3,696 647 3,280 8,363
Category and Measure Baseline Baseline + Combined Heat and Power, 3000 kW, 490 ton absorber Baseline + Cool Roof, 100% of roof at Abs=0.3 Baseline + High Efficiency Glazing, U=0.26, SHGC=0.29 Baseline + High Efficiency Heating, Boiler Comb Eff = 85% Baseline + High Efficiency Cooling, 0.461 kW/ton Centrifugal Chillers Baseline + High Efficiency Lighting, 0.9 watts/sqft Baseline + Envelope Insulation - Roof, 6" R23 XPS	Elec kWh 14,371,930 5,542,578 14,366,120 14,226,000 14,371,930 14,084,210 13,579,380 14,368,340	Elec MMBtu 163,784 63,163 163,717 162,120 163,784 160,504 154,752 163,744	Gas MMBtu 11,065 92,572 11,096 9,032 10,418 11,065 11,733 11,034	Total MMBtu 174,848 155,734 174,813 171,153 174,201 171,568 166,485 174,778	MMBtu Diff 0 19,114 35 3,696 647 3,280 8,363 70
Category and Measure Baseline Baseline + Combined Heat and Power, 3000 kW, 490 ton absorber Baseline + Cool Roof, 100% of roof at Abs=0.3 Baseline + High Efficiency Glazing, U=0.26, SHGC=0.29 Baseline + High Efficiency Glazing, Boiler Comb Eff = 85% Baseline + High Efficiency Lighting, 0.461 kW/ton Centrifugal Chillers Baseline + High Efficiency Lighting, 0.9 watts/sqft Baseline + High Efficiency Lighting, 0.9 watts/sqft Baseline + Thermal Storage, 25% of max load, 7818 ton-hrs	Elec kWh 14,371,930 5,542,578 14,366,120 14,226,000 14,371,930 14,084,210 13,579,380 14,368,340 14,485,280	Elec MMBtu 163,784 63,163 163,717 162,120 163,784 160,504 154,752 163,744 165,076	Gas MMBtu 11,065 92,572 11,096 9,032 10,418 11,065 11,733 11,034 11,065	Total MMBtu 174,848 155,734 174,813 171,153 174,201 171,568 166,485 174,778 176,141	MMBtu Diff 0 19,114 35 3,696 647 3,280 8,363 70 -1,293

Prototype 05 – 33-story Highrise Hotel Data

Category and Measure	Elec Cost	Gas Cost	Total Cost	Alt Cost	Payback
Baseline	\$3,125,714	\$1,341,522	\$4,467,237	\$0	NA
Baseline + Combined Heat and Power, 2500 kW, 500 ton absorber	\$1,377,275	\$2,019,232	\$3,396,507	\$6,007,570	6.5
Baseline + Cool Roof, 100% of roof at Abs=0.3	\$3,124,742	\$1,341,947	\$4,466,689	\$12,500	22.8
Baseline + High Efficiency Glazing, U=0.26, SHGC=0.29	\$3,123,103	\$1,241,680	\$4,364,782	\$1,127,165	11.0
Baseline + High Efficiency Heating, Boiler Comb Eff = 85%	\$3,125,714	\$1,271,467	\$4,397,182	\$230,271	3.3
Baseline + High Efficiency Cooling, 0.461 kW/ton Centrifugal Chillers	\$3,021,314	\$1,341,522	\$4,362,836	\$230,381	2.2
Baseline + High Efficiency Lighting, 1.19 watts/sqft	\$3,045,015	\$1,348,890	\$4,393,904	\$3,124,976	42.6
Baseline + Envelope Insulation - Roof, 6" R23 XPS	\$3,125,656	\$1,341,075	\$4,466,731	\$6,818	13.5
Baseline + Thermal Storage, 15% of max load, 7799 ton-hrs	\$3,065,626	\$1,341,522	\$4,407,149	\$545,930	9.1
Baseline + Envelope Insulation - Walls, Reduced thermal bridging	\$3,130,476	\$1,243,736	\$4,374,213	\$1,127,165	12.1
Category and Measure	Elec kWh	Elec MMBtu	Gas MMBtu	Total MMBtu	MMBtu Diff
Category and Measure Baseline	Elec kWh 17,289,660	Elec MMBtu 197,033	Gas MMBtu 96,974	Total MMBtu 294,007	MMBtu Diff 0
Category and Measure Baseline Baseline + Combined Heat and Power, 2500 kW, 500 ton absorber	Elec kWh 17,289,660 9,707,363	Elec MMBtu 197,033 110,627	Gas MMBtu 96,974 150,694	Total MMBtu 294,007 261,321	MMBtu Diff 0 32,686
Category and Measure Baseline Baseline + Combined Heat and Power, 2500 kW, 500 ton absorber Baseline + Cool Roof, 100% of roof at Abs=0.3	Elec kWh 17,289,660 9,707,363 17,284,260	Elec MMBtu 197,033 110,627 196,973	Gas MMBtu 96,974 150,694 97,005	Total MMBtu 294,007 261,321 293,978	MMBtu Diff 0 32,686 30
Category and Measure Baseline Baseline + Combined Heat and Power, 2500 kW, 500 ton absorber Baseline + Cool Roof, 100% of roof at Abs=0.3 Baseline + High Efficiency Glazing, U=0.26, SHGC=0.29	Elec kWh 17,289,660 9,707,363 17,284,260 17,329,680	Elec MMBtu 197,033 110,627 196,973 197,491	Gas MMBtu 96,974 150,694 97,005 89,732	Total MMBtu 294,007 261,321 293,978 287,223	MMBtu Diff 0 32,686 30 6,785
Category and Measure Baseline Baseline + Combined Heat and Power, 2500 kW, 500 ton absorber Baseline + Cool Roof, 100% of roof at Abs=0.3 Baseline + High Efficiency Glazing, U=0.26, SHGC=0.29 Baseline + High Efficiency Heating, Boiler Comb Eff = 85%	Elec kWh 17,289,660 9,707,363 17,284,260 17,329,680 17,289,660	Elec MMBtu 197,033 110,627 196,973 197,491 197,033	Gas MMBtu 96,974 150,694 97,005 89,732 91,892	Total MMBtu 294,007 261,321 293,978 287,223 288,925	MMBtu Diff 0 32,686 30 6,785 5,082
Category and Measure Baseline Baseline + Combined Heat and Power, 2500 kW, 500 ton absorber Baseline + Cool Roof, 100% of roof at Abs=0.3 Baseline + High Efficiency Glazing, U=0.26, SHGC=0.29 Baseline + High Efficiency Heating, Boiler Comb Eff = 85% Baseline + High Efficiency Cooling, 0.461 kW/ton Centrifugal Chillers	Elec kWh 17,289,660 9,707,363 17,284,260 17,329,680 17,289,660 16,822,640	Elec MMBtu 197,033 110,627 196,973 197,491 197,033 191,713	Gas MMBtu 96,974 150,694 97,005 89,732 91,892 96,974	Total MMBtu 294,007 261,321 293,978 287,223 288,925 288,687	MMBtu Diff 0 32,686 30 6,785 5,082 5,321
Category and Measure Baseline Baseline + Combined Heat and Power, 2500 kW, 500 ton absorber Baseline + Cool Roof, 100% of roof at Abs=0.3 Baseline + High Efficiency Glazing, U=0.26, SHGC=0.29 Baseline + High Efficiency Heating, Boiler Comb Eff = 85% Baseline + High Efficiency Cooling, 0.461 kW/ton Centrifugal Chillers Baseline + High Efficiency Lighting, 1.19 watts/sqft	Elec kWh 17,289,660 9,707,363 17,284,260 17,329,680 17,289,660 16,822,640 16,881,320	Elec MMBtu 197,033 110,627 196,973 197,491 197,033 191,713 192,381	Gas MMBtu 96,974 150,694 97,005 89,732 91,892 96,974 97,508	Total MMBtu 294,007 261,321 293,978 287,223 288,925 288,687 289,889	MMBtu Diff 0 32,686 30 6,785 5,082 5,321 4,119
Category and Measure Baseline Baseline + Combined Heat and Power, 2500 kW, 500 ton absorber Baseline + Cool Roof, 100% of roof at Abs=0.3 Baseline + High Efficiency Glazing, U=0.26, SHGC=0.29 Baseline + High Efficiency Heating, Boiler Comb Eff = 85% Baseline + High Efficiency Cooling, 0.461 kW/ton Centrifugal Chillers Baseline + High Efficiency Lighting, 1.19 watts/sqft Baseline + Envelope Insulation - Roof, 6" R23 XPS	Elec kWh 17,289,660 9,707,363 17,284,260 17,289,660 16,822,640 16,881,320 17,289,770	Elec MMBtu 197,033 110,627 196,973 197,491 197,033 191,713 192,381 197,037	Gas MMBtu 96,974 150,694 97,005 89,732 91,892 96,974 97,508 96,942	Total MMBtu 294,007 261,321 293,978 287,223 288,925 288,687 289,889 293,978	MMBtu Diff 0 32,686 30 6,785 5,082 5,321 4,119 29
Category and Measure Baseline Baseline + Combined Heat and Power, 2500 kW, 500 ton absorber Baseline + Cool Roof, 100% of roof at Abs=0.3 Baseline + High Efficiency Glazing, U=0.26, SHGC=0.29 Baseline + High Efficiency Heating, Boiler Comb Eff = 85% Baseline + High Efficiency Cooling, 0.461 kW/ton Centrifugal Chillers Baseline + High Efficiency Lighting, 1.19 watts/sqft Baseline + Envelope Insulation - Roof, 6" R23 XPS Baseline + Thermal Storage, 15% of max load, 7799 ton-hrs	Elec kWh 17,289,660 9,707,363 17,284,260 17,329,680 17,289,660 16,822,640 16,881,320 17,289,770 17,393,510	Elec MMBtu 197,033 110,627 196,973 197,491 197,033 191,713 192,381 197,037 198,219	Gas MMBtu 96,974 150,694 97,005 89,732 91,892 96,974 97,508 96,942 96,974	Total MMBtu 294,007 261,321 293,978 287,223 288,925 288,687 289,889 293,978 295,193	MMBtu Diff 0 32,686 30 6,785 5,082 5,321 4,119 29 -1,186

Prototype 06 – 18-story Midrise Hotel Data

Category and Measure	Elec Cost	Gas Cost	Total Cost	Alt Cost	Payback
Baseline	\$520,602	\$208,942	\$729,545	\$0	NA
Baseline + Combined Heat and Power, 400 kW, 80 ton absorber	\$246,143	\$324,547	\$570,690	\$961,198	7.1
Baseline + Cool Roof, 100% of roof at Abs=0.3	\$520,267	\$209,039	\$729,306	\$3,813	16.0
Baseline + High Efficiency Glazing, U=0.26, SHGC=0.29	\$520,781	\$199,033	\$719,814	\$339,583	34.9
Baseline + High Efficiency Heating, Boiler Comb Eff = 85%	\$520,602	\$198,344	\$718,947	\$34,271	3.2
Baseline + High Efficiency Cooling, 0.461 kW/ton Centrifugal Chillers	\$502,864	\$208,942	\$711,806	\$33,834	1.9
Baseline + High Efficiency Lighting, 1.19 watts/sqft	\$506,896	\$209,845	\$716,740	\$520,002	40.6
Baseline + Envelope Insulation - Roof, 6" R23 XPS	\$520,580	\$208,818	\$729,399	\$2,080	14.2
Baseline + Thermal Storage, 15% of max load, 1265 ton-hrs	\$509,934	\$208,942	\$718,876	\$88,538	8.3
Baseline + Envelope Insulation - Walls, R19, 2x4.16	\$520,842	\$207,689	\$728,532	\$22,465	22.2
Category and Measure	Elec kWh	Elec MMBtu	Gas MMBtu	Total MMBtu	MMBtu Diff
Category and Measure Baseline	Elec kWh 2,895,951	Elec MMBtu 33,003	Gas MMBtu 14,824	Total MMBtu 47,827	MMBtu Diff 0
Category and Measure Baseline Baseline + Combined Heat and Power, 400 kW, 80 ton absorber	Elec kWh 2,895,951 1,642,262	Elec MMBtu 33,003 18,714	Gas MMBtu 14,824 23,980	Total MMBtu 47,827 42,695	MMBtu Diff 0 5,133
Category and Measure Baseline Baseline + Combined Heat and Power, 400 kW, 80 ton absorber Baseline + Cool Roof, 100% of roof at Abs=0.3	Elec kWh 2,895,951 1,642,262 2,894,049	Elec MMBtu 33,003 18,714 32,979	Gas MMBtu 14,824 23,980 14,832	Total MMBtu 47,827 42,695 47,811	MMBtu Diff 0 5,133 16
Category and Measure Baseline Baseline + Combined Heat and Power, 400 kW, 80 ton absorber Baseline + Cool Roof, 100% of roof at Abs=0.3 Baseline + High Efficiency Glazing, U=0.26, SHGC=0.29	Elec kWh 2,895,951 1,642,262 2,894,049 2,914,989	Elec MMBtu 33,003 18,714 32,979 33,220	Gas MMBtu 14,824 23,980 14,832 14,106	Total MMBtu 47,827 42,695 47,811 47,326	MMBtu Diff 0 5,133 16 501
Category and Measure Baseline Baseline + Combined Heat and Power, 400 kW, 80 ton absorber Baseline + Cool Roof, 100% of roof at Abs=0.3 Baseline + High Efficiency Glazing, U=0.26, SHGC=0.29 Baseline + High Efficiency Heating, Boiler Comb Eff = 85%	Elec kWh 2,895,951 1,642,262 2,894,049 2,914,989 2,895,951	Elec MMBtu 33,003 18,714 32,979 33,220 33,003	Gas MMBtu 14,824 23,980 14,832 14,106 14,056	Total MMBtu 47,827 42,695 47,811 47,326 47,059	MMBtu Diff 0 5,133 16 501 768
Category and Measure Baseline Baseline + Combined Heat and Power, 400 kW, 80 ton absorber Baseline + Cool Roof, 100% of roof at Abs=0.3 Baseline + High Efficiency Glazing, U=0.26, SHGC=0.29 Baseline + High Efficiency Heating, Boiler Comb Eff = 85% Baseline + High Efficiency Cooling, 0.461 kW/ton Centrifugal Chillers	Elec kWh 2,895,951 1,642,262 2,894,049 2,914,989 2,895,951 2,814,202	Elec MMBtu 33,003 18,714 32,979 33,220 33,003 32,071	Gas MMBtu 14,824 23,980 14,832 14,106 14,056 14,824	Total MMBtu 47,827 42,695 47,811 47,326 47,059 46,895	MMBtu Diff 0 5,133 16 501 768 932
Category and Measure Baseline Baseline + Combined Heat and Power, 400 kW, 80 ton absorber Baseline + Cool Roof, 100% of roof at Abs=0.3 Baseline + High Efficiency Glazing, U=0.26, SHGC=0.29 Baseline + High Efficiency Heating, Boiler Comb Eff = 85% Baseline + High Efficiency Cooling, 0.461 kW/ton Centrifugal Chillers Baseline + High Efficiency Lighting, 1.19 watts/sqft	Elec kWh 2,895,951 1,642,262 2,894,049 2,914,989 2,895,951 2,814,202 2,826,321	Elec MMBtu 33,003 18,714 32,979 33,220 33,003 32,071 32,208	Gas MMBtu 14,824 23,980 14,832 14,106 14,056 14,824 14,890	Total MMBtu 47,827 42,695 47,811 47,326 47,059 46,895 47,098	MMBtu Diff 0 5,133 16 501 768 932 729
Category and Measure Baseline Baseline + Combined Heat and Power, 400 kW, 80 ton absorber Baseline + Cool Roof, 100% of roof at Abs=0.3 Baseline + High Efficiency Glazing, U=0.26, SHGC=0.29 Baseline + High Efficiency Heating, Boiler Comb Eff = 85% Baseline + High Efficiency Lighting, 1.19 watts/sqft Baseline + High Efficiency Lighting, 1.19 watts/sqft Baseline + Envelope Insulation - Roof, 6" R23 XPS	Elec kWh 2,895,951 1,642,262 2,894,049 2,914,989 2,895,951 2,814,202 2,826,321 2,895,858	Elec MMBtu 33,003 18,714 32,979 33,220 33,003 32,071 32,208 33,003	Gas MMBtu 14,824 23,980 14,832 14,106 14,056 14,824 14,890 14,815	Total MMBtu 47,827 42,695 47,811 47,326 47,059 46,895 47,098 47,818	MMBtu Diff 0 5,133 16 501 768 932 729 9
Category and Measure Baseline Baseline + Combined Heat and Power, 400 kW, 80 ton absorber Baseline + Cool Roof, 100% of roof at Abs=0.3 Baseline + High Efficiency Glazing, U=0.26, SHGC=0.29 Baseline + High Efficiency Glazing, Boiler Comb Eff = 85% Baseline + High Efficiency Leating, Boiler Comb Eff = 85% Baseline + High Efficiency Lighting, 1.19 watts/sqft Baseline + High Efficiency Lighting, 1.19 watts/sqft Baseline + Envelope Insulation - Roof, 6" R23 XPS Baseline + Thermal Storage, 15% of max load, 1265 ton-hrs	Elec kWh 2,895,951 1,642,262 2,894,049 2,914,989 2,895,951 2,814,202 2,826,321 2,895,858 2,913,303	Elec MMBtu 33,003 18,714 32,979 33,220 33,003 32,071 32,208 33,003 33,200	Gas MMBtu 14,824 23,980 14,832 14,106 14,056 14,824 14,890 14,815 14,824	Total MMBtu 47,827 42,695 47,811 47,326 47,059 46,895 47,098 47,098 47,818 48,024	MMBtu Diff 0 5,133 16 501 768 932 729 9 -197

Prototype 07 – 55-story Highrise Residential Data

Category and Measure	Elec Cost	Gas Cost	Total Cost	Alt Cost	Payback
Baseline	\$1,551,558	\$505,528	\$2,057,086	\$0	NA
Baseline + High Efficiency Appliances, Energy Star Rated	\$1,550,852	\$505,571	\$2,056,424	\$155,608	235.1
Baseline + Combined Heat and Power, 1500 kW, 300 ton absorber	\$637,897	\$910,283	\$1,548,180	\$3,604,478	8.3
Baseline + Cool Roof, 100% of roof at Abs=0.3	\$1,550,915	\$505,705	\$2,056,620	\$4,266	9.2
Baseline + High Efficiency Glazing, U=0.26, SHGC=0.29	\$1,488,622	\$402,701	\$1,891,324	\$1,077,459	6.5
Baseline + High Efficiency Heating, Boiler Comb Eff = 85%	\$1,551,558	\$480,836	\$2,032,394	\$122,608	5.0
Baseline + High Efficiency Cooling, 0.461 kW/ton Centrifugal Chillers	\$1,497,032	\$505,528	\$2,002,559	\$109,250	2.0
Baseline + High Efficiency Lighting, 0.675 watts/sqft	\$1,536,395	\$506,413	\$2,042,808	\$1,744,993	122.2
Baseline + Envelope Insulation - Roof, 6" R23 XPS	\$1,551,397	\$505,391	\$2,056,788	\$2,327	7.8
Baseline + Thermal Storage, 15% of max load, 3751 ton-hrs	\$1,543,104	\$505,528	\$2,048,632	\$262,547	31.1
Baseline + Envelope Insulation - Walls, Reduced thermal bridging	\$1,504,398	\$410,653	\$1,915,051	\$1,077,459	7.6
Category and Measure	Elec kWh	Elec MMBtu	Gas MMBtu	Total MMBtu	MMBtu Diff
Category and Measure Baseline	Elec kWh 8,664,978	Elec MMBtu 98,747	Gas MMBtu 36,336	Total MMBtu 135,083	MMBtu Diff 0
Category and Measure Baseline Baseline + High Efficiency Appliances, Energy Star Rated	Elec kWh 8,664,978 8,660,950	Elec MMBtu 98,747 98,700	Gas MMBtu 36,336 36,339	Total MMBtu 135,083 135,040	MMBtu Diff 0 44
Category and Measure Baseline Baseline + High Efficiency Appliances, Energy Star Rated Baseline + Combined Heat and Power, 1500 kW, 300 ton absorber	Elec kWh 8,664,978 8,660,950 4,762,240	Elec MMBtu 98,747 98,700 54,272	Gas MMBtu 36,336 36,339 68,112	Total MMBtu 135,083 135,040 122,383	MMBtu Diff 0 44 12,700
Category and Measure Baseline Baseline + High Efficiency Appliances, Energy Star Rated Baseline + Combined Heat and Power, 1500 kW, 300 ton absorber Baseline + Cool Roof, 100% of roof at Abs=0.3	Elec kWh 8,664,978 8,660,950 4,762,240 8,661,909	Elec MMBtu 98,747 98,700 54,272 98,710	Gas MMBtu 36,336 36,339 68,112 36,349	Total MMBtu 135,083 135,040 122,383 135,059	MMBtu Diff 0 44 12,700 24
Category and Measure Baseline Baseline + High Efficiency Appliances, Energy Star Rated Baseline + Combined Heat and Power, 1500 kW, 300 ton absorber Baseline + Cool Roof, 100% of roof at Abs=0.3 Baseline + High Efficiency Glazing, U=0.26, SHGC=0.29	Elec kWh 8,664,978 8,660,950 4,762,240 8,661,909 8,334,327	Elec MMBtu 98,747 98,700 54,272 98,710 94,980	Gas MMBtu 36,336 36,339 68,112 36,349 28,877	Total MMBtu 135,083 135,040 122,383 135,059 123,857	MMBtu Diff 0 44 12,700 24 11,226
Category and Measure Baseline Baseline + High Efficiency Appliances, Energy Star Rated Baseline + Combined Heat and Power, 1500 kW, 300 ton absorber Baseline + Cool Roof, 100% of roof at Abs=0.3 Baseline + High Efficiency Glazing, U=0.26, SHGC=0.29 Baseline + High Efficiency Heating, Boiler Comb Eff = 85%	Elec kWh 8,664,978 8,660,950 4,762,240 8,661,909 8,334,327 8,664,978	Elec MMBtu 98,747 98,700 54,272 98,710 94,980 98,747	Gas MMBtu 36,336 36,339 68,112 36,349 28,877 34,546	Total MMBtu 135,083 135,040 122,383 135,059 123,857 133,293	MMBtu Diff 0 44 12,700 24 11,226 1,790
Category and Measure Baseline Baseline + High Efficiency Appliances, Energy Star Rated Baseline + Combined Heat and Power, 1500 kW, 300 ton absorber Baseline + Cool Roof, 100% of roof at Abs=0.3 Baseline + High Efficiency Glazing, U=0.26, SHGC=0.29 Baseline + High Efficiency Heating, Boiler Comb Eff = 85% Baseline + High Efficiency Cooling, 0.461 kW/ton Centrifugal Chillers	Elec kWh 8,664,978 8,660,950 4,762,240 8,661,909 8,334,327 8,664,978 8,407,912	Elec MMBtu 98,747 98,700 54,272 98,710 94,980 98,747 95,818	Gas MMBtu 36,336 36,339 68,112 36,349 28,877 34,546 36,336	Total MMBtu 135,083 135,040 122,383 135,059 123,857 133,293 132,154	MMBtu Diff 0 44 12,700 24 11,226 1,790 2,929
Category and Measure Baseline Baseline + High Efficiency Appliances, Energy Star Rated Baseline + Combined Heat and Power, 1500 kW, 300 ton absorber Baseline + Cool Roof, 100% of roof at Abs=0.3 Baseline + High Efficiency Glazing, U=0.26, SHGC=0.29 Baseline + High Efficiency Heating, Boiler Comb Eff = 85% Baseline + High Efficiency Cooling, 0.461 kW/ton Centrifugal Chillers Baseline + High Efficiency Lighting, 0.675 watts/sqft	Elec kWh 8,664,978 8,660,950 4,762,240 8,661,909 8,334,327 8,664,978 8,407,912 8,585,753	Elec MMBtu 98,747 98,700 54,272 98,710 94,980 98,747 95,818 97,845	Gas MMBtu 36,336 36,339 68,112 36,349 28,877 34,546 36,336 36,400	Total MMBtu 135,083 135,040 122,383 135,059 123,857 133,293 132,154 134,245	MMBtu Diff 0 44 12,700 24 11,226 1,790 2,929 838
Category and Measure Baseline Baseline + High Efficiency Appliances, Energy Star Rated Baseline + Combined Heat and Power, 1500 kW, 300 ton absorber Baseline + Combined Heat and Power, 1500 kW, 300 ton absorber Baseline + Combined Heat and Power, 1500 kW, 300 ton absorber Baseline + Combined Heat and Power, 1500 kW, 300 ton absorber Baseline + High Efficiency Glazing, U=0.26, SHGC=0.29 Baseline + High Efficiency Heating, Boiler Comb Eff = 85% Baseline + High Efficiency Cooling, 0.461 kW/ton Centrifugal Chillers Baseline + High Efficiency Lighting, 0.675 watts/sqft Baseline + Envelope Insulation - Roof, 6" R23 XPS	Elec kWh 8,664,978 8,660,950 4,762,240 8,661,909 8,334,327 8,664,978 8,407,912 8,585,753 8,664,109	Elec MMBtu 98,747 98,700 54,272 98,710 94,980 98,747 95,818 97,845 98,737	Gas MMBtu 36,336 36,339 68,112 36,349 28,877 34,546 36,336 36,400 36,327	Total MMBtu 135,083 135,040 122,383 135,059 123,857 133,293 132,154 134,245 135,064	MMBtu Diff 0 44 12,700 24 11,226 1,790 2,929 838 19
Category and Measure Baseline Baseline + High Efficiency Appliances, Energy Star Rated Baseline + Combined Heat and Power, 1500 kW, 300 ton absorber Baseline + Cool Roof, 100% of roof at Abs=0.3 Baseline + High Efficiency Glazing, U=0.26, SHGC=0.29 Baseline + High Efficiency Heating, Boiler Comb Eff = 85% Baseline + High Efficiency Cooling, 0.461 kW/ton Centrifugal Chillers Baseline + High Efficiency Lighting, 0.675 watts/sqft Baseline + Envelope Insulation - Roof, 6" R23 XPS Baseline + Thermal Storage, 15% of max load, 3751 ton-hrs	Elec kWh 8,664,978 8,660,950 4,762,240 8,661,909 8,334,327 8,664,978 8,407,912 8,585,753 8,664,109 8,754,765	Elec MMBtu 98,747 98,700 54,272 98,710 94,980 98,747 95,818 97,845 98,737 99,769	Gas MMBtu 36,336 36,339 68,112 36,349 28,877 34,546 36,336 36,400 36,327 36,336	Total MMBtu 135,083 135,040 122,383 135,059 123,857 133,293 132,154 134,245 135,064 136,105	MMBtu Diff 0 44 12,700 24 11,226 1,790 2,929 838 19 -1,022

Prototype 08 – 43-story Highrise Residential Data

Category and Measure	Elec Cost	Gas Cost	Total Cost	Alt Cost	Payback
Baseline	\$737,107	\$310,309	\$1,047,416	\$0	NA
Baseline + High Efficiency Appliances, Energy Star Rated	\$736,794	\$310,331	\$1,047,125	\$71,188	244.6
Baseline + Combined Heat and Power, 750 kW, 160 ton absorber	\$307,967	\$503,866	\$811,833	\$1,802,353	9.0
Baseline + Cool Roof, 100% of roof at Abs=0.3	\$736,737	\$310,439	\$1,047,175	\$2,506	10.4
Baseline + High Efficiency Glazing, U=0.26, SHGC=0.29	\$699,553	\$245,720	\$945,273	\$642,390	6.3
Baseline + High Efficiency Heating, Boiler Comb Eff = 85%	\$737,107	\$294,024	\$1,031,131	\$76,334	4.7
Baseline + High Efficiency Cooling, 0.461 kW/ton Centrifugal Chillers	\$711,398	\$310,309	\$1,021,707	\$57,408	2.2
Baseline + High Efficiency Lighting, 0.675 watts/sqft	\$730,474	\$310,762	\$1,041,237	\$797,506	129.1
Baseline + Envelope Insulation - Roof, 6" R23 XPS	\$737,011	\$310,208	\$1,047,219	\$1,367	6.9
Baseline + Thermal Storage, 15% of max load, 1820 ton-hrs	\$729,310	\$310,309	\$1,039,619	\$127,423	16.3
Baseline + Envelope Insulation - Walls, Reduced thermal bridging	\$708,760	\$250,838	\$959,597	\$642,390	7.3
Category and Measure	Elec kWh	Elec MMBtu	Gas MMBtu	Total MMBtu	MMBtu Diff
Category and Measure Baseline	Elec kWh 4,094,859	Elec MMBtu 46,666	Gas MMBtu 22,178	Total MMBtu 68,844	MMBtu Diff 0
Category and Measure Baseline Baseline + High Efficiency Appliances, Energy Star Rated	Elec kWh 4,094,859 4,093,069	Elec MMBtu 46,666 46,646	Gas MMBtu 22,178 22,179	Total MMBtu 68,844 68,825	MMBtu Diff 0 19
Category and Measure Baseline Baseline + High Efficiency Appliances, Energy Star Rated Baseline + Combined Heat and Power, 750 kW, 160 ton absorber	Elec kWh 4,094,859 4,093,069 2,239,767	Elec MMBtu 46,666 46,646 25,524	Gas MMBtu 22,178 22,179 37,403	Total MMBtu 68,844 68,825 62,927	MMBtu Diff 0 19 5,917
Category and Measure Baseline Baseline + High Efficiency Appliances, Energy Star Rated Baseline + Combined Heat and Power, 750 kW, 160 ton absorber Baseline + Cool Roof, 100% of roof at Abs=0.3	Elec kWh 4,094,859 4,093,069 2,239,767 4,093,093	Elec MMBtu 46,666 46,646 25,524 46,646	Gas MMBtu 22,178 22,179 37,403 22,187	Total MMBtu 68,844 68,825 62,927 68,833	MMBtu Diff 0 19 5,917 11
Category and Measure Baseline Baseline + High Efficiency Appliances, Energy Star Rated Baseline + Combined Heat and Power, 750 kW, 160 ton absorber Baseline + Cool Roof, 100% of roof at Abs=0.3 Baseline + High Efficiency Glazing, U=0.26, SHGC=0.29	Elec kWh 4,094,859 4,093,069 2,239,767 4,093,093 3,889,771	Elec MMBtu 46,666 25,524 46,646 44,328	Gas MMBtu 22,178 22,179 37,403 22,187 17,492	Total MMBtu 68,844 68,825 62,927 68,833 61,821	MMBtu Diff 0 19 5,917 11 7,023
Category and Measure Baseline Baseline + High Efficiency Appliances, Energy Star Rated Baseline + Combined Heat and Power, 750 kW, 160 ton absorber Baseline + Cool Roof, 100% of roof at Abs=0.3 Baseline + High Efficiency Glazing, U=0.26, SHGC=0.29 Baseline + High Efficiency Heating, Boiler Comb Eff = 85%	Elec kWh 4,094,859 4,093,069 2,239,767 4,093,093 3,889,771 4,094,859	Elec MMBtu 46,666 25,524 46,646 44,328 46,666	Gas MMBtu 22,178 22,179 37,403 22,187 17,492 20,995	Total MMBtu 68,844 68,825 62,927 68,833 61,821 67,662	MMBtu Diff 0 19 5,917 11 7,023 1,182
Category and Measure Baseline Baseline + High Efficiency Appliances, Energy Star Rated Baseline + Combined Heat and Power, 750 kW, 160 ton absorber Baseline + Cool Roof, 100% of roof at Abs=0.3 Baseline + High Efficiency Glazing, U=0.26, SHGC=0.29 Baseline + High Efficiency Heating, Boiler Comb Eff = 85% Baseline + High Efficiency Cooling, 0.461 kW/ton Centrifugal Chillers	Elec kWh 4,094,859 4,093,069 2,239,767 4,093,093 3,889,771 4,094,859 3,980,826	Elec MMBtu 46,666 46,646 25,524 46,646 44,328 46,666 45,367	Gas MMBtu 22,178 22,179 37,403 22,187 17,492 20,995 22,178	Total MMBtu 68,844 68,825 62,927 68,833 61,821 67,662 67,545	MMBtu Diff 0 19 5,917 11 7,023 1,182 1,299
Category and Measure Baseline Baseline + High Efficiency Appliances, Energy Star Rated Baseline + Combined Heat and Power, 750 kW, 160 ton absorber Baseline + Cool Roof, 100% of roof at Abs=0.3 Baseline + High Efficiency Glazing, U=0.26, SHGC=0.29 Baseline + High Efficiency Heating, Boiler Comb Eff = 85% Baseline + High Efficiency Cooling, 0.461 kW/ton Centrifugal Chillers Baseline + High Efficiency Lighting, 0.675 watts/sqft	Elec kWh 4,094,859 4,093,069 2,239,767 4,093,093 3,889,771 4,094,859 3,980,826 4,059,815	Elec MMBtu 46,666 46,646 25,524 46,646 44,328 46,666 45,367 46,266	Gas MMBtu 22,178 22,179 37,403 22,187 17,492 20,995 22,178 22,210	Total MMBtu 68,844 68,825 62,927 68,833 61,821 67,662 67,545 68,476	MMBtu Diff 0 19 5,917 11 7,023 1,182 1,299 368
Category and Measure Baseline Baseline + High Efficiency Appliances, Energy Star Rated Baseline + Combined Heat and Power, 750 kW, 160 ton absorber Baseline + Cool Roof, 100% of roof at Abs=0.3 Baseline + High Efficiency Glazing, U=0.26, SHGC=0.29 Baseline + High Efficiency Heating, Boiler Comb Eff = 85% Baseline + High Efficiency Cooling, 0.461 kW/ton Centrifugal Chillers Baseline + High Efficiency Lighting, 0.675 watts/sqft Baseline + Envelope Insulation - Roof, 6" R23 XPS	Elec kWh 4,094,859 4,093,069 2,239,767 4,093,093 3,889,771 4,094,859 3,980,826 4,059,815 4,094,356	Elec MMBtu 46,666 46,646 25,524 46,646 44,328 46,666 45,367 46,266 46,660	Gas MMBtu 22,178 22,179 37,403 22,187 17,492 20,995 22,178 22,210 22,170	Total MMBtu 68,844 68,825 62,927 68,833 61,821 67,662 67,545 68,476 68,830	MMBtu Diff 0 19 5,917 11 7,023 1,182 1,299 368 14
Category and Measure Baseline Baseline + High Efficiency Appliances, Energy Star Rated Baseline + Combined Heat and Power, 750 kW, 160 ton absorber Baseline + Cool Roof, 100% of roof at Abs=0.3 Baseline + High Efficiency Glazing, U=0.26, SHGC=0.29 Baseline + High Efficiency Heating, Boiler Comb Eff = 85% Baseline + High Efficiency Cooling, 0.461 kW/ton Centrifugal Chillers Baseline + High Efficiency Lighting, 0.675 watts/sqft Baseline + Envelope Insulation - Roof, 6" R23 XPS Baseline + Thermal Storage, 15% of max load, 1820 ton-hrs	Elec kWh 4,094,859 4,093,069 2,239,767 4,093,093 3,889,771 4,094,859 3,980,826 4,059,815 4,094,356 4,132,463	Elec MMBtu 46,666 46,646 25,524 46,646 44,328 46,666 45,367 46,266 46,660 47,094	Gas MMBtu 22,178 22,179 37,403 22,187 17,492 20,995 22,178 22,210 22,170 22,178	Total MMBtu 68,844 68,825 62,927 68,833 61,821 67,662 67,545 68,476 68,830 69,272	MMBtu Diff 0 19 5,917 11 7,023 1,182 1,299 3,68 14 -428

Prototype 09 – 34-story Highrise Residential Data

Category and Measure	Elec Cost	Gas Cost	Total Cost	Alt Cost	Payback
Baseline	\$970,010	\$353,124	\$1,323,134	\$0	NA
Baseline + High Efficiency Appliances, Energy Star Rated	\$969,546	\$353,161	\$1,322,708	\$105,062	246.6
Baseline + Combined Heat and Power, 850 kW, 180 ton absorber	\$421,136	\$598,073	\$1,019,209	\$2,042,676	7.9
Baseline + Cool Roof, 100% of roof at Abs=0.3	\$969,201	\$353,299	\$1,322,500	\$4,710	7.4
Baseline + High Efficiency Glazing, U=0.26, SHGC=0.29	\$930,344	\$284,617	\$1,214,961	\$691,905	6.4
Baseline + High Efficiency Heating, Boiler Comb Eff = 85%	\$970,010	\$334,590	\$1,304,600	\$85,456	4.6
Baseline + High Efficiency Cooling, 0.461 kW/ton Centrifugal Chillers	\$940,844	\$353,124	\$1,293,968	\$65,301	2.2
Baseline + High Efficiency Lighting, 0.675 watts/sqft	\$959,957	\$353,814	\$1,313,771	\$1,177,509	125.8
Baseline + Envelope Insulation - Roof, 6" R23 XPS	\$969,844	\$352,987	\$1,322,831	\$2,569	8.5
Baseline + Thermal Storage, 15% of max load, 2143 ton-hrs	\$961,013	\$353,124	\$1,314,136	\$150,022	16.7
Baseline + Envelope Insulation - Walls, Reduced thermal bridging	\$940.177	\$290.772	\$1,230,949	\$691,905	7.5
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Category and Measure	Elec kWh	Elec MMBtu	Gas MMBtu	Total MMBtu	MMBtu Diff
Category and Measure Baseline	Elec kWh 5,419,618	Elec MMBtu 61,763	Gas MMBtu 25,283	Total MMBtu 87,046	MMBtu Diff 0
Category and Measure Baseline Baseline + High Efficiency Appliances, Energy Star Rated	Elec kWh 5,419,618 5,416,972	Elec MMBtu 61,763 61,733	Gas MMBtu 25,283 25,285	Total MMBtu 87,046 87,018	MMBtu Diff 0 28
Category and Measure Baseline Baseline + High Efficiency Appliances, Energy Star Rated Baseline + Combined Heat and Power, 850 kW, 180 ton absorber	Elec kWh 5,419,618 5,416,972 2,996,552	Elec MMBtu 61,763 61,733 34,148	Gas MMBtu 25,283 25,285 44,579	Total MMBtu 87,046 87,018 78,727	MMBtu Diff 0 28 8,319
Category and Measure Baseline Baseline + High Efficiency Appliances, Energy Star Rated Baseline + Combined Heat and Power, 850 kW, 180 ton absorber Baseline + Cool Roof, 100% of roof at Abs=0.3	Elec kWh 5,419,618 5,416,972 2,996,552 5,415,965	Elec MMBtu 61,763 61,733 34,148 61,720	Gas MMBtu 25,283 25,285 44,579 25,296	Total MMBtu 87,046 87,018 78,727 87,015	MMBtu Diff 0 28 8,319 31
Category and Measure Baseline Baseline + High Efficiency Appliances, Energy Star Rated Baseline + Combined Heat and Power, 850 kW, 180 ton absorber Baseline + Cool Roof, 100% of roof at Abs=0.3 Baseline + High Efficiency Glazing, U=0.26, SHGC=0.29	Elec kWh 5,419,618 5,416,972 2,996,552 5,415,965 5,200,928	Elec MMBtu 61,763 61,733 34,148 61,720 59,272	Gas MMBtu 25,283 25,285 44,579 25,296 20,313	Total MMBtu 87,046 87,018 78,727 87,015 79,584	MMBtu Diff 0 28 8,319 31 7,462
Category and Measure Baseline Baseline + High Efficiency Appliances, Energy Star Rated Baseline + Combined Heat and Power, 850 kW, 180 ton absorber Baseline + Cool Roof, 100% of roof at Abs=0.3 Baseline + High Efficiency Glazing, U=0.26, SHGC=0.29 Baseline + High Efficiency Heating, Boiler Comb Eff = 85%	Elec kWh 5,419,618 5,416,972 2,996,552 5,415,965 5,200,928 5,419,618	Elec MMBtu 61,763 61,733 34,148 61,720 59,272 61,763	Gas MMBtu 25,283 25,285 44,579 25,296 20,313 23,939	Total MMBtu 87,046 87,018 78,727 87,015 79,584 85,702	MMBtu Diff 0 28 8,319 31 7,462 1,344
Category and Measure Baseline Baseline + High Efficiency Appliances, Energy Star Rated Baseline + Combined Heat and Power, 850 kW, 180 ton absorber Baseline + Cool Roof, 100% of roof at Abs=0.3 Baseline + High Efficiency Glazing, U=0.26, SHGC=0.29 Baseline + High Efficiency Heating, Boiler Comb Eff = 85% Baseline + High Efficiency Cooling, 0.461 kW/ton Centrifugal Chillers	Elec kWh 5,419,618 5,416,972 2,996,552 5,415,965 5,200,928 5,419,618 5,287,690	Elec MMBtu 61,763 61,733 34,148 61,720 59,272 61,763 60,260	Gas MMBtu 25,283 25,285 44,579 25,296 20,313 23,939 25,283	Total MMBtu 87,046 87,018 78,727 87,015 79,584 85,702 85,543	MMBtu Diff 0 28 8,319 31 7,462 1,344 1,503
Category and Measure Baseline Baseline + High Efficiency Appliances, Energy Star Rated Baseline + Combined Heat and Power, 850 kW, 180 ton absorber Baseline + Cool Roof, 100% of roof at Abs=0.3 Baseline + High Efficiency Glazing, U=0.26, SHGC=0.29 Baseline + High Efficiency Heating, Boiler Comb Eff = 85% Baseline + High Efficiency Looling, 0.461 kW/ton Centrifugal Chillers Baseline + High Efficiency Lighting, 0.675 watts/sqft	Elec kWh 5,419,618 5,416,972 2,996,552 5,415,965 5,200,928 5,419,618 5,287,690 5,367,563	Elec MMBtu 61,763 61,733 34,148 61,720 59,272 61,763 60,260 61,169	Gas MMBtu 25,283 25,285 44,579 25,296 20,313 23,939 25,283 25,283	Total MMBtu 87,046 87,018 78,727 87,015 79,584 85,702 85,543 86,501	MMBtu Diff 0 28 8,319 31 7,462 1,344 1,503 545
Category and Measure Baseline Baseline + High Efficiency Appliances, Energy Star Rated Baseline + Combined Heat and Power, 850 kW, 180 ton absorber Baseline + Cool Roof, 100% of roof at Abs=0.3 Baseline + High Efficiency Glazing, U=0.26, SHGC=0.29 Baseline + High Efficiency Glazing, D=0.26, SHGC=0.29 Baseline + High Efficiency Cooling, 0.461 kW/ton Centrifugal Chillers Baseline + High Efficiency Lighting, 0.675 watts/sqft Baseline + Envelope Insulation - Roof, 6" R23 XPS	Elec kWh 5,419,618 5,416,972 2,996,552 5,415,965 5,200,928 5,419,618 5,287,690 5,367,563 5,418,693	Elec MMBtu 61,763 61,733 34,148 61,720 59,272 61,763 60,260 61,169 61,753	Gas MMBtu 25,283 25,285 44,579 25,296 20,313 23,939 25,283 25,332 25,332	Total MMBtu 87,046 87,018 78,727 87,015 79,584 85,702 85,543 86,501 87,026	MMBtu Diff 0 28 8,319 31 7,462 1,344 1,503 545 20
Category and Measure Baseline Baseline + High Efficiency Appliances, Energy Star Rated Baseline + Combined Heat and Power, 850 kW, 180 ton absorber Baseline + Cool Roof, 100% of roof at Abs=0.3 Baseline + High Efficiency Glazing, U=0.26, SHGC=0.29 Baseline + High Efficiency Glazing, U=0.26, SHGC=0.29 Baseline + High Efficiency Heating, Boiler Comb Eff = 85% Baseline + High Efficiency Cooling, 0.461 kW/ton Centrifugal Chillers Baseline + High Efficiency Lighting, 0.675 watts/sqft Baseline + Finvelope Insulation - Roof, 6" R23 XPS Baseline + Thermal Storage, 15% of max load, 2143 ton-hrs	Elec kWh 5,419,618 5,416,972 2,996,552 5,415,965 5,200,928 5,419,618 5,287,690 5,367,563 5,418,693 5,463,198	Elec MMBtu 61,763 61,733 34,148 61,720 59,272 61,763 60,260 61,169 61,753 62,258	Gas MMBtu 25,283 25,285 44,579 25,296 20,313 23,939 25,283 25,283 25,332 25,272 25,283	Total MMBtu 87,046 87,018 78,727 87,015 79,584 85,702 85,543 86,501 87,026 87,541	MMBtu Diff 0 28 8,319 31 7,462 1,344 1,503 545 20 -494

Prototype 10 – 25-story Highrise Residential Data

Category and Measure	Elec Cost	Gas Cost	Total Cost	Alt Cost	Payback
Baseline	\$1,746,538	\$504,831	\$2,251,369	\$0	NA
Baseline + High Efficiency Appliances, Energy Star Rated	\$1,745,561	\$504,890	\$2,250,451	\$217,005	236.4
Baseline + Combined Heat and Power, 1500 kW, 250 ton absorber	\$738,484	\$930,551	\$1,669,035	\$3,603,807	7.2
Baseline + Cool Roof, 100% of roof at Abs=0.3	\$1,744,334	\$505,242	\$2,249,576	\$13,379	7.5
Baseline + High Efficiency Glazing, U=0.26, SHGC=0.29	\$1,699,760	\$425,326	\$2,125,086	\$848,086	6.7
Baseline + High Efficiency Heating, Boiler Comb Eff = 85%	\$1,746,538	\$478,363	\$2,224,901	\$118,139	4.5
Baseline + High Efficiency Cooling, 0.461 kW/ton Centrifugal Chillers	\$1,704,085	\$504,831	\$2,208,916	\$92,883	2.2
Baseline + High Efficiency Lighting, 0.675 watts/sqft	\$1,725,749	\$506,153	\$2,231,902	\$2,432,509	125.0
Baseline + Envelope Insulation - Roof, 6" R23 XPS	\$1,746,073	\$504,541	\$2,250,614	\$7,298	9.7
Baseline + Thermal Storage, 15% of max load, 3299 ton-hrs	\$1,734,740	\$504,831	\$2,239,571	\$230,930	19.6
Baseline + Envelope Insulation - Walls, Reduced thermal bridging	\$1,711,046	\$432,297	\$2,143,343	\$848,086	7.9
Category and Measure	Elec kWh	Elec MMBtu	Gas MMBtu	Total MMBtu	MMBtu Diff
Category and Measure Baseline	Elec kWh 9,816,055	Elec MMBtu 111,863	Gas MMBtu 36,286	Total MMBtu 148,149	MMBtu Diff 0
Category and Measure Baseline Baseline + High Efficiency Appliances, Energy Star Rated	Elec kWh 9,816,055 9,810,413	Elec MMBtu 111,863 111,800	Gas MMBtu 36,286 36,290	Total MMBtu 148,149 148,090	MMBtu Diff 0 59
Category and Measure Baseline Baseline + High Efficiency Appliances, Energy Star Rated Baseline + Combined Heat and Power, 1500 kW, 250 ton absorber	Elec kWh 9,816,055 9,810,413 5,429,196	Elec MMBtu 111,863 111,800 61,870	Gas MMBtu 36,286 36,290 69,878	Total MMBtu 148,149 148,090 131,748	MMBtu Diff 0 59 16,401
Category and Measure Baseline Baseline + High Efficiency Appliances, Energy Star Rated Baseline + Combined Heat and Power, 1500 kW, 250 ton absorber Baseline + Cool Roof, 100% of roof at Abs=0.3	Elec kWh 9,816,055 9,810,413 5,429,196 9,803,718	Elec MMBtu 111,863 111,800 61,870 111,723	Gas MMBtu 36,286 36,290 69,878 36,315	Total MMBtu 148,149 148,090 131,748 148,038	MMBtu Diff 0 59 16,401 111
Category and Measure Baseline Baseline + High Efficiency Appliances, Energy Star Rated Baseline + Combined Heat and Power, 1500 kW, 250 ton absorber Baseline + Cool Roof, 100% of roof at Abs=0.3 Baseline + High Efficiency Glazing, U=0.26, SHGC=0.29	Elec kWh 9,816,055 9,810,413 5,429,196 9,803,718 9,560,870	Elec MMBtu 111,863 111,800 61,870 111,723 108,957	Gas MMBtu 36,286 36,290 69,878 36,315 30,518	Total MMBtu 148,149 148,090 131,748 148,038 139,475	MMBtu Diff 0 59 16,401 111 8,674
Category and Measure Baseline Baseline + High Efficiency Appliances, Energy Star Rated Baseline + Combined Heat and Power, 1500 kW, 250 ton absorber Baseline + Cool Roof, 100% of roof at Abs=0.3 Baseline + High Efficiency Glazing, U=0.26, SHGC=0.29 Baseline + High Efficiency Heating, Boiler Comb Eff = 85%	Elec kWh 9,816,055 9,810,413 5,429,196 9,803,718 9,560,870 9,816,055	Elec MMBtu 111,863 111,800 61,870 111,723 108,957 111,863	Gas MMBtu 36,286 36,290 69,878 36,315 30,518 34,366	Total MMBtu 148,149 148,090 131,748 148,038 139,475 146,229	MMBtu Diff 0 59 16,401 111 8,674 1,920
Category and Measure Baseline Baseline + High Efficiency Appliances, Energy Star Rated Baseline + Combined Heat and Power, 1500 kW, 250 ton absorber Baseline + Cool Roof, 100% of roof at Abs=0.3 Baseline + High Efficiency Glazing, U=0.26, SHGC=0.29 Baseline + High Efficiency Heating, Boiler Comb Eff = 85% Baseline + High Efficiency Cooling, 0.461 kW/ton Centrifugal Chillers	Elec kWh 9,816,055 9,810,413 5,429,196 9,803,718 9,560,870 9,816,055 9,621,466	Elec MMBtu 111,863 111,800 61,870 111,723 108,957 111,863 109,646	Gas MMBtu 36,286 36,290 69,878 36,315 30,518 34,366 36,286	Total MMBtu 148,149 148,090 131,748 148,038 139,475 146,229 145,931	MMBtu Diff 0 59 16,401 111 8,674 1,920 2,218
Category and Measure Baseline Baseline Baseline + High Efficiency Appliances, Energy Star Rated Baseline + Combined Heat and Power, 1500 kW, 250 ton absorber Baseline + Cool Roof, 100% of roof at Abs=0.3 Baseline + High Efficiency Glazing, U=0.26, SHGC=0.29 Baseline + High Efficiency Heating, Boiler Comb Eff = 85% Baseline + High Efficiency Cooling, 0.461 kW/ton Centrifugal Chillers Baseline + High Efficiency Lighting, 0.675 watts/sqft	Elec kWh 9,816,055 9,810,413 5,429,196 9,803,718 9,560,870 9,816,055 9,621,466 9,707,522	Elec MMBtu 111,863 111,800 61,870 111,723 108,957 111,863 109,646 110,627	Gas MMBtu 36,286 36,290 69,878 36,315 30,518 34,366 36,286 36,381	Total MMBtu 148,149 148,090 131,748 148,038 139,475 146,229 145,931 147,009	MMBtu Diff 0 59 16,401 111 8,674 1,920 2,218 1,141
Category and Measure Baseline Baseline + High Efficiency Appliances, Energy Star Rated Baseline + Combined Heat and Power, 1500 kW, 250 ton absorber Baseline + Cool Roof, 100% of roof at Abs=0.3 Baseline + High Efficiency Glazing, U=0.26, SHGC=0.29 Baseline + High Efficiency Glazing, U=0.26, SHGC=0.29 Baseline + High Efficiency Leating, Boiler Comb Eff = 85% Baseline + High Efficiency Lighting, 0.675 watts/sqft Baseline + High Efficiency Lighting, 0.675 watts/sqft Baseline + Envelope Insulation - Roof, 6'' R23 XPS	Elec kWh 9,816,055 9,810,413 5,429,196 9,803,718 9,560,870 9,816,055 9,621,466 9,707,522 9,813,230	Elec MMBtu 111,863 111,800 61,870 111,723 108,957 111,863 109,646 110,627 111,833	Gas MMBtu 36,286 36,290 69,878 36,315 30,518 34,366 36,286 36,286 36,381 36,265	Total MMBtu 148,149 148,090 131,748 148,038 139,475 146,229 145,931 147,009 148,098	MMBtu Diff 0 59 16,401 111 8,674 1,920 2,218 1,141 51
Category and Measure Baseline Baseline + High Efficiency Appliances, Energy Star Rated Baseline + Combined Heat and Power, 1500 kW, 250 ton absorber Baseline + Cool Roof, 100% of roof at Abs=0.3 Baseline + High Efficiency Glazing, U=0.26, SHGC=0.29 Baseline + High Efficiency Heating, Boiler Comb Eff = 85% Baseline + High Efficiency Cooling, 0.461 kW/ton Centrifugal Chillers Baseline + High Efficiency Lighting, 0.675 watts/sqft Baseline + Envelope Insulation - Roof, 6" R23 XPS Baseline + Thermal Storage, 15% of max load, 3299 ton-hrs	Elec kWh 9,816,055 9,810,413 5,429,196 9,803,718 9,560,870 9,816,055 9,621,466 9,707,522 9,813,230 9,888,220	Elec MMBtu 111,863 111,800 61,870 111,723 108,957 111,863 109,646 110,627 111,833 112,688	Gas MMBtu 36,286 36,290 69,878 36,315 30,518 34,366 36,286 36,286 36,281 36,265 36,286	Total MMBtu 148,149 148,090 131,748 148,038 139,475 146,229 145,931 147,009 148,098 148,974	MMBtu Diff 0 59 16,401 111 8,674 1,920 2,218 1,141 51 -825

Prototype 11 – 12-story Midrise Residential Data

Category and Measure	Elec Cost	Gas Cost	Total Cost	Alt Cost	Payback
Baseline	\$270,294	\$86,909	\$357,203	\$0	NA
Baseline + High Efficiency Appliances, Energy Star Rated	\$270,147	\$86,922	\$357,069	\$34,139	254.8
Baseline + Combined Heat and Power, 250 kW, 40 ton absorber	\$120,781	\$173,803	\$294,584	\$600,620	12.1
Baseline + Cool Roof, 100% of roof at Abs=0.3	\$269,085	\$87,036	\$356,120	\$4,590	4.2
Baseline + High Efficiency Glazing, U=0.26, SHGC=0.29	\$258,983	\$71,449	\$330,432	\$227,677	8.5
Baseline + High Efficiency Heating, Boiler Comb Eff = 85%	\$270,294	\$82,143	\$352,437	\$20,853	4.4
Baseline + High Efficiency Cooling, 0.461 kW/ton Centrifugal Chillers	\$263,659	\$86,909	\$350,568	\$14,027	2.1
Baseline + High Efficiency Lighting, 0.675 watts/sqft	\$266,874	\$87,212	\$354,086	\$382,501	122.7
Baseline + Envelope Insulation - Roof, 6" R23 XPS	\$270,215	\$86,889	\$357,103	\$2,504	25.0
Baseline + Thermal Storage, 15% of max load, 506 ton-hrs	\$267,670	\$86,909	\$354,579	\$35,438	13.5
Baseline + Envelope Insulation - Walls, R19, 2x4.16	\$269,902	\$85,469	\$355,371	\$15,062	8.2
Category and Measure	Elec kWh	Elec MMBtu	Gas MMBtu	Total MMBtu	MMBtu Diff
Category and Measure Baseline	Elec kWh 1,522,627	Elec MMBtu 17,351	Gas MMBtu 6,047	Total MMBtu 23,399	MMBtu Diff 0
Category and Measure Baseline Baseline + High Efficiency Appliances, Energy Star Rated	Elec kWh 1,522,627 1,521,775	Elec MMBtu 17,351 17,341	Gas MMBtu 6,047 6,049	Total MMBtu 23,399 23,390	MMBtu Diff 0 9
Category and Measure Baseline Baseline + High Efficiency Appliances, Energy Star Rated Baseline + Combined Heat and Power, 250 kW, 40 ton absorber	Elec kWh 1,522,627 1,521,775 830,077	Elec MMBtu 17,351 17,341 9,459	Gas MMBtu 6,047 6,049 12,717	Total MMBtu 23,399 23,390 22,176	MMBtu Diff 0 9 1,223
Category and Measure Baseline Baseline + High Efficiency Appliances, Energy Star Rated Baseline + Combined Heat and Power, 250 kW, 40 ton absorber Baseline + Cool Roof, 100% of roof at Abs=0.3	Elec kWh 1,522,627 1,521,775 830,077 1,517,903	Elec MMBtu 17,351 17,341 9,459 17,298	Gas MMBtu 6,047 6,049 12,717 6,057	Total MMBtu 23,399 23,390 22,176 23,355	MMBtu Diff 0 9 1,223 44
Category and Measure Baseline Baseline + High Efficiency Appliances, Energy Star Rated Baseline + Combined Heat and Power, 250 kW, 40 ton absorber Baseline + Cool Roof, 100% of roof at Abs=0.3 Baseline + High Efficiency Glazing, U=0.26, SHGC=0.29	Elec kWh 1,522,627 1,521,775 830,077 1,517,903 1,459,927	Elec MMBtu 17,351 17,341 9,459 17,298 16,637	Gas MMBtu 6,047 6,049 12,717 6,057 4,933	Total MMBtu 23,399 23,390 22,176 23,355 21,570	MMBtu Diff 0 9 1,223 44 1,829
Category and Measure Baseline Baseline + High Efficiency Appliances, Energy Star Rated Baseline + Combined Heat and Power, 250 kW, 40 ton absorber Baseline + Cool Roof, 100% of roof at Abs=0.3 Baseline + High Efficiency Glazing, U=0.26, SHGC=0.29 Baseline + High Efficiency Heating, Boiler Comb Eff = 85%	Elec kWh 1,522,627 1,521,775 830,077 1,517,903 1,459,927 1,522,627	Elec MMBtu 17,351 17,341 9,459 17,298 16,637 17,351	Gas MMBtu 6,047 6,049 12,717 6,057 4,933 5,707	Total MMBtu 23,399 23,390 22,176 23,355 21,570 23,058	MMBtu Diff 0 9 1,223 44 1,829 340
Category and Measure Baseline Baseline + High Efficiency Appliances, Energy Star Rated Baseline + Combined Heat and Power, 250 kW, 40 ton absorber Baseline + Cool Roof, 100% of roof at Abs=0.3 Baseline + High Efficiency Glazing, U=0.26, SHGC=0.29 Baseline + High Efficiency Heating, Boiler Comb Eff = 85% Baseline + High Efficiency Cooling, 0.461 kW/ton Centrifugal Chillers	Elec kWh 1,522,627 1,521,775 830,077 1,517,903 1,459,927 1,522,627 1,491,627	Elec MMBtu 17,351 17,341 9,459 17,298 16,637 17,351 16,997	Gas MMBtu 6,047 6,049 12,717 6,057 4,933 5,707 6,047	Total MMBtu 23,399 23,390 22,176 23,355 21,570 23,058 23,045	MMBtu Diff 0 9 1,223 44 1,829 340 354
Category and Measure Baseline Baseline + High Efficiency Appliances, Energy Star Rated Baseline + Combined Heat and Power, 250 kW, 40 ton absorber Baseline + Cool Roof, 100% of roof at Abs=0.3 Baseline + High Efficiency Glazing, U=0.26, SHGC=0.29 Baseline + High Efficiency Heating, Boiler Comb Eff = 85% Baseline + High Efficiency Cooling, 0.461 kW/ton Centrifugal Chillers Baseline + High Efficiency Lighting, 0.675 watts/sqft	Elec kWh 1,522,627 1,521,775 830,077 1,517,903 1,459,927 1,522,627 1,491,627 1,506,623	Elec MMBtu 17,351 17,341 9,459 17,298 16,637 17,351 16,997 17,171	Gas MMBtu 6,047 6,049 12,717 6,057 4,933 5,707 6,047 6,069	Total MMBtu 23,399 23,390 22,176 23,355 21,570 23,058 23,045 23,240	MMBtu Diff 0 9 1,223 44 1,829 340 354 158
Category and Measure Baseline Baseline + High Efficiency Appliances, Energy Star Rated Baseline + Combined Heat and Power, 250 kW, 40 ton absorber Baseline + Combined Heat and Power, 250 kW, 40 ton absorber Baseline + Cool Roof, 100% of roof at Abs=0.3 Baseline + High Efficiency Glazing, U=0.26, SHGC=0.29 Baseline + High Efficiency Heating, Boiler Comb Eff = 85% Baseline + High Efficiency Lighting, 0.675 watts/sqft Baseline + High Efficiency Lighting, 0.675 watts/sqft Baseline + Envelope Insulation - Roof, 6" R23 XPS	Elec kWh 1,522,627 1,521,775 830,077 1,517,903 1,459,927 1,522,627 1,491,627 1,506,623 1,522,280	Elec MMBtu 17,351 17,341 9,459 17,298 16,637 17,351 16,997 17,171 17,348	Gas MMBtu 6,047 6,049 12,717 6,057 4,933 5,707 6,047 6,069 6,046	Total MMBtu 23,399 23,390 22,176 23,355 21,570 23,058 23,045 23,240 23,394	MMBtu Diff 0 9 1,223 44 1,829 340 354 158 4
Category and Measure Baseline Baseline + High Efficiency Appliances, Energy Star Rated Baseline + Combined Heat and Power, 250 kW, 40 ton absorber Baseline + Combined Heat and Power, 250 kW, 40 ton absorber Baseline + Cool Roof, 100% of roof at Abs=0.3 Baseline + High Efficiency Glazing, U=0.26, SHGC=0.29 Baseline + High Efficiency Heating, Boiler Comb Eff = 85% Baseline + High Efficiency Cooling, 0.461 kW/ton Centrifugal Chillers Baseline + High Efficiency Lighting, 0.675 watts/sqft Baseline + Envelope Insulation - Roof, 6" R23 XPS Baseline + Thermal Storage, 15% of max load, 506 ton-hrs	Elec kWh 1,522,627 1,521,775 830,077 1,517,903 1,459,927 1,522,627 1,491,627 1,506,623 1,522,280 1,525,671	Elec MMBtu 17,351 17,341 9,459 17,298 16,637 17,351 16,997 17,171 17,348 17,388	Gas MMBtu 6,047 6,049 12,717 6,057 4,933 5,707 6,047 6,069 6,046 6,047	Total MMBtu 23,399 23,390 22,176 23,355 21,570 23,058 23,045 23,240 23,240 23,394 23,436	MMBtu Diff 0 9 1,223 44 1,829 340 354 158 4 -37

Prototype 12 – 55-story Highrise Mixed Use, Office Data

Category and Measure	Elec Cost	Gas Cost	Total Cost	Alt Cost	Payback
Baseline	\$3,888,611	\$291,930	\$4,180,541	\$0	NA
Baseline + Combined Heat and Power, 3500 kW, 680 ton absorber	\$1,417,114	\$1,542,199	\$2,959,313	\$8,510,130	8.4
Baseline + High Efficiency Glazing, U=0.26, SHGC=0.29	\$3,827,554	\$228,393	\$4,055,947	\$901,609	7.2
Baseline + High Efficiency Heating, Boiler Comb Eff = 85%	\$3,888,611	\$275,032	\$4,163,643	\$300,647	17.8
Baseline + High Efficiency Cooling, 0.461 kW/ton Centrifugal Chillers	\$3,768,660	\$291,930	\$4,060,591	\$247,163	2.1
Baseline + High Efficiency Lighting, 0.9 watts/sqft	\$3,672,496	\$301,957	\$3,974,453	\$2,443,757	11.9
Baseline + Thermal Storage, 25% of max load, 10798 ton-hrs	\$3,745,058	\$291,930	\$4,036,989	\$755,848	5.3
Baseline + Envelope Insulation - Walls, Reduced thermal bridging	\$3,843,543	\$232,033	\$4,075,576	\$901,609	8.6
		2			
Category and Measure	Elec kWh	Elec MMBtu	Gas MMBtu	Total MMBtu	MMBtu Diff
Category and Measure Baseline	Elec kWh 18,848,550	Elec MMBtu 214,799	Gas MMBtu 20,858	Total MMBtu 235,657	MMBtu Diff 0
Category and Measure Baseline Baseline + Combined Heat and Power, 3500 kW, 680 ton absorber	Elec kWh 18,848,550 7,758,062	Elec MMBtu 214,799 88,413	Gas MMBtu 20,858 118,310	Total MMBtu 235,657 206,723	MMBtu Diff 0 28,934
Category and Measure Baseline Baseline + Combined Heat and Power, 3500 kW, 680 ton absorber Baseline + High Efficiency Glazing, U=0.26, SHGC=0.29	Elec kWh 18,848,550 7,758,062 18,567,840	Elec MMBtu 214,799 88,413 211,599	Gas MMBtu 20,858 118,310 16,250	Total MMBtu 235,657 206,723 227,850	MMBtu Diff 0 28,934 7,808
Category and Measure Baseline Baseline + Combined Heat and Power, 3500 kW, 680 ton absorber Baseline + High Efficiency Glazing, U=0.26, SHGC=0.29 Baseline + High Efficiency Heating, Boiler Comb Eff = 85%	Elec kWh 18,848,550 7,758,062 18,567,840 18,848,550	Elec MMBtu 214,799 88,413 211,599 214,799	Gas MMBtu 20,858 118,310 16,250 19,638	Total MMBtu 235,657 206,723 227,850 234,436	MMBtu Diff 0 28,934 7,808 1,221
Category and Measure Baseline Baseline + Combined Heat and Power, 3500 kW, 680 ton absorber Baseline + High Efficiency Glazing, U=0.26, SHGC=0.29 Baseline + High Efficiency Heating, Boiler Comb Eff = 85% Baseline + High Efficiency Cooling, 0.461 kW/ton Centrifugal Chillers	Elec kWh 18,848,550 7,758,062 18,567,840 18,848,550 18,456,650	Elec MMBtu 214,799 88,413 211,599 214,799 210,333	Gas MMBtu 20,858 118,310 16,250 19,638 20,858	Total MMBtu 235,657 206,723 227,850 234,436 231,191	MMBtu Diff 0 28,934 7,808 1,221 4,466
Category and Measure Baseline Baseline + Combined Heat and Power, 3500 kW, 680 ton absorber Baseline + High Efficiency Glazing, U=0.26, SHGC=0.29 Baseline + High Efficiency Heating, Boiler Comb Eff = 85% Baseline + High Efficiency Cooling, 0.461 kW/ton Centrifugal Chillers Baseline + High Efficiency Lighting, 0.9 watts/sqft	Elec kWh 18,848,550 7,758,062 18,567,840 18,848,550 18,456,650 17,873,240	Elec MMBtu 214,799 88,413 211,599 214,799 210,333 203,683	Gas MMBtu 20,858 118,310 16,250 19,638 20,858 21,586	Total MMBtu 235,657 206,723 227,850 234,436 231,191 225,269	MMBtu Diff 0 28,934 7,808 1,221 4,466 10,388
Category and Measure Baseline Baseline + Combined Heat and Power, 3500 kW, 680 ton absorber Baseline + High Efficiency Glazing, U=0.26, SHGC=0.29 Baseline + High Efficiency Heating, Boiler Comb Eff = 85% Baseline + High Efficiency Cooling, 0.461 kW/ton Centrifugal Chillers Baseline + High Efficiency Lighting, 0.9 watts/sqft Baseline + Thermal Storage, 25% of max load, 10798 ton-hrs	Elec kWh 18,848,550 7,758,062 18,567,840 18,848,550 18,456,650 17,873,240 19,028,540	Elec MMBtu 214,799 88,413 211,599 214,799 210,333 203,683 216,850	Gas MMBtu 20,858 118,310 16,250 19,638 20,858 21,586 20,858	Total MMBtu 235,657 206,723 227,850 234,436 231,191 225,269 237,708	MMBtu Diff 0 28,934 7,808 1,221 4,466 10,388 -2,051

Prototype 12 – 55-story Highrise Mixed Use, Residential Data

Catagory and Moasura	Eloc Cost	Gos Cost	Total Cost	Alt Cost	Payhack
				AILOUSI	FayDack
Baseline	\$1,791,409	\$522,467	\$2,313,876	\$0	NA
Baseline + High Efficiency Appliances, Energy Star Rated	\$1,790,462	\$522,494	\$2,312,956	\$218,063	237.0
Baseline + Combined Heat and Power, 1500 kW, 270 ton absorber	\$773,138	\$957,670	\$1,730,808	\$3,604,028	7.2
Baseline + Cool Roof, 100% of roof at Abs=0.3	\$1,789,493	\$522,846	\$2,312,339	\$11,947	7.8
Baseline + High Efficiency Glazing, U=0.26, SHGC=0.29	\$1,741,437	\$435,148	\$2,176,585	\$901,609	6.6
Baseline + High Efficiency Heating, Boiler Comb Eff = 85%	\$1,791,409	\$495,343	\$2,286,753	\$122,201	4.5
Baseline + High Efficiency Cooling, 0.461 kW/ton Centrifugal Chillers	\$1,745,939	\$522,467	\$2,268,405	\$98,284	2.2
Baseline + High Efficiency Lighting, 0.675 watts/sqft	\$1,770,355	\$523,030	\$2,293,384	\$2,443,757	119.3
Baseline + Envelope Insulation - Roof, 6" R23 XPS	\$1,791,028	\$522,396	\$2,313,424	\$6,517	14.4
Baseline + Thermal Storage, 15% of max load, 3472 ton-hrs	\$1,780,065	\$522,467	\$2,302,532	\$243,034	21.4
Baseline + Envelope Insulation - Walls, Reduced thermal bridging	\$1,753,358	\$442,714	\$2,196,072	\$901,609	7.7
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Category and Measure	Elec kWh	Elec MMBtu	Gas MMBtu	Total MMBtu	MMBtu Diff
Category and Measure Baseline	Elec kWh 10,064,280	Elec MMBtu 114,692	Gas MMBtu 37,564	Total MMBtu 152,257	MMBtu Diff 0
Category and Measure Baseline Baseline + High Efficiency Appliances, Energy Star Rated	Elec kWh 10,064,280 10,058,920	Elec MMBtu 114,692 114,632	Gas MMBtu 37,564 37,566	Total MMBtu 152,257 152,199	MMBtu Diff 0 58
Category and Measure Baseline Baseline + High Efficiency Appliances, Energy Star Rated Baseline + Combined Heat and Power, 1500 kW, 270 ton absorber	Elec kWh 10,064,280 10,058,920 5,588,816	Elec MMBtu 114,692 114,632 63,690	Gas MMBtu 37,564 37,566 71,888	Total MMBtu 152,257 152,199 135,579	MMBtu Diff 0 58 16,678
Category and Measure Baseline Baseline + High Efficiency Appliances, Energy Star Rated Baseline + Combined Heat and Power, 1500 kW, 270 ton absorber Baseline + Cool Roof, 100% of roof at Abs=0.3	Elec kWh 10,064,280 10,058,920 5,588,816 10,053,900	Elec MMBtu 114,692 114,632 63,690 114,575	Gas MMBtu 37,564 37,566 71,888 37,593	Total MMBtu 152,257 152,199 135,579 152,168	MMBtu Diff 0 58 16,678 89
Category and Measure Baseline Baseline + High Efficiency Appliances, Energy Star Rated Baseline + Combined Heat and Power, 1500 kW, 270 ton absorber Baseline + Cool Roof, 100% of roof at Abs=0.3 Baseline + High Efficiency Glazing, U=0.26, SHGC=0.29	Elec kWh 10,064,280 10,058,920 5,588,816 10,053,900 9,791,154	Elec MMBtu 114,692 114,632 63,690 114,575 111,579	Gas MMBtu 37,564 37,566 71,888 37,593 31,231	Total MMBtu 152,257 152,199 135,579 152,168 142,810	MMBtu Diff 0 58 16,678 89 9,446
Category and Measure Baseline Baseline + High Efficiency Appliances, Energy Star Rated Baseline + Combined Heat and Power, 1500 kW, 270 ton absorber Baseline + Cool Roof, 100% of roof at Abs=0.3 Baseline + High Efficiency Glazing, U=0.26, SHGC=0.29 Baseline + High Efficiency Heating, Boiler Comb Eff = 85%	Elec kWh 10,064,280 10,058,920 5,588,816 10,053,900 9,791,154 10,064,280	Elec MMBtu 114,692 114,632 63,690 114,575 111,579 114,692	Gas MMBtu 37,564 37,566 71,888 37,593 31,231 35,598	Total MMBtu 152,257 152,199 135,579 152,168 142,810 150,290	MMBtu Diff 0 58 16,678 89 9,446 1,966
Category and Measure Baseline Baseline + High Efficiency Appliances, Energy Star Rated Baseline + Combined Heat and Power, 1500 kW, 270 ton absorber Baseline + Cool Roof, 100% of roof at Abs=0.3 Baseline + High Efficiency Glazing, U=0.26, SHGC=0.29 Baseline + High Efficiency Heating, Boiler Comb Eff = 85% Baseline + High Efficiency Cooling, 0.461 kW/ton Centrifugal Chillers	Elec kWh 10,064,280 10,058,920 5,588,816 10,053,900 9,791,154 10,064,280 9,854,940	Elec MMBtu 114,692 114,632 63,690 114,575 111,579 114,692 112,308	Gas MMBtu 37,564 37,566 71,888 37,593 31,231 35,598 37,564	Total MMBtu 152,257 152,199 135,579 152,168 142,810 150,290 149,872	MMBtu Diff 0 58 16,678 89 9,446 1,966 2,385
Category and Measure Baseline Baseline + High Efficiency Appliances, Energy Star Rated Baseline + Combined Heat and Power, 1500 kW, 270 ton absorber Baseline + Cool Roof, 100% of roof at Abs=0.3 Baseline + High Efficiency Glazing, U=0.26, SHGC=0.29 Baseline + High Efficiency Heating, Boiler Comb Eff = 85% Baseline + High Efficiency Cooling, 0.461 kW/ton Centrifugal Chillers Baseline + High Efficiency Lighting, 0.675 watts/sqft	Elec kWh 10,064,280 10,058,920 5,588,816 10,053,900 9,791,154 10,064,280 9,854,940 9,954,384	Elec MMBtu 114,692 114,632 63,690 114,575 111,579 114,692 112,308 113,440	Gas MMBtu 37,564 37,566 71,888 37,593 31,231 35,598 37,564 37,605	Total MMBtu 152,257 152,199 135,579 152,168 142,810 150,290 149,872 151,045	MMBtu Diff 0 58 16,678 89 9,446 1,966 2,385 1,212
Category and Measure Baseline Baseline + High Efficiency Appliances, Energy Star Rated Baseline + Combined Heat and Power, 1500 kW, 270 ton absorber Baseline + Cool Roof, 100% of roof at Abs=0.3 Baseline + High Efficiency Glazing, U=0.26, SHGC=0.29 Baseline + High Efficiency Heating, Boiler Comb Eff = 85% Baseline + High Efficiency Cooling, 0.461 kW/ton Centrifugal Chillers Baseline + High Efficiency Lighting, 0.675 watts/sqft Baseline + Envelope Insulation - Roof, 6" R23 XPS	Elec kWh 10,064,280 10,058,920 5,588,816 10,053,900 9,791,154 10,064,280 9,854,940 9,954,384 10,062,010	Elec MMBtu 114,692 114,632 63,690 114,575 111,579 114,692 112,308 113,440 114,669	Gas MMBtu 37,564 37,566 71,888 37,593 31,231 35,598 37,564 37,605 37,560	Total MMBtu 152,257 152,199 135,579 152,168 142,810 150,290 149,872 151,045 152,229	MMBtu Diff 0 58 16,678 89 9,446 1,966 2,385 1,212 28
Category and Measure Baseline Baseline + High Efficiency Appliances, Energy Star Rated Baseline + Combined Heat and Power, 1500 kW, 270 ton absorber Baseline + Cool Roof, 100% of roof at Abs=0.3 Baseline + High Efficiency Glazing, U=0.26, SHGC=0.29 Baseline + High Efficiency Heating, Boiler Comb Eff = 85% Baseline + High Efficiency Lighting, 0.675 watts/sqft Baseline + High Efficiency Lighting, 0.675 watts/sqft Baseline + Envelope Insulation - Roof, 6" R23 XPS Baseline + Thermal Storage, 15% of max load, 3472 ton-hrs	Elec kWh 10,064,280 10,058,920 5,588,816 10,053,900 9,791,154 10,064,280 9,854,940 9,954,384 10,062,010 10,140,410	Elec MMBtu 114,692 114,632 63,690 114,575 111,579 114,692 112,308 113,440 114,669 115,561	Gas MMBtu 37,564 37,566 71,888 37,593 31,231 35,598 37,564 37,564 37,560 37,560	Total MMBtu 152,257 152,199 135,579 152,168 142,810 150,290 149,872 151,045 152,229 153,125	MMBtu Diff 0 58 16,678 89 9,446 1,966 2,385 1,212 28 -868

Corner Retail Shop - Type I Construction Data

Category and Measure	Elec Cost	Gas Cost	Total Cost	Alt Cost	Payback
Baseline	\$9,681	\$3,108	\$12,789	\$0	NA
Baseline + High Efficiency Domestic Hot Water, EF=0.823	\$9,681	\$2,818	\$12,499	\$371	1.3
Baseline + High Efficiency Glazing, U=0.26, SHGC=0.29	\$9,313	\$2,933	\$12,246	\$3,767	6.9
Baseline + High Efficiency Heating, Furnace 94% AFUE	\$9,681	\$2,756	\$12,437	\$1,163	3.3
Baseline + High Efficiency Cooling, 14 SEER, 12.5 EER Unitary AC	\$8,988	\$3,108	\$12,097	\$2,588	3.7
Baseline + Envelope Insulation - Walls, Reduced thermal bridging	\$9,492	\$2,895	\$12,387	\$11,930	29.7
Category and Measure	Elec kWh	Elec MMBtu	Gas MMBtu	Total MMBtu	MMBtu Diff
Category and Measure Baseline	Elec kWh 44,572	Elec MMBtu 508	Gas MMBtu 188	Total MMBtu 696	MMBtu Diff 0
Category and Measure Baseline Baseline + High Efficiency Domestic Hot Water, EF=0.823	Elec kWh 44,572 44,572	Elec MMBtu 508 508	Gas MMBtu 188 170	Total MMBtu 696 677	MMBtu Diff 0 19
Category and Measure Baseline Baseline + High Efficiency Domestic Hot Water, EF=0.823 Baseline + High Efficiency Glazing, U=0.26, SHGC=0.29	Elec kWh 44,572 44,572 42,964	Elec MMBtu 508 508 491	Gas MMBtu 188 170 177	Total MMBtu 696 677 668	MMBtu Diff 0 19 28
Category and Measure Baseline Baseline + High Efficiency Domestic Hot Water, EF=0.823 Baseline + High Efficiency Glazing, U=0.26, SHGC=0.29 Baseline + High Efficiency Heating, Furnace 94% AFUE	Elec kWh 44,572 44,572 42,964 44,572	Elec MMBtu 508 508 491 508	Gas MMBtu 188 170 177 165	Total MMBtu 696 677 668 673	MMBtu Diff 0 19 28 23
Category and Measure Baseline Baseline + High Efficiency Domestic Hot Water, EF=0.823 Baseline + High Efficiency Glazing, U=0.26, SHGC=0.29 Baseline + High Efficiency Heating, Furnace 94% AFUE Baseline + High Efficiency Cooling, 14 SEER, 12.5 EER Unitary AC	Elec kWh 44,572 44,572 42,964 44,572 42,399	Elec MMBtu 508 508 491 508 484	Gas MMBtu 188 170 177 165 188	Total MMBtu 696 677 668 673 673	MMBtu Diff 0 19 28 23 23 23

Internal Retail Shop – Type I Construction Data

Category and Measure	Elec Cost	Gas Cost	Total Cost	Alt Cost	Payback
Baseline	\$8,561	\$2,485	\$11,046	\$0	NA
Baseline + High Efficiency Domestic Hot Water, EF=0.823	\$8,561	\$2,193	\$10,753	\$371	1.3
Baseline + High Efficiency Glazing, U=0.26, SHGC=0.29	\$8,410	\$2,392	\$10,802	\$1,884	7.7
Baseline + High Efficiency Heating, Furnace 94% AFUE	\$8,561	\$2,242	\$10,802	\$891	3.7
Baseline + High Efficiency Cooling, 14 SEER, 12.5 EER Unitary AC	\$8,015	\$2,485	\$10,500	\$2,050	3.8
Baseline + Envelope Insulation - Walls, Reduced thermal bridging	\$8,451	\$2,365	\$10,816	\$13,813	60.1
Category and Measure	Elec kWh	Elec MMBtu	Gas MMBtu	Total MMBtu	MMBtu Diff
Baseline	39,669	451	147	597	0
Baseline + High Efficiency Domestic Hot Water, EF=0.823	39,669	451	129	580	18
Baseline + High Efficiency Glazing, U=0.26, SHGC=0.29	39,065	444	140	585	13
Baseline + High Efficiency Heating, Furnace 94% AFUE	39,669	451	131	582	16
Baseline + High Efficiency Cooling, 14 SEER, 12.5 EER Unitary AC	37,918	431	147	577	20
Baseline + Envelope Insulation - Walls, Reduced thermal bridging	39.219	448	139	587	11

Corner Restaurant – Type I Construction Data

Category and Measure	Elec Cost	Gas Cost	Total Cost	Alt Cost	Payback
Baseline	\$71,291	\$43,804	\$115,095	\$0	NA
Baseline + High Efficiency Domestic Hot Water, EF=0.823	\$71,291	\$43,640	\$114,931	\$1,483	9.0
Baseline + High Efficiency Glazing, U=0.26, SHGC=0.29	\$70,880	\$43,337	\$114,218	\$7,247	8.3
Baseline + High Efficiency Heating, Furnace 94% AFUE	\$71,291	\$40,582	\$111,872	\$7,019	2.2
Baseline + High Efficiency Cooling, 14 SEER, 12.5 EER Unitary AC	\$69,330	\$43,804	\$113,135	\$7,674	3.9
Baseline + Envelope Insulation - Walls, Reduced thermal bridging	\$70,896	\$43,400	\$114,296	\$22,947	28.7
Category and Measure	Elec kWh	Elec MMBtu	Gas MMBtu	Total MMBtu	MMBtu Diff
Category and Measure Baseline	Elec kWh 376,430	Elec MMBtu 4,289	Gas MMBtu 2,933	Total MMBtu 7,221	MMBtu Diff 0
Category and Measure Baseline Baseline + High Efficiency Domestic Hot Water, EF=0.823	Elec kWh 376,430 376,430	Elec MMBtu 4,289 4,289	Gas MMBtu 2,933 2,922	Total MMBtu 7,221 7,211	MMBtu Diff 0 10
Category and Measure Baseline Baseline + High Efficiency Domestic Hot Water, EF=0.823 Baseline + High Efficiency Glazing, U=0.26, SHGC=0.29	Elec kWh 376,430 376,430 374,525	Elec MMBtu 4,289 4,289 4,269	Gas MMBtu 2,933 2,922 2,900	Total MMBtu 7,221 7,211 7,169	MMBtu Diff 0 10 52
Category and Measure Baseline Baseline + High Efficiency Domestic Hot Water, EF=0.823 Baseline + High Efficiency Glazing, J=0.26, SHGC=0.29 Baseline + High Efficiency Heating, Furnace 94% AFUE	Elec kWh 376,430 376,430 374,525 376,430	Elec MMBtu 4,289 4,289 4,269 4,289	Gas MMBtu 2,933 2,922 2,900 2,706	Total MMBtu 7,221 7,211 7,169 6,995	MMBtu Diff 0 10 52 226
Category and Measure Baseline Baseline + High Efficiency Domestic Hot Water, EF=0.823 Baseline + High Efficiency Glazing, U=0.26, SHGC=0.29 Baseline + High Efficiency Heating, Furnace 94% AFUE Baseline + High Efficiency Cooling, 14 SEER, 12.5 EER Unitary AC	Elec kWh 376,430 376,430 374,525 376,430 369,577	Elec MMBtu 4,289 4,289 4,269 4,289 4,289 4,212	Gas MMBtu 2,933 2,922 2,900 2,706 2,933	Total MMBtu 7,221 7,211 7,169 6,995 7,144	MMBtu Diff 0 10 52 226 77

Corner Retail Shop – Type II Construction Data

Category and Measure	Elec Cost	Gas Cost	Total Cost	Alt Cost	Payback
Baseline	\$9,039	\$2,279	\$11,318	\$0	NA
Baseline + High Efficiency Domestic Hot Water, EF=0.823	\$9,039	\$1,987	\$11,025	\$371	1.3
Baseline + High Efficiency Glazing, U=0.26, SHGC=0.29	\$8,753	\$2,150	\$10,903	\$3,767	9.1
Baseline + High Efficiency Heating, Furnace 94% AFUE	\$9,039	\$2,067	\$11,106	\$908	4.3
Baseline + High Efficiency Cooling, 14 SEER, 12.5 EER Unitary AC	\$8,414	\$2,279	\$10,693	\$2,242	3.6
Baseline + Envelope Insulation - Walls, R19, 2x4.16	\$9,013	\$2,225	\$11,239	\$789	10.0
Category and Measure	Elec kWb	Elec MMBtu	Gas MMBtu	Total MMRtu	MMRtu Diff
eutogoly and modeare		LICC WIWIDIU	Ous miniblu	TOTAL MINIDLU	MINDLU DIII
Baseline	41,614	474	133	607	0
Baseline Baseline + High Efficiency Domestic Hot Water, EF=0.823	41,614 41,614	474 474	133 115	607 589	0 18
Baseline + High Efficiency Domestic Hot Water, EF=0.823 Baseline + High Efficiency Glazing, U=0.26, SHGC=0.29	41,614 41,614 40,421	474 474 461	133 115 125	607 589 586	0 18 22
Baseline Baseline + High Efficiency Domestic Hot Water, EF=0.823 Baseline + High Efficiency Glazing, U=0.26, SHGC=0.29 Baseline + High Efficiency Heating, Furnace 94% AFUE	41,614 41,614 40,421 41,614	474 474 461 474	133 115 125 119	607 589 586 594	0 18 22 14
Baseline + High Efficiency Colory Hating, Furnace 94% AFUE Baseline + High Efficiency Clazing, U=0.26, SHGC=0.29 Baseline + High Efficiency Heating, Furnace 94% AFUE Baseline + High Efficiency Cooling, 14 SEER, 12.5 EER Unitary AC	41,614 41,614 40,421 41,614 39,613	474 474 461 474 451	133 115 125 119 133	607 589 586 594 584	0 18 22 14 23

Internal Retail Shop – Type II Construction Data

Category and Measure	Elec Cost	Gas Cost	Total Cost	Alt Cost	Payback
Baseline	\$8,244	\$2,018	\$10,262	\$0	NA
Baseline + High Efficiency Domestic Hot Water, EF=0.823	\$8,244	\$1,720	\$9,963	\$371	1.2
Baseline + High Efficiency Glazing, U=0.26, SHGC=0.29	\$8,094	\$1,949	\$10,042	\$1,884	8.6
Baseline + High Efficiency Heating, Furnace 94% AFUE	\$8,244	\$1,853	\$10,096	\$751	4.5
Baseline + High Efficiency Cooling, 14 SEER, 12.5 EER Unitary AC	\$7,734	\$2,018	\$9,753	\$1,890	3.7
Baseline + Envelope Insulation - Walls, R19, 2x4.16	\$8,229	\$1,985	\$10,215	\$914	19.4
Category and Measure	Elec kWh	Elec MMBtu	Gas MMBtu	Total MMBtu	MMBtu Diff
Category and Measure Baseline	Elec kWh 38,274	Elec MMBtu 438	Gas MMBtu 116	Total MMBtu 554	MMBtu Diff 0
Category and Measure Baseline Baseline + High Efficiency Domestic Hot Water, EF=0.823	Elec kWh 38,274 38,274	Elec MMBtu 438 438	Gas MMBtu 116 97	Total MMBtu 554 535	MMBtu Diff 0 19
Category and Measure Baseline Baseline + High Efficiency Domestic Hot Water, EF=0.823 Baseline + High Efficiency Glazing, U=0.26, SHGC=0.29	Elec kWh 38,274 38,274 37,636	Elec MMBtu 438 438 428	Gas MMBtu 116 97 111	Total MMBtu 554 535 539	MMBtu Diff 0 19 15
Category and Measure Baseline Baseline + High Efficiency Domestic Hot Water, EF=0.823 Baseline + High Efficiency Glazing, U=0.26, SHGC=0.29 Baseline + High Efficiency Heating, Furnace 94% AFUE	Elec kWh 38,274 38,274 37,636 38,274	Elec MMBtu 438 438 428 438	Gas MMBtu 116 97 111 105	Total MMBtu 554 535 539 542	MMBtu Diff 0 19 15 12
Category and Measure Baseline Baseline + High Efficiency Domestic Hot Water, EF=0.823 Baseline + High Efficiency Glazing, U=0.26, SHGC=0.29 Baseline + High Efficiency Heating, Furnace 94% AFUE Baseline + High Efficiency Cooling, 14 SEER, 12.5 EER Unitary AC	Elec kWh 38,274 37,636 38,274 37,636 38,274 36,617	Elec MMBtu 438 438 428 438 438 418	Gas MMBtu 116 97 111 105 116	Total MMBtu 5554 535 539 542 534	MMBtu Diff 0 19 15 12 20

Corner Restaurant – Type II Construction Data

Category and Measure	Elec Cost	Gas Cost	Total Cost	Alt Cost	Payback
Baseline	\$69,911	\$42,231	\$112,141	\$0	NA
Baseline + High Efficiency Domestic Hot Water, EF=0.823	\$69,911	\$42,067	\$111,978	\$1,483	9.1
Baseline + High Efficiency Glazing, U=0.26, SHGC=0.29	\$69,585	\$41,888	\$111,473	\$7,247	10.8
Baseline + High Efficiency Heating, Furnace 94% AFUE	\$69,911	\$39,244	\$109,155	\$6,495	2.2
Baseline + High Efficiency Cooling, 14 SEER, 12.5 EER Unitary AC	\$68,084	\$42,231	\$110,315	\$6,940	3.8
Baseline + Envelope Insulation - Walls, R19, 2x4.16	\$69,818	\$42,134	\$111,953	\$1,518	8.1
Category and Measure	Elec kWh	Elec MMBtu	Gas MMBtu	Total MMBtu	MMBtu Diff
Category and Measure Baseline	Elec kWh 370,202	Elec MMBtu 4,218	Gas MMBtu 2,822	Total MMBtu 7,040	MMBtu Diff 0
Category and Measure Baseline Baseline + High Efficiency Domestic Hot Water, EF=0.823	Elec kWh 370,202 370,202	Elec MMBtu 4,218 4,218	Gas MMBtu 2,822 2,810	Total MMBtu 7,040 7,029	MMBtu Diff 0 12
Category and Measure Baseline Baseline + High Efficiency Domestic Hot Water, EF=0.823 Baseline + High Efficiency Glazing, U=0.26, SHGC=0.29	Elec kWh 370,202 370,202 368,631	Elec MMBtu 4,218 4,218 4,202	Gas MMBtu 2,822 2,810 2,798	Total MMBtu 7,040 7,029 6,999	MMBtu Diff 0 12 41
Category and Measure Baseline Baseline + High Efficiency Domestic Hot Water, EF=0.823 Baseline + High Efficiency Glazing, U=0.26, SHGC=0.29 Baseline + High Efficiency Heating, Furnace 94% AFUE	Elec kWh 370,202 370,202 368,631 370,202	Elec MMBtu 4,218 4,218 4,202 4,218	Gas MMBtu 2,822 2,810 2,798 2,613	Total MMBtu 7,040 7,029 6,999 6,832	MMBtu Diff 0 12 41 208
Category and Measure Baseline Baseline + High Efficiency Domestic Hot Water, EF=0.823 Baseline + High Efficiency Glazing, U=0.26, SHGC=0.29 Baseline + High Efficiency Heating, Furnace 94% AFUE Baseline + High Efficiency Cooling, 14 SEER, 12.5 EER Unitary AC	Elec kWh 370,202 368,631 370,202 363,708	Elec MMBtu 4,218 4,218 4,202 4,218 4,218 4,145	Gas MMBtu 2,822 2,810 2,798 2,613 2,822	Total MMBtu 7,040 7,029 6,999 6,832 6,967	MMBtu Diff 0 12 41 208 73

-	Frototype of - So-Story ringing	se Onice (Qty T)		DAU		IVIIQ-	LOW	IV	lia	Mia-High			gn
Measure	Baseline	Alternative	Payback	Pen Rate	Total Pen	Pen Rate	Total Pen	Pen Rate	Total Pen	Pen Rate	Total Pen	Pen Rate	Total Pen
Appliances	None	None	NA	١	IA	N	A	L L	NA .	N	IA	N	JA A
CHP	None	6500 kW, 1390 ton absorber	9.1	17%	0	21%	0	24%	0	28%	0	31%	0
Cool Roof	100% of roof at Abs=0.90	100% of roof at Abs=0.3	20.2	4%	0	5%	0	6%	0	7%	0	8%	0
Water Heating	Boiler Comb Eff = 80%	Boiler Comb Eff = 85%	NA	See Spa	ce Heating	See Space	e Heating	See Space	ce Heating	See Space	e Heating	See Space	ce Heating
Windows	U=0.50, SHGC=0.35	U=0.26, SHGC=0.29	7.4	21%	0	26%	0	30%	0	34%	0	38%	0
Space Heating	Boiler Comb Eff = 80%	Boiler Comb Eff = 85%	18.9	5%	0	6%	0	7%	0	8%	0	9%	0
Space Cooling	0.576 kW/ton Centrifugal Chillers	0.461 kW/ton Centrifugal Chillers	1.9	43%	0	52%	0	61%	0	70%	0	78%	0
Lighting	1.1 watts/sqft	0.9 watts/sqft	11.1	13%	0	16%	0	19%	0	21%	0	24%	0
Roof Insulation	5" R19 XPS	6" R23 XPS	2.7	39%	0	47%	0	54%	0	62%	0	70%	0
Thermal Storage	None	25% of max load, 23376 ton-hrs	8.5	19%	0	22%	0	26%	0	30%	0	34%	0
Wall Insulation	Typical Aluminum Curtain Wall	Reduced thermal bridging	9.0	17%	0	21%	0	24%	0	28%	0	31%	0
F	Prototype 02 - 41-story Highris	se Office (Qty 6)		BAU		Mid	Low	M	lid	Mid-	High	Hi	gh
F Measure	Prototype 02 - 41-story Highris Baseline	se Office (Qty 6) Alternative	Payback	BAU Pen Rate	Total Pen	Mid- Pen Rate	Low Total Pen	N Pen Rate	lid Total Pen	Mid- Pen Rate	High Total Pen	Hi Pen Rate	igh Total Pen
Measure Appliances	Prototype 02 - 41-story Highris Baseline None	se Office (Qty 6) Alternative None	Payback NA	BAU Pen Rate	Total Pen	Mid- Pen Rate	Low Total Pen	N Pen Rate	lid Total Pen	Mid- Pen Rate	High Total Pen	Hi Pen Rate	i gh Total Pen IA
Measure Appliances CHP	Prototype 02 - 41-story Highris Baseline None None	se Office (Qty 6) Alternative None 5500 kW, 1150 ton absorber	Payback NA 8.8	BAU Pen Rate	Total Pen IA 1	Mid- Pen Rate N 22%	Low Total Pen A	N Pen Rate N 25%	Iid Total Pen M 1	Mid- Pen Rate N 29%	High Total Pen IA 1	Hi Pen Rate N 32%	i gh Total Pen JA 1
Measure Appliances CHP Roof Material	Prototype 02 - 41-story Highris Baseline None None 100% of roof at Abs=0.90	Se Office (Qty 6) Alternative None 5500 kW, 1150 ton absorber 100% of roof at Abs=0.3	Payback NA 8.8 12.2	BAU Pen Rate 18% 12%	Total Pen IA 1 0	Mid- Pen Rate N 22% 14%	Low Total Pen A 1 0	N Pen Rate 25% 16%	Iid Total Pen NA 1 0	Mid- Pen Rate N 29% 19%	High Total Pen IA 1 1	Hi Pen Rate N 32% 21%	i gh Total Pen IA 1 1
Measure Appliances CHP Roof Material Water Heating	Prototype 02 - 41-story Highris Baseline None 100% of roof at Abs=0.90 Boiler Comb Eff = 80%	se Office (Qty 6) <u>Alternative</u> None 5500 kW, 1150 ton absorber 100% of roof at Abs=0.3 Boiler Comb Eff = 85%	Payback NA 8.8 12.2 NA	BAU Pen Rate 18% 12% See Space	Total Pen IA 1 0 ce Heating	Mid- Pen Rate N 22% 14% See Space	Low Total Pen A 1 0 te Heating	Pen Rate N 25% 16% See Space	Iid Total Pen NA 1 0 ce Heating	Mid- Pen Rate N 29% 19% See Space	High Total Pen IA 1 :e Heating	Hi Pen Rate N 32% 21% See Space	i gh Total Pen IA 1 2 Heating
Measure Appliances CHP Roof Material Water Heating Windows	Prototype 02 - 41-story Highris Baseline None None 100% of roof at Abs=0.90 Boiler Comb Eff = 80% U=0.50, SHGC=0.35	See Office (Qty 6) Alternative None 5500 kW, 1150 ton absorber 100% of roof at Abs=0.3 Bolier Comb Eff = 85% U=0.26, SHGC=0.29	Payback NA 8.8 12.2 NA 7.4	BAU Pen Rate 18% 12% See Space 21%	Total Pen IA 0 ce Heating 1	Mid- Pen Rate N 22% 14% See Spac 26%	Low Total Pen A 1 0 te Heating 1	Pen Rate N 25% 16% See Spac 30%	Iid Total Pen VA 1 0 Ce Heating 1	Mid- Pen Rate N 29% 19% See Spac 34%	High Total Pen IA 1 :e Heating 2	Hi Pen Rate 32% 21% See Spac 39%	i gh Total Pen NA 1 1 ∞ Heating 2
Measure Appliances CHP Roof Material Water Heating Windows Space Heating	Prototype 02 - 41-story Highris Baseline None 100% of rof at Abs=0.90 Boiler Comb Eff = 80% U=0.50, SHGC=0.35 Boiler Comb Eff = 80%	See Office (Qty 6) Alternative None 5500 kW, 1150 ton absorber 100% of roof at Abs=0.3 Boiler Comb Eff = 85% U=0.26, SHGC=0.29 Boiler Comb Eff = 85%	Payback NA 8.8 12.2 NA 7.4 19.0	BAU Pen Rate 18% 12% See Space 21% 5%	Total Pen IA 0 ce Heating 1 0	Mid- Pen Rate 22% 14% See Spac 26% 6%	Low Total Pen A 1 0 te Heating 1 0	M Pen Rate 25% 16% See Spac 30% 7%	Iid Total Pen NA 0 ce Heating 1 0	Mid- Pen Rate N 29% 19% See Spac 34% 8%	High Total Pen IA 1 te Heating 2 0	Hi Pen Rate 32% 21% See Spac 39% 9%	igh Total Pen A I E Heating 2 0
Measure Appliances CHP Roof Material Water Heating Windows Space Heating Space Cooling	Prototype 02 - 41-story Highris Baseline None 100% of roof at Abs=0.90 Boiler Comb Eff = 80% U=0.50, SHGC=0.35 Boiler Comb Eff = 80% 0.576 kW/Mon Centrifugal Chillers	See Office (Qty 6) Alternative None 5500 kW, 1150 ton absorber 100% of roof at Abs=0.3 Boiler Comb Eff = 85% U=0.26, SHGC=0.29 Boiler Comb Eff = 85% 0.461 kW/k0n Centrifugal Chillers	Payback NA 8.8 12.2 NA 7.4 19.0 2.0	BAU Pen Rate 18% 12% See Spar 21% 5% 43%	Total Pen IA 0 ce Heating 1 0 2	Mid- Pen Rate 22% 14% See Spac 26% 6% 51%	Low Total Pen A 1 0 te Heating 1 0 3	M Pen Rate 25% 16% See Spac 30% 7% 60%	Iid Total Pen JA 0 Ce Heating 1 0 3	Mid- Pen Rate N 29% 19% See Spac 34% 8% 69%	High Total Pen A 1 te Heating 2 0 4	Hi Pen Rate 32% 21% See Spac 39% 9% 77%	igh Total Pen NA 1 2e Heating 2 0 4
Appliances CHP Roof Material Water Heating Windows Space Heating Space Cooling Lighting	Prototype 02 - 41-story Highris Baseline None 100% of roof at Abs=0.90 Boiler Comb Eff = 80% U=0.50, SHGC=0.35 Boiler Comb Eff = 80% 0.576 kW/kon Centrifugal Chillers 1.1 watts/sqft	See Office (Qty 6) Alternative None 5500 kW, 1150 ton absorber 100% of roof at Abs=0.3 Boiler Comb Eff = 85% U=0.26, SHGC=0.29 Boiler Comb Eff = 85% 0.461 kW/ton Centrifugal Chillers 0.9 watts/sqft	Payback NA 8.8 12.2 NA 7.4 19.0 2.0 11.4	BAU Pen Rate 18% 12% See Spau 21% 5% 43% 13%	Total Pen IA 0 ce Heating 1 0 2 0	Mid- Pen Rate N 22% 14% See Spac 26% 6% 51% 15%	Low Total Pen A 1 0 we Heating 1 0 3 0	N Pen Rate 25% 16% See Spac 30% 7% 60% 18%	Iid Total Pen JA 1 0 ce Heating 1 0 3 3	Mid- Pen Rate N 29% 19% See Spac 34% 8% 69% 21%	High Total Pen A 1 1 :e Heating 2 0 4 4	Hi Pen Rate N 32% 21% See Spac 39% 9% 77% 23%	igh Total Pen JA 1 2e Heating 2 0 4 1
Appliances CHP Cof Material Water Heating Windows Space Heating Space Cooling Lighting Roof Insulation	Prototype 02 - 41-story Highris Baseline None 100% of rof at Abs=0.90 Boiler Comb Eff = 80% U=0.50, SHGC=0.35 Boiler Comb Eff = 80% 0.576 kW/ton Centrifugal Chillers 1.1 watts/sqft 5° R19 XPS	See Office (Qty 6) Alternative None 5500 kW, 1150 ton absorber 100% of roof at Abs=0.3 Boiler Comb Eff = 85% U=0.26, SHGC=0.29 Boiler Comb Eff = 85% 0.461 kW/ton Centrifugal Chillers 0.9 watts/sqft 6" R23 XPS	Payback NA 8.8 12.2 NA 7.4 19.0 2.0 11.4 4.9	BAU Pen Rate 18% 12% See Spar 21% 5% 43% 13% 30%	Total Pen IA 1 0 ce Heating 1 0 2 0 1	Mid- Pen Rate N 22% 14% See Spac 26% 6% 51% 15% 35%	Low Total Pen A 1 0 we Heating 1 0 3 0 2	N Pen Rate 25% 16% See Space 30% 7% 60% 18% 41%	Iid Total Pen JA 1 0 ce Heating 1 0 3 1 2	Mid- Pen Rate N 29% 19% See Spac 34% 8% 69% 21% 47%	High Total Pen A 1 1 e: Heating 2 0 4 1 2	Hi Pen Rate N 32% 21% See Spac 39% 9% 77% 23% 53%	igh Total Pen JA 1 2 Heating 2 0 4 1 3
Appliances CHP Roof Material Water Heating Windows Space Heating Space Cooling Lighting Roof Insulation Thermal Storage	Prototype 02 - 41-story Highris Baseline None 100% of roof at Abs=0.90 Boiler Comb Eff = 80% U=0.50, SHGC=0.35 Boiler Comb Eff = 80% 0.576 kWkton Centrifugal Chillers 1.1 watts/sqt 6" R19 XPS None	See Office (Qty 6) Alternative None 5500 kW, 1150 ton absorber 100% of roof at Abs=0.3 Bolier Comb Eff = 85% U=0.26, SHGC=0.29 Bolier Comb Eff = 85% 0.461 kW/ton Centrityagal Chillers 0.9 watts/sqft 6* R23 XP5 25% of max load, 15073 ton-hrs	Payback NA 8.8 12.2 NA 7.4 19.0 2.0 11.4 4.9 5.3	BAU Pen Rate 18% 12% See Spar 21% 5% 43% 13% 30% 28%	Total Pen IA 0 ce Heating 1 0 2 0 1 1	Mid- Pen Rate 22% 14% See Spac 26% 6% 51% 51% 35% 34%	Low Total Pen A 1 0 e Heating 1 0 3 0 2 2 2	M Pen Rate 25% 16% See Spac 30% 7% 60% 18% 41% 39%	Iid Total Pen A 1 0 ce Heating 1 0 3 1 2 2	Mid- Pen Rate N 29% 19% See Spac 34% 8% 69% 21% 47% 45%	High Total Pen A 1 1 te Heating 2 0 4 1 2 2 2	Hi Pen Rate 32% 21% See Spac 39% 9% 77% 23% 53% 51%	igh Total Pen JA 1 2e Heating 2 0 4 1 3 3

	Prototype 03 - 34-story Highris	se Office (Qty 5)	BAU			Mid-Low		Mid		Mid-High		Hi	gh
Measure	Baseline	Alternative	Payback	Pen Rate	Total Pen	Pen Rate	Total Pen	Pen Rate	Total Pen	Pen Rate	Total Pen	Pen Rate	Total Pen
Appliances	None	None	NA	١	٨٨	N	IA	١	١A	N	IA	N	IA
CHP	None	4500 kW, 1020 ton absorber	8.9	18%	0	21%	1	25%	1	28%	1	32%	1
Roof Material	100% of roof at Abs=0.90	100% of roof at Abs=0.3	7.2	22%	1	26%	1	31%	1	35%	1	40%	1
Water Heating	Boiler Comb Eff = 80%	Boiler Comb Eff = 85%	NA	See Spa	ce Heating	See Space	ce Heating	See Spa	ce Heating	See Space	ce Heating	See Space	ce Heating
Windows	U=0.50, SHGC=0.35	U=0.26, SHGC=0.29	7.3	22%	1	26%	1	31%	1	35%	1	39%	1
Space Heating	Boiler Comb Eff = 80%	Boiler Comb Eff = 85%	18.4	5%	0	6%	0	7%	0	8%	0	10%	0
Space Cooling	0.576 kW/ton Centrifugal Chillers	0.461 kW/ton Centrifugal Chillers	2.0	42%	2	51%	2	59%	2	68%	3	76%	3
Lighting	1.1 watts/sqft	0.9 watts/sqft	11.5	13%	0	15%	0	18%	0	20%	1	23%	1
Roof Insulation	5" R19 XPS	6" R23 XPS	8.8	18%	0	22%	1	25%	1	29%	1	33%	1
Thermal Storage	None	25% of max load, 16172 ton-hrs	6.4	24%	1	29%	1	34%	1	39%	1	44%	2
Wall Insulation	Typical Aluminum Curtain Wall	Reduced thermal bridging	8.8	18%	0	22%	1	25%	1	29%	1	32%	1

	Prototype 04 - 20-story Midris	se Office (Qty 3)	BAU		Mid	Mid-Low		Mid		Mid-High		igh	
Measure	Baseline	Alternative	Payback	Payback Pen Rate Total Pen F		Pen Rate Total Pen		Pen Rate Total Pen		Pen Rate Total Pen		Pen Rate	Total Pen
Appliances	None	None	NA	1	A	Ν	JA .	NA		NA		١	1A
CHP	None	3000 kW, 490 ton absorber	9.0	18%	0	21%	0	25%	0	28%	0	32%	0
Roof Material	100% of roof at Abs=0.90	100% of roof at Abs=0.3	7.4	22%	0	26%	0	30%	0	34%	1	39%	1
Water Heating	Boiler Comb Eff = 80%	Boiler Comb Eff = 85%	NA	See Spa	ce Heating	See Space	ce Heating	See Spa	ce Heating	See Spa	ce Heating	See Spa	ce Heating
Windows	U=0.50, SHGC=0.35	U=0.26, SHGC=0.29	10.8	14%	0	17%	0	20%	0	22%	0	25%	0
Space Heating	Boiler Comb Eff = 80%	Boiler Comb Eff = 85%	22.7	3%	0	4%	0	4%	0	5%	0	5%	0
Space Cooling	0.576 kW/ton Centrifugal Chillers	0.461 kW/ton Centrifugal Chillers	2.0	43%	1	51%	1	60%	1	68%	2	77%	2
Lighting	1.1 watts/sqft	0.9 watts/sqft	11.7	12%	0	15%	0	17%	0	20%	0	22%	0
Roof Insulation	5" R19 XPS	6" R23 XPS	6.9	23%	0	27%	0	32%	0	36%	1	41%	1
Thermal Storage	None	25% of max load, 7818 ton-hrs	5.0	29%	0	35%	1	41%	1	47%	1	52%	1
Wall Insulation	R11, 2x4.16	R19, 2x4.16	12.6	11%	0	13%	0	16%	0	18%	0	20%	0

	Prototype 05 - 33-story Highri	se Hotel (Qty 1)	BAU			Mid-Low		Mid		Mid-High		High	
Measure	Baseline	Alternative	Payback Pen Rate Total Pen			Pen Rate	Total Pen	Pen Rate	Total Pen	Pen Rate	Total Pen	Pen Rate	Total Pen
Appliances	None	None		NA			IA	١	NA .	1	IA	١	NA .
CHP	None	2500 kW, 500 ton absorber	6.5	6.5 24% 0			0	34%	0	39%	0	44%	0
Roof Material	100% of roof at Abs=0.90	100% of roof at Abs=0.3	22.8	3%	0	4%	0	4%	0	5%	0	5%	0
Water Heating	Boiler Comb Eff = 80%	Boiler Comb Eff = 85%	Se	e Space He	ating	See Space	ce Heating	See Spa	ce Heating	See Spa	ce Heating	See Spa	ce Heating
Windows	U=0.50, SHGC=0.35	U=0.26, SHGC=0.29	11.0	14%	0	16%	0	19%	0	22%	0	24%	0
Space Heating	Boiler Comb Eff = 80%	Boiler Comb Eff = 85%	3.3	36%	0	43%	0	51%	0	58%	0	65%	0
Space Cooling	0.576 kW/ton Centrifugal Chillers	0.461 kW/ton Centrifugal Chillers	2.2	42%	0	50%	0	58%	0	66%	0	75%	0
Lighting	1.3 watts/sqft	1.19 watts/sqft	42.6	0%	0	0%	0	0%	0	0%	0	0%	0
Roof Insulation	5" R19 XPS	6" R23 XPS	13.5	10%	0	12%	0	14%	0	16%	0	18%	0
Thermal Storage	None	15% of max load, 7799 ton-hrs	9.1	17%	0	21%	0	24%	0	28%	0	31%	0
Wall Insulation	Typical Aluminum Curtain Wall	Reduced thermal bridging	12.1	12%	0	14%	0	16%	0	19%	0	21%	0

	Prototype 06 - 18-story Midris	se Hotel (Qty 5)	BAU		Mid-Low		Mid		Mid-High		High					
Measure	Baseline	Alternative	Payback Pen Rate Total Pen			Pen Rate	Total Pen	Pen Rate Total Pen		Pen Rate Total Pen		Pen Rate	Total Pen			
Appliances	None	None	NA			N	1A	NA		NA		NA		١	NA	
CHP	None	400 kW, 80 ton absorber	7.1	22%	1	27%	1	31%	1	36%	1	40%	2			
Roof Material	100% of roof at Abs=0.90	100% of roof at Abs=0.3	16.0	7%	0	9%	0	10%	0	12%	0	13%	0			
Water Heating	Boiler Comb Eff = 80%	Boiler Comb Eff = 85%	Se	e Space He	ating	See Space	ce Heating	See Spa	ce Heating	See Space	e Heating	See Spa	ce Heating			
Windows	U=0.50, SHGC=0.35	U=0.26, SHGC=0.29	34.9	1%	0	1%	0	1%	0	1%	0	1%	0			
Space Heating	Boiler Comb Eff = 80%	Boiler Comb Eff = 85%	3.2	36%	1	44%	2	51%	2	58%	2	66%	3			
Space Cooling	0.576 kW/ton Centrifugal Chillers	0.461 kW/ton Centrifugal Chillers	1.9	43%	2	52%	2	60%	3	69%	3	78%	3			
Lighting	1.3 watts/sqft	1.19 watts/sqft	40.6	0%	0	0%	0	0%	0	1%	0	1%	0			
Roof Insulation	5" R19 XPS	6" R23 XPS	14.2	9%	0	11%	0	13%	0	14%	0	16%	0			
Thermal Storage	None	15% of max load, 1265 ton-hrs	8.3	19%	0	23%	1	27%	1	31%	1	34%	1			
Wall Insulation	R11, 2x4.16	R19, 2x4.16	22.2	3%	0	4%	0	5%	0	5%	0	6%	0			

Pro	ototype 07 - 55-story Highrise	Residential (Qty 2)		BAU		Mid	-Low	M	lid	Mid-	High	Hi	igh
Measure	Baseline	Alternative	Payback	Pen Rate	Total Pen	Pen Rate	Total Pen	Pen Rate	Total Pen	Pen Rate	Total Pen	Pen Rate	Total Pen
Appliances	State Appliance Regulations	Energy Star Rated	235.1	0%	0	0%	0	0%	0	0%	0	0%	0
CHP	None	1500 kW, 300 ton absorber	8.3	19%	0	23%	0	27%	0	31%	0	35%	0
Roof Material	100% of roof at Abs=0.90	100% of roof at Abs=0.3	9.2	17%	0	21%	0	24%	0	27%	0	31%	0
Water Heating	Boiler Comb Eff = 80%	Boiler Comb Eff = 85%	Se	e Space He	ating	See Space	ce Heating						
Windows	U=0.50, SHGC=0.35	U=0.26, SHGC=0.29	6.5	24%	0	29%	0	34%	0	38%	0	43%	0
Space Heating	Boiler Comb Eff = 80%	Boiler Comb Eff = 85%	5.0	29%	0	35%	0	41%	0	47%	0	53%	1
Space Cooling	0.576 kW/ton Centrifugal Chillers	0.461 kW/ton Centrifugal Chillers	2.0	43%	0	51%	1	60%	1	68%	1	77%	1
Lighting	0.70 watts/sqft	0.675 watts/sqft	122.2	0%	0	0%	0	0%	0	0%	0	0%	0
Roof Insulation	5" R19 XPS	6" R23 XPS	7.8	20%	0	24%	0	29%	0	33%	0	37%	0
Thermal Storage	None	15% of max load, 3751 ton-hrs	31.1	1%	0	1%	0	1%	0	2%	0	2%	0
Wall Insulation	Typical Aluminum Curtain Wall	Reduced thermal bridging	7.6	21%	0	25%	0	29%	0	34%	0	38%	0

Pro	ototype 08 - 43-story Highrise	Residential (Qtv 4)	1	BAU		Mid	-Low	N	lid	Mid	Hiah	Н	iah
Measure	Baseline	Alternative	Payback	Pen Rate	Total Pen	Pen Rate	Total Pen	Pen Rate	Total Pen	Pen Rate	Total Pen	Pen Rate	Total Pen
Appliances	State Appliance Regulations	Energy Star Rated	244.6	0%	0	0%	0	0%	0	0%	0	0%	0
CHP	None	750 kW, 160 ton absorber	9.0	18%	0	21%	0	25%	0	28%	1	32%	1
Root Material	100% of root at Abs=0.90 Poilor Comb Eff - 90%	100% of root at Abs=0.3 Poiler Comb Eff - 95%	10.4	15%	0	18%		21%	0 Hosting	23%	0 Hosting	26%	1 an Heating
Windows	U=0.50, SHGC=0.35	U=0.26, SHGC=0.29	6.3	25%	0	30%	1	35%	1	40%	1	44%	1
Space Heating	Boiler Comb Eff = 80%	Boiler Comb Eff = 85%	4.7	30%	1	36%	1	42%	1	48%	1	55%	2
Space Cooling	0.576 kW/ton Centrifugal Chillers	0.461 kW/ton Centrifugal Chillers	2.2	41%	1	50%	1	58%	2	66%	2	75%	2
Lighting	0.70 watts/sqft	0.675 watts/sqft	129.1	0%	0	0%	0	0%	0	0%	0	0%	0
Thermal Storage	5 RI9 APS	0 R23 APS 15% of max load 1820 ton-brs	0.9 16.3	23%	0	21%	0	32%	0	30%	0	41%	0
Wall Insulation	Typical Aluminum Curtain Wall	Reduced thermal bridging	7.3	22%	0	26%	1	30%	1	35%	1	39%	1
Pro	ototype 09 - 34-story Highrise F	Residential (Qty 10)		BAU		Mid	-Low	N	lid	Mid	·High	Н	igh
Measure	Baseline	Alternative	Payback	Pen Rate	Total Pen	Pen Rate	Total Pen	Pen Rate	Total Pen	Pen Rate	Total Pen	Pen Rate	Total Pen
Appliances	State Appliance Regulations	Energy Star Rated	246.6	0%	0	0%	0	0%	0	0%	0	0%	0
Roof Material	100% of roof at Abs=0.90	100% of roof at Abs=0.3	7.4	20%	2	24%	2	30%	2	34%	3	38%	3
Water Heating	Boiler Comb Eff = 80%	Boiler Comb Eff = 85%	Se	e Space He	ating	See Space	ce Heating	See Spa	ce Heating	See Space	ce Heating	See Spa	ce Heating
Windows	U=0.50, SHGC=0.35	U=0.26, SHGC=0.29	6.4	24%	2	29%	2	34%	3	39%	3	44%	4
Space Heating	Boiler Comb Eff = 80%	Boiler Comb Eff = 85%	4.6	31%	3	37%	3	43%	4	49%	4	55%	5
Lighting	0.576 kW/ton Centinugar Chillers	0.461 kW/ton Centinugar Chillers	125.8	41%	4	0%	4	0%	0	0%	0	0%	0
Roof Insulation	5" R19 XPS	6" R23 XPS	8.5	19%	1	22%	2	26%	2	30%	2	34%	3
Thermal Storage	None	15% of max load, 2143 ton-hrs	16.7	7%	0	8%	0	9%	0	11%	1	12%	1
Wall Insulation	Typical Aluminum Curtain Wall	Reduced thermal bridging	7.5	21%	2	25%	2	30%	2	34%	3	38%	3
	ototypo 10 - 25. story Highrigh	Posidontial (Oty 5)	1	BALL		Mia	-1.0W		lid	Mia	High		iah
Measure	Baseline	Alternative	Pavhack	Pen Rato	Total Pen	Pen Rate	Total Pen	Pen Rato	Total Pen	Pen Rato	Total Pen	Pen Rato	Total Pen
Appliances	State Appliance Regulations	Energy Star Rated	236.4	0%	0	0%	0	0%	0	0%	0	0%	0
CHP	None	1500 kW, 250 ton absorber	7.2	22%	1	26%	1	31%	1	35%	1	40%	1
Roof Material	100% of roof at Abs=0.90	100% of roof at Abs=0.3	7.5	21%	1	26%	1	30%	1	34%	1	38%	1
Water Heating	Boiler Comb Eff = 80%	Boiler Comb Eff = 85%	Se	e Space He	ating	See Space	ce Heating	See Spa	ce Heating	See Space	ce Heating	See Spa	ce Heating
Space Heating	0=0.50, SHGC=0.35 Boiler Comb Eff = 80%	0=0.20, SHGC=0.29 Boiler Comb Eff = 85%	0.7	∠3% 31%	1	∠8% 37%	1	33% 44%	1	37% 50%	1 2	42%	2
Space Cooling	0.576 kW/ton Centrifugal Chillers	0.461 kW/ton Centrifugal Chillers	2.2	42%	2	50%	2	58%	2	67%	3	75%	3
Lighting	0.70 watts/sqft	0.675 watts/sqft	125.0	0%	0	0%	0	0%	0	0%	0	0%	0
Roof Insulation	5" R19 XPS	6" R23 XPS	9.7	16%	0	19%	0	23%	1	26%	1	29%	1
Wall Insulation	None Typical Aluminum Curtain Wall	15% of max load, 3299 ton-hrs Reduced thermal bridging	19.6	5% 20%	0	5% 24%	0	6% 28%	0	7% 32%	0	8% 36%	0
wait insulation	Typical Aluminum Curtain Wait	Reduced thermal bridging	1.5	2078		24/0		2078		JZ /6		30%	
Pro	ototype 11 - 12-story Midrise R	esidential (Qty 14)		BAU		Mid	-Low	N	lid	Mid	·High	Н	igh
Measure	Baseline	Alternative	Payback	Pen Rate	Total Pen	Pen Rate	Total Pen	Pen Rate	Total Pen	Pen Rate	Total Pen	Pen Rate	Total Pen
Appliances	State Appliance Regulations	Energy Star Rated	254.8	0%	0	0%	0	0%	0	0%	0	0%	0
CHP Boof Motorial	None	250 kW, 40 ton absorber	12.1	12%	1	14%	1	17%	2	19%	2	21%	2
Water Heating	Boiler Comb Eff = 80%	Boiler Comb Eff = 85%	4.2 Se	e Space He	4 ating	See Spar	ce Heating	45% See Spar	e Heating	See Spar	/ ce Heating	See Spa	ce Heating
Windows	U=0.50, SHGC=0.35	U=0.26, SHGC=0.29	8.5	19%	2	22%	3	26%	3	30%	4	34%	4
Space Heating	Boiler Comb Eff = 80%	Boiler Comb Eff = 85%	4.4	32%	4	38%	5	44%	6	50%	7	57%	7
Space Cooling	0.576 kW/ton Centrifugal Chillers	0.461 kW/ton Centrifugal Chillers	2.1	42%	5	50%	7	59%	8	67%	9	76%	10
Lighting Roof Insulation	5" R19 XPS	0.6/5 Watts/sqtt 6" R23 XPS	25.0	2%	0	0%	0	0%	0	0% 4%	0	4%	0
Thermal Storage	None	15% of max load, 506 ton-hrs	13.5	10%	1	12%	1	14%	1	16%	2	18%	2
Wall Insulation	R11, 2x4.16	R19, 2x4.16	8.2	19%	2	23%	3	27%	3	31%	4	35%	4
			r	<u> </u>									
Proto	type 12 - 55-story Highrise Mix	ed Use, Office (Qty 1)	Buckey	BAU	T	Mid	-Low	N	lid	Mid	High	H	igh LTrí LDru
Appliances	None	None	NA	Pen Rate	I otal Pen	Pen Rate	JA	Pen Rate	I otal Pen	Pen Rate	JA	Pen Rate	I otal Pen
CHP	None	3500 kW, 680 ton absorber	8.4	19%	0	23%	0	26%	0	30%	0	34%	0
Roof Material	100% of roof at Abs=0.90	None	NA	1	ŇA	N	NA .	١	NA .	١	A	1	ŇA
Water Heating	Boiler Comb Eff = 80%	Boiler Comb Eff = 85%	Se	e Space He	eating	See Space	ce Heating	See Spa	ce Heating	See Space	ce Heating	See Spa	ce Heating
Space Heating	0=0.50, SHGC=0.35 Boiler Comb Eff = 80%	0=0.26, SHGC=0.29 Boiler Comb Eff = 85%	17.8	6%	0	26%	0	31%	0	35%	0	39%	0
Space Cooling	0.576 kW/ton Centrifugal Chillers	0.461 kW/ton Centrifugal Chillers	2.1	42%	0 0	51%	ŏ	59%	0	68%	Ő	76%	ŏ
Lighting	1.1 watts/sqft	0.9 watts/sqft	11.9	12%	0	15%	0	17%	0	19%	0	22%	0
Roof Insulation	5" R19 XPS	None	NA	000/	A A	N	A A	N 2001	A A	N 1501	A A	1	A A
Wall Insulation	None Typical Aluminum Curtain Wall	≥o% or max load, 10/98 ton-hrs Reduced thermal bridging	5.3	28%	0	34% 22%	0	39% 26%	0	45%	0	51% 33%	0
	Jenning Surfain Hall		0.0	.570				2070		5576		5570	
Prototyp	e 12 - 55-story Highrise Mixed	Use, Residential (Qty 1)		BAU		Mid	-Low	N	lid	Mid	·High	н	igh
Measure	Baseline	Alternative	Payback	Pen Rate	Total Pen	Pen Rate	Total Pen	Pen Rate	Total Pen	Pen Rate	Total Pen	Pen Rate	Total Pen
Appliances	State Appliance Regulations	Energy Star Rated	237.0	0%	0	0%	0	0%	0	0%	0	0%	0
CHP Roof Material	None 100% of roof at Abs=0.90	1500 kW, 270 ton absorber	7.2	22%	0	26%	0	31%	0	35%	0	39%	0
Water Heating	Boiler Comb Eff = 80%	Boiler Comb Eff = 85%	7.0 Se	e Space He	ating	See Space	ce Heating	See Spa	ce Heating	See Space	ce Heating	See Spa	ce Heating
Windows	U=0.50, SHGC=0.35	U=0.26, SHGC=0.29	6.6	24%	0	29%	0	33%	0	38%	0	43%	0
Space Heating	Boiler Comb Eff = 80%	Boiler Comb Eff = 85%	4.5	31%	0	37%	0	43%	0	50%	0	56%	0
Space Cooling	0.576 kW/ton Centrifugal Chillers	0.461 kW/ton Centrifugal Chillers	2.2	42%	0	50%	0	58%	0	67%	0	75%	0
Roof Insulation	5" R19 XPS	6" R23 XPS	14.4	9%	0	11%	0	12%	0	14%	0	16%	0
Thermal Storage	None	15% of max load, 3472 ton-hrs	21.4	4%	Ő	4%	0	5%	0	6%	0	6%	Ő
Wall Insulation	Typical Aluminum Curtain Wall	Reduced thermal bridging	7.7	21%	0	25%	0	29%	0	33%	0	37%	0
			r	<u> </u>									
Corn	er Retail Shop - Type I Constru	uction (Qty 34 Bldgs)	Bouhard	BAU	Total Da	Mid-	-LOW	N Ret Dat	IId	Mid-	High	H Born Dari	igh
Appliances	None	None	Payback	N∆ NA	Total Pen	ren Kate	A I DEAL PEN	Pen Kate	A NOTAL PEN	ren Kate	A Iotal Pen	ren Katé	I I otal Pen
CHP	None	None	<u> </u>	NA		N	NA	Ň	NA.		NA	1	NA
Roof Material	None	None		NA		N	NA	1	NA	١	IA	1	NA
Water Heating	EF=0.525	EF=0.823	1.3	47%	15	56%	19	65%	22	75%	25	84%	28
Windows Space Heating	U=0.50, SHGC=0.35	U=0.26, SHGC=0.29 Euroace 94% AFLIE	6.9	23%	12	27%	18 14	32% 51%	18 17	36% 58%	21 19	41%	21
. space rouning	1 411400 7070 711 OL	1 411400 07/0 /11 OL	5.5	0070	12	.370		0170	40	550/		000/	20
Space Cooling	10 SEER, 9.5 EER Unitary AC	14 SEER, 12.5 EER Unitary AC	3.7	34%	11	41%	13	48%	10	55%	18	62%	
Space Cooling Lighting	10 SEER, 9.5 EER Unitary AC 1.50 watts/sqft	14 SEER, 12.5 EER Unitary AC None	3.7	34% NA	11	41%	13 NA	48%	I6 NA	55%	18 NA	62%	NA
Space Cooling Lighting Roof Insulation	10 SEER, 9.5 EER Unitary AC 1.50 watts/sqft None	14 SEER, 12.5 EER Unitary AC None None	3.7	NA NA	11	41%	NA NA	48%		55% N	18 NA NA	62%	NA NA

Intern	al Datail Shan Tuma I Canata	untion (Oty 24 Pldge)		DALL		Mia	1	M	1.4	Mia	Himb	· · ·	ar h
Intern	lai Ketali Shop - Type i Colisti	uction (Qty 34 Blugs)	Bertert	BAU	Train	WIG	-LOW	IV.	Trial Day	Wild-	-nign	п	gn
Appliances	Baseline	Alternative	Раураск	Pen Rate	Total Pen	Pen Rate	I otal Pen	Pen Rate	Total Pen	Pen Rate	I otal Pen	Pen Rate	Total Pen
Appliances	None	None		NA		l I							
Roof Material	None	None		NA				I N					
Water Heating	FE-0.525	EE=0.823	13	47%	15	56%	10	66%	22	75%	25	84%	28
Windows	U=0.50_SHGC=0.35	U=0.26_SHGC=0.29	7.7	21%	45	25%	67	29%	67	33%	70	37%	70
Space Heating	Furnace 78% AFUE	Furnace 94% AFUE	3.7	35%	11	41%	14	48%	16	55%	18	62%	21
Space Cooling	10 SEER, 9.5 EER Unitary AC	14 SEER, 12.5 EER Unitary AC	3.8	34%	11	41%	13	48%	16	55%	18	61%	20
Lighting	1.50 watts/soft	None	0.0	NA		1	NA	N	A	N N	IA	1	IA I
Roof Insulation	None	None		NA		1	NA	N	A	Ň	JA	i i	A
Thermal Storage	None	None		NA		1	NA	N	A	N 1	IA.	1	A
Wall Insulation	Typical Aluminum Curtain Wall	Reduced thermal bridging	60.1	0%	45	0%	67	0%	67	0%	70	0%	70
							•						
Corn	er Restaurant - Type I Constru	uction (Qtv 30 Bldgs)		BAU		Mid	-Low	M	lid	Mid	·Hiah	н	ah
Measure	Baseline	Alternative	Pavback	Pen Rate	Total Pen	Pen Rate	Total Pen	Pen Rate	Total Pen	Pen Rate	Total Pen	Pen Rate	Total Pen
Appliances	None	None		NA		1	NA A	N	A	L N	A	1	A
CHP	None	None		NA		1	NA	N	A	Ň	JA .	1	A
Roof Material	None	None		NA			NA	Ň	IA	Ň	JA A	i	IA
Water Heating	EF=0.800	EF=0.823	9.0	17%	5	21%	7	24%	8	28%	9	31%	10
Windows	U=0.50 SHGC=0.35	U=0.26_SHGC=0.29	8.3	19%	4	23%	5	27%	5	31%	6	35%	6
Space Heating	Furnace 78% AFUE	Furnace 94% AFUE	2.2	42%	14	50%	17	58%	19	67%	22	75%	25
Space Cooling	10 SEER, 9.5 EER Unitary AC	14 SEER, 12.5 EER Unitary AC	3.9	33%	11	40%	13	47%	15	53%	18	60%	20
Lighting	1.50 watts/soft	None	0.0	NA		1070	NA	N 10	A	N	A	1	A LO
Roof Insulation	None	None		NA		Ň	NA	N	IA	Ň	JA	, i	IA
Thermal Storage	None	None		NA		N	NA	N	IA.	i i	NA	İ	A
Wall Insulation	Typical Aluminum Curtain Wall	Reduced thermal bridging	28.7	1%	4	2%	. 5	2%	5	2%	6	3%	6
	· /			.,.		_,*		-/*	-	-/*		0,0	-
Corne	er Retail Shon - Type II Constr	uction (Oty 17 Bldgs)		BAU		Mid	-l ow	M	lid	Mid	High	н	ah
Mossuro	Basolino	Alternative	Payback	Pop Pate	Total Pon	Pon Pate	Total Bon	Pon Pato	Total Pan	Pon Pato	Total Bon	Pon Pate	Total Bon
Appliances	None	None	Гаураск	NA	Total Fell	ren Kale	Inotarren	renkate	Internet	r en Kale	Internet	renitate	Internet
	None	None		NA				I. I.					10
Doof Motorial	None	None		NA									10
Water Heating	EE=0.525	EE_0 923	13	1NA 47%	7	56%		66%	11	75%	12	8/19/	14
Windows	LI =0.525	LI = 0.025	0.1	47 /6	6	21%	9	24%	0	28%	12	31%	14
Space Heating	0=0.30, 3HGC=0.33	0=0.20, 3HGC=0.29	9.1	229/	5	2170	9	24%	3	20%	0	51%	12
Space Cooling	10 SEEP 9.5 EEP Unitary AC	14 SEEP 12.5 EEP Unitary AC	4.3	32.70	5	30% 12%	7	43%	2	56%	0	62%	9 10
Jighting	1 50 wette/eaft	None	3.0	5578	5	4Z /0		4376	0	JU /0	5	0378	10
Roof Insulation	None	None		NA									
Thormal Storage	None	None		NA				N N	10				10
Wall Insulation	P11 2v4 16	P10. 2v4 16	10.0	15%	6	10%		22%	<u>م</u>	25%	12	28%	12
wairmsulation	1(11, 224.10	1(13, 2/4.10	10.0	1378	0	1370	5	2278	3	2378	12	2078	12
Intorn	al Potail Shon - Type II Constr	ruction (Oty 17 Bldgs)		BAIL		Mid	-Low	M	lid	Mid	High	L 1	ab
Maaauma	ai Ketali Silop - Type li Colisti	Alternative	Dauhaala	DAU Den Dete	Total Dam	Ivilu Den Dete	Tetel Dem	IV Dam Data	Tatal Dam	Nilu-	Tatal Dam	Den Dete	gii Tatal Dan
Weasure	Baseline	Alternative	Раураск	Pen Rate	Total Pen	Pen Rate	l lotal Pen	Pen Rate	Total Pen	Pen Rate	Total Pen	Pen Rate	Total Pen
Appliances	None	None		NA		ľ	NA	N N		ľ			IA IA
CHP Roof Motorial	None	None		NA		 		L L					
Water Heating	EE_0.525	EE_0 923	12	1N/A //79/	7	56%	0	66%	11	75%	12	95%	14
Windowo			1.2	4/%	10	22%	9 10	26%	10	10%	12	00%	24
Space Heating	0=0.30, SHGC=0.35	U=0.20, SHGU=0.29	0.0	19%	5	22%	6	20% 43%	10	50%	24	33% 56%	24
Space Cooling	10 SEED 0.5 EED Lipitan AC	14 SEED 12.5 EED Unitors AC	4.0	3/1%	5	/19/	6	43%	2	55%	0	62%	3 10
Jighting	1 50 watte/caft	14 SEEK, 12.5 EEK Unitary AC	3.1	34%	5	4170	0	40 %	0	- 55% N	9	0276	10
Boof Insulation	Nono	None		NA									10
Thormal Storage	None	None		NA									
Wall Insulation	P11 2v4 16	P10. 2v4 16	10.4	5%	12	6%	10	6%	19	70/.	24	9%	24
wairinsulation	1(11, 224.10	1(13, 2/4.10	13.4	578	12	0 /8	10	078	10	1 /6	24	078	24
Corn	or Postaurant - Typo II Constru	uction (Oty 17 Bldgs)	1	BALL		Mid	-Low	M	lid	Mid	High	<u>ц</u>	ab
Maaaura	Pasalina	Alternative	Dauhaala	BAU Dem Dete	Tatal Dan	Nilu Dan Data	Tetel Dem	IV Dam Data	Tatal Dam	Nilu-	Tatal Dam	Den Dete	gii Tatal Dan
Measure	Baseline	Alternative	Раураск	Pen Rate	Total Pen	Pen Rate	Total Pen	Pen Rate	Total Pen	Pen Rate	Total Pen	Pen Rate	Total Pen
Appliances	None	None		NA			NA	N N		<u> </u>			NA IA
CHP	None	None		NA		r	NA	r	NA .	r	NA .		NA .
Koot Material	None	None	0.4	NA 470/		040/	NA 2	D 40/	IA A	0.00/	NA 4	240/	NA E
vvater Heating	EF=0.800	EF=0.823	9.1	1/%	2	21%	3	24%	4	28%	4	31%	5
Windows	U=0.50, SHGC=0.35	U=0.26, SHGC=0.29	10.8	14%	2	1/%	3	19%	3	22%	4	25%	4
Space Heating	Furnace 78% AFUE	Furnace 94% AFUE	2.2	42%	7	50%	8	58%	9	67%	11	75%	12
Space Cooling	10 SEER, 9.5 EER Unitary AC	14 SEER, 12.5 EER Unitary AC	3.8	34%	5	41%	6	4/%	8	54%	9	61%	10
Lighting	1.50 watts/sqft	None		NA		1	NA	N	IA	L N	NA .		NA .
Roof Insulation	None	None		NA			NA	N N	IA		NA		A
i nermai Storage	None	None	0.4	NA 000/		0.49/		N 0001		P 000/		050/	IA (
14/-11/													-

[Prototype 01 - 56-story Highri	se Office (Qtv 1)	Mo	d 14-RA	BAU	Mod 14R	Mid-Low	Mod 14	RA Mid	Mod 14RA	Mid-High	Mod 14	RA High
Measure	Baseline	Alternative	Pavhack	Pen Rate	Total Pen	Pen Rate	Total Pen	Pen Rate	Total Pen	Pen Rate	Total Pen	Pen Rate	Total Pen
Appliances	None	None	NA	N	A	N	A	N	A	N	A	N	A
CHP	None	6500 kW, 1390 ton absorber	6.4	24%	0	29%	0	34%	0	39%	0	44%	0
Cool Roof	100% of roof at Abs=0.90	100% of roof at Abs=0.3	20.2	4%	0	5%	0	6%	0	7%	0	8%	0
Water Heating	Boiler Comb Eff = 80%	Boiler Comb Eff = 85%	NA	See Space	ce Heating	See Space	e Heating	See Space	e Heating	See Space	e Heating	See Space	ce Heating
Windows	U=0.50, SHGC=0.35	U=0.26, SHGC=0.29	7.4	21%	0	26%	0	30%	0	34%	0	38%	0
Space Heating	Boiler Comb Eff = 80%	Boiler Comb Eff = 85%	18.9	5%	0	6%	0	7%	0	8%	0	9%	0
Space Cooling	0.576 kW/ton Centrifugal Chillers	0.461 kW/ton Centrifugal Chillers	1.9	43%	0	52%	0	61%	0	70%	0	78%	0
Lighting	1.1 watts/sqft	0.9 watts/sqft	11.1	13%	0	16%	0	19%	0	21%	0	24%	0
Roof Insulation	5" R19 XPS	6" R23 XPS	2.7	39%	0	47%	0	54%	0	62%	0	70%	0
Thermal Storage	None	25% of max load, 23376 ton-hrs	8.5	19%	0	22%	0	26%	0	30%	0	34%	0
Wall Insulation	Typical Aluminum Curtain Wall	Reduced thermal bridging	9.0	17%	0	21%	0	24%	0	28%	0	31%	0
	Bastations 00 44 stamplinks	Office (Office)	Ma		DALL	Maddab		Madda		MaddaDA	Mi al I li ada	Madda	DALLah
	Prototype U2 - 41-story Highri	se Office (Qty 6)	NIO	a 14-RA,	BAU	MOD 14RA	A MIG-LOW	MOG 14		MOG 14RA	wia-High	WO0 14	RA High
Measure	Baseline	Alternative	Payback	Pen Rate	Total Pen	Pen Rate	Total Pen	Pen Rate	I otal Pen	Pen Rate	I otal Pen	Pen Rate	I otal Pen
Appliances	None	None	NA 0.0	050(NA 4	0.00/	IA 4	050/	A	100/	A	150/	
CHP Roof Matorial	100% of roof at Abc=0.90	100% of roof at Abs-0.2	0.2	25%	1	30%	0	35%	2	40%	1	45%	
Water Heating	Poilor Comb Eff - 90%	Poilor Comb Eff - 95%	NIA	12 /0 Soo Soo	loging	1470 Soo Soor	- Hosting	10% Soo Soo	o Hoating	13% Soo Sooo		21/0 Soo Spor	
Windows	LI=0.50 SHGC=0.35	U=0.26 SHGC=0.29	7.4	21%	1 1	26%	1 1 1 1 1 1	30%	1	34%	2	30%	2 2
Space Heating	Boiler Comb Eff = 80%	Boiler Comb Eff = 85%	19.0	5%	0	6%	0	7%	Ó	8%	0	9%	0
Space Cooling	0.576 kW/ton Centrifugal Chillers	0.461 kW/ton Centrifugal Chillers	2.0	43%	2	51%	3	60%	3	69%	4	77%	4
Lighting	1.1 watts/sqft	0.9 watts/sqft	11.4	13%	0	15%	0	18%	1	21%	1	23%	1
Roof Insulation	5" R19 XPS	6" R23 XPS	4.9	30%	1	35%	2	41%	2	47%	2	53%	3
Thermal Storage	None	25% of max load, 15073 ton-hrs	5.3	28%	1	34%	2	39%	2	45%	2	51%	3
Wall Insulation	Typical Aluminum Curtain Wall	Reduced thermal bridging	9.0	17%	1	21%	1	24%	1	28%	1	31%	1
	Prototype 03 - 34-story Highri	se Office (Qty 5)	Mo	d 14-RA,	BAU	Mod 14RA	Mid-Low	Mod 14	RA Mid	Mod 14RA	Mid-High	Mod 14	RA High
Measure	Baseline	Alternative	Payback	Pen Rate	Total Pen	Pen Rate	Total Pen	Pen Rate	Total Pen	Pen Rate	Total Pen	Pen Rate	Total Pen
Appliances	None	None	NA	N	A	N	A	N	A	N	A	N	IA
CHP	None	4500 kW, 1020 ton absorber	6.1	25%	1	30%	1	35%	1	41%	2	46%	2
Roof Material	100% of roof at Abs=0.90	100% of roof at Abs=0.3	7.2	22%	1	26%	1	31%	1	35%	1	40%	1
Water Heating	Boiler Comb Eff = 80%	Boiler Comb Eff = 85%	NA	See Space	ce Heating	See Space	e Heating	See Space	e Heating	See Space	e Heating	See Space	ce Heating
windows	U=0.50, SHGC=0.35	U=0.26, SHGC=0.29	7.3	22%		26%	1	31%	1	35%	1	39%	1
Space Heating	Boiler Comb Eff = 80%	Boiler Comb Eff = 85%	18.4	5%	0	6%	0	7%	0	8%	0	10%	0
Space Cooling	0.576 KW/ton Centrifugal Chillers	0.461 KW/ton Centrifugal Chillers	2.0	42%	2	51%	2	59%	2	68%	3	/6%	3
Lighting Roof Insulation	5" P10 XPC	0.9 watts/sqit	0.0	10%	0	10%	U 4	10%	0	20%	1	23%	
Thormal Storage	5 R19 APS	6 R23 APS	8.8	18%	1	22%	1	25%	1	29%	1	33%	2
Wall Inculation	Typical Aluminum Curtain Wall	25% of fillax load, 16172 toff-fills	0.4	24%	0	29%	1	34%	1	39%	1	220/	1
wait insulation	Typical Aluminum Curtain Wall	Reduced thermal bridging	0.0	1076	0	22 /0		2378		2378	1	32 /8	
[Prototype 04 - 20-story Midris	e Office (Otv 3)	Mo	d 14-R 4	BAII	Mod 14R	Mid-Low	Mod 14	RA Mid	Mod 14RA	Mid-High	Mod 14	RA High
Moasuro	Baseline	Alternative	Pavback	Pen Rate	Total Pan	Pen Rate	Total Pen	Pen Rate	Total Pen	Pen Rate	Total Pen	Pen Rate	Total Pan
Appliances	None	None	ΝΔ	T CH I Kato		T CH Rate		T CH I Kato		T CH Rate	Δ	T CITIVALC	
СНР	None	3000 kW 490 ton absorber	6.5	24%		20%	0	3/1%	1	3.8%	1	43%	1 1
Roof Material	100% of roof at Abs=0.90	100% of roof at Abs=0.3	7.4	22%	0	26%	0	30%	Ó	34%	1	39%	1
Water Heating	Boiler Comb Eff = 80%	Boiler Comb Eff = 85%	NA	See Spar	e Heating	See Space	e Heating	See Spar	e Heating	See Space	e Heating	See Space	e Heating
Windows	U=0.50. SHGC=0.35	U=0.26, SHGC=0.29	10.8	14%	0	17%	0	20%	0	22%	0	25%	0
Space Heating	Boiler Comb Eff = 80%	Boiler Comb Eff = 85%	22.7	3%	0	4%	0	4%	0	5%	0	5%	0
Space Cooling	0.576 kW/ton Centrifugal Chillers	0.461 kW/ton Centrifugal Chillers	2.0	43%	1	51%	1	60%	1	68%	2	77%	2
Lighting	1.1 watts/sqft	0.9 watts/sqft	11.7	12%	0	15%	0	17%	0	20%	0	22%	0
Roof Insulation	5" R19 XPS	6" R23 XPS	6.9	23%	0	27%	0	32%	0	36%	1	41%	1
Thermal Storage	None	25% of max load, 7818 ton-hrs	5.0	29%	0	35%	1	41%	1	47%	1	52%	1
Wall Insulation	R11, 2x4.16	R19, 2x4.16	12.6	11%	0	13%	0	16%	0	18%	0	20%	0
r													
	Prototype 05 - 33-story Highri	se Hotel (Qty 1)	Mo	d 14-RA,	BAU	Mod 14RA	A Mid-Low	Mod 14	RA Mid	Mod 14RA	Mid-High	Mod 14	RA High
Measure	Baseline	Alternative	Payback	Pen Rate	Total Pen	Pen Rate	Total Pen	Pen Rate	Total Pen	Pen Rate	Total Pen	Pen Rate	Total Pen
Appliances	None	None	NA	000/	A	0.5%/	A	N 140/	A	170/	A	N 50%	NA O
CHP Roof Matorial	100% of roof at Abc=0.00	100% of roof at Abs-0.2	22.0	29%	0	35%	0	41%	0	47%	0	52%	0
Water Heating	Boiler Comb Eff = 80%	Boiler Comb Eff = 85%	22.0 See	Snace He	ating	5ee Spar	e Heating	5ee Spar	e Heating	See Spac	e Heating	See Spac	e Heating
Windows	U=0.50, SHGC=0.35	U=0.26, SHGC=0.29	11.0	14%	0	16%	0	19%	0	22%	0	24%	0
Space Heating	Boiler Comb Eff = 80%	Boiler Comb Eff = 85%	3.3	36%	0	43%	0	51%	0	58%	0	65%	0
Space Cooling	0.576 kW/ton Centrifugal Chillers	0.461 kW/ton Centrifugal Chillers	2.2	42%	0	50%	0	58%	0	66%	0	75%	0
Lighting	1.3 watts/sqft	1.19 watts/sqft	42.6	0%	0	0%	0	0%	0	0%	0	0%	0
Roof Insulation	5" R19 XPS	6" R23 XPS	13.5	10%	0	12%	0	14%	0	16%	0	18%	0
Thermal Storage	None	15% of max load, 7799 ton-hrs	9.1	17%	0	21%	0	24%	0	28%	0	31%	0
Wall Insulation	I ypical Aluminum Curtain Wall	Reduced thermal bridging	12.1	12%	0	14%	0	16%	0	19%	0	21%	0
r	Drototyme 06 40 stars Milli				DAU	Mad 44D	Midlen	Madia	DA MI-I	Med 44P 4	Middle	Media	
Magazin	Prototype up - 18-story Midris		NIO	U 14-KA,	DAU Totol Dr	Wod 14RA	A WIIG-LOW			NICO 14RA	Tate! Day		
Appliances	Daseline	None	rayback	ren Kate	TOTAL PEN	ren Rate	Total Pen	ren Katé	I Utal Peri	ren Kate	I Utal Peri	ren Kate	
Appliances	None	None 400 kW 80 top absorbor	INA 5.2	28%	1	3/0/	1	30% N	1	150/.	2	50%	2
Roof Matorial	100% of roof at Abe=0.00	100% of roof at Abc=0.2	3.3	2070		04%	0	10%		4,3%	2	1 20/	4
Water Heating	Boiler Comb Fff = 80%	Boiler Comb Fff = 85%	0.0	Snace Ho	ating	See Snoo	e Heating	See Sea	e Heating	See Space	e Heating	See Spoo	re Heating
Windows	U=0.50, SHGC=0.35	U=0.26, SHGC=0.29	34.9	1%	0	1%	0	1%	n nearing	1%	0	1%	0
Space Heating	Boiler Comb Fff = 80%	Boiler Comb Fff = 85%	3.2	36%	Ĭ	44%	2	51%	2	58%	2	66%	3
Space Cooling	0.576 kW/ton Centrifugal Chillers	0.461 kW/ton Centrifugal Chillers	1.9	43%	2	52%	2	60%	3	69%	3	78%	3
Lighting	1.3 watts/sqft	1.19 watts/sqft	40.6	0%	0	0%	0	0%	0	1%	0	1%	0
Roof Insulation	5" R19 XPS	6" R23 XPS	14.2	9%	0	11%	0	13%	0	14%	0	16%	0
Thermal Storage	None	15% of max load, 1265 ton-hrs	8.3	19%	0	23%	1	27%	1	31%	1	34%	1
Wall Insulation	R11, 2x4.16	R19, 2x4.16	22.2	3%	0	4%	0	5%	0	5%	0	6%	0
Pr	ototype 07 - 55-story Highrise	Residential (Qty 2)	Mo	d 14-RA,	BAU	Mod 14RA	A Mid-Low	Mod 14	RA Mid	Mod 14RA	Mid-High	Mod 14	RA High
Measure	Baseline	Alternative	Payback	Pen Rate	Total Pen	Pen Rate	Total Pen	Pen Rate	Total Pen	Pen Rate	Total Pen	Pen Rate	Total Pen
Appliances	State Appliance Regulations	Energy Star Rated	235.1	0%	0	0%	0	0%	0	0%	0	0%	0
CHP	None	1500 kW, 300 ton absorber	6.1	25%	0	30%	0	35%	0	41%	0	46%	0
KOOT Material	100% of root at Abs=0.90	100% of root at Abs=0.3	9.2	1/%	0 O	21%		24%	0	2/%	0	31%	0
water Heating	Boller Comb Eff = 80%	Boller Comb Eff = 85%	See	 space He add 	aung	See Space	e meating	See Space	e neating	See Spac	e rieating	See Spac	Le meating
Windows Space Leasting	U=0.50, SHGC=0.35	U=U.26, SHGC=0.29 Boilor Comb 5# 95%	6.5 E 0	24%	0	29%	0	34%	0	38%	0	43%	0
Space Heating	0.576 kW/top Contributed Chiller	0.461 kW/top Costributed Chiller	3.0	23%	0	33% E40/	U 4	41%	1	41%	1	33% 77%	
Lighting	0.370 KW/IOH CENTINGAL CHILLERS	0.401 KW/ION CENTINUGAI Chillers	2.0	43%	0	51%	1	00%		00%		11%	
 Lighting 	0.70 watte/eaft	0.675 watte/eaft	122.2	()%		19%		()%	0	0%	0	0%	
Roof Inculation	0.70 watts/sqft	0.675 watts/sqft	122.2	20%	0	2/0/	0	20%	0	0%	0	0%	0
Roof Insulation	0.70 watts/sqft 5" R19 XPS	0.675 watts/sqft 6" R23 XPS 15% of max load 3751 top.brc	122.2 7.8 31.1	0% 20% 1%	0	24% 1%	0	0% 29% 1%	0	0% 33% 2%	0	0% 37% 2%	0
Roof Insulation Thermal Storage Wall Insulation	0.70 watts/sqft 5" R19 XPS None Typical Aluminum Curtain Wall	0.675 watts/sqft 6" R23 XPS 15% of max load, 3751 ton-hrs Reduced thermal bridging	122.2 7.8 31.1 7.6	0% 20% 1% 21%	0	0% 24% 1% 25%	0	0% 29% 1% 29%	0 0 0 0 0	0% 33% 2% 34%	0 0 0	0% 37% 2% 38%	0 0 0

Pr	ototype 08 - 43-story Highrise	Residential (Qtv 4)	Mo	d 14-RA.	BAU	Mod 14R	Mid-Low	Mod 14	RA Mid	Mod 14RA	Mid-Hiah	Mod 14	RA High	
Measure	Baseline	Alternative	Payback	Pen Rate	Total Pen	Pen Rate	Total Pen	Pen Rate	Total Pen	Pen Rate	Total Pen	Pen Rate	Total Pen	
Appliances	State Appliance Regulations	Energy Star Rated	244.6	0%	0	0%	0	0%	0	0%	0	0%	0	
CHP	None	750 kW, 160 ton absorber	6.4	24%	0	29%	1	34%	1	39%	1	44%	1	
Water Heating	100% of roof at Abs=0.90 Boilor Comb Eff = 90%	100% of root at Abs=0.3 Boilor Comb Eff = 95%	10.4	15% Space He	0 ating	18%	0 Heating	21%	0 Hosting	23%	0 Hoating	26%	1 Hosting	
Windows	U=0.50, SHGC=0.35	U=0.26, SHGC=0.29	6.3	25%	0	30%	1	35%	1	40%	1	44%	1	
Space Heating	Boiler Comb Eff = 80%	Boiler Comb Eff = 85%	4.7	30%	1	36%	1	42%	1	48%	1	55%	2	
Space Cooling	0.576 kW/ton Centrifugal Chillers	0.461 kW/ton Centrifugal Chillers	2.2	41%	1	50%	1	58%	2	66%	2	75%	2	
Lighting	0.70 watts/sqft	0.675 watts/sqft	129.1	0%	0	0%	0	0%	0	0%	0	0%	0	
Root Insulation	5" R19 XPS	6" R23 XPS	6.9	23%	0	27%	1	32%	1	36%	1	41%	1	
Wall Insulation	Typical Aluminum Curtain Wall	Reduced thermal bridging	7.3	22%	0	26%	1	30%	1	35%	1	39%	1	
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Pro	ototype 09 - 34-story Highrise F	Residential (Qty 10)	Mo	d 14-RA,	BAU	Mod 14R	A Mid-Low	Mod 14	RA Mid	Mod 14RA	Mid-High	Mod 14	RA High	
Measure	Baseline	Alternative	Payback	Pen Rate	Total Pen	Pen Rate	Total Pen	Pen Rate	Total Pen	Pen Rate	Total Pen	Pen Rate	Total Pen	
Appliances	State Appliance Regulations	Energy Star Rated	246.6	0%	0	0%	0	0%	0	0%	0	0%	0	
CHP Roof Matorial	None 100% of roof at Abc=0.00	100% of roof at Abc=0.2	5.7	21%	2	32%	3	37%	3	43%	4	48%	4	
Water Heating	Boiler Comb Eff = 80%	Boiler Comb Eff = 85%	7.4 Sei	Space He	ating	See Spar	e Heating	See Space	e Heating	See Space	e Heating	See Space	e Heating	
Windows	U=0.50, SHGC=0.35	U=0.26, SHGC=0.29	6.4	24%	2	29%	2	34%	3	39%	3	44%	4	
Space Heating	Boiler Comb Eff = 80%	Boiler Comb Eff = 85%	4.6	31%	3	37%	3	43%	4	49%	4	55%	5	
Space Cooling	0.576 kW/ton Centrifugal Chillers	0.461 kW/ton Centrifugal Chillers	2.2	41%	4	50%	4	58%	5	66%	6	74%	7	
Lighting	0.70 watts/sqtt	0.675 watts/sqtt	125.8	0%	0	0%	0	0%	0	0%	0	0%	0	
Thermal Storage	5 R 19 AP 3 None	15% of max load 2143 ton-brs	0.5	7%	0	8%	0	9%	0	11%	1	12%	3	
Wall Insulation	Typical Aluminum Curtain Wall	Reduced thermal bridging	7.5	21%	2	25%	2	30%	2	34%	3	38%	3	
	· · · · · · · · · · · · · · · · · · ·			•	· · · · · · ·									
Pr	ototype 10 - 25-story Highrise	Residential (Qty 5)	Mo	d 14-RA,	BAU	Mod 14R	A Mid-Low	Mod 14	RA Mid	Mod 14RA	Mid-High	Mod 14	RA High	
Measure	Baseline	Alternative	Payback	Pen Rate	Total Pen	Pen Rate	Total Pen	Pen Rate	Total Pen	Pen Rate	Total Pen	Pen Rate	Total Pen	
Appliances	State Appliance Regulations	Energy Star Rated	236.4	0%	0	0%	0	0%	0	0%	0	0%	0	
Roof Material	100% of roof at Abs=0.90	100% of roof at Abs=0.3	7.5	20%	1	26%	1	39%	1	34%	1	38%	1	
Water Heating	Boiler Comb Eff = 80%	Boiler Comb Eff = 85%	See	e Space He	ating	See Space	e Heating	See Space	e Heating	See Space	e Heating	See Spac	e Heating	
Windows	U=0.50, SHGC=0.35	U=0.26, SHGC=0.29	6.7	23%	1	28%	1	33%	1	37%	1	42%	2	
Space Heating	Boiler Comb Eff = 80%	Boiler Comb Eff = 85%	4.5	31%	1	37%	1	44%	2	50%	2	56%	2	
Space Cooling	0.576 kW/ton Centrifugal Chillers	0.461 kW/ton Centrifugal Chillers	2.2	42%	2	50%	2	58%	2	67%	3	75%	3	
Roof Insulation	5" P10 XPS	6" P23 XPS	9.7	16%	0	19%	0	23%	1	26%	1	20%	1	
Thermal Storage	None	15% of max load, 3299 ton-hrs	19.6	5%	0	5%	0	6%	0	7%	0	8%	0	
Wall Insulation	Typical Aluminum Curtain Wall	Reduced thermal bridging	7.9	20%	1	24%	1	28%	1	32%	1	36%	1	
				144.54	D 411	M. 1445								
Pre	ototype 11 - 12-story Midrise R	esidential (Qty 14)	Mo	d 14-RA,	BAU	Mod 14R	Mid-Low	Mod 14	RA Mid	Mod 14RA	Mid-High	Mod 14	RA High	
Pro Measure Appliances	ototype 11 - 12-story Midrise R Baseline State Appliance Regulations	esidential (Qty 14) Alternative	Mo Payback 254.8	d 14-RA, Pen Rate	BAU Total Pen	Mod 14R	A Mid-Low Total Pen	Mod 14 Pen Rate	RA Mid Total Pen	Mod 14RA Pen Rate	Mid-High Total Pen	Mod 14 Pen Rate	RA High Total Pen	
Pro Measure Appliances CHP	ototype 11 - 12-story Midrise R Baseline State Appliance Regulations None	Alternative Energy Star Rated 250 kW, 40 ton absorber	Mo Payback 254.8 8.0	d 14-RA, Pen Rate 0% 20%	BAU Total Pen 0 2	Mod 14R/ Pen Rate 0% 24%	A Mid-Low Total Pen 0 3	Mod 14 Pen Rate 0% 28%	RA Mid Total Pen 0 3	Mod 14RA Pen Rate 0% 32%	Mid-High Total Pen 0 4	Mod 14 Pen Rate 0% 36%	RA High Total Pen 0 5	
Pro Measure Appliances CHP Roof Material	ototype 11 - 12-story Midrise R Baseline State Appliance Regulations None 100% of roof at Abs=0.90	Lesidential (Qty 14) Alternative Energy Star Rated 250 kW, 40 ton absorber 100% of roof at Abs=0.3	Mo Payback 254.8 8.0 4.2	d 14-RA, Pen Rate 0% 20% 32%	BAU Total Pen 0 2 4	Mod 14R/ Pen Rate 0% 24% 38%	A Mid-Low Total Pen 0 3 5	Mod 14 Pen Rate 0% 28% 45%	RA Mid Total Pen 0 3 6	Mod 14RA Pen Rate 0% 32% 51%	Mid-High Total Pen 0 4 7	Mod 14 Pen Rate 0% 36% 58%	RA High Total Pen 0 5 8	
Pro Measure Appliances CHP Roof Material Water Heating	ototype 11 - 12-story Midrise R Baseline State Appliance Regulations None 100% of roof at Abs=0.90 Boiler Comb Eff = 80%	Alternative Energy Star Rated 250 kW, 40 ton absorber 100% of roof at Abs=0.3 Boiler Comb Eff = 85%	Mo Payback 254.8 8.0 4.2 Set	d 14-RA, Pen Rate 0% 20% 32% Space He	BAU Total Pen 0 2 4 ating	Mod 14R/ Pen Rate 0% 24% 38% See Space	A Mid-Low Total Pen 0 3 5 e Heating	Mod 14 Pen Rate 0% 28% 45% See Space	RA Mid Total Pen 0 3 6 e Heating	Mod 14RA Pen Rate 0% 32% 51% See Space	Mid-High Total Pen 0 4 7 e Heating	Mod 14 Pen Rate 0% 36% 58% See Spac	RA High Total Pen 0 5 8 e Heating	
Pro Measure Appliances CHP Roof Material Water Heating Windows	ototype 11 - 12-story Midrise R Baseline State Appliance Regulations None 100% of roof at Abs=0.90 Boiler Comb Eff = 80% U=0.50, SHGC=0.35 Beito Comb Eff = 80%	Alternative Alternative Energy Star Rated 250 kW, 40 ton absorber 100% of roof at Abs=0.3 Boiler Comb Eff = 85% U=0.26, SHGC=0.29 Decide Comb Eff = 65%	Mo Payback 254.8 8.0 4.2 Set 8.5	d 14-RA, Pen Rate 0% 20% 32% Space He 19%	BAU Total Pen 0 2 4 ating 2	Mod 14RA Pen Rate 0% 24% 38% See Spac 22%	A Mid-Low Total Pen 0 3 5 re Heating 3 r	Mod 14 Pen Rate 0% 28% 45% See Spac 26%	RA Mid Total Pen 0 3 6 we Heating 3 6	Mod 14RA Pen Rate 0% 32% 51% See Spac 30%	Mid-High Total Pen 0 4 7 e Heating 4 7	Mod 14 Pen Rate 0% 36% 58% See Spac 34%	RA High Total Pen 0 5 8 20 Heating 4 7	
Provide a contract of the second seco	State Appliance Regulations Baseline State Appliance Regulations None 100% of roof at Abs=0.90 Boiler Comb Eff = 80% U=0.50, SHGC=0.35 Boiler Comb Eff = 80% 0.576 W/mon Centifungal Chillers	Alternative Energy Star Rated 250 KW, 40 ton absorber 100% of roof at Abs=0.3 Boiler Comb Eff = 85% U=0.26, SHGC=0.29 Boiler Comb Eff = 85% 0.461 KW/non Centifungal Chillers	Mo Payback 254.8 8.0 4.2 See 8.5 4.4 2 1	d 14-RA, Pen Rate 0% 20% 32% e Space He 19% 32% 42%	BAU Total Pen 0 2 4 ating 2 4 5	Mod 14RA Pen Rate 0% 24% 38% See Spac 22% 38% 50%	A Mid-Low Total Pen 0 3 5 re Heating 3 5 7	Mod 14 Pen Rate 0% 28% 45% See Spac 26% 44% 59%	RA Mid Total Pen 0 3 6 e Heating 3 6 8	Mod 14RA Pen Rate 0% 32% 51% See Spac 30% 50% 67%	Mid-High Total Pen 0 4 7 e Heating 4 7 9	Mod 14 Pen Rate 0% 36% 58% See Spac 34% 57% 76%	RA High Total Pen 0 5 8 we Heating 4 7 10	
Provide a straight of the second seco	ototype 11 - 12-story Midrise R Baseline State Appliance Regulations None 100% of root at Abs=0.90 Boiler Comb Eff = 80% U=0.50, SHGC=0.35 Boiler Comb Eff = 80% 0.576 kW/Ion Centrifugal Chillers 0.70 watts/soft	tesidential (Qty 14) Alternative Energy Star Rated 250 kW, 40 ton absorber 100% of roof at Abs=0.3 Boiler Comb Eff = 85% U=0.26, SHGC=0.29 Boiler Comb Eff = 85% 0.461 kW/Ion Centrifugal Chillers 0.675 watts/sdn	Mo Payback 254.8 8.0 4.2 See 8.5 4.4 2.1 122.7	d 14-RA, Pen Rate 0% 20% 32% e Space He 19% 32% 42% 0%	BAU Total Pen 0 2 4 ating 2 4 5 0	Mod 14R/ Pen Rate 0% 24% 38% See Spac 22% 38% 50% 0%	A Mid-Low Total Pen 0 3 5 te Heating 3 5 7 0	Mod 14 Pen Rate 0% 28% 45% See Spac 26% 44% 59% 0%	RA Mid Total Pen 0 3 6 we Heating 3 6 8 0	Mod 14RA Pen Rate 0% 32% 51% See Spac 30% 50% 67% 0%	Mid-High Total Pen 0 4 7 e Heating 4 7 9 0	Mod 14 Pen Rate 0% 36% 58% See Spac 34% 57% 76% 0%	RA High Total Pen 0 5 8 we Heating 4 7 10 0	
Provide a state of the second state of the sec	ototype 11 - 12-story Midrise R Baseline State Appliance Regulations None 100% of roof at Abs=0.90 Boiler Comb Eff = 80% U=0.50, SHGC=0.35 Boiler Comb Eff = 80% 0.576 kW/ton Centinfugal Chillers 0.70 watts/sqft 5 ° R19 XPS	tesidential (Qty 14) Alternative Energy Star Rated 250 kW, 40 ton absorber 100% of roof at Abs=0.3 Boiler Comb Eff = 85% U=0.26, SHGC=0.29 Boiler Comb Eff = 85% 0.461 kW/ton Centrifugal Chillers 0.675 watts/sqtt 6° R23 XPS	Mo Payback 254.8 8.0 4.2 8.5 4.4 2.1 122.7 25.0	d 14-RA, Pen Rate 0% 20% 32% e Space He 19% 32% 42% 0% 2%	BAU Total Pen 0 2 4 ating 2 4 5 0 0 0	Mod 14R/ Pen Rate 0% 24% 38% See Spac 22% 38% 50% 0% 3%	A Mid-Low Total Pen 0 3 5 2 4 4 5 5 7 0 0 0	Mod 14 Pen Rate 0% 28% 45% See Spac 26% 44% 59% 0% 3%	RA Mid Total Pen 0 3 6 te Heating 3 6 8 0 0	Mod 14RA Pen Rate 0% 32% 51% See Spac 30% 50% 67% 0% 4%	Mid-High Total Pen 0 4 7 e Heating 4 7 9 0 0 0	Mod 14 Pen Rate 0% 36% 58% See Spac 34% 57% 76% 0% 4%	RA High Total Pen 0 5 8 we Heating 4 7 10 0 0	
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Mo Payback 7.2 17.8 2.1 11.9 NA 5.3 8.6 Mo Payback 237.0 5.4 5.4 7.8 Set 6.6 4.5 2.2 119.3 14.4	d 14-RA, Pen Rate 0% 20% 32% 42% 42% 42% 0% 2% 10% 19% 19% 19% 10% 19% 10% 10% 10% 10% 10% 10% 10% 12% N 25% 6% 6% 22% 6% 22% 6% 22% 6% 22% 6% 22% 22	BAU Total Pen 0 2 4 ating 2 4 5 0 1 2 4 5 0 1 2 4 5 0 1 2 4 5 0 1 2 4 5 0	Mod 14R/ Pen Rate 0% 24% 38% See Space 29% 39% 50% 0% 38% 98% 70% 30% 28% 76% NA See Space 15% NA 34% 26% 51% 15% NA 34% 26% 51% 15% NA 34% 26% 51% 15% NA 34% 26% 26% 26% 26% 26% 26% 26% 26% 26% 26% 26% 26% 26% 26% 26%	A Mid-Low Total Pen 0 3 5 6 4 Mid-Low Total Pen 4 Mid-Low Total Pen 4 0 0 0 0 0 0 0 0 0 0 0 0 0	Mod 14 Pen Rate 0% 28% 45% 59% 59% 14% 27% 0% 3% 44% 27% 7% Mod 14 9en Rate 0% 58% 17% NA See Spac 31% 8% 59% 17% NA 99% 28% 29% 29% 29% 29% 29% 29% 29% 29% 29% 29	RA Mid Total Pen 0 3 6 e Heating 0 1 3 6 8 0 1 3 6 8 0 1 3 7 7 7 0 0	Mod 14R.P Pen Rate 0% 32% 51% See Space 30% 50% 67% 0% 4% 16% 35% 68% 19% NA 56% 66% 19% NA 45% 33% 66% 19% NA 45% 33% See Space 38% 50% 65% 0% 44% 33% See Space 38% 50% 67% 0% 44% 33% See Space 38% 50% 67% 0%	Mid-High Total Pen 0 4 7 e Heating 0 2 Mid-High Total Pen 0 2 Mid-High Total Pen 0	Mod 14/ Pen Rate 0% 58% 58% See Spac 4% 76% 76% 76% 18% Mod 14/ Pen Rate NA See Spac 45% 76% 22% NA 51% 33% 33% See Spac 43% 56% 77%	RA High Total Pen 0 5 8 ve Heating 7 10 0 2 4 7 10 0 2 4 7 10 0 2 4 7 10 0
Prot Measure Appliances CHP Roof Material Water Heating Space Heating Space Heating Space Cooling Lighting Roof Insulation Proto Measure Appliances CHP Roof Material Water Heating Windows Space Heating Space Cooling Lighting Roof Insulation Prototyp Measure Appliances CHP Roof Material Water Heating Wall Insulation Prototyp Measure Appliances CHP Roof Material Water Heating Wall Insulation Prototyp Measure Appliances CHP Roof Material Water Heating Windows Space Heating Space Cooling Util String Space Cooling Undows Space Heating Space Cooling Undows Space Heating Space Cooling Undows Space Heating Space Cooling Thermal Storage	State Appliance Regulations None None 100% of nod at Abs=0.90 Boiler Comb Eff = 80% U=0.50, SHGC=0.35 Boiler Comb Eff = 80% 0.576 KW/ton Centrifugal Chillers 0.776 KW/ton Centrifugal Chillers 0.770 watts/sqft 5" R19 XPS None 10% of not at Abs=0.90 Boiler Comb Eff = 80% 0.576 KW/ton Centrifugal Chillers None Typical Aluminum Curtain Wall Deller Comb Eff = 80% U=0.50, SHGC=0.35 Boiler Comb Eff = 80% U=0.50, SHGC=0.35 Boiler Comb Eff = 80%	Alternative Alternative Energy Star Rated 250 kW, 40 ton absorber 100% of roof at Abs=0.3 Boiler Comb Eff = 85% U=0.26, SHGC=0.29 Boiler Comb Eff = 85% 0.675 watts/sqft 6 7 R23 XPS 15% of max load, 506 ton-hrs R19, 2x4.16 None 3000 kW, 680 ton absorber None 3000 kW, 680 ton absorber None Boiler Comb Eff = 85% U=0.26, SHGC=0.29	Mo Payback 254.8 8.0 4.2 8.5 4.4 2.1 122.7 25.0 13.5 8.2 Mo Payback NA Set 7.2 17.8 2.1 17.8 2.1 NA Sat 2.1.1 NA Sat 7.2 17.8 2.1 NA Sat 7.2 17.8 2.1 NA Sat 6.6 4.5 2.37.0 5.4 7.8 Set 6.6 4.5 2.4 119.3 14.4 21.4	d 14-RA, Pen Rate 0% 20% 32% 32% 42% 0% 10% 19% 19% d 14-RA, 10% 19% d 14-RA, 22% 6% 6% 42% 18% 18% 18% 18% 18% 18% 18% 18% 18% 18	BAU Total Pen 0 2 4 5 0 1 2 4 5 0 1 2 4 5 0 1 2 BAU Total Pen 0	Mod 14R, Pen Rate 0% 24% 38% See Space 22% 38% 50% 0% 3% 22% 38% See Space NA Pen Rate N 30% 28% 7% 51% 15% NA See Space 0% 33% 22% Mod 14R/ Pen Rate 0% 33% 22% Mod 14R/ Pen Rate 0% 33% 22% Mod 14R/ Pen Rate 0% 33% 22% 33% 28% 37% 50% 0% 0% 0% 0% <td>A Mid-Low Total Pen 0 3 5 5 6 6 7 7 0 1 3 7 7 0 1 3 7 7 0 1 1 3 7 7 0 0 1 3 7 7 0 0 1 3 7 7 0 0 0 0 1 3 7 7 0 0 0 0 0 0 0 0 0 0 0 0 0</td> <td>Mod 14 Pen Rate 0% 28% 28% 59% 59% 0% 3% 14% 27% 8% 0% 3% 14% 27% 8% 14% 27% 14% 27% 8% 14% 27% 8% 14% 28% 14% 28% 14% 28% 14% 8% 58% 14% 58% 14% 14% 14% 14% 14% 14% 14% 14% 14% 14</td> <td>RA Mid Total Pen 0 3 6 e Heating 0 1 3 6 e Heating 0</td> <td>Mod 14R.P Pen Rate 0% 32% 51% See Space 30% 50% 67% 0% 4% 16% 31% Mod 14R.P Pen Rate NA See Space 35% 19% 68% 9% 68% 19% 88% 19% 88% 19% 88% 19% 88% 19% 88% 19% 88% 19% 88% 19% 80% 10% 30% 80% 50% 60% 6%</td> <td>Mid-High Total Pen 0 4 7 e Heating 0 2 4 7 0 2 4 7 0 0 2 4 7 0 <tr< td=""><td>Mod 14! Pen Rate 0% 36% 58% See Space 34% 57% 0% 4% 57% Mod 14! Pen Rate NA See Space 39% 10% 76% 0% 33% Mod 14! Pen Rate 0% 50% 37% See Space 37% See Space 45% 56% 75% 0% 56% 75% 0%</td><td>RA High Total Pen 0 5 8 ve Heating 4 7 10 0 2 4 7 10 0 2 4 7 10 0</td></tr<></td>	A Mid-Low Total Pen 0 3 5 5 6 6 7 7 0 1 3 7 7 0 1 3 7 7 0 1 1 3 7 7 0 0 1 3 7 7 0 0 1 3 7 7 0 0 0 0 1 3 7 7 0 0 0 0 0 0 0 0 0 0 0 0 0	Mod 14 Pen Rate 0% 28% 28% 59% 59% 0% 3% 14% 27% 8% 0% 3% 14% 27% 8% 14% 27% 14% 27% 8% 14% 27% 8% 14% 28% 14% 28% 14% 28% 14% 8% 58% 14% 58% 14% 14% 14% 14% 14% 14% 14% 14% 14% 14	RA Mid Total Pen 0 3 6 e Heating 0 1 3 6 e Heating 0	Mod 14R.P Pen Rate 0% 32% 51% See Space 30% 50% 67% 0% 4% 16% 31% Mod 14R.P Pen Rate NA See Space 35% 19% 68% 9% 68% 19% 88% 19% 88% 19% 88% 19% 88% 19% 88% 19% 88% 19% 88% 19% 80% 10% 30% 80% 50% 60% 6%	Mid-High Total Pen 0 4 7 e Heating 0 2 4 7 0 2 4 7 0 0 2 4 7 0 <tr< td=""><td>Mod 14! Pen Rate 0% 36% 58% See Space 34% 57% 0% 4% 57% Mod 14! Pen Rate NA See Space 39% 10% 76% 0% 33% Mod 14! Pen Rate 0% 50% 37% See Space 37% See Space 45% 56% 75% 0% 56% 75% 0%</td><td>RA High Total Pen 0 5 8 ve Heating 4 7 10 0 2 4 7 10 0 2 4 7 10 0</td></tr<>	Mod 14! Pen Rate 0% 36% 58% See Space 34% 57% 0% 4% 57% Mod 14! Pen Rate NA See Space 39% 10% 76% 0% 33% Mod 14! Pen Rate 0% 50% 37% See Space 37% See Space 45% 56% 75% 0% 56% 75% 0%	RA High Total Pen 0 5 8 ve Heating 4 7 10 0 2 4 7 10 0 2 4 7 10 0	

	Prototype 01 - 56-story Highris	se Office (Qty 1)		CCT5, BA	NU N	CCT5, I	Mid-Low	CCT	5 Mid	CCT5, N	/lid-High	CCT5	i, High
Measure	Baseline	Alternative	Payback	Pen Rate	Total Pen	Pen Rate	Total Pen	Pen Rate	Total Pen	Pen Rate	Total Pen	Pen Rate	Total Pen
Appliances	None	None	NA	N	A	N	A	N	A	N	JA A	N	A
CHP	None	6500 kW, 1390 ton absorber	8.3	19%	0	23%	0	27%	0	31%	0	35%	0
Cool Roof	100% of roof at Abs=0.90	100% of roof at Abs=0.3	20.2	4%	0	5%	0	6%	0	7%	0	8%	0
Water Heating	Boiler Comb Eff = 80%	Boiler Comb Eff = 85%	NA	See Spar	ce Heating	See Space	ce Heating	See Spa	e Heating	See Space	ce Heating	See Space	ce Heating
Windows	U=0.50, SHGC=0.35	U=0.26, SHGC=0.29	7.2	22%	0	26%	0	31%	0	35%	0	40%	0
Space Heating	Boiler Comb Eff = 80%	Boiler Comb Eff = 85%	18.6	5%	0	6%	0	7%	0	8%	0	9%	0
Space Cooling	0.576 kW/ton Centrifugal Chillers	0.461 kW/ton Centrifugal Chillers	1.8	44%	0	53%	0	61%	0	70%	0	79%	0
Lighting	1.1 watts/sqft	0.9 watts/sqft	10.7	14%	0	17%	0	20%	0	23%	0	25%	0
Roof Insulation	5" R19 XPS	6" R23 XPS	2.6	40%	0	48%	0	56%	0	64%	0	72%	0
Thermal Storage	None	25% of max load, 23376 ton-hrs	8.5	19%	0	22%	0	26%	0	30%	0	34%	0
Wall Insulation	Typical Aluminum Curtain Wall	Reduced thermal bridging	8.8	18%	0	22%	0	25%	0	29%	0	32%	0
													-
	Prototype 02 - 41-story Highris	se Office (Qty 6)		CCT5, BA	U	CCT5, I	Mid-Low	CCT	5 Mid	CCT5, I	/lid-High	CCT5	i, High
Measure	Baseline	Alternative	Payback	Pen Rate	Total Pen	Pen Rate	Total Pen	Pen Rate	Total Pen	Pen Rate	Total Pen	Pen Rate	Total Pen
Appliances	None	None	NA	N	٨٨	Ν	A A	١	IA	N	JA	N	١A
CHP	None	5500 kW, 1150 ton absorber	8.0	20%	1	24%	1	28%	1	32%	1	36%	2
Roof Material	100% of roof at Abs=0.90	100% of roof at Abs=0.3	12.2	12%	0	14%	0	16%	0	19%	1	21%	1
Water Heating	Boiler Comb Eff = 80%	Boiler Comb Eff = 85%	NA	See Space	ce Heating	See Space	ce Heating	See Spa	ce Heating	See Space	ce Heating	See Space	ce Heating
Windows	U=0.50, SHGC=0.35	U=0.26, SHGC=0.29	7.2	22%	1	26%	1	31%	1	35%	2	40%	2
Space Heating	Boiler Comb Eff = 80%	Boiler Comb Eff = 85%	18.6	5%	0	6%	0	7%	0	8%	0	9%	0
Space Cooling	0.576 kW/ton Centrifugal Chillers	0.461 kW/ton Centrifugal Chillers	1.9	43%	2	52%	3	61%	3	69%	4	78%	4
Lighting	1.1 watts/sqft	0.9 watts/sqft	11.0	14%	0	16%	0	19%	1	22%	1	25%	1
Roof Insulation	5" R19 XPS	6" R23 XPS	4.6	31%	1	37%	2	43%	2	49%	2	55%	3
Thermal Storage	None	25% of max load, 15073 ton-hrs	5.3	28%	1	34%	2	39%	2	45%	2	51%	3
Wall Insulation	Typical Aluminum Curtain Wall	Reduced thermal bridging	8.8	18%	1	22%	1	25%	1	29%	1	32%	1
	Destations 00 04 4 17 1 1	0(1) (0) 5		00T5 5		0077	M		- MI-2	0077		0.077	
	Prototype U3 - 34-story Highri	se uffice (Qty 5)	<u> </u>	CC15, BA	U	CCT5, I	VIID-LOW	CCT	5 Mid	CCT5, I	/IId-High	CC15	, High
Measure	Baseline	Alternative	Payback	Pen Rate	Total Pen	Pen Rate	Total Pen	Pen Rate	Total Pen	Pen Rate	Fotal Pen	Pen Rate	Total Pen
Appliances	None	None	NA	N N	A	N N	A .	N	IA .	N	IA .	N	NA .
CHP	None	4500 kW, 1020 ton absorber	8.0	20%	0	24%		28%	1	32%		36%	1
Roof Material	100% of roof at Abs=0.90	100% of roof at Abs=0.3	7.1	22%	1	27%	1	31%	1	36%		40%	2
vvater Heating	Boller Comb Ett = 80%	Boller Comb Ett = 85%	NA T A	See Space	ce Heating	See Spac	ce Heating	See Spa	e Heating	See Space	e Heating	See Spac	ce Heating
vvindows	U=0.50, SHGC=0.35	U=0.26, SHGC=0.29	1.0	22%	1	2/%		31%	1	36%		40%	2
Space Heating	Boller Comb Eff = 80%	Boller Comb Eff = 85%	18.0	6%	0	1% F10/	0	8% 60%	0	9%	0	10%	0
Space Cooling	0.576 kW/ton Centrilugal Chillers	0.461 kW/ton Centrilugal Chillers	2.0	43%	2	51%	2	60%	2	68%	3	77%	3
Lignung Reef Insulation	F" P10 XPS	0.9 Watts/sqlt	0.2	13%	0	10%	0	19%	0	22%		24%	1
Thormal Storage	5 KI9 AFS	0 R23 AF3	0.3	19%	1	23%		21%	1	209/		3376	2
Moll Inculation	Typical Aluminum Curtain Wall	25% of filax load, 16172 toff-fils	0.4	24%	0	29%		34%	1	39%		24470	2
Wall Insulation	Typical Aluminum Curtain Wall	Reduced thermal bridging	0.0	1976	0	2270		20%		30%		34%	I
	Prototype 04 20 story Midris	o Office (Otv 2)				COTE	Midlow	ССТ	E Mid		Mid High	COTE	Linh
	Prototype 04 - 20-story wildris	e Office (Qty 3)		CCIS, BA		CC15,1	VIId-LOW	001		CC15, 1	/ild-High	0015	, rign
Measure	Baseline	Alternative	Payback	Pen Rate	Total Pen	Pen Rate	Total Pen	Pen Rate	Total Pen	Pen Rate	I otal Pen	Pen Rate	Total Pen
Appliances	None	None	NA	100/	NA O	P		P		P		N 050/	NA (
CHP	None	3000 kW, 490 ton absorber	8.2	19%	0	23%	0	21%	0	31%	0	35%	1
Notor Heating	Roller Comb Eff - 90%	Roller Comb Eff - 85%	7.Z	22%	U De Heating	20%		31%	U	35%		40%	I Hosting
Windowo			10.4	300 Space		3ee 3pa		300 Spa		300 Space		See Spac	
Space Heating	0=0.30, SHGC=0.35	0=0.20, SHGC=0.29 Boiler Comb Eff = 85%	22.3	3%	0	17.70	0	20%	0	Z370 5%	0	20%	0
Space Cooling	0.576 kW/top Centrifugal Chillers	0.461 kW/ton Centrifugal Chillers	1.0	43%	1	52%	1	60%	1	69%	2	77%	2
Lighting	1.1 watts/soft	0.401 kW/ton Centinugai Chillers	11.2	13%	0	16%	0	18%	0	21%	2	24%	0
Roof Insulation	5" R19 XPS	6" R23 XPS	6.7	23%	0	28%	0	33%	0	38%	1	42%	1
Thermal Storage	None	25% of max load 7818 ton-brs	5.0	29%	0	35%	1	41%	1	47%	1	52%	1
Wall Insulation	R11, 2x4,16	R19, 2x4, 16	12.2	12%	0	14%	0	16%	0	19%	0	21%	0
	,=	,							-				÷
	Prototype 05 - 33-story Highri	se Hotel (Qtv 1)		CCT5. BA	LU L	CCT5.	Mid-Low	CCT	5 Mid	CCT5.	Mid-High	CCT5	. Hiah
Measure	Baseline	Alternative	Payback	Pen Rate	Total Pen	Pen Rate	Total Pen	Pen Rate	Total Pen	Pen Rate	Total Pen	Pen Rate	Total Pen
Appliances	None	None	1 ayback	NA	rotarren	I cli itate	A	1 chi reate	A	N	A	1 ciritate	A
CHP	None	2500 kW, 500 ton absorber	5.9	26%	0			200/	0				
Roof Material	100% of roof at Abs=0.90	100% of roof at Abs=0.3	21.2			31%	0	30%	0	41%	0	47%	0
Water Heating	Boiler Comb Eff = 80%		-	4%	0	31% 4%	0	<u> </u>	0	41% <u>6</u> %	0	47% 7%	0
Windows		Boiler Comb Eff = 85%	Se	4% e Space He	0 ating	31% 4% See Space	0 0 ce Heating	5% See Spa	0 0 ce Heating	41% 6% See Spa	0 0 ce Heating	47% 7% See Space	0 0 ce Heating
Space Heating	0=0.50, SHGC=0.35	Boiler Comb Eff = 85% U=0.26, SHGC=0.29	Se 10.8	4% e Space He 14%	0 ating 0	31% 4% See Spac 17%	0 0 ce Heating 0	5% See Space 19%	0 ce Heating 0	41% 6% See Spac 22%	0 0 ce Heating 0	47% 7% See Spac 25%	0 0 ce Heating 0
	Boiler Comb Eff = 80%	Boiler Comb Eff = 85% U=0.26, SHGC=0.29 Boiler Comb Eff = 85%	Se 10.8 3.2	4% e Space He 14% 36%	0 ating 0 0	31% 4% See Spac 17% 44%	0 0 ce Heating 0 0	36% 5% See Spai 19% 51%	0 0 ce Heating 0 0	41% 6% See Space 22% 58%	0 0 ce Heating 0 0	47% 7% See Spac 25% 66%	0 0 ce Heating 0 0
Space Cooling	Boiler Comb Eff = 80% 0.576 kW/ton Centrifugal Chillers	Boiler Comb Eff = 85% U=0.26, SHGC=0.29 Boiler Comb Eff = 85% 0.461 kW/ton Centrifugal Chillers	Se 10.8 3.2 2.1	4% e Space He 14% 36% 42%	0 ating 0 0 0	31% 4% See Spac 17% 44% 50%	0 0 ce Heating 0 0 0	36% 5% See Spa 19% 51% 59%	0 0 ce Heating 0 0 0	41% 6% See Spac 22% 58% 67%	0 0 ce Heating 0 0 0	47% 7% See Spac 25% 66% 76%	0 0 ce Heating 0 0
Space Cooling Lighting	0=0.50, SHGC=0.35 Boiler Comb Eff = 80% 0.576 kW/ton Centrifugal Chillers 1.3 watts/sqft	Boiler Comb Eff = 85% U=0.26, SHGC=0.29 Boiler Comb Eff = 85% 0.461 kW/ton Centrifugal Chillers 1.19 watts/sqft	Se 10.8 3.2 2.1 40.5	4% e Space He 14% 36% 42% 0%	0 ating 0 0 0	31% 4% See Spac 17% 44% 50% 0%	0 0 ce Heating 0 0 0 0	36% 5% See Space 19% 51% 59% 0%	0 0 ce Heating 0 0 0 0	41% 6% See Spac 22% 58% 67% 1%	0 0 2e Heating 0 0 0 0	47% 7% See Spac 25% 66% 76% 1%	0 0 ce Heating 0 0 0 0
Space Cooling Lighting Roof Insulation	Boiler Comb Eff = 80% 0.576 kW/ton Centrifugal Chillers 1.3 watts/sqft 5° R19 XPS	Boiler Comb Eff = 85% U=0.26, SHGC=0.29 Boiler Comb Eff = 85% 0.461 kW/ton Centrifugal Chillers 1.19 watts/sqft 6" R23 XPS	Se 10.8 3.2 2.1 40.5 13.3	4% he Space He 14% 36% 42% 0% 10%	0 ating 0 0 0 0	31% 4% See Space 17% 44% 50% 0% 12%	0 0 ce Heating 0 0 0 0	36% 5% See Space 19% 51% 59% 0% 14%	0 ce Heating 0 0 0 0	41% 6% See Spac 22% 58% 67% 1% 16%	0 0 ce Heating 0 0 0 0	47% 7% See Spac 25% 66% 76% 1% 1%	0 0 ce Heating 0 0 0 0
Space Cooling Lighting Roof Insulation Thermal Storage	Boiler Comb Eff = 80% 0.576 kW/ton Centrifugal Chillers 1.3 watts/sqft 5° R19 XPS None	Boiler Comb Eff = 85% U=0.26, SHGC-0.29 Boiler Comb Eff = 85% 0.461 kW/ton Centrifugal Chillers 1.19 watts/sqft 6*R23 XPS 15% of max load, 7799 ton-hrs	Se 10.8 3.2 2.1 40.5 13.3 9.1	4% ee Space He 14% 36% 42% 0% 10% 10%	0 ating 0 0 0 0 0	31% 4% See Space 17% 44% 50% 0% 12% 21%	0 0 ce Heating 0 0 0 0 0	36% 5% See Spat 19% 51% 59% 0% 14% 24%	0 0 0 0 0 0 0 0 0 0	41% 6% See Space 22% 58% 67% 1% 16% 28%	0 0 0 0 0 0 0 0 0 0 0	47% 7% See Spac 25% 66% 76% 1% 1% 18% 31%	0 0 ce Heating 0 0 0 0 0
Space Cooling Lighting Roof Insulation Thermal Storage Wall Insulation	Boiler Comb Eff = 80% 0.576 kW/ton Centrifugal Chillers 1.3 watts/sqft 5* R19 XPS None Typical Aluminum Curtain Wall	Boiler Comb Eff = 85% U=0.26, SHGC=0.29 Boiler Comb Eff = 85% 0.461 kW/ton Centrifugal Chillers 1.19 watts/sqft 6" R23 XPS 15% of max load, 7799 ton-hrs Reduced thermal bridging	Se 10.8 3.2 2.1 40.5 13.3 9.1 12.1	4% ee Space He 14% 36% 42% 0% 10% 10% 17% 12%	0 ating 0 0 0 0 0 0 0	31% 4% See Space 17% 44% 50% 0% 12% 21% 14%	0 0 ce Heating 0 0 0 0 0 0 0	36% 5% See Span 19% 51% 59% 0% 14% 24% 16%	0 0 0 0 0 0 0 0 0 0 0 0 0	41% 6% See Space 22% 58% 67% 1% 16% 28% 19%	0 0 ce Heating 0 0 0 0 0 0 0	47% 7% See Spac 25% 66% 76% 1% 18% 31% 21%	0 0 ce Heating 0 0 0 0 0 0 0
Space Cooling Lighting Roof Insulation Thermal Storage Wall Insulation	DieU.30, ShGL=0.35 Boiler Comb Eff = 80% 0.576 kW/ton Centrifugal Chillers 1.3 watts/sqft 5° R19 XPS None Typical Aluminum Curtain Wall	Boiler Comb Eff = 85% U=0.26, SHGC-0.29 Boiler Comb Eff = 85% 0.461 kW/ton Centrifugal Chillers 1.19 wattis/sqft 6* R23 XPS 15% of max load, 7799 ton-hrs Reduced thermal bridging	S€ 10.8 3.2 2.1 40.5 13.3 9.1 12.1	4% ee Space He 14% 36% 42% 0% 10% 10% 12%	0 eating 0 0 0 0 0 0	31% 4% See Space 17% 44% 50% 0% 12% 21% 14%	0 0 ce Heating 0 0 0 0 0 0 0	36% 5% See Spar 19% 51% 59% 0% 14% 24% 16%	0 0 ce Heating 0 0 0 0 0 0 0 0	41% 6% See Space 58% 67% 1% 16% 28% 19%	0 0 ce Heating 0 0 0 0 0 0 0 0 0 0 0 0 0	47% 7% See Spac 25% 66% 76% 1% 1% 18% 31% 21%	0 0 ce Heating 0 0 0 0 0 0 0
Space Cooling Lighting Roof Insulation Thermal Storage Wall Insulation	Boiler Corb Eff = 80% 0.576 kW/ton Centrifugal Chillers 1.3 watts/sqft 5° R19 XPS None Typical Aluminum Curtain Wall Prototype 06 - 18-story Midris	Boiler Comb Eff = 85% U=0.26, SHGC-0.29 Boiler Comb Eff = 85% 0.461 kW/ton Centrifugal Chillers 1.19 watts/sqft 6" R23 XPS 15% of max load, 7799 ton-hrs Reduced thermal bridging Se Hotel (Qty 5)	Se 10.8 3.2 2.1 40.5 13.3 9.1 12.1	4% espace He 14% 36% 42% 0% 10% 17% 12%	0 eating 0 0 0 0 0 0	31% 4% See Space 17% 44% 50% 0% 12% 21% 14% CCT5, I	0 0 ce Heating 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	36% 5% See Spar 19% 51% 59% 0% 14% 24% 16%	0 0 ce Heating 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	41% 6% See Space 22% 58% 67% 1% 16% 28% 19%	0 0 0 0 0 0 0 0 0 0 0 0 0 0	47% 7% See Spac 25% 66% 76% 1% 1% 18% 31% 21% CCT5	0 0 ce Heating 0 0 0 0 0 0 0 0 0 0 0 0 0
Space Cooling Lighting Roof Insulation Thermal Storage Wall Insulation	Boiler Comb Eff = 80% 0.576 kW/ton Centrifugal Chillers 1.3 watts/sqft 5" R19 XPS None Typical Aluminum Curtain Wall Prototype 06 - 18-story Midris Baseline	Boiler Comb Eff = 85% U=0.26, SHGC=0.29 Boiler Comb Eff = 85% 0.461 kW/ton Centrifugal Chillers 1.19 watts/sqft 6" R23 XPS 15% of max load, 7799 ton-hrs Reduced thermal bridging 3e Hotel (Qty 5) Alternative	Se 10.8 3.2 2.1 40.5 13.3 9.1 12.1 Payback	4% espace He 14% 36% 422% 0% 10% 17% 12% CCT5, BA Pen Rate	0 eating 0 0 0 0 0 0 0 0 0	31% 4% See Spac 17% 44% 50% 0% 12% 21% 21% 21% 21% Pen Rate	0 ce Heating 0 0 0 0 0 0 0 0 0 0 0 0 0	36% 5% See Spat 19% 51% 59% 0% 14% 24% 16% CCT Pen Rate	0 0 10 10 10 10 10 10 10 10 10	41% 6% See Space 22% 58% 67% 1% 16% 28% 19% CCT5, I Pen Rate	0 0 ce Heating 0 0 0 0 0 0 0 0 0 0 0 0 0	47% 7% See Spac 25% 66% 76% 1% 18% 31% 21% CCT5 Pen Rate	0 0 ce Heating 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
Space Cooling Lighting Roof Insulation Thermal Storage Wall Insulation Measure Appliances	Boiler Comb Eff = 80% 0.576 kW/ton Centrifugal Chillers 1.3 watts/sqft 5" R19 XPS None Typical Aluminum Curtain Wall Prototype 06 - 18-story Midris Baseline None	Boiler Comb Eff = 85% U=0.26, SHGC-0.29 Boiler Comb Eff = 85% 0.461 kW/ton Centrifugal Chillers 1.19 watts/sqft 6" R23 XPS 15% of max load, 7799 ton-hrs Reduced thermal bridging 3e Hotel (Qty 5) Alternative None	Se 10.8 3.2 2.1 40.5 13.3 9.1 12.1 Payback	4% ee Space He 14% 36% 42% 0% 10% 10% 12% CCT5, BA Pen Rate NA	0 ating 0 0 0 0 0 0 0	31% 4% See Space 17% 44% 50% 0% 12% 21% 14% CCT5, I Pen Rate	0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	36% 5% See Spar 19% 51% 59% 0% 14% 24% 16% CCT Pen Rate	0 0 2e Heating 0 0 0 0 0 0 5 Mid Total Pen IA	41% 6% See Space 22% 58% 67% 1% 16% 28% 19% 19% CCT5, I Pen Rate	0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	47% 7% See Spat 25% 66% 1% 1% 18% 31% 21% CCT5 Pen Rate N M 44%	0 0 ce Heating 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
Space Cooling Lighting Roof Insulation Thermal Storage Wall Insulation Measure Appliances CHP Boof Matada	Boiler Comb Eff = 80% 0.576 kW/ton Centrifugal Chillers 1.3 watts/sqft 5° R19 XPS None Typical Aluminum Curtain Wall Prototype 06 - 18-story Midris Baseline None None	Boiler Comb Eff = 85% U=0.26, SHGC-0.29 Boiler Comb Eff = 85% 0.461 kW/ton Centrifugal Chillers 1.19 wattis/sqft 6" R23 XPS 15% of max load, 7799 ton-hrs Reduced thermal bridging Se Hotel (Qty 5) Alternative None 400 kW, 80 ton absorber	Se 10.8 3.2 2.1 40.5 13.3 9.1 12.1 Payback 6.4	4% ee Space He 14% 36% 42% 0% 10% 17% 12% CCT5, BA Pen Rate NA 24%	0 ating 0 0 0 0 0 0 0 VU Total Pen	31% 4% See Spar 17% 44% 50% 0% 12% 21% 14% CCT5, I Pen Rate	0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	36% 5% See Spar 19% 51% 59% 0% 14% 24% 16% CCT Pen Rate N 34%	0 0 2e Heating 0 0 0 0 0 0 5 Mid Total Pen IA 1 0	41% 6% See Spat 22% 58% 67% 67% 1% 1% 16% 28% 19% CCT5, I Pen Rate	0 ce Heating 0 0 0 0 0 0 0 0 0 0 0 0 0	47% 7% See Spac 25% 66% 76% 1% 1% 18% 31% 21% 21% CCT5 Pen Rate N 44%	0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
Space Cooling Lighting Roof Insulation Thermal Storage Wall Insulation Measure Appliances CHP Roof Material Water Heating	Boiler Comb Eff = 80% 0.576 kW/ton Centrifugal Chillers 1.3 watts/sqft 5* R19 XPS None Typical Aluminum Curtain Wall Prototype 06 - 18-story Midris Baseline None None None None None	Boiler Comb Eff = 85% U=0.26, SHGC=0.29 Boiler Comb Eff = 85% 0.461 kW/ton Centrifugal Chillers 1.19 watts/sqft 6" R23 XPS 15% of max load, 7799 ton-hrs Reduced thermal bridging Se Hotel (Qty 5) Alternative None 400 kW, 80 ton absorber 100% of root at Abs=0.3 Briler Comb Eff = 85%	Se 10.8 3.2 2.1 40.5 13.3 9.1 12.1 Payback 6.4 14.9	4% ee Space He 14% 36% 42% 0% 10% 17% 12% CCT5, BA Pen Rate NA 24% 8% e Space He	0 ating 0 0 0 0 0 0 0 VU Total Pen 1 0	31% 4% See Spat 17% 44% 50% 0% 12% 21% 12% 21% 12% 21% 14% CCT5, I Pen Rate 29% 10% Sec Sec	0 0 0 0 0 0 0 0 0 0 0 0 0 0	36% 5% See Space 19% 51% 59% 0% 14% 14% 16% CCT Pen Rate Pen Rate 34% 12% Sec Sec Sec Sec Sec Sec Sec Sec Sec Sec	0 0 0 0 0 0 0 0 0 0 0 0 0 0	41% 6% See Space 22% 58% 67% 1% 1% 16% 28% 19% 19% CCT5, I Pen Rate Sec Sec Sec Sec	0 0 0 0 0 0 0 0 0 0 0 0 0 0	47% 7% See Spat 25% 66% 76% 1% 18% 31% 21% 21% CCT5 Pen Rate N 44% 15% See Spac	0 0 0 0 0 0 0 0 0 0 0 0 0 0
Space Cooling Lighting Roof Insulation Thermal Storage Wall Insulation Measure Appliances CHP Roof Material Water Heating Windows	Boiler Comb Eff = 80% 0.576 kW/ton Centrifugal Chillers 1.3 watts/sqft 5' R 19 XPS None Typical Aluminum Curtain Wall Prototype 06 - 18-story Midris Baseline None None 100% of roof at Abs=0.90 Boiler Comb Eff = 80% U=0 53 H2C-0.35	Boiler Comb Eff = 85% U=0.26, SHGC-0.29 Boiler Comb Eff = 85% 0.461 kW/ton Centrifugal Chillers 1.19 watts/sqft 6" R23 XPS 15% of max load, 7799 ton-hrs Reduced thermal bridging se Hotel (Qty 5) Alternative None 400 kW, 80 ton absorber 10% of rof at Abs=0.3 Boiler Comb Eff = 85% Ul=0.26 SHGC-0.29	Se 10.8 3.2 2.1 40.5 13.3 9.1 12.1 Payback 6.4 14.9 Se 34 9	4% ee Space He 14% 36% 42% 0% 10% 10% 12% CCT5, BA Pen Rate NA 24% 8% e Space He 1%	0 ating 0 0 0 0 0 0 0 VU Total Pen 1 0 ating 0	31% 4% See Spac 17% 44% 50% 0% 12% 21% 12% 21% 14% CCT5, I Pen Rate 29% 10% See Spac	0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	30% 5% See Spai 19% 51% 59% 0% 14% 24% 16% Pen Rate Page Spai 24% 12% See Spai	0 ce Heating 0 0 0 0 0 0 0 0 0 0 0 0 0	41% 6% See Spar 22% 58% 67% 1% 1% 16% 28% 19% CCT5, I Pen Rate See Spar 39% 13% See Spar 1%	0 0 0 0 0 0 0 0 0 0 0 0 0 0	47% 7% See Spar 25% 66% 76% 1% 1% 18% 31% 21% CCT5 Pen Rate N 44% 15% See Spac	0 0 0 0 0 0 0 0 0 0 0 0 0 0
Space Cooling Lighting Roof Insulation Thermal Storage Wall Insulation Measure Appliances CHP Roof Material Water Heating Windows Space Heating	Boiler Comb Eff = 80% 0.576 kW/ton Centrifugal Chillers 1.3 watts/sqft 5' R19 XPS None Typical Aluminum Curtain Wall Prototype 06 - 18-story Midris Baseline None 100% of rod at Abs=0.90 Boiler Comb Eff = 80% U=0.50, SHGC=0.35 Boilier Comb Fff = 80%	Boiler Comb Eff = 85% U=0.26, SHGC=0.29 Boiler Comb Eff = 85% 0.461 kW/ton Centrifugal Chillers 1.19 watts/sqft 6" R23 XFS Reduced thermal bridging se Hotel (Qty 5) Alternative None 400 kW, 80 ton absorber 100% of roof at Abs=0.3 Boiler Comb Eff = 85% U=0.26, SHGC=0.29 Boiler Comb Ff = 85%	Se 10.8 3.2 2.1 40.5 13.3 9.1 12.1 Payback 6.4 14.9 Se 34.9 3.2	4% es Space He 14% 36% 42% 0% 10% 10% 12% CCT5, BA Pen Rate NA 24% e Space He e Space He 1% 37%	0 ating 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	31% 4% See Spat 17% 44% 0% 0% 12% 21% 14% CCT5, I Pen Rate N 29% 10% See Spat 10% See Spat	0 0 0 0 0 0 0 0 0 0 0 0 0 0	30% 5% See Spai 19% 51% 59% 0% 14% 24% 16% CCT Pen Rate Pen Rate N 34% 12% See Spai 1% 51%	0 2e Heating 0 0 0 0 0 0 0 0 0 0 0 0 0	41% 6% See Space 22% 58% 67% 1% 16% 28% 19% CCT5, I Pen Rate N 39% 13% See Space 13% 59%	0 0 0 0 0 0 0 0 0 0 0 0 0 0	47% 7% See Spar 25% 66% 1% 1% 1% 21% CCT5 Pen Rate N 44% 15% See Spac 1% 66%.	0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
Space Cooling Lighting Roof Insulation Thermal Storage Wall Insulation Measure Appliances CHP Roof Material Water Heating Windows Space Heating Space Cooling	D=0.30, SHGL=0.35 Boiler Comb Eff = 80% 0.576 kW/ton Centrifugal Chillers 1.3 watts/sqft 5" R19 XPS None Typical Aluminum Curtain Wall Prototype 06 - 18-story Midris Baseline None 100% of roof at Abs=0.90 Boiler Comb Eff = 80% U=0.50, SHGC=0.35 Boiler Comb Eff = 80% 0.576 kW/ton Centrifunal Chillare	Boiler Comb Eff = 85% U=0.26, SHGC-0.29 Boiler Comb Eff = 85% 0.461 kW/ton Centrifugal Chillers 1.19 watts/sqft 6" R23 XPS 15% of max load, 7799 ton-hrs Reduced thermal bridging se Hotel (Qty 5) Alternative None 400 kW, 80 ton absorber 100% of roof at Abs=0.3 Boiler Comb Eff = 85% U=0.26, SHGC=0.29 Boiler Comb Eff = 85% U=0.26, Utgn act Chillers	Se 10.8 3.2 2.1 40.5 13.3 9.1 12.1 Payback 6.4 14.9 Se 34.9 3.2 1.8	4% es Space He 14% 36% 42% 0% 10% 17% 12% 12% CCT5, BA Pen Rate NA 24% 8% e e Space He 1% 37% 37%	0 ating 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	31% 4% See Spar 17% 44% 50% 0% 12% 21% 12% 21% 12% CCT5,I Pen Rate N 29% 10% See Spar 1% 44% 55%	0 0 0 0 0 0 0 0 0 0 0 0 0 0	30% 5% See Spat 19% 51% 59% 0% 14% 24% 16% Ten Rate Pen Rate Na% 12% See Spat 1% 51% 61%	0 0 2e Heating 0 0 0 0 0 0 0 0 0 0 0 5 Mid Total Pen IA 1 0 0 2e Heating 0 2 3	41% 6% See Spat 22% 5% 67% 1% 16% 28% 19% CCT5, I Pen Rate N 39% 13% See Spat 1%	0 0 0 0 0 0 0 0 0 0 0 0 0 0	47% 7% See Spat 25% 66% 76% 1% 1% 1% 31% 21% CCT5 Pen Rate Value N 44% 15% See Spac 1% 76% 1%	0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
Space Cooling Lighting Roof Insulation Thermal Storage Wall Insulation Measure Appliances CHP Roof Material Water Heating Windows Space Heating Space Cooling Lighting	D=0.30, ShGL=0.35 Boiler Comb Eff = 80% 0.576 kW/ton Centrifugal Chillers 1.3 watts/sqft 5" R19 XPS None Typical Aluminum Curtain Wall Prototype 06 - 18-story Midris Baseline None None 100% of roof at Abs=0.90 Boiler Comb Eff = 80% U=0.60, SHGC=0.35 Boiler Comb Eff = 80% 0.576 kW/ton Centrifugal Chillers 1.3 watts/soft	Boiler Comb Eff = 85% U=0.26, SHGC-0.29 Boiler Comb Eff = 85% 0.461 kW/ton Centrifugal Chillers 1.19 watts/sqft 6" R23 XPS 15% of max load, 7799 ton-hrs Reduced thermal bridging set Hotel (Qty 5) Alternative None 400 kW, 80 ton absorber 10% of rod at Abs=0.3 Boiler Comb Eff = 85% U=0.26, SHGC-0.29 Boiler Comb Eff = 85% 0.461 kW/ton Centrifugal Chillers 1,19 watts/soft	Se 10.8 3.2 2.1 40.5 13.3 9.1 12.1 Payback 6.4 14.9 Se 34.9 3.2 1.8 34.9 3.2 1.8 38.7	4% • space He 14% 36% 42% 0% 10% 17% 12% CCT5, BA Pen Rate NA 24% 8% e Space He 1% 37% 44% 0%	0 ating 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	31% 4% See Spat 50% 0% 12% 21% 14% CCT5, 14% CCT5, 14% CCT5, 10% See Spat 10% See Spat 10% 52% 0%	0 0 0 0 0 0 0 0 0 0 0 0 0 0	30% 5% See Spat 19% 51% 59% 0% 14% 24% 14% 24% 14% 24% 14% 24% 14% 59% 0% 14% 12% See Spat 12% 51% 61% 11%	0 2e Heating 0 0 0 0 0 0 0 0 0 0 0 0 0	41% 6% See Spat 22% 58% 67% 67% 67% 28% 19% 28% 19% CCT5, I Pen Rate N 39% 13% See Spat 13% 59% 70%	0 0 ce Heating 0 0 0 0 0 0 0 0 0 0 0 0 0	47% 7% See Spar 25% 66% 76% 1% 1% 31% 21% 21% 21% CCT5 Pen Rate N 44% 15% See Spac 1% 66% 78% 1%	0 0 0 0 0 0 0 0 0 0 0 0 0 0
Space Cooling Lighting Roof Insulation Thermal Storage Wall Insulation Measure Appliances CHP Roof Material Water Heating Windows Space Heating Space Cooling Lighting Roof Insulation	Boiler Comb Eff = 80% 0.576 kW/ton Centrifugal Chillers 1.3 watts/sqft 5' R19 XPS None Typical Aluminum Curtain Wall Prototype 06 - 18-story Midris Baseline None None 100% of tod at Abs=0.90 Boiler Comb Eff = 80% U=0.50, SHGC=0.35 Boiler Comb Eff = 80% 0.576 kW/ton Centrifugal Chillers 1.3 watts/sqft 5' R19 XPS	Boiler Comb Eff = 85% U=0.26, SHGC=0.29 Boiler Comb Eff = 85% 0.461 kW/ton Centrifugal Chillers 1.19 watts/sqft 6" R23 XPS 15% of max load, 7799 ton-hrs Reduced thermal bridging se Hotel (Qty 5) Alternative 100% of roof at Abs=0.3 Boiler Comb Eff = 85% U=0.26, SHGC=0.29 Boiler Comb Eff = 85% 0.461 kW/ton Centrifugal Chillers 1.19 watts/sqft 6" R23 XPS	Se 10.8 3.2 2.1 40.5 13.3 9.1 12.1 Payback 6.4 14.9 Se 34.9 3.2 1.8 38.7 14.0	4% espace He 14% 36% 42% 0% 10% 17% 12% CCT5, BA Pen Rate NA 24% 8% e Space He 1% 37% 44% 0% 9%	0 ating 0 0 0 0 0 0 0 0 U Total Pen 1 0 ating 0 1 2 0 0	31% 4% See Space 17% 44% 50% 0% 12% 21% 12% 21% 12% 21% 12% 21% 14% ECT5,1 Pen Rate N See Space 10% 52% 52% 0% 11%	0 0 ce Heating 0 0 0 0 0 0 0 0 0 0 0 0 0	36% 5% See Spar 19% 51% 59% 0% 14% 24% 16% 14% 16% CCT Pen Rate N See Spar 1% 51% 61% 13%	0 0 12 Heating 0 0 0 0 0 0 0 0 0 0 0 0 0	41% 6% See Spat 22% 58% 67% 1% 16% 28% 19% 19% CCT5, I Pen Rate N See Spat 1% 59% 70% 1%	0 0 0 0 0 0 0 0 0 0 0 0 0 0	47% 7% 28e Spat 25% 66% 76% 76% 18% 31% 21% CCT5 Pen Rate N 44% 15% 58e Spat 1% 66% 78% 78% 78%	0 0 0 0 0 0 0 0 0 0 0 0 0 0
Space Cooling Lighting Roof Insulation Thermal Storage Wall Insulation Measure Appliances CHP Roof Material Water Heating Windows Space Heating Space Cooling Lighting Roof Insulation Thermal Storace	D=0.30, ShGL=0.35 Boiler Comb Eff = 80% 0.576 kW/ton Centrifugal Chillers 1.3 watts/sqft 5" R19 XPS None Typical Aluminum Curtain Wall Prototype 06 - 18-story Midris Baseline None 100% of roof at Abs=0.90 Boiler Comb Eff = 80% 0.576 kW/ton Centrifugal Chillers 1.3 watts/sqft 5" R19 XPS None	Boiler Comb Eff = 85% U=0.26, SHGC-0.29 Boiler Comb Eff = 85% 0.461 kW/ton Centrifugal Chillers 1.19 watts/sqft 6" R23 XPS 15% of max load, 7799 ton-hrs Reduced thermal bridging se Hotel (Qty 5) Alternative None 400 kW, 80 ton absorber 100% of roof at Abs=0.3 Boiler Comb Eff = 85% U=0.26, SHGC=0.29 Boiler Comb Eff = 85% 0.461 kW/ton Centrifugal Chillers 1.19 watts/sqft 6" R23 XPS	Se 10.8 3.2 2.1 40.5 13.3 9.1 12.1 Payback 6.4 14.9 Se 34.9 3.2 1.8 38.7 14.0 8.3	4% • space He 14% 36% 42% 0% 10% 17% 12% CCT5, BA Pen Rate NA 24% 8% e Space He 1% 37% 44% 0% 9% 9%	0 ating 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	31% 4% See Spar 17% 44% 50% 0% 12% 21% 12% 21% 12% 21% 12% 21% 12% 21% 12% 21% 12% 21% 12% 23%	0 0 ce Heating 0 0 0 0 0 0 0 0 0 0 0 0 0	36% 5% See Spar 19% 51% 59% 0% 14% 24% 16% CCT Pen Rate N 34% 12% See Spar 1% 51% 51% 51% 51% 27%	0 0 2e Heating 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	41% 6% See Spat 22% 58% 67% 1% 16% 28% 1% CCT5, I Pen Rate N 39% 13% See Spat 1% 1% 59% 70% 70% 1%	0 0 ce Heating 0 0 0 0 0 0 0 0 0 0 0 0 0	47% 7% 25% 66% 76% 18% 31% 21% 21% 21% CCT5 Pen Rate Pen Rate Pen Rate 15% 586 Space 15% 66% 78% 78% 78% 78% 21% 54%	0 0 0 0 0 0 0 0 0 0 0 0 0 0
Space Cooling Lighting Roof Insulation Thermal Storage Wall Insulation Measure Appliances CHP Roof Material Water Heating Space Cooling Uighting Roof Insulation Thermal Storage Wall Insulation	D=0.30, SHGL=0.35 Boiler Comb Eff = 80% 0.576 kW/ton Centrifugal Chillers 1.3 watts/sqft 5" R19 XPS None Typical Aluminum Curtain Wall Prototype 06 - 18-story Midris Baseline None None 100% of rod at Abs=0.90 Boiler Comb Eff = 80% U=0.50, SHGC=0.35 Boiler Comb Eff = 80% 0.576 kW/ton Centrifugal Chillers 1.3 watts/sqft 5" R19 XPS None R11, 2x4.16	Boiler Comb Eff = 85% U=0.26, SHGC-0.29 Boiler Comb Eff = 85% 0.461 kW/ton Centrifugal Chillers 1.19 watts/sqft 6" R23 XPS 15% of max load, 7799 ton-hrs Reduced thermal bridging set Hotel (Qty 5) Alternative None 400 kW, 80 ton absorber 10% of rod at Abs=0.3 Boiler Comb Eff = 85% U=0.26, SHGC-0.29 Boiler Comb Eff = 85% 0.461 kW/ton Centrifugal Chillers 1.19 watts/sqft 6" R23 XPS 15% of max load, 1265 ton-hrs R19, 2x4.16	Se 10.8 3.2 2.1 40.5 13.3 9.1 12.1 Payback 6.4 14.9 Se 34.9 3.2 1.8 38.7 14.0 8.3 8.7	4% • Space He 14% 36% 42% 0% 17% 17% 12% CCT5, BA Pen Rate NA 24% 8 Space He 1% 37% 44% 0% 44% 0% 3%	0 ating 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	31% 4% See Spac 17% 44% 50% 0% 12% 21% 14% 21% 14% CCT5, I Pen Rate Pen Rate 10% See Spac 10% 52% 0% 11% 52% 0% 11% 52% 23% 44%	0 0 ce Heating 0 0 0 0 0 0 0 0 0 0 0 0 0	30% 5% See Span 51% 51% 59% 0% 14% 24% 14% 24% 14% 24% 14% 24% 50% 50% 51% 61% 13% 27% 55%	0 0 2e Heating 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	41% 6% See Spat 22% 58% 67% 1% 16% 28% 19% 16% 28% 19% CCT5, I Pen Rate N 39% 13% 59% 70% 15% 31% 55%	0 0 ce Heating 0 0 0 0 0 0 0 0 0 0 0 0 0	47% 7% 25% 66% 76% 1% 18% 31% 21% 21% CCT5 Pen Rate N 44% 15% See Spac 1% 66% 66% 66% 66% 66% 34% 34%	0 0 0 0 0 0 0 0 0 0 0 0 0 0
Space Cooling Lighting Roof Insulation Thermal Storage Wall Insulation Measure Appliances CHP Roof Material Water Heating Windows Space Acoling Lighting Roof Insulation Thermal Storage Wall Insulation	D=0.30, SHGL=0.33 Boiler Comb Eff = 80% 0.576 kW/ton Centrifugal Chillers 1.3 watts/sqft 5" R19 XPS None Typical Aluminum Curtain Wall Prototype 06 - 18-story Midris Baseline None 100% of roof at Abs=0.90 Boiler Comb Eff = 80% U=0.50, SHGC=0.35 Boiler Comb Eff = 80% 0.576 kW/ton Centrifugal Chillers 1.3 watts/sqft 5" R19 XPS None R11, 2x4.16	Boiler Comb Eff = 85% U=0.26, SHGC=0.29 Boiler Comb Eff = 85% 0.461 kW/ton Centrifugal Chillers 1.19 watts/sqft 6" R23 XPS T5% of max load, 7799 ton-hrs Reduced thermal bridging se Hotel (Qty 5) Alternative None 400 kW, 80 ton absorber 100% of roof at Abs=0.3 Boiler Comb Eff = 85% U=0.26, SHGC=0.29 Boiler Comb Eff = 85% 0.461 kW/ton Centrifugal Chillers 1.19 watts/sqft 6" R23 XPS 15% of max load, 1265 ton-hrs R19, 224.16	Se 10.8 3.2 2.1 40.5 13.3 9.1 12.1 Payback 6.4 14.9 3.2 1.8 38.7 14.0 8.3 22.2	4% 4% es Space He 14% 36% 42% 0% 10% 17% 17% 12% CCT5, BA Pen Rate NA 24% 8% e Space He 8% 8% e Space He 1% 37% 44% 0% 9% 44%	0 ating 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	31% 34% See Spat 17% 44% 50% 0% 12% 21% 12% 21% 12% 21% 12% 21% 12% 21% 12% 21% 12% 21% 12% 23% 4%	0 0 ce Heating 0 0 0 0 0 0 0 0 0 0 0 0 0	30% 5% 5% 5% 51% 51% 51% 51% 24% 16% CCT Pen Rate 16% 16% 16% 12% 51% 51% 51% 51% 51% 55%	0 0 2e Heating 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	41% 6% See Spat 22% 58% 67% 1% 19% CCT5, I Pen Rate CCT5, I 9% 13% See Spat 1% 59% 70% 15% 31% 5%	0 0 ce Heating 0 0 0 0 0 0 0 0 0 0 0 0 0	47% 7% See Spat 25% 66% 76% 1% 18% 18% 21% 21% 21% 21% 21% 21% 5% See Spac 1% 66% 76% 1% 1% 5% 5% 5% 66% 6%	0 0 0 0 0 0 0 0 0 0 0 0 0 0
Space Cooling Lighting Roof Insulation Thermal Storage Wall Insulation Measure Appliances CHP Roof Material Water Heating Space Heating Space Cooling Space Cooling Lighting Roof Insulation Thermal Storage Wall Insulation	D=0.30, ShGL=0.35 Boiler Comb Eff = 80% 0.576 kW/ton Centrifugal Chillers 1.3 watts/sqt 5" R19 XPS None Typical Aluminum Curtain Wall Prototype 06 - 18-story Midris Baseline None 100% of roof at Abs=0.90 Boiler Comb Eff = 80% 0.576 kW/ton Centrifugal Chillers 1.3 watts/sqt 5" R19 XPS None 1.3 watts/sqt 5" R19 XPS None R11, 2x4.16 ototype 07 - 55-story Highrise	Boiler Comb Eff = 85% U=0.26, SHGC-0.29 Boiler Comb Eff = 85% 0.461 kW/ton Centrifugal Chillers 1.19 watts/sqft 6" R23 XPS 15% of max load, 7799 ton-hrs Reduced thermal bridging 8e Hotel (Qty 5) Alternative None 400 kW, 80 ton absorber 100% of roof at Abs=0.3 Boiler Comb Eff = 85% U=0.26, SHGC=0.29 Boiler Comb Eff = 85% 0.461 kW/ton Centrifugal Chillers 1.19 watts/sqft 6" R23 XPS 1.9 watts/sqft 6" R23 XPS Rejet Comb Eff = 85% 0.461 kW/ton Centrifugal Chillers 1.19 watts/sqft 6" R23 XPS 15% of max load, 1265 ton-hrs R19, 2x4.16 Residential (Qtv 2)	Se 10.8 3.2 2.1 40.5 13.3 9.1 12.1 Payback 6.4 14.9 Se 34.9 3.2 1.8 38.7 14.0 8.3 22.2	4% • Space He 14% 36% 42% 0% 17% 12% CCT5, BA Pen Rate NA 24% 8% • Space He 1% 37% 44% 0% 9% 19% 57% 57% 57% 57% 57% 57% 57% 57	0 ating 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	31%, 4% See Spat 17%, 44%, 50%, 0%, 12%, 21%, 12%, 21%, 12%, 21%, 12%, 21%, 12%, 21%, 12%, 21%, 12%, 21%, 12%, 21%, 12%, 22%, 0%, 29%, 10%, 44%, 22%, 24%, 24%, 24%, 24%, 24%, 24	0 0 ce Heating 0 0 0 0 0 0 0 0 0 0 0 0 0	30% 5% See Span 19% 51% 59% 0% 14% 24% 14% 24% 14% 24% 14% 24% 12% See Span 12% 51% 61% 51% 51% 51% 55%	0 0 2e Heating 0 0 0 0 0 0 0 0 0 0 0 0 0	41% 6% See Spat 22% 58% 67% 1% 16% 28% 28% 1% CCT5, I Pen Rate Pen Rate Pen Rate See Spat 13% 59% 70% 15% 31% 5%	0 0 0 0 0 0 0 0 0 0 0 0 0 0	47% 7% See Spat 25% 66% 76% 1% 18% 31% 21% 21% Pen Rate Pen Rate Pen Rate 15% 5% See Spat 1% 66% 78% 1% 66% 66% 78% 78% 66% 78% 78% 2% 5% 5% 5% 5% 5% 5% 5% 5% 5% 5% 5% 5% 5%	0 0 0 0 0 0 0 0 0 0 0 0 0 0
Space Cooling Lighting Roof Insulation Thermal Storage Wall Insulation Measure Appliances CHP Roof Material Water Heating Windows Space Heating Space Cooling Lighting Roof Insulation Thermal Storage Wall Insulation Thermal Storage Wall Insulation	0=0.30, SHGL=0.35 Boiler Comb Eff = 80% 0.576 kW/ton Centrifugal Chillers 1.3 watts/sqft 5' R 19 XPS None Typical Aluminum Curtain Wall Prototype 06 - 18-story Midris Baseline None None 100% of roof at Abs=0.90 Boiler Comb Eff = 80% U=0.50, SHGC=0.35 Boiler Comb Eff = 80% 0.576 kW/ton Centrifugal Chillers 1,3 watts/sqft 5' R 19 XPS None R11, 2x4.16 ototype 07 - 55-story Highrise Baseline	Boiler Comb Eff = 85% U=0.26, SHGC=0.29 Boiler Comb Eff = 85% 0.461 kW/ton Centrifugal Chillers 1.19 watts/sqft 6" R23 XFS Reduced thermal bridging se Hotel (Qty 5) Alternative None 400 kW, 80 ton absorber 100% of roof at Abs=0.3 Boiler Comb Eff = 85% U=0.26, SHGC=0.29 Boiler Comb Eff = 85% 0.461 kW/ton Centrifugal Chillers 1.19 watts/sqft 6" R23 XFS 15% of max load, 1265 ton-hrs R19, 2x4.16 Residential (Qty 2) Alternative	Se 10.8 3.2 2.1 40.5 13.3 9.1 12.1 Payback 6.4 14.9 Se 34.9 3.2 1.8 38.7 14.0 8.3 22.2 22.2 14.0 8.3 24.9 3.2 14.0 8.3 22.2 14.0 8.3 24.0 14.0 14.0 14.0 14.0 14.0 14.0 14.0 1	4% • e Space He 14% 36% 42% 0% 17% 12% CCT5, BA Pen Rate 1% 37% 44% 0% 9% 9% 9% Space He CCT5, BA	0 ating 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	31% 4% See Spat 17% 50% 0% 12% 21% 12% 21% 14% CCT5, 1% 44% See Spat 1% 5% 5% 0% See Spat 1% 1% 29% 10% 11% 23% 44% 5% CCT5, 1% Pen Rate	0 0 0 ce Heating 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	30% 5% See Spar 19% 51% 59% 0% 14% 14% 14% 14% 16% 16% 16% 16% 16% 16% 16% 16% 16% 11% 11	0 0 2e Heating 0 0 0 0 0 0 0 0 0 0 0 0 0	41% 6% See Spat 22% 58% 67% 1% 16% 28% 19% 28% 19% CCT5, I Pen Rate Pen Rate	0 0 ce Heating 0 0 0 0 0 0 0 0 0 0 0 0 0	47% 7% 25% 66% 76% 1% 18% 31% 21% 21% CCT5 Pen Rate 1% 66% 66% 78% 17% 34% 66% 66% CCT5 Pen Rate	0 0 0 0 0 0 0 0 0 0 0 0 0 0
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Space Cooling Lighting Roof Insulation Thermal Storage Wall Insulation Appliances CHP Roof Material Water Heating Space Heating Space Heating Space Heating Space Heating Lighting Lighting Roof Insulation Thermal Storage Wall Insulation	Boiler Comb Eff = 80% 0.576 kW/ton Centrifugal Chillers 1.3 watts/sqft 5" R19 XPS None Typical Aluminum Curtain Wall Prototype 06 - 18-story Midris Baseline None 100% of roof at Abs=0.90 Boiler Comb Eff = 80% 0.576 kW/ton Centrifugal Chillers 1.3 watts/sqft 5" R19 XPS None R11, 2x4.16 ototype 07 - 55-story Highrise Baseline State Appliance Regulations None	Boiler Comb Eff = 85% U=0.26, SHGC-0.29 Boiler Comb Eff = 85% 0.461 kW/ton Centrifugal Chillers 1.19 watts/sqft 6" R23 XPS 15% of max load, 7799 ton-hrs Reduced thermal bridging 8e Hotel (Qty 5) Alternative None 400 kW, 80 ton absorber 100% of roaf at Abs=0.3 Boiler Comb Eff = 85% 0.461 kW/ton Centrifugal Chillers 1.19 watts/sqft 6" R23 XPS 8oiler Comb Eff = 85% 0.461 kW/ton Centrifugal Chillers 1.19 watts/sqft 6" R23 XPS 15% of max load, 1265 ton-hrs Rej, 2x4.16 Residential (Qty 2) Alternative Energy Star Rated 1500 kW, 300 ton absorber	Se 10.8 3.2 2.1 40.5 13.3 9.1 12.1 Payback 6.4 14.9 Se 34.9 3.2 1.8 38.7 14.0 8.3 22.2 Payback 222.2 7.6	4% • Space He 14% 36% 42% 0% 17% 12% CCT5, BA Pen Rate NA 24% 8% 9% 44% 9% 44% 0% 23% CCT5, BA Pen Rate 0% 21%	0 ating 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	31% 4% See Spat 17% 44% 50% 0% 21% 12% 21% 12% 21% 12% 21% 12% 0% CCT5,1 Pen Rate 0% 22% 0% 22% 0% 22%	0 0 0 ce Heating 0 0 0 0 0 0 0 0 0 0 0 0 0	30% 5% See Span 19% 51% 51% 59% 0% 14% 24% 14% 24% 14% 24% 12% See Span 12% 51% 61% 51% 51% 51% 51% 51% 51% 51% 51% 51% 5	0 0 2e Heating 0 0 0 0 0 0 0 0 0 0 0 0 0	41% 6% 5ee Spat 22% 58% 67% 1% 16% 28% 7% CCT5, I Pen Rate 0% 39% 70% 13% 59% 70% 15% 31% 59% 70% 15% 31% 59% 70% 10% 34%	0 0 0 0 0 0 0 0 0 0 0 0 0 0	47% 7% 25% 66% 76% 1% 1% 18% 18% 31% 21% 21% Pen Rate 9% 34% 66% 66% 66% 66% 66% 78% 17% 66% 66% 78% 78% 17% 66% 78% 78% 78% 78% 78% 78% 76% 76% 76% 76% 76% 76% 76% 76% 76% 76	0 0 0 0 0 0 0 0 0 0 0 0 0 0
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Space Cooling Lighting Roof Insulation Thermal Storage Wall Insulation Measure Appliances CHP Roof Material Water Heating Space Cooling Lighting Roof Insulation Thermal Storage Wall Insulation Pro Measure Appliances CHP Roof Material Water Heating Water Heating	D=0.30, SHGL=0.33 Boiler Comb Eff = 80% 0.576 kW/ton Centrifugal Chillers 1.3 watts/sqft 5" R19 XPS None Typical Aluminum Curtain Wall Prototype 06 - 18-story Midris Baseline None 100% of roof at Abs=0.90 Boiler Comb Eff = 80% 0.576 kW/ton Centrifugal Chillers 1.3 watts/sqft 5" R19 XPS None R11, 2x4.16 ototype 07 - 55-story Highrise Baseline None R11, 2x4.16 Ototype 07 - 45-story Highrise Baseline None State Appliance Regulations None None Boiler Comb Eff = 80%	Boiler Comb Eff = 85% U=0.26, SHGC=0.29 Boiler Comb Eff = 85% 0.461 kW/ton Centrifugal Chillers 1.19 watts/sqft 6" R23 XPS 15% of max load, 7799 ton-hrs Reduced thermal bridging Se Hotel (Qty 5) Alternative None 400 kW, 80 ton absorber 100% of roof at Abs=0.3 Boiler Comb Eff = 85% U=0.26, SHGC=0.29 Boiler Comb Eff = 85% 0.461 kW/ton Centrifugal Chillers 1.19 watts/sqft 6" R23 XPS 15% of max load, 1265 ton-hrs R19, 2x4.16 Residential (Qty 2) Alternative Energy Star Rated 1500 kW, 300 ton absorber 100% of roof at Abs=0.3 Boiler Comb Eff = 85%.	Se 10.8 3.2 2.1 40.5 13.3 9.1 13.3 9.1 13.3 9.1 13.3 9.1 13.3 9.1 5 8.3 8.7 14.0 8.3 22.2 7.6 8.6 8.5	4% e Space He 14% 36% 42% 0% 17% 12% 12% 12% CCT5, BA Pen Rate 0% 9% 1% 3% CCT5, BA Pen Rate 0% 1% 24% 6% 1% 1% 1% 1% 1% 1% 1% 1% 1% 1	0 ating 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	31% 4% 5ee Spat 17% 44% 50% 0% 12% 21% 12% 21% 12% 21% 12% 21% 12% 21% 10% See Spat 4% 23% 23% 23% 25% 25% 25% 25% 25% 25% 25%	0 0 ce Heating 0 0 0 0 0 0 0 0 0 0 0 0 0	30% 5% See Spart 51% 51% 59% 0% 14% 24% 16% 16% 16% 16% 16% 12% 51% 51% 51% 51% 51% 51% 51% 55% 24% 27% 5% 5% 5% 5% 5% 5% 5% 5% 5% 5% 5% 5% 19% 19% 5% 5% 10% 5% 5% 10% 5% 5% 10% 5% 5% 10% 5% 5% 10% 5% 5% 10% 5% 10% 5% 10% 5% 10% 5% 10% 5% 10% 5% 10% 5% 10% 5% 10% 5% 10% 5% 10% 5% 10% 5% 10% 5% 5% 5% 5% 5% 5% 5% 5% 5% 5% 5% 5% 5%	0 0 0 0 0 0 0 0 0 0 0 0 0 0	41% 6% See Spat 22% 58% 67% 1% 16% 28% 19% CCT5, I Pen Rate 0% 59% 70% 1% 15% 31% 5% 5% 5% CCT5, I Pen Rate 0% 34% 24% 28% 5% 5% 5%	0 0 0 0 0 0 0 0 0 0 0 0 0 0	47% 7% 25% 66% 76% 18% 31% 21% 21% 21% 21% 21% 21% 21% 56% 56% 78% 78% 66% 78% 66% 78% 66% 78% 66% 78% 66% 78% 66% 58% 58% 58% 58% 58% 58% 58% 58% 58% 58	0 0 0 0 0 0 0 0 0 0 0 0 0 0
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Pre	ototype 08 - 43-story Highrise	Residential (Qty 4)		CCT5, BA	NU	CCT5, I	Mid-Low	CCT	5 Mid	CCT5, I	Mid-High	CCTS	5, High
Measure	Baseline	Alternative	Payback	Pen Rate	Total Pen	Pen Rate	Total Pen	Pen Rate	Total Pen	Pen Rate	Total Pen	Pen Rate	Total Pen
Appliances	State Appliance Regulations	Energy Star Rated	231.5	0%	0	0%	0	0%	0	0%	0	0%	0
CHP	None	750 kW, 160 ton absorber	8.2	19%	0	23%	0	27%	1	31%	1	35%	1
Roof Material	100% of roof at Abs=0.90	100% of roof at Abs=0.3	9.8	16%	0	19%	0	22%	0	25%	1	28%	1
Windows	U=0.50 SHGC=0.35	LI-0.26 SHGC-0.29	61	25%	1	30%	1 1	35%	1 1	40%	1 1	46%	1 1
Space Heating	Boiler Comb Eff = 80%	Boiler Comb Eff = 85%	4.6	31%	1	37%	1	43%	1	49%	1	55%	2
Space Cooling	0.576 kW/ton Centrifugal Chillers	0.461 kW/ton Centrifugal Chillers	2.1	42%	1	50%	2	59%	2	67%	2	75%	3
Lighting	0.70 watts/sqft	0.675 watts/sqft	122.6	0%	0	0%	0	0%	0	0%	0	0%	0
Roof Insulation	5" R19 XPS	6" R23 XPS	6.7	23%	0	28%	1	33%	1	38%	1	42%	1
Thermal Storage	None	15% of max load, 1820 ton-hrs	16.3	7%	0	8%	0	10%	0	11%	0	12%	0
vvail insulation	Typical Aluminum Curtain Wall	Reduced thermal bridging	7.1	22%	0	27%	1	31%	1	36%	1	40%	1
Pro	ntotyne 09 - 34-story Highrise I	Residential (Otv 10)		CCT5 B4	11	CCT5 I	Mid-Low	CCT	5 Mid	CCT5 I	Mid-Hiah	CCT	High
Measure	Baseline	Alternative	Payback	Pen Rate	Total Pen	Pen Rate	Total Pen	Pen Rate	Total Pen	Pen Rate	Total Pen	Pen Rate	Total Pen
Appliances	State Appliance Regulations	Energy Star Rated	233.1	0%	0	0%	0	0%	0	0%	0	0%	0
CHP	None	850 kW, 180 ton absorber	7.2	22%	2	27%	2	31%	3	35%	3	40%	3
Roof Material	100% of roof at Abs=0.90	100% of roof at Abs=0.3	7.1	22%	2	27%	2	31%	3	36%	3	40%	4
Water Heating	Boiler Comb Eff = 80%	Boiler Comb Eff = 85%	Se	e Space He	eating	See Space	ce Heating	See Spa	ce Heating	See Spa	ce Heating	See Spa	ce Heating
Windows Space Heating	U=0.50, SHGC=0.35 Boiler Comb Eff = 80%	U=0.26, SHGC=0.29 Boiler Comb Eff = 85%	6.2	25%	2	30%	2	35%	3	40%	3	45%	4
Space Cooling	0.576 kW/ton Centrifugal Chillers	0.461 kW/ton Centrifugal Chillers	2.1	42%	4	50%	5	59%	5	67%	6	75%	7
Lighting	0.70 watts/sqft	0.675 watts/sqft	119.6	0%	0	0%	0	0%	0	0%	0	0%	0
Roof Insulation	5" R19 XPS	6" R23 XPS	8.2	19%	1	23%	2	27%	2	31%	3	35%	3
Thermal Storage	None	15% of max load, 2143 ton-hrs	16.7	7%	0	8%	0	9%	0	11%	1	12%	1
Wall Insulation	Typical Aluminum Curtain Wall	Reduced thermal bridging	7.3	22%	2	26%	2	30%	3	35%	3	39%	3
	ototype 10 - 25-story Lightige	Residential (Oty 5)				CC75 1	Midel ow	007	5 Mid	0075	Mid-Link	007	High
Measuro	Basolino	Alternativo	Pavback	Pen Pata	Total Pan	Pen Pata	Total Dam	Pen Pata	Total Por	Pen Pata	Total Ban	Pen Pata	Total Por
Appliances	State Appliance Regulations	Energy Star Rated	223.7	0%	notal ren	0%	notal ren	0%	notal refi	0%	notai ren	0%	notal refi
CHP	None	1500 kW, 250 ton absorber	6.6	24%	1	28%	1	33%	1	38%	1	43%	2
Roof Material	100% of roof at Abs=0.90	100% of roof at Abs=0.3	7.0	22%	1	27%	1	31%	1	36%	1	40%	2
Water Heating	Boiler Comb Eff = 80%	Boiler Comb Eff = 85%	Se	e Space He	ating	See Space	ce Heating	See Spa	ce Heating	See Spa	ce Heating	See Spa	ce Heating
Windows	U=0.50, SHGC=0.35	U=0.26, SHGC=0.29	6.5	24%	1	29%	1	34%	1	38%	1	43%	2
Space Cooling	0.576 kW/top Centrifugel Chillers	0 461 kW/ton Centrifugal Chillers	4.4	31%	2	38% 51%	2	44% 50%	2	50% 67%	2	5/%	2
Lighting	0,70 watts/soft	0.675 watts/soft	118.8	-+2 %	0	0%	0	0%		01%	0	0%	0
Roof Insulation	5" R19 XPS	6" R23 XPS	9.3	17%	0	20%	1	24%	1	27%	1	30%	1
Thermal Storage	None	15% of max load, 3299 ton-hrs	19.6	5%	0	5%	0	6%	0	7%	0	8%	0
Wall Insulation	Typical Aluminum Curtain Wall	Reduced thermal bridging	7.6	21%	1	25%	1	29%	1	33%	1	37%	1
			r										
Pro	ototype 11 - 12-story Midrise R	esidential (Qty 14)		CC15, BA	10	CC15, I	Mid-Low	CCI	5 Mid	CC15, I	Mid-High	COR	, High
Appliances	Baseline State Appliance Regulations	Alternative	Payback 240.2	Pen Rate	Iotal Pen	Pen Rate	Total Pen	Pen Rate	Total Pen	Pen Rate	Total Pen	Pen Rate	Total Pen
CHP	None	250 kW 40 ton absorber	10.6	14%	1	17%	2	20%	2	23%	3	26%	3
Roof Material	100% of roof at Abs=0.90	100% of roof at Abs=0.3	4.1	33%	4	39%	5	46%	6	52%	7	59%	8
Water Heating	Boiler Comb Eff = 80%	Boiler Comb Eff = 85%	Se	e Space He	ating	See Space	ce Heating	See Spa	ce Heating	See Spa	ce Heating	See Spa	ce Heating
Windows	U=0.50, SHGC=0.35	U=0.26, SHGC=0.29	8.2	19%	2	23%	3	27%	3	31%	4	35%	4
Space Heating	Boiler Comb Eff = 80%	Boiler Comb Eff = 85%	4.3	32%	4	38%	5	45%	6	51%	7	57%	8
Space Cooling	0.576 kW/ton Centrifugal Chillers	0.461 kW/ton Centrifugal Chillers	2.0	43%	5	51%	/	60%	8	68%	9	//%	10
Roof Insulation	5" R19 XPS	6" R23 XPS	24.3	3%	0	3%	0	4%	0	4%	0	5%	0
Thermal Storage	None	15% of max load, 506 ton-hrs	13.5	10%	1	12%	1	14%	1	16%	2	18%	2
Wall Insulation	R11, 2x4.16	R19, 2x4.16	8.0	20%	2	24%	3	28%	3	32%	4	36%	4
			r										
Proto	type 12 - 55-story Highrise Mix	ted Use, Office (Qty 1)	Burkert	CCT5, BA		CCT5, I	Mid-Low	CCT	5 Mid	CCT5, I	Mid-High	CCTS	5, High
Appliances	Baseline	Alternative	Раураск	Pen Rate	Iotal Pen	Pen Rate		Pen Rate	I otal Pen	Pen Rate	I otal Pen	Pen Rate	Iotal Pen
CHP	None	3500 kW, 680 ton absorber	7.7	21%	0	25%	0	29%	0	33%	0	37%	0
Roof Material	100% of roof at Abs=0.90	None	NA	/ •	NA	N	NA	1	NA .	1	NA .	1	NA .
Water Heating	Boiler Comb Eff = 80%	Boiler Comb Eff = 85%	Se	e Space He	ating	See Space	ce Heating	See Spa	ce Heating	See Spa	ce Heating	See Spa	ce Heating
Windows	U=0.50, SHGC=0.35	U=0.26, SHGC=0.29	7.0	23%	0	27%	0	32%	0	36%	0	41%	0
Space Heating	Boiler Comb Eff = 80%	Boiler Comb Eff = 85%	17.5	6%	0	/% 51%	0	8%	0	10%	0	11%	0
Lighting	1.1 watts/soft	0.9 watts/soft	11.4	13%	0	16%	0	18%	0	21%	0	23%	0
Roof Insulation	5" R19 XPS	None	NA		NA Č	N 1970	NA Č	1	NA	<u> </u>	NA Č	1	NA Č
Thermal Storage	None	25% of max load, 10798 ton-hrs	5.3	28%	0	34%	0	39%	0	45%	0	51%	0
Wall Insulation	Typical Aluminum Curtain Wall	Reduced thermal bridging	8.3	19%	0	23%	0	27%	0	30%	0	34%	0
Brotot	o 12 - 55-story Highrigg Mired	Use Residential (Oty 4)	<u> </u>			CC75 1	Midel ow	007	5 Mid	0075	Mid-Line	007	High
Measuro	Rasolino	Alternative	Pavhack	Pen Pata	Total Par	Pen Pate	Total Par	Pen Roto	J WILL Total Por	Pen Pata	Total Par	Pen Rato	Total Par
Appliances	State Appliance Regulations	Energy Star Rated	224.9	0%	0	0%	0	0%	0	0%	0	0%	0
CHP	None	1500 kW, 270 ton absorber	6.6	24%	0	28%	0	33%	0	38%	0	43%	0
Roof Material	100% of roof at Abs=0.90	100% of roof at Abs=0.3	7.3	22%	0	26%	0	30%	0	35%	0	39%	0
Water Heating	Boiler Comb Eff = 80%	Boiler Comb Eff = 85%	Se	e Space He	eating	See Space	ce Heating	See Spa	ce Heating	See Spa	ce Heating	See Spa	ce Heating
Space Heating	U=U.50, SHGC=0.35 Boiler Comb Eff – 80%	U=U.26, SHGC=0.29 Boiler Comb Eff – 85%	6.4 4.4	24%	0	29%	0	34% 44%	0	39% 50%	0	44% 56%	0
Space Cooling	0.576 kW/ton Centrifugal Chillers	0.461 kW/ton Centrifugal Chillers	2.1	42%	0	51%	0	59%	0	68%	0	76%	0
Lighting	0.70 watts/sqft	0.675 watts/sqft	113.5	0%	0	0%	0	0%	0	0%	0	0%	0
Roof Insulation	5" R19 XPS	6" R23 XPS	13.8	10%	0	11%	0	13%	0	15%	0	17%	0
Thermal Storage	None	15% of max load, 3472 ton-hrs	21.4	4%	0	4%	0	5%	0	6%	0	6%	0
Wall Insulation	i ypical Aluminum Curtain Wall	Reduced thermal bridging	7.4	21%	0	26%	0	30%	0	34%	0	38%	0
Corn	er Retail Shon - Type I Constru	uction (Oty 34 Bldgs)		CCT5 P/		CCT5	Mid-Low	007	5 Mid	CCT5	Mid-Hiah	0074	High
Measure	Baseline	Alternative	Payback	Pen Rate	Total Pen	Pen Rate	Total Pen	Pen Rate	Total Pen	Pen Rate	Total Pen	Pen Rate	Total Pen
Appliances	None	None	· ayback	NA		N	VA		A	N Ser Rate	NA	1	NA
CHP	None	None		NA		N	A		A		NA	1	A
Roof Material	None	None		NA		Ν	A	1	A	1	A	1	A
Water Heating	EF=0.525	EF=0.823	1.3	47%	15	56%	19	66%	22	75%	25	84%	28
VVINDOWS	U=0.50, SHGC=0.35	U=U.26, SHGC=0.29	б./ 2.2	23%	12	28%	18	33%	21	37%	21	42% 65%	21
Space Cooling	10 SEER, 9.5 FER Unitary AC	14 SEER, 12.5 EER Unitary AC	3.6	35%	11	42%	14	48%	16	55%	19	62%	22
Lighting	1.50 watts/sqft	None		NA			NA	1	NA .	1	NA	1	NA .
Roof Insulation	None	None		NA		N	A	1	A	1	NA .	1	NA
		Nana	1	NA			AV		NA	1 1	JA	1 1	A
Thermal Storage	None Turnical Aluminum Cuntain Maril	Roduced the methodala	20.0	10/	10	20/	40	20/	04	20/	04	20/	04

Intern	al Potail Shan Tuna I Constr	uction (Oty 24 Bldgs)				COTE	Midlow	CCT	E Mid	COTE I	Mid Liah	ССТА	Linh
Massura	Baseline	Alternative	Boyhook	Don Bata	L Total Ban	Bon Boto	Total Ban	Don Boto	J WILU Total Ban	Bon Boto	Total Ban	Don Boto	, FIIGH Total Ban
Appliances	None	None	FayDack		Total Fell	Fell Kale		ren Kale		Fell Kale		ren Kale	
CHP	None	None		NA			NA	N	IA IA		JA	N	JA
Roof Material	None	None		NA			NA		IA	i i	JA		JA
Water Heating	EF=0.525	EF=0.823	1.2	47%	15	56%	19	66%	22	75%	25	84%	28
Windows	U=0.50, SHGC=0.35	U=0.26, SHGC=0.29	7.5	21%	45	25%	67	30%	70	34%	70	38%	70
Space Heating	Furnace 78% AFUE	Furnace 94% AFUE	3.6	35%	11	42%	14	49%	16	56%	18	63%	21
Space Cooling	10 SEER, 9.5 EER Unitary AC	14 SEER, 12.5 EER Unitary AC	3.6	35%	11	42%	14	48%	16	55%	18	62%	21
Lighting	1.50 watts/sqft	None		NA		1	NA	١	IA	1	A	1	NA
Roof Insulation	None	None		NA		1	NA	١	IA	1	A	1	NA
Thermal Storage	None	None		NA		1	NA	1	IA	1	A	1	NA
Wall Insulation	Typical Aluminum Curtain Wall	Reduced thermal bridging	58.9	0%	45	0%	67	0%	70	0%	70	0%	70
			1										
Corn	er Restaurant - Type I Constru	uction (Qty 30 Bldgs)		сст5, ва	10	CCT5,	Mid-Low	CCT	5 Mid	CCT5, I	Mid-High	CCT5	i, High
Measure	Baseline	Alternative	Payback	Pen Rate	Total Pen	Pen Rate	Total Pen	Pen Rate	Total Pen	Pen Rate	Total Pen	Pen Rate	Total Pen
Appliances	None	None		NA		1	NA	Ν	IA	1	NA	Ν	NA .
CHP	None	None		NA		1	NA	Ν	IA	1	NA	Ν	NA .
Roof Material	None	None		NA		1	NA	L L	A	1	A	۲.	NA
Water Heating	EF=0.800	EF=0.823	8.9	18%	6	21%	7	25%	8	28%	9	32%	10
Windows	U=0.50, SHGC=0.35	U=0.26, SHGC=0.29	8.0	20%	4	24%	5	28%	6	32%	6	36%	6
Space Heating	Furnace 78% AFUE	Furnace 94% AFUE	2.1	42%	14	50%	1/	59%	19	67%	22	75%	25
Space Cooling	10 SEER, 9.5 EER Unitary AC	14 SEER, 12.5 EER Unitary AC	3.8	34%	11	41%	13	48%	16	54%	18	61%	20
Ligriting Roof Insulation	1.50 watts/sqtt	None		NA		1 r	NA NA		14		10		10
Thormol Storess	None	None		NA NA				r N			N/A	r N	
Wall Insulation	Typical Aluminum Curtain Wall	Reduced thermal bridging	27.0	2%	4	29/	5	2%	6	30/	6	3%	6 F
waii insulation	Typical Aluminum Curtain Wai	Reduced thermal bridging	21.5	2 /0	4	2 /0	5	2 /0	0	378	0	378	0
Corne	r Retail Shon - Type II Constr	uction (Oty 17 Bldgs)		CCT5 BA		CCT5	Mid-Low	ССТ	5 Mid	CCT5	Mid-High	ССТЯ	High
Magguro	Baseline	Alternative	Baybaak	Bon Bata	Total Ban	Bon Boto	Total Ban	Bon Boto	Total Dan	Bon Boto	Total Ban	Bon Boto	, Tilgii Totol Bon
Appliances	None	None	FayDack		Total Fell	Fell Kale		ren Kale		Fell Kale		ren Kale	
CHP	None	None		NA			NΔ						
Roof Material	None	None		NA			NA	N	IA		JA	N	JA
Water Heating	EF=0.525	EF=0.823	1.2	47%	7	56%	9	66%	11	75%	12	84%	14
Windows	U=0.50, SHGC=0.35	U=0.26. SHGC=0.29	8.8	18%	6	22%	9	25%	9	29%	12	32%	12
Space Heating	Furnace 78% AFUE	Furnace 94% AFUE	4.2	32%	5	39%	6	45%	7	52%	8	58%	9
Space Cooling	10 SEER, 9.5 EER Unitary AC	14 SEER, 12.5 EER Unitary AC	3.5	35%	6	42%	7	49%	8	57%	9	64%	10
Lighting	1.50 watts/sqft	None		NA		١	ŇA	١	A	1	ĀĀ	1	NA .
Roof Insulation	None	None		NA		١	NA	N	IA	1	١A	1	NA .
Thermal Storage	None	None		NA		1	NA	1	IA	1	A	1	A
Wall Insulation	R11, 2x4.16	R19, 2x4.16	9.9	16%	6	19%	9	22%	9	25%	12	28%	12
						-							
Intern	al Retail Shop - Type II Constr	uction (Qty 17 Bldgs)		CCT5, BA	10	CCT5,	Mid-Low	CCT	5 Mid	CCT5, I	Mid-High	CCT5	i, High
Measure	Baseline	Alternative	Payback	Pen Rate	Total Pen	Pen Rate	Total Pen	Pen Rate	Total Pen	Pen Rate	Total Pen	Pen Rate	Total Pen
Appliances	None	None		NA		1	NA	1	IA	1	A	1	NA .
CHP	None	None		NA		1	NA	N	IA	1	NA .	N	NA .
Roof Material	None	None		NA		1	NA	N	IA	1	NA (a	١	NA
Water Heating	EF=0.525	EF=0.823	1.2	47%	8	57%	9	66%	11	75%	12	85%	14
Windows	U=0.50, SHGC=0.35	U=0.26, SHGC=0.29	8.2	19%	12	23%	18	21%	18	31%	24	35%	24
Space Heating	FURNACE /8% AFUE	FURNACE 94% AFUE	4.4	31%	5	38%	5	44%	(50%	8	56%	9
Space Cooling	10 SEER, 9.5 EER Unitary AC	14 SEER, 12.5 EER Unitary AC	3.0	35%	5	42%	/	49%	8	50%	9	03%	10
Roof Insulation	None	None		NA		l I	MΔ	r N	14			г м	
Thormal Storago	None	None		NA		N		N				N	JA JA
Wall Insulation	R11 2v4 16	R19 2v4 16	18.1	6%	12	7%	18	8%	18	9%	24	10%	24
wairinsdiadorr	111, 224.10	110, 24,10	10.1	070	12	1 /0	10	070	10	570	24	1070	27
Corn	er Restaurant - Type II Constru	uction (Qtv 17 Bldgs)		CCT5 B4	AU	CCT5	Mid-Low	CCT	5 Mid	CCT5	Mid-Hiah	CCT	i. Hiah
Mossuro	Basolino	Alternative	Payback	Don Date	Total Ban	Don Pate	Total Bon	Pon Pate	Total Pon	Don Pate	Total Bon	Pon Pate	Total Bon
Appliances	None	None	Fayback	NA	Total Fell	r en Kale	Iotarren	ren kate		ren Kate		rentate	
CHP	None	None		NA		N	NA	N	IA IA	N	NA NA	N	JA
Roof Material	None	None		NA		N	NA	N	IA	N	NA NA	N	JA
Water Heating	EF=0.800	EF=0.823	8.9	18%	3	21%	3	25%	4	28%	4	32%	
Windows	U=0.50, SHGC=0.35	U=0.26, SHGC=0.29	10.5	14%	2	17%	3	20%	3	23%	4	26%	4
Space Heating	Furnace 78% AFUE	Furnace 94% AFUE	2.1	42%	7	50%	8	59%	9	67%	11	75%	12
Space Cooling	10 SEER, 9.5 EER Unitary AC	14 SEER, 12.5 EER Unitary AC	3.7	34%	5	41%	7	48%	8	55%	9	62%	10
Lighting	1.50 watts/sqft	None		NA	•	1	ŇA	١	A	1	NA .	١	NA
Roof Insulation	None	None		NA		1	NA	N	IA	1	NA	N	JA
Thermal Storage	None	None		NA		1	NA	1	A	1	A	1	NA
	D44_0.440	D40 0-440	7.0	000/	0	0.40/	1	0.00/	2	200/	4	200/	4

	Prototype 01 - 56-story Highri	se Office (Qtv 1)		CCT10. B	AU	CCT10.	Mid-Low	CCT	0 Mid	CCT10.	Mid-Hiah	CCT1	0. Hiah
Measure	Baseline	Alternative	Pavback	Pen Rate	Total Pen	Pen Rate	Total Pen	Pen Rate	Total Pen	Pen Rate	Total Pen	Pen Rate	Total Pen
Appliances	None	None	NA	1 011 1 1 1 1	VA	1	NA	N	A	1	VA	1	VA
CHP	None	6500 kW, 1390 ton absorber	7.6	21%	0	25%	0	29%	0	34%	0	38%	0
Cool Roof	100% of roof at Abs=0.90	100% of roof at Abs=0.3	20.2	4%	0	5%	0	6%	0	7%	0	8%	0
Water Heating	Boiler Comb Eff = 80%	Boiler Comb Eff = 85%	NA	See Spa	ce Heating	See Spa	ce Heating	See Spa	ce Heating	See Spa	ce Heating	See Spa	ce Heating
Windows Space Heating	U=0.50, SHGC=0.35 Boiler Comb Eff = 80%	U=0.26, SHGC=0.29 Boiler Comb Eff = 85%	7.0	23%	0	27%	0	32%	0	36%	0	41%	0
Space Cooling	0.576 kW/top Centrifugal Chillers	0.461 kW/top Centrifugal Chillers	10.2	3%	0	53%	0	62%	0	9% 71%	0	79%	0
Lighting	1.1 watts/soft	0.9 watts/soft	10.3	15%	0	18%	0	21%	0	24%	0	27%	0
Roof Insulation	5" R19 XPS	6" R23 XPS	2.4	41%	0	49%	0	57%	0	65%	0	73%	0
Thermal Storage	None	25% of max load, 23376 ton-hrs	8.5	19%	0	22%	0	26%	0	30%	0	34%	0
Wall Insulation	Typical Aluminum Curtain Wall	Reduced thermal bridging	8.5	19%	0	22%	0	26%	0	30%	0	33%	0
r													
	Prototype 02 - 41-story Highri	se Office (Qty 6)	(CCT10, B.	AU	CCT10,	Mid-Low	CCT1	0 Mid	CCT10,	Mid-High	CCT1	0, High
Measure	Baseline	Alternative	Payback	Pen Rate	Total Pen	Pen Rate	Total Pen	Pen Rate	Total Pen	Pen Rate	Total Pen	Pen Rate	Total Pen
Appliances	None	None EE00 kW 11E0 top obsorbor	NA Z 4	229/	NA 1	26%	NA 1	209/	NA 1	259/		209/	NA 2
Roof Material	100% of roof at Abs=0.90	100% of roof at Abs=0.3	12.2	12%	0	14%	0	16%	0	19%	1	21%	2
Water Heating	Boiler Comb Eff = 80%	Boiler Comb Eff = 85%	NA	See Spa	ce Heating	See Spa	ce Heating	See Spa	ce Heating	See Spa	ce Heating	See Spa	ce Heating
Windows	U=0.50, SHGC=0.35	U=0.26, SHGC=0.29	7.0	23%	1	27%	1	32%	1	36%	2	41%	2
Space Heating	Boiler Comb Eff = 80%	Boiler Comb Eff = 85%	18.3	5%	0	6%	0	8%	0	9%	0	10%	0
Space Cooling	0.576 kW/ton Centrifugal Chillers	0.461 kW/ton Centrifugal Chillers	1.8	44%	2	52%	3	61%	3	70%	4	78%	4
Lighting	1.1 watts/sqft	0.9 watts/sqft	10.5	14%	0	17%	1	20%	1	23%	1	26%	1
Roof Insulation	5" R19 XPS	6" R23 XPS	4.3	32%	1	38%	2	45%	2	51%	3	57%	3
Wall Insulation	Typical Aluminum Curtain Wall	Reduced thermal bridging	0.3	20%	1	22%	1	26%	1	40%	1	34%	2
	. picar taninani Ourtain Hall	Reddood thornal bridging	5.5			/0		2070		0070		01/0	-
	Prototype 03 - 34-story Highri	se Office (Qty 5)	(CCT10, B	AU	CCT10.	Mid-Low	CCT1	0 Mid	CCT10.	Mid-High	CCT1	0, High
Measure	Baseline	Alternative	Payback	Pen Rate	Total Pen	Pen Rate	Total Pen	Pen Rate	Total Pen	Pen Rate	Total Pen	Pen Rate	Total Pen
Appliances	None	None	NA		A	1	NA	N	A	1	A	1	A
CHP	None	4500 kW, 1020 ton absorber	7.3	22%	1	26%	1	30%	1	35%	1	39%	1
Roof Material	100% of roof at Abs=0.90	100% of roof at Abs=0.3	7.0	23%	1	27%	1 1	32%	1	36%	1	41%	2
Windows	Boller Comb Ett = 80%	Boller Comb Ett = 85%	NA 6 º	See Spa	ce Heating	28%	ce Heating	See Spar	e Heating	370/	ce Heating	See Spa	ce Heating
Space Heating	0=0.30, SHGC=0.35 Boiler Comb Eff = 80%	U=0.20, SHGU=0.29 Boiler Comb Eff = 95%	0.8 17.7	23%	1	∠0% 7%	1	32% 8%	1	31%	1	42%	2
Space Cooling	0.576 kW/ton Centrifugal Chillers	0.461 kW/ton Centrifugal Chillers	1.9	43%	2	52%	2	60%	3	69%	3	78%	3
Lighting	1.1 watts/sqft	0.9 watts/sqft	10.6	14%	0	17%	0	20%	0	23%	1	26%	1
Roof Insulation	5" R19 XPS	6" R23 XPS	7.8	20%	1	24%	1	28%	1	33%	1	37%	1
Thermal Storage	None	25% of max load, 16172 ton-hrs	6.4	24%	1	29%	1	34%	1	39%	1	44%	2
Wall Insulation	Typical Aluminum Curtain Wall	Reduced thermal bridging	8.3	19%	0	23%	1	27%	1	31%	1	35%	1
	Prototype 04 - 20-story Midris	e Office (Qty 3)	(CCT10, B.	AU	CCT10,	Mid-Low	CCT	0 Mid	CCT10,	Mid-High	CCT1	0, High
Measure	Baseline	Alternative	Payback	Pen Rate	Total Pen	Pen Rate	Total Pen	Pen Rate	Total Pen	Pen Rate	Total Pen	Pen Rate	Total Pen
Appliances	None	None 2000 kW 400 top obsorbor	NA Z G	210/		259/		20%	NA O	2.49/	NA 1	200/	NA 1
Roof Material	100% of roof at Abs=0.90	100% of roof at Abs=0.3	7.0	21%	0	23%	0	32%	0	36%	1	41%	1
Water Heating	Boiler Comb Eff = 80%	Boiler Comb Eff = 85%	NA	See Spa	ce Heating	See Spa	ce Heating	See Spa	ce Heating	See Spa	ce Heating	See Spa	ce Heating
Windows	U=0.50, SHGC=0.35	U=0.26, SHGC=0.29	10.2	15%	0	18%	0	21%	0	24%	0	27%	0
Space Heating	Boiler Comb Eff = 80%	Boiler Comb Eff = 85%	21.9	3%	0	4%	0	5%	0	5%	0	6%	0
Space Cooling	0.576 kW/ton Centrifugal Chillers	0.461 kW/ton Centrifugal Chillers	1.9	43%	1	52%	1	61%	1	69%	2	78%	2
Lighting	1.1 watts/sqft	0.9 watts/sqft	10.8	14%	0	17%	0	20%	0	22%	0	25%	0
Roof Insulation	5" R19 XPS	6" R23 XPS	6.5	24%	0	29%	0	34%	1	39%	1	44%	1
Wall Insulation	R11 2x4 16	R19 2x4 16	11.8	12%	0	15%	0	17%	0	20%	0	22%	0
	,						, ,			/ .		/	
	Prototype 05 - 33-story Highri	se Hotel (Qty 1)	(CCT10, B	AU	CCT10,	Mid-Low	CCT1	I0 Mid	CCT10,	Mid-High	CCT1	0, High
Measure	Baseline	Alternative	Payback	Pen Rate	Total Pen	Pen Rate	Total Pen	Pen Rate	Total Pen	Pen Rate	Total Pen	Pen Rate	Total Pen
Appliances	None	None		NA		1	NA	١	A	1	NA	1	A
CHP	None	2500 kW, 500 ton absorber	5.5	27%	0	33%	0	38%	0	44%	0	49%	0
Roof Material	100% of roof at Abs=0.90	100% of roof at Abs=0.3	19.7	4%	0	5%	0	6%	0	7%	0	8%	0
Windows	Boller Comb Eff = 80%	Boller Comb Eff = 85%	10.7	1/10/2		5ee Spa	Ce meating	20%	e neating	22%	Le rreating	25%	Le rieating
Space Heating	Boiler Comb Eff - 80%	Boiler Comb Eff - 85%	3.2	37%	0	44%	0	20% 51%	0	59%	0	23%	0
Space Cooling	0.576 kW/ton Centrifugal Chillers	0.461 kW/ton Centrifugal Chillers	2.0	42%	ŏ	51%	ŏ	59%	Ő	68%	ŏ	76%	ŏ
Lighting	1.3 watts/sqft	1.19 watts/sqft	38.7	0%	0	0%	0	1%	0	1%	0	1%	0
Roof Insulation	5" R19 XPS	6" R23 XPS	13.2	10%	0	12%	0	14%	0	16%	0	18%	0
Thermal Storage	None	15% of max load, 7799 ton-hrs	9.1	17%	0	21%	0	24%	0	28%	0	31%	0
vvaii Insulation	i ypicai Aiuminum Curtain Wall	Reduced thermal bridging	12.1	12%	U	14%	0	16%	U	19%	U	21%	U
	Prototype 06 - 18-story Midel	se Hotel (Otv 5)		CT10 P	A11	CCT10	Mid-Low	0074		CCT10	Mid-Hiah	CCT4	0 Hich
Moasuro	Baseline	Alternative	Payback	Don Pate	AU Total Bon	Bon Pate	Total Bon	Bon Pate	Total Ban	Bon Pate	Total Ban	Don Pate	U, HIGH Total Ban
Appliances	None	None	i uyback	NA	i otar ren	N CH Kale	NA	. en Nate	A	N CH Kale	VA	. en nate	VA
CHP	None	400 kW, 80 ton absorber	5.9	26%	1	31%	1	36%	1	42%	2	47%	2
Roof Material	100% of roof at Abs=0.90	100% of roof at Abs=0.3	13.9	9%	0	11%	0	13%	0	15%	0	17%	0
Water Heating	Boiler Comb Eff = 80%	Boiler Comb Eff = 85%	Se	e Space He	ating	See Spa	ce Heating	See Spa	ce Heating	See Spa	ce Heating	See Spa	ce Heating
Windows	U=0.50, SHGC=0.35	U=0.26, SHGC=0.29	34.9	1%	0	1%	0	1%	0	1%	0	1%	0
Space Heating	Boller Comb Eff = 80%	Boller Comb Ett = 85%	3.1	31%	1	44% 52%	2	52%	2	59%	2	b/%	3
Lighting	1.3 watts/soft	1 19 watts/soft	36.9	44 %	0	1%	2	1%	0	1%	0	19%	0
Roof Insulation	5" R19 XPS	6" R23 XPS	13.8	10%	ŏ	11%	ŏ	13%	0	15%	ŏ	17%	0
Thermal Storage	None	15% of max load, 1265 ton-hrs	8.3	19%	0	23%	1	27%	1	31%	1	34%	1
Wall Insulation	R11, 2x4.16	R19, 2x4.16	22.2	3%	0	4%	0	5%	0	5%	0	6%	0
Pr	ototype 07 - 55-story Highrise	Residential (Qty 2)	- (CT10, B	AU	CCT10,	Mid-Low	CCT1	0 Mid	CCT10,	Mid-High	CCT1	0, High
Measure	Baseline	Alternative	Payback	Pen Rate	Total Pen	Pen Rate	Total Pen	Pen Rate	Total Pen	Pen Rate	Total Pen	Pen Rate	Total Pen
Appliances	State Appliance Regulations	Energy Star Rated	210.7	0%	0	0%	0	0%	0	0%	0	U% 41%	0
Roof Material	100% of roof at Abs=0.90	100% of roof at Abs=0.3	8.2	19%	0	23%	0	27%	0	31%	0	35%	0
Water Heating	Boiler Comb Eff = 80%	Boiler Comb Eff = 85%	Se	e Space He	ating	See Spa	ce Heating	See Spa	ce Heating	See Spa	ce Heating	See Spa	ce Heating
Windows	U=0.50, SHGC=0.35	U=0.26, SHGC=0.29	6.1	25%	0	30%	0	35%	0	40%	0	45%	0
Space Heating	Boiler Comb Eff = 80%	Boiler Comb Eff = 85%	4.8	30%	0	36%	0	42%	0	48%	0	54%	1
Space Cooling	0.576 kW/ton Centrifugal Chillers	0.461 kW/ton Centrifugal Chillers	1.8	44%	0	52%	1	61%	1	70%	1	78%	1
Lighting Roof Insulation	U./U Watts/sqft	0.075 Watts/sqft	110.8	0%	0	0%	0	0%	0	0%	0	0%	0
Thermal Storage	None	15% of max load. 3751 ton-brs	31.1	1%	0	20%	0	1%	0	2%	0	2%	0
Wall Insulation	Typical Aluminum Curtain Wall	Reduced thermal bridging	7.2	22%	ŏ	26%	ŏ	31%	Ő	35%	Ŏ	40%	Ő
wai insulation					-		-				-		

Pre	ototype 08 - 43-story Highrise	Residential (Qty 4)	(CCT10, B.	AU	CCT10,	Mid-Low	CCT1	I0 Mid	CCT10,	Mid-High	CCT1	0, High
Measure	Baseline	Alternative	Payback	Pen Rate	Total Pen	Pen Rate	Total Pen	Pen Rate	Total Pen	Pen Rate	Total Pen	Pen Rate	Total Pen
Appliances	State Appliance Regulations	Energy Star Rated	219.7	0%	0	0%	0	0%	0	0%	0	0%	0
CHP	None	750 kW, 160 ton absorber	7.5	21%	0	25%	1	30%	1	34%	1	38%	1
Roof Material	100% of roof at Abs=0.90	100% of roof at Abs=0.3	9.3	17%	0	20%	0	24%	0	27%	1	30%	1
Windowo	Boller Comb Eff = 80%	Boller Comb Eff = 85%	50	e Space He	ating	See Spa	ce Heating	See Spa	ce Heating	See Spa	ce Heating	See Spa	ce Heating
Space Heating	0=0.50, SHGC=0.35 Boiler Comb Eff = 80%	0=0.26, SHGC=0.29 Boiler Comb Eff - 85%	5.9	20%	1	31%	1	30% 43%	1	41%	1	47%	2
Space Cooling	0.576 kW/ton Centrifugal Chillers	0.461 kW/ton Centrifugal Chillers	2.1	42%	1	51%	2	59%	2	68%	2	76%	3
Lighting	0.70 watts/soft	0.675 watts/sqft	116.7	0%	0	0%	0	0%	0	0%	0	0%	0
Roof Insulation	5" R19 XPS	6" R23 XPS	6.5	24%	0	29%	1	34%	1	39%	1	44%	1
Thermal Storage	None	15% of max load, 1820 ton-hrs	16.3	7%	0	8%	0	10%	0	11%	0	12%	0
Wall Insulation	Typical Aluminum Curtain Wall	Reduced thermal bridging	6.9	23%	0	27%	1	32%	1	36%	1	41%	1
Pro	ototype 09 - 34-story Highrise F	Residential (Qty 10)	(CT10, B.	AU	CCT10,	Mid-Low	CCT1	0 Mid	CCT10,	Mid-High	CCT1	0, High
Measure	Baseline	Alternative	Payback	Pen Rate	Total Pen	Pen Rate	Total Pen	Pen Rate	Total Pen	Pen Rate	Total Pen	Pen Rate	Total Pen
Appliances	State Appliance Regulations	Energy Star Rated	221.1	0%	0	0%	0	0%	0	0%	0	0%	0
Roof Material	100% of roof at Abs-0.90	100% of roof at Abs-0.3	6.7	24%	2	29%	2	33%	3	30%	3	43%	4
Water Heating	Boiler Comb Eff = 80%	Boiler Comb Eff = 85%	Se	e Space He	eating	See Spa	ce Heating	See Spa	ce Heating	See Spa	ce Heating	See Spa	ce Heating
Windows	U=0.50, SHGC=0.35	U=0.26, SHGC=0.29	6.0	26%	2	31%	3	36%	3	41%	4	46%	4
Space Heating	Boiler Comb Eff = 80%	Boiler Comb Eff = 85%	4.4	31%	3	37%	3	44%	4	50%	4	56%	5
Space Cooling	0.576 kW/ton Centrifugal Chillers	0.461 kW/ton Centrifugal Chillers	2.1	42%	4	51%	5	59%	5	68%	6	76%	7
Lighting	0.70 watts/sqft	0.675 watts/sqft	114.0	0%	0	0%	0	0%	0	0%	0	0%	0
Roof Insulation	5" R19 XPS	6" R23 XPS	7.9	20%	2	24%	2	28%	2	32%	3	36%	3
Wall Insulation	NORe Typical Aluminum Curtain Well	15% or max load, 2143 ton-hrs Reduced thermal bridging	7 1	1%	2	8% 27%	2	9% 31%	2	11%	2	12%	1
TTUI IIISUIduUII	. picar Administri Ourtain Wall	Reduced merinal bruging	1 (.)	22 /0		21/0		01/0	5	0070			
Pr	ototype 10 - 25-story Highrise	Residential (Qtv 5)		CCT10. B	AU	CCT10	Mid-Low	CCT	0 Mid	CCT10	Mid-Hiah	CCT1	0. Hiah
Measure	Baseline	Alternative	Payback	Pen Rate	- Total Pen	Pen Rate	Total Pen	Pen Rate	Total Pen	Pen Rate	Total Pen	Pen Rate	Total Pen
Appliances	State Appliance Regulations	Energy Star Rated	212.3	0%	0	0%	0	0%	0	0%	0	0%	0
CHP	None	1500 kW, 250 ton absorber	6.1	25%	1	30%	1	35%	1	41%	2	46%	2
Roof Material	100% of roof at Abs=0.90	100% of roof at Abs=0.3	6.6	24%	1	28%	1	33%	1	38%	1	43%	2
Water Heating	Boiler Comb Eff = 80%	Boiler Comb Eff = 85%	Se	e Space He	ating	See Spa	ce Heating	See Spa	ce Heating	See Spa	ce Heating	See Spa	ce Heating
Windows	U=0.50, SHGC=0.35	U=0.26, SHGC=0.29	6.3	25%	1	30%	1	34%	1	39%	1	44%	2
Space Heating	Boller Comb Eff = 80%	Boller Comb Ett = 85%	4.3	32%	1	38%	1	45%	2	51%	2	5/%	2
Lighting	0.376 kW/ton Centinugal Chillers	0.461 KW/ton Centinugal Chillers	2.0	43%	2	0%	2	0%	2	00%	0	0%	0
Roof Insulation	5" R19 XPS	6" R23 XPS	8.9	18%	0	21%	1	25%	1	28%	1	32%	1
Thermal Storage	None	15% of max load, 3299 ton-hrs	19.6	5%	0	5%	0	6%	0	7%	0	8%	0
Wall Insulation	Typical Aluminum Curtain Wall	Reduced thermal bridging	7.4	21%	1	26%	1	30%	1	34%	1	38%	1
Pro	ototype 11 - 12-story Midrise R	lesidential (Qty 14)	0	CCT10, B.	AU	CCT10,	Mid-Low	CCT1	I0 Mid	CCT10,	Mid-High	CCT1	0, High
Measure	Baseline	Alternative	Payback	Pen Rate	Total Pen	Pen Rate	Total Pen	Pen Rate	Total Pen	Pen Rate	Total Pen	Pen Rate	Total Pen
Appliances	State Appliance Regulations	Energy Star Rated	227.2	0%	0	0%	0	0%	0	0%	0	0%	0
CHP Boof Motorial	None 100% of roof at Aba-0.00	250 kW, 40 ton absorber	9.5	16%	2	20%	2	23%	3	26%	3	30%	4
Water Heating	Boiler Comb Eff = 80%	Boiler Comb Eff = 85%	3.9	33% o Spaco Ho	4	40% Soo Spo	D Co Hoating	47% Soo Spa	0 Heating	500 Spo	/	500 Spa	o Heating
Windows	U=0.50, SHGC=0.35	U=0.26. SHGC=0.29	8.0	20%	2	24%	3	28%	3	32%	4	36%	5
Space Heating	Boiler Comb Eff = 80%	Boiler Comb Eff = 85%	4.2	32%	4	39%	5	45%	6	51%	7	58%	8
Space Cooling	0.576 kW/ton Centrifugal Chillers	0.461 kW/ton Centrifugal Chillers	1.9	43%	6	52%	7	60%	8	69%	9	77%	10
Lighting	0.70 watts/sqft	0.675 watts/sqft	112.2	0%	0	0%	0	0%	0	0%	0	0%	0
Roof Insulation	5" R19 XPS	6" R23 XPS	23.6	3%	0	3%	0	4%	0	4%	0	5%	0
Thermal Storage	None D44_0u4.40	15% of max load, 506 ton-hrs	13.5	10%	1	12%	1	14%	1	16%	2	18%	2
wait insulation	R11, 2X4.16	R 19, 2X4.16	7.8	20%	Z	24%	3	28%	3	33%	4	31%	5
Proto	type 12 - 55-story Highrise Mix	red Use Office (Otv 1)		CT10 B	A11	CCT10	Mid-Low	CCT	IO Mid	CCT10	Mid-High	CCT1	0 High
Measure	Baseline	Alternative	Pavback	Pen Rate	Total Pen	Pen Rate	Total Pen	Pen Rate	Total Pen	Pen Rate	Total Pen	Pen Rate	Total Pen
Appliances	None	None	NA	1 cir itale	VA	1 chi haite	VA	N	A	I CHI Kute	VA	1 cir itale	VA
CHP	None	3500 kW, 680 ton absorber	7.1	22%	0	27%	0	31%	0	36%	0	40%	0
Roof Material	100% of roof at Abs=0.90	None	NA	1	ŇA	1	ŇA	١	NA .	1	ŇA	1	ŇA
Water Heating	Boiler Comb Eff = 80%	Boiler Comb Eff = 85%	Se	e Space He	eating	See Spa	ce Heating	See Spa	ce Heating	See Spa	ce Heating	See Spa	ce Heating
Windows	U=0.50, SHGC=0.35	U=0.26, SHGC=0.29	6.8	23%	0	28%	0	32%	0	37%	0	42%	0
Space Heating	0 576 kW/top Ceptrifugal Chillero	0.461 kW/top Contrifugal Chillora	17.2	6% 42%	0	1% 52%	0	9% 60%	0	10%	0	11%	0
Lighting	1.1 watts/soft	0.9 watts/soft	10.9	14%	0	17%	0	19%	0	22%	0	25%	0
Roof Insulation	5" R19 XPS	None	NA	1	NA Č	1	NA Č	. 570 N	NA Č	1 1	NA Č	1	NA Č
Thermal Storage	None	25% of max load, 10798 ton-hrs	5.3	28%	0	34%	0	39%	0	45%	0	51%	0
Wall Insulation	Typical Aluminum Curtain Wall	Reduced thermal bridging	8.1	20%	0	24%	0	28%	0	31%	0	35%	0
						00-11				00711			
Prototyp	e 12 - 55-story Highrise Mixed	Use, Residential (Qty 1)	(JCI 10, B		CCT10,	MID-LOW	CCT	U MIC	CCT10,	wia-High	CCT1	u, High
Measure Appliances	Baseline State Appliance Pegulations	Alternative	Payback 212.0	Pen Rate	Iotal Pen	Pen Rate	I otal Pen	Pen Rate	í otal Pen	Pen Rate	Iotal Pen	Pen Rate	Iotal Pen
CHP	None	1500 kW 270 ton absorber	61	25%	0	30%	0	36%	0	0% 41%	0	46%	0
Roof Material	100% of roof at Abs=0.90	100% of roof at Abs=0.3	7.0	23%	0	27%	0	32%	0	36%	0	41%	0
Water Heating	Boiler Comb Eff = 80%	Boiler Comb Eff = 85%	Se	e Space He	ating	See Spa	ce Heating	See Spa	ce Heating	See Spa	ce Heating	See Spa	ce Heating
Windows	U=0.50, SHGC=0.35	U=0.26, SHGC=0.29	6.2	25%	0	30%	0	35%	0	40%	0	45%	0
Space Heating	Boiler Comb Eff = 80%	Boiler Comb Eff = 85%	4.3	32%	0	38%	0	44%	0	51%	0	57%	0
Space Cooling	0.576 kW/ton Centrifugal Chillers	0.461 kW/ton Centrifugal Chillers	2.0	43%	0	51%	0	60%	0	68%	0	77%	0
Lighting Reaf Insulation	0.70 watts/sqtt	0.675 watts/sqtt	108.3	0%	0	0%	0	0%	0	0%	0	0%	0
Thermal Storage	U KIYAPO None	15% of max load 3472 ton-bre	21 4	4%	0	12% ∆%	0	14%	0	6%	0	6%	0
Wall Insulation	Typical Aluminum Curtain Wall	Reduced thermal bridging	7.3	22%	0	26%	0	31%	0	35%	0	39%	0
- Train in Sulduol1	. , picar , terminani Ourtain Wall	Readeds thermal bridging		/0				0170		0070			
Corn	er Retail Shop - Type I Constru	uction (Qty 34 Bldas)	(CCT10. B	AU	CCT10.	Mid-Low	CCT1	0 Mid	CCT10.	Mid-Hiah	CCT1	0, High
Measure	Baseline	Alternative	Payback	Pen Rate	Total Pen	Pen Rate	Total Pen	Pen Rate	Total Pen	Pen Rate	Total Pen	Pen Rate	Total Pen
Appliances	None	None		NA		1	A	N	A	1	A	1	A
CHP	None	None		NA		1	A	١	NA	1	NA	1	NA
Roof Material	None	None	10	NA	1.75	1	NA CO	1 0001	NA CO	750/	NA of	1	NA CO
Windows	EF=0.525	EF=0.823	1.2	4/%	15	20%	19	3/9/	22	75%	25	85% 42%	28
Space Heating	Eurnace 78% AFUE	Furnace 94% AFLIF	3.0	37%	12	44%	14	51%	17	59%	19	66%	21
Space Cooling	10 SEER, 9.5 EER Unitary AC	14 SEER, 12.5 EER Unitary AC	3.5	35%	11	42%	14	49%	16	56%	19	63%	21
Lighting	1.50 watts/sqft	None	5.0	NA		1	NA	1	NA	1	NA	1	NA .
Roof Insulation	None	None		NA		1	NA	1	NA	1	NA	1	NA
Thermal Storage	None	None		NA		1	A	١	JA .	1	A	1	A
	transianal Alexandra Createria Mall	Boducod thormal bridging	28.0	20/	12	20/	10	20/	21	20/	. 01	20/	

Intern	al Retail Shon - Type I Constr	uction (Oty 34 Bldgs)		CT10. B	4 U	CCT10	Mid-I ow	CCT	0 Mid	CCT10.	Mid-Hiah	CCT1). High
Measure	Baseline	Alternative	Pavback	Pen Rate	Total Pen	Pen Rate	Total Pen	Pen Rate	Total Pen	Pen Rate	Total Pen	Pen Rate	Total Pen
Appliances	None	None		NA		1	NA	N	A	1	VA	١	A
CHP	None	None		NA		1	٨٨	١	IA	1	١A	١	IA.
Roof Material	None	None		NA		2	A	٢	IA	1	A	٢	IA
Water Heating	EF=0.525	EF=0.823	1.2	47%	15	56%	19	66%	22	75%	25	85%	28
Windows	U=0.50, SHGC=0.35	U=0.26, SHGC=0.29	7.3	22%	45	26%	67	30%	70	35%	70	39%	92
Space Heating	Furnace 78% AFUE	Furnace 94% AFUE	3.5	35%	11	42%	14	49%	16	56%	19	63%	21
Space Cooling	10 SEER, 9.5 EER Unitary AC	14 SEER, 12.5 EER Unitary AC	3.5	35%	11	42%	14	49%	16	56%	19	63%	21
Lighting Roof Insulation	1.50 Walls/sqlt	None		NA NA		I'		r N		ľ		I N	
Thermal Storage	None	None		NΔ				N	14			N	
Wall Insulation	Typical Aluminum Curtain Wall	Reduced thermal bridging	57.7	0%	45	0%	67	0%	70	0%	70	0%	92
wairmsdiadorr	Typical Adminiant Outlain Wall	Reddeed thermal bridging	01.1	070	40	070	0/	070	10	070	10	070	52
Corn	er Restaurant - Type I Constru	uction (Oty 30 Bldgs)		CT10 B	Δ11	CCT10	Mid-Low	CCT	0 Mid	CCT10	Mid-Hiah	CCT1) High
Measure	Baseline	Alternative	Pavback	Pen Rate	Total Pen	Pen Rate	Total Pen	Pen Rate	Total Pen	Pen Rate	Total Pen	Pen Rate	Total Pen
Appliances	None	None	Гаураск	NA	Total Ten	1 ch Ruie	VA	T CH Hate	A	I CH Rate	JA	I CH Hate	JA
CHP	None	None		NA			NA		IA	N	JA A		IA
Roof Material	None	None		NA		1	NA	N	A	i i	NA.	N	A
Water Heating	EF=0.800	EF=0.823	8.8	18%	6	22%	7	25%	8	29%	9	33%	11
Windows	U=0.50, SHGC=0.35	U=0.26, SHGC=0.29	7.8	20%	4	24%	5	28%	6	33%	6	37%	8
Space Heating	Furnace 78% AFUE	Furnace 94% AFUE	2.1	42%	14	51%	17	59%	20	67%	22	76%	25
Space Cooling	10 SEER, 9.5 EER Unitary AC	14 SEER, 12.5 EER Unitary AC	3.7	34%	11	41%	14	48%	16	55%	18	62%	21
Lighting	1.50 watts/sqft	None		NA		1	A	N	A	1	A	1	A
Roof Insulation	None	None	NA NA			1	A	٢	IA	1	A	٢	IA
Thermal Storage	None	None	NA 27.1 2% 4			1	A	Ν	A	1	A	Ν	A
Wall Insulation	Typical Aluminum Curtain Wall	Reduced thermal bridging	27.1	2%	4	2%	5	2%	6	3%	6	3%	8
-													
Corne	er Retail Shop - Type II Constr	uction (Qty 17 Bldgs)	0	CT10, B	AU	CCT10,	Mid-Low	CCT1	0 Mid	CCT10,	Mid-High	CCT1	0, High
Measure	Baseline	Alternative	Payback	Pen Rate	Total Pen	Pen Rate	Total Pen	Pen Rate	Total Pen	Pen Rate	Total Pen	Pen Rate	Total Pen
Appliances	None	None		NA		1	NA	N	IA	1	A	1	IA .
CHP	None	None		NA		1	NA	1	IA .	N N	NA	1	A
Root Material	None	None	4.0	NA 470/	7	F C0/	NA O	000/	IA 11	750/		050/	IA 11
Water Heating	EF=0.525	EF=0.823	1.2	47%	7	56%	9	66%	11	75%	12	85%	14
Windows	0=0.50, SHGC=0.35	0=0.26, SHGC=0.29	6.5	19%	6	22%	9	20%	9	30%	12	33%	15
Space Cooling	10 SEEP 0.5 EEP Uniton AC	14 SEEP 12.5 EEP Unitary AC	4.1	32 %	5	39% 13%	7	43%	2	57%	0	64%	9
Lighting	1 50 watts/soft	None	0.4	NA	0	4070 N	14	0070		0170	14	0470	10
Roof Insulation	None	None		NA			A		IA		JA		IA
Thermal Storage	None	None		NA		1	NA	N	IA	i i	A	N	IA
Wall Insulation	R11, 2x4.16	R19, 2x4.16	9.8	16%	6	19%	9	22%	9	25%	12	28%	15
Intern	al Retail Shop - Type II Constr	uction (Qtv 17 Bldas)	(CT10. B/	AU	CCT10.	Mid-Low	CCT	0 Mid	CCT10.	Mid-Hiah	CCT1	0. Hiah
Measure	Baseline	Alternative	Pavback	Pen Rate	Total Pen	Pen Rate	Total Pen	Pen Rate	Total Pen	Pen Rate	Total Pen	Pen Rate	Total Pen
Appliances	None	None		NA		1	NA NA	١	A	1	Ā	١	A
CHP	None	None		NA		١	٨٨	1	IA	1	A	1	IA
Roof Material	None	None		NA		1	٨٨	١	IA	1	JA .	١	IA
Water Heating	EF=0.525	EF=0.823	1.2	47%	8	57%	9	66%	11	76%	12	85%	14
Windows	U=0.50, SHGC=0.35	U=0.26, SHGC=0.29	7.9	20%	12	24%	18	28%	18	32%	24	36%	30
Space Heating	Furnace 78% AFUE	Furnace 94% AFUE	4.4	32%	5	38%	6	44%	7	50%	8	57%	9
Space Cooling	10 SEER, 9.5 EER Unitary AC	14 SEER, 12.5 EER Unitary AC	3.5	35%	6	42%	7	49%	8	56%	9	64%	10
Lighting	1.50 watts/sqft	None		NA		1	NA	N 1	IA IA		NA	1	NA .
Roof Insulation	None	None		NA		1	NA	r	IA .	1	NA .	r	IA .
I nermal Storage	None D44_0::440	None D40. 2:440	40.0	INA C0/	40	00/	NA 40	P 00/	IA 40	100/	NA 04	4.00/	IA 20
wall insulation	R11, 2x4.16	R 19, 2X4.16	10.9	0%	12	8%	18	9%	18	10%	24	12%	30
Corn	or Postaurant - Typo II Constru	uction (Oty 17 Bldgs)		CT10 P	A11	CCT10	Mid-Low	CCT	0 Mid	CCT10	Mid-Hich	CCT4	High
Com	er Restaurant - Type il Constitu	uction (aty 17 Blags)	Post set			CCTIU,	WIG-LOW		UNIC	CCTTU,	Mid-High	COTT	, High
Weasure	Baseline	Alternative	Раураск	Pen Rate	Total Pen	Pen Rate	Total Pen	Pen Rate	Total Pen	Pen Rate	Total Pen	Pen Rate	Total Pen
CHP	None	None		NA NA			MA A			Г М	Δ		
Roof Material	None	None		ΝΔ		N	A	N	IA	N	JA	N	IA A
Water Heating	EF=0.800	EF=0.823	8.8	18%	3	22%	3	25%	4	29%	4	32%	5
Windows	U=0.50, SHGC=0.35	U=0.26, SHGC=0.29	10.2	15%	2	18%	3	21%	3	24%	4	27%	5
Space Heating	Furnace 78% AFUE	Furnace 94% AFUE	2.1	42%	7	51%	8	59%	10	67%	11	76%	12
Space Cooling	10 SEER, 9.5 EER Unitary AC	14 SEER, 12.5 EER Unitary AC	3.6	35%	5	42%	7	49%	8	56%	9	63%	10
Lighting	1.50 watts/sqft	None		NA		1	ŇA	١	A	1	ΝA	١	A
Roof Insulation	None	None		NA		1	A	N	IA	1	A	N	IA
Thermal Storage	None	None		NA		1	A	Ν	A	1	A	Ν	IA
				0.101		0.001		0.001		0.001		0.000	

	Prototype 01 - 56-story Highri	se Office (Qtv 1)	(CCT15. B	AU	CCT15.	Mid-Low	CCT1	5. Mid	CCT15.	Mid-Hiah	CCT1	5. Hiah
Measure	Baseline	Alternative	Payback	Pen Rate	Total Pen	Pen Rate	Total Pen	Pen Rate	Total Pen	Pen Rate	Total Pen	Pen Rate	Total Pen
Appliances	None	None	ŇA		NA	1	NA .	1	ĀA	1	NA	1	ĀA
CHP	None	6500 kW, 1390 ton absorber	7.0	23%	0	27%	0	32%	0	36%	0	41%	0
Cool Roof	100% of roof at Abs=0.90	100% of roof at Abs=0.3	20.2	4%	0	5%	0	6%	0	7%	0	8%	0
Windows	Boller Comb Eff = 80%	Boller Comb Eff = 85%	NA C P	See Spa	ce Heating	See Spa	ce Heating	See Spa	ce Heating	27%	ce Heating	See Spa	ce Heating
Space Heating	Boiler Comb Eff = 80%	Boiler Comb Eff = 85%	17.9	6%	0	20%	0	32% 8%	0	9%	0	42%	0
Space Cooling	0.576 kW/ton Centrifugal Chillers	0.461 kW/ton Centrifugal Chillers	1.7	44%	0	53%	0	62%	0	71%	0	80%	0
Lighting	1.1 watts/sqft	0.9 watts/sqft	9.9	16%	0	19%	0	22%	0	25%	0	28%	0
Roof Insulation	5" R19 XPS	6" R23 XPS	2.3	41%	0	49%	0	58%	0	66%	0	74%	0
Thermal Storage	None	25% of max load, 23376 ton-hrs	8.5	19%	0	22%	0	26%	0	30%	0	34%	0
Wall Insulation	Typical Aluminum Curtain Wall	Reduced thermal bridging	8.3	19%	0	23%	0	27%	0	31%	0	34%	0
	Prototype 02 - 41-story Highri	se Office (Qty 6)	(CT15, B	AU	CCT15,	Mid-Low	CCT1	5, Mid	CCT15,	Mid-High	CCT1	5, High
Measure	Baseline	Alternative	Payback	Pen Rate	Total Pen	Pen Rate	Total Pen	Pen Rate	Total Pen	Pen Rate	Total Pen	Pen Rate	Total Pen
Appliances	None	5500 kW 1150 top absorber	NA 6.8	23%	NA 1	28%	NA 1	329/	NA 1	37%	NA 2	12%	2
Roof Material	100% of roof at Abs=0.90	100% of roof at Abs=0.3	12.2	12%	0	14%	0	16%	0	19%	1	21%	1
Water Heating	Boiler Comb Eff = 80%	Boiler Comb Eff = 85%	NA	See Spa	ce Heating	See Spa	ce Heating	See Spa	ce Heating	See Spa	ce Heating	See Spa	ce Heating
Windows	U=0.50, SHGC=0.35	U=0.26, SHGC=0.29	6.8	23%	1	28%	1	33%	1	37%	2	42%	2
Space Heating	Boiler Comb Eff = 80%	Boiler Comb Eff = 85%	18.0	6%	0	7%	0	8%	0	9%	0	10%	0
Space Cooling	0.576 kW/ton Centrifugal Chillers	0.461 kW/ton Centrifugal Chillers	1.8	44%	2	53%	3	61%	3	70%	4	79%	4
Lighting	1.1 watts/sqft	0.9 watts/sqft	10.1	15%	0	18%	1	21%	1	24%	1	27%	1
Roof Insulation	5" R19 XPS	6" R23 XPS	4.1	33%	1	39%	2	46%	2	53%	3	59%	3
Wall Insulation	Typical Aluminum Curtain Wall	25% of max load, 15073 ton-his Reduced thermal bridging	5.3	28%	1	34%	<u> </u>	39%	<u> </u>	45%	<u> </u>	35%	3
	. ypidar Aldrinindini Ourtaini Wdll	Reddoca merinai bridging	0.0	1370	<u> </u>	2070	<u> </u>	21/0		01/0	. ·	0070	
	Prototype 03 - 34-story Highright	se Office (Qty 5)		CCT15. B	AU	CCT15	Mid-Low	CCT1	5. Mid	CCT15	Mid-Hiah	CCT1	5. Hiah
Measure	Baseline	Alternative	Payback	Pen Rate	Total Pen	Pen Rate	Total Pen	Pen Rate	Total Pen	Pen Rate	Total Pen	Pen Rate	Total Pen
Appliances	None	None	NA		NA	1	NA	1	A	1	NA .	1	A
CHP	None	4500 kW, 1020 ton absorber	6.7	23%	1	28%	1	33%	1	37%	1	42%	2
Roof Material	100% of roof at Abs=0.90	100% of roof at Abs=0.3	6.8	23%	1	28%	1	32%	1	37%	1	41%	2
Water Heating	Boiler Comb Eff = 80%	Boiler Comb Eff = 85%	NA	See Spa	ce Heating	See Spa	ce Heating	See Spa	ce Heating	See Spa	ce Heating	See Spa	ce Heating
Windows	U=0.50, SHGC=0.35	U=U.26, SHGC=0.29	6.6	24%	1	28%		33%	1	38%	1	43%	2
Space Cooling	0.576 kW/ton Centrifugal Chillors	0.461 kW/ton Centrifugal Chillers	1/.4	43%	2	52%	2	0% 61%	3	60%	3	78%	3
Lighting	1.1 watts/soft	0.9 watts/soft	10.2	15%	0	18%	0	21%	1	24%	1	27%	1
Roof Insulation	5" R19 XPS	6" R23 XPS	7.4	21%	1	26%	1	30%	1	34%	1	39%	1
Thermal Storage	None	25% of max load, 16172 ton-hrs	6.4	24%	1	29%	1	34%	1	39%	1	44%	2
Wall Insulation	Typical Aluminum Curtain Wall	Reduced thermal bridging	8.0	20%	0	24%	1	28%	1	32%	1	36%	1
			1					1				1	
	Prototype 04 - 20-story Midris	se Office (Qty 3)	(CCT15, B	AU	CCT15,	Mid-Low	CCT1	5, Mid	CCT15,	Mid-High	CCT1	5, High
Measure	Baseline	Alternative	Payback	Pen Rate	Total Pen	Pen Rate	Total Pen	Pen Rate	Total Pen	Pen Rate	Total Pen	Pen Rate	Total Pen
Appliances	None	None	NA	000/	NA	1	NA O	1	NA O	1	NA (1400	NA (
CHP Boof Matorial	None	3000 kW, 490 ton absorber	7.0	23%	0	27%	0	32%	0	36%	1	41%	1
Water Heating	Boiler Comb Eff – 80%	Boiler Comb Eff – 85%	0.0 NA	See Sna	ce Heating	20% See Sna	ce Heating	See Sna	ce Heating	See Sna	e Heating	41% See Sna	re Heating
Windows	U=0.50, SHGC=0.35	U=0.26. SHGC=0.29	9.9	16%	0	19%	0	22%	0	25%	0	28%	0
Space Heating	Boiler Comb Eff = 80%	Boiler Comb Eff = 85%	21.5	4%	0	4%	0	5%	0	6%	0	6%	0
Space Cooling	0.576 kW/ton Centrifugal Chillers	0.461 kW/ton Centrifugal Chillers	1.8	44%	1	52%	1	61%	1	70%	2	79%	2
Lighting	1.1 watts/sqft	0.9 watts/sqft	10.3	15%	0	18%	0	21%	0	24%	0	27%	0
Roof Insulation	5" R19 XPS	6" R23 XPS	6.2	25%	0	30%	0	35%	1	40%	1	45%	1
Thermal Storage	None P11_3v4.16	25% of max load, 7818 ton-hrs	5.0	29%	0	35%	1	41%	1	4/%	1	52%	1
Wall Insulation	K11, 2X4.10	R 19, 2X4.10	11.5	13%	0	1376	0	1070	0	20%	0	23%	0
r	Prototype 05 - 33-story Highri	se Hotel (Otv 1)		CCT15 B	ΔU	CCT15	Mid-Low	CCT1	5 Mid	CCT15	Mid-Hiah	CCT1	5 Hiah
Measure	Baseline	Alternative	Pavback	Pen Rate	Total Pen	Pen Rate	Total Pen	Pen Rate	Total Pen	Pen Rate	Total Pen	Pen Rate	Total Pen
Appliances	None	None	. ay baon	NA	rotarr on	1	VA	1	VA	1	VA	1 011 11440	VA
CHP	None	2500 kW, 500 ton absorber	5.1	29%	0	34%	0	40%	0	46%	0	52%	0
Roof Material	100% of roof at Abs=0.90	100% of roof at Abs=0.3	18.5	5%	0	6%	0	7%	0	8%	0	9%	0
Water Heating	Boiler Comb Eff = 80%	Boiler Comb Eff = 85%	Se	e Space He	eating	See Spa	ce Heating	See Spa	ce Heating	See Spa	ce Heating	See Spa	ce Heating
Windows	U=0.50, SHGC=0.35	U=0.26, SHGC=0.29	10.6	14%	0	17%	0	20%	0	23%	0	26%	0
Space Heating	Boller Comp Eff = 80%	Boller Comb Eff = 85%	3.1	37%	0	44% 51%	0	52%	0	59%	0	6/% 770/	0
Lighting	1.3 watts/soft	1.19 watts/soft	36.9	1%	0	1%	0	1%	0	1%	0	1%	0
Roof Insulation	5" R19 XPS	6" R23 XPS	13.1	10%	ŏ	13%	ŏ	15%	0	17%	Ő	19%	0
Thermal Storage	None	15% of max load, 7799 ton-hrs	9.1	17%	0	21%	0	24%	0	28%	0	31%	0
Wall Insulation	Typical Aluminum Curtain Wall	Reduced thermal bridging	12.1	12%	0	14%	0	16%	0	19%	0	21%	0
	B / / AA 10 /												
L	Prototype 06 - 18-story Midris	se Hotel (Qty 5)		CT15, B	AU	CCT15,	Mid-Low	CCT1	5, Mid	CCT15,	Mid-High	CCT1	5, High
Measure	Baseline	Alternative	Payback	Pen Rate	Total Pen	Pen Rate	Total Pen	Pen Rate	Fotal Pen	Pen Rate	Total Pen	Pen Rate	Fotal Pen
Appliances	None	A00 kW/ 80 top shearbor	5.5	NA 27%	1	230/	1	280/	1	1 10/	2	/00/	2
Roof Material	100% of roof at Abs=0.90	100% of roof at Abs=0.3	13.1	10%	0	13%	0	15%	0	17%		19%	
Water Heating	Boiler Comb Eff = 80%	Boiler Comb Eff = 85%	Se	e Space He	eating	See Spa	ce Heating	See Spa	ce Heating	See Spa	ce Heating	See Spa	ce Heating
Windows	U=0.50, SHGC=0.35	U=0.26, SHGC=0.29	34.9	1%	0	1%	0	1%	0	1%	0	1%	0
Space Heating	Boiler Comb Eff = 80%	Boiler Comb Eff = 85%	3.1	37%	1	45%	2	52%	2	60%	2	67%	3
Space Cooling	0.576 kW/ton Centrifugal Chillers	0.461 kW/ton Centrifugal Chillers	1.7	44%	2	53%	2	62%	3	71%	3	80%	3
Lighting	1.3 watts/sqft	1.19 watts/sqft	35.3	1%	0	1%	0	1%	0	1%	0	1%	0
Thermal Storage	D KIYAPS	0 K23 XPS	13.0	10%	0	12%	1	14%	1	10%	1	10%	1
Wall Insulation	R11. 2x4.16	R19. 2x4.16	22.2	3%	0	4%	0	5%	0	5%	0	6%	0
	, 24				. ·		. ×		. ~		. ~		. ~
Pre	ototype 07 - 55-story Highrise	Residential (Qty 2)	(CCT15, B	AU	CCT15.	Mid-Low	CCT1	5, Mid	CCT15.	Mid-High	CCT1	5, High
Measure	Baseline	Alternative	Payback	Pen Rate	Total Pen	Pen Rate	Total Pen	Pen Rate	Total Pen	Pen Rate	Total Pen	Pen Rate	Total Pen
Appliances	State Appliance Regulations	Energy Star Rated	200.3	0%	0	0%	0	0%	0	0%	0	0%	0
CHP	None	1500 kW, 300 ton absorber	6.5	24%	0	29%	0	34%	0	39%	0	43%	0
Roof Material	100% of roof at Abs=0.90	100% of roof at Abs=0.3	7.8	20%	0	25%	0	29%	0	33%	0	37%	0
Windows	Boller Comb Eff = 80%	Boller Comb Eff = 85%	Se 6.0	26%	eating	31%	ce Heating	36%	ce Heating	5ee Spa	Le Heating	5ee Spa 46%	ce Heating
Space Heating	Boiler Comb Eff = 80%	Boiler Comb Fff = 85%	47	30%	0	36%	0	42%	0	48%	0	54%	1
Space Cooling	0.576 kW/ton Centrifugal Chillers	0.461 kW/ton Centrifugal Chillers	1.8	44%	Ő	53%	1	62%	1	70%	1	79%	1
Lighting	0.70 watts/sqft	0.675 watts/sqft	105.8	0%	0	0%	0	0%	0	0%	0	0%	0
Roof Insulation	5" R19 XPS	6" R23 XPS	7.0	22%	0	27%	0	31%	0	36%	0	40%	0
Thermal Storage	None	15% of max load, 3751 ton-hrs	31.1	1%	0	1%	0	1%	0	2%	0	2%	0
Wall Insulation	Uvnical Aluminum Curtain Wall	Reduced thermal bridging	1 70		. 0	· · 70/.	• 0		. 0	1/02/	. 0	. 410/	. 0

Pre	ototype 08 - 43-story Highrise	Residential (Qty 4)	(CCT15, B/	AU	CCT15,	Mid-Low	CCT1	5, Mid	CCT15,	Mid-High	CCT1	5, High
Measure	Baseline	Alternative	Payback	Pen Rate	Total Pen	Pen Rate	Total Pen	Pen Rate	Total Pen	Pen Rate	Total Pen	Pen Rate	Total Pen
Appliances	State Appliance Regulations	Energy Star Rated	209.1	0%	0	0%	0	0%	0	0%	0	0%	0
CHP	None	750 kW, 160 ton absorber	7.0	23%	0	27%	1	32%	1	36%	1	41%	1
Roof Material	100% of roof at Abs=0.90	100% of roof at Abs=0.3	8.8	18%	0	21%	0	25%	1	29%	1	32%	1
Windown		Boller Comb Ell = 85%	50	26 Space He		300/ See Spa	Ce Heating	300 See Spar	ce Heating	3ee 5pa		5ee 5pa	
Space Heating	Boiler Comb Eff = 80%	Boiler Comb Eff = 85%	3.8 4.4	31%	1	32%	1	44%	1	42 % 50%	2	40 % 56%	2
Space Cooling	0.576 kW/ton Centrifugal Chillers	0.461 kW/ton Centrifugal Chillers	2.0	43%	1	51%	2	60%	2	68%	2	77%	3
Lighting	0.70 watts/sqft	0.675 watts/sqft	111.4	0%	0	0%	0	0%	0	0%	0	0%	0
Roof Insulation	5" R19 XPS	6" R23 XPS	6.2	25%	0	30%	1	35%	1	40%	1	45%	1
Thermal Storage	None	15% of max load, 1820 ton-hrs	16.3	7%	0	8%	0	10%	0	11%	0	12%	0
Wall Insulation	Typical Aluminum Curtain Wall	Reduced thermal bridging	6.7	23%	0	28%	1	33%	1	37%	1	42%	1
Pro	ototype 09 - 34-story Highrise F	Residential (Qty 10)	(CCT15, B/	AU	CCT15,	Mid-Low	CCT1	5, Mid	CCT15,	Mid-High	CCT1	5, High
Measure	Baseline	Alternative	Payback	Pen Rate	Total Pen	Pen Rate	Total Pen	Pen Rate	Total Pen	Pen Rate	Total Pen	Pen Rate	Total Pen
Appliances	State Appliance Regulations	Energy Star Rated	210.2	0%	0	0%	0	0%	0	0%	0	0%	0
CHP Roof Matorial	100% of roof at Abs=0.90	100% of roof at Abs=0.3	6.1	25%	2	30%	3	30%	3	41%	4	40%	4
Water Heating	Boiler Comb Eff – 80%	Boiler Comb Eff – 85%	0.4 So	e Space He		See Sna	ce Heating	See Sna	ce Heating	See Sna	ce Heating	See Sna	ce Heating
Windows	U=0.50, SHGC=0.35	U=0.26, SHGC=0.29	5.9	26%	2	31%	3	37%	3	42%	4	47%	4
Space Heating	Boiler Comb Eff = 80%	Boiler Comb Eff = 85%	4.4	32%	3	38%	3	44%	4	50%	5	57%	5
Space Cooling	0.576 kW/ton Centrifugal Chillers	0.461 kW/ton Centrifugal Chillers	2.0	43%	4	51%	5	60%	5	68%	6	77%	7
Lighting	0.70 watts/sqft	0.675 watts/sqft	108.8	0%	0	0%	0	0%	0	0%	0	0%	0
Roof Insulation	5" R19 XPS	6" R23 XPS	7.6	21%	2	25%	2	29%	2	33%	3	37%	3
Thermal Storage	None	15% of max load, 2143 ton-hrs	16.7	7%	0	8%	0	9%	0	11%	1	12%	1
wall insulation	Typical Aluminum Curtain Wall	Reduced thermal bridging	6.9	23%	2	21%	2	32%	3	36%	3	41%	4
Dr	ototype 10 - 25-story Highrico	Residential (Oty 5)		CCT15 P	A11	CCT1F	Mid-Low	0074	5 Mid	CCT1F	Mid-High	CCT4	5 High
Measure	Basolino	Alternative	Pavback	Pen Pata	Total Pan	Pen Pata	Total Pan	Pen Pata	Total Pon	Pen Pata	Total Por	Pen Pata	Total Par
Appliances	State Appliance Regulations	Energy Star Rated	202.0		O			n%				n%	O
CHP	None	1500 kW, 250 ton absorber	5.7	27%	1	32%	1	37%	1	43%	2	48%	2
Roof Material	100% of roof at Abs=0.90	100% of roof at Abs=0.3	6.3	25%	1	30%	1	35%	1	39%	1	44%	2
Water Heating	Boiler Comb Eff = 80%	Boiler Comb Eff = 85%	Se	e Space He	ating	See Spa	ce Heating	See Spa	ce Heating	See Spa	ce Heating	See Spa	ce Heating
Windows	U=0.50, SHGC=0.35	U=0.26, SHGC=0.29	6.1	25%	1	30%	1	35%	1	40%	2	45%	2
Space Heating	Boiler Comb Eff = 80%	Boiler Comb Eff = 85%	4.2	32%	1	39%	1	45%	2	51%	2	58%	2
Space Cooling	0.576 kW/ton Centrifugal Chillers	0.461 kW/ton Centrifugal Chillers	1.9	43%	2	52%	2	60%	3	69%	3	77%	3
Lighting Roof Insulation	0.70 Watts/sqft	0.675 Watts/sqft	108.1	10%	0	0%	0	0%	0	0%	0	0%	0
Thermal Storage	S RI9AFS	0 R23 AF3 15% of max load 3299 ton-brs	19.6	5%	0	5%	0	6%	0	29%	0	8%	0
Wall Insulation	Typical Aluminum Curtain Wall	Reduced thermal bridging	7.2	22%	1	26%	1	31%	1	35%	1	39%	1
				/*		- • / •							
Pro	ototype 11 - 12-story Midrise R	esidential (Qty 14)	(CCT15, B/	AU	CCT15,	Mid-Low	CCT1	5, Mid	CCT15,	Mid-High	CCT1	5. High
Measure	Baseline	Alternative	Payback	Pen Rate	Total Pen	Pen Rate	Total Pen	Pen Rate	Total Pen	Pen Rate	Total Pen	Pen Rate	Total Pen
Appliances	State Appliance Regulations	Energy Star Rated	215.6	0%	0	0%	0	0%	0	0%	0	0%	0
CHP	None	250 kW, 40 ton absorber	8.6	18%	2	22%	3	26%	3	30%	4	33%	4
Roof Material	100% of roof at Abs=0.90	100% of roof at Abs=0.3	3.8	34%	4	41%	5	48%	6	54%	7	61%	8
Water Heating	Boiler Comb Eff = 80%	Boiler Comb Eff = 85%	Se	e Space He	eating	See Spa	ce Heating	See Spa	ce Heating	See Spa	ce Heating	See Spa	ce Heating
Windows	U=0.50, SHGC=0.35	U=0.26, SHGC=0.29	7.7	21%	2	25%	3	29%	4	33%	4	37%	5
Space Reating	0.576 kW/top Contributed Chillers	0.461 kW/top Contributed Chillers	4.1	32%	4	39% 52%	5	45%	8	52% 60%	0	28%	8 10
Lighting	0.570 kW/ton centilidgal chillers	0.401 kW/ton centingai chillers	107.7	43%	0	0%	0	0%	0	0%	0	0%	0
Roof Insulation	5" R19 XPS	6" R23 XPS	22.9	3%	0	4%	0	4%	0	5%	0	5%	0
Thermal Storage	None	15% of max load, 506 ton-hrs	13.5	10%	1	12%	1	14%	1	16%	2	18%	2
Wall Insulation	R11, 2x4.16	R19, 2x4.16	7.6	21%	2	25%	3	29%	4	33%	4	37%	5
Proto	type 12 - 55-story Highrise Mix	ed Use, Office (Qty 1)	(CCT15, B/	AU	CCT15,	Mid-Low	CCT1	5, Mid	CCT15,	Mid-High	CCT1	5, High
Measure	Baseline	Alternative	Payback	Pen Rate	Total Pen	Pen Rate	Total Pen	Pen Rate	Total Pen	Pen Rate	Total Pen	Pen Rate	Total Pen
Appliances	None	None	NA	1	NA .	1	NA .	N	A	1	NA .	1	NA .
CHP	None	3500 kW, 680 ton absorber	6.5	24%	0	29%	0	34%	0	38%	0	43%	0
Woter Heating	Poilor Comb Eff - 90%	None Boiler Comb Eff - 95%	INA So	i Space He	va	Soo Soo	vA co Hoating	Soo Spa	NA co Hoating	See See	NA Co Hoating	Soo Soo	va co Hoating
Windows	U=0,50. SHGC=0.35	U=0.26. SHGC=0 29	6.6	24%	0	28%	0	33%	0	38%	0	43%	0
Space Heating	Boiler Comb Eff = 80%	Boiler Comb Eff = 85%	16.9	6%	0	8%	0	9%	0	10%	0	12%	0
Space Cooling	0.576 kW/ton Centrifugal Chillers	0.461 kW/ton Centrifugal Chillers	1.9	43%	0	52%	0	61%	0	69%	0	78%	0
Lighting	1.1 watts/sqft	0.9 watts/sqft	10.5	15%	0	17%	0	20%	0	23%	0	26%	0
Roof Insulation	5" R19 XPS	None	NA	1	NA	1	NA .	N	A	1	NA .	1	NA .
Thermal Storage	None Turpical Aluminum Quatric Mart	25% of max load, 10798 ton-hrs	5.3	28%	0	34%	0	39%	0	45%	0	51%	0
vvaii insulation	rypical Aluminum Curtain Wall	Reduced inermal bridging	7.9	20%	U	∠4%	U	28%	U	32%	U	30%	U
Prototyn	o 12 - 55-story Highrise Mixed	Use Residential (Otv 1)		CCT15 B	A11	CCT15	Mid-Low	CCT1	5 Mid	CCT15	Mid-High	CCT1	5 High
Measure	Baseline	Alternative	Pavback	Pen Rato	Total Pen	Pen Rato	Total Pen	Pen Rato	Total Pon	Pen Rate	Total Pen	Pen Rato	Total Pen
Appliances	State Appliance Regulations	Energy Star Rated	203.9	0%	0	0%	0	0%	0	0%	0	0%	0
CHP	None	1500 kW, 270 ton absorber	5.6	27%	0	32%	0	38%	0	43%	0	48%	0
Roof Material	100% of roof at Abs=0.90	100% of roof at Abs=0.3	6.6	24%	0	28%	0	33%	0	38%	0	43%	0
Water Heating	Boiler Comb Eff = 80%	Boiler Comb Eff = 85%	Se	e Space He	ating	See Spa	ce Heating	See Spa	ce Heating	See Spa	ce Heating	See Spa	ce Heating
Windows	U=0.50, SHGC=0.35	U=0.26, SHGC=0.29	6.0	26%	0	31%	0	36%	0	41%	0	46%	0
Space Heating	Boller Comb Eff = 80%	Boller Comb Eff = 85%	4.3	32%	0	38%	0	45%	0	51%	0	58%	0
Jighting	0.570 kwyton Centrildgal Chillers	0.401 kw/ion Centrildgal Chillers	1.9	43%	0	5∠% 0%	0	00%	0	09%	0	/8%	0
Roof Insulation	5" R19 XPS	6" R23 XPS	12.7	11%	0	13%	0	15%	0	18%	0	20%	0
Thermal Storage	None	15% of max load, 3472 ton-hrs	21.4	4%	Ő	4%	0	5%	0	6%	Ő	6%	Ő
Wall Insulation	Typical Aluminum Curtain Wall	Reduced thermal bridging	7.1	22%	0	27%	0	31%	0	36%	0	40%	0
Corn	er Retail Shop - Type I Constru	uction (Qty 34 Bldgs)		CCT15, B	AU	CCT15,	Mid-Low	CCT1	5, Mid	CCT15,	Mid-High	CCT1	5, High
Measure	Baseline	Alternative	Payback	Pen Rate	Total Pen	Pen Rate	Total Pen	Pen Rate	Total Pen	Pen Rate	Total Pen	Pen Rate	Total Pen
Appliances	None	None		NA		1	A	Ν	A	1	NA	1	A
CHP	None	None	ļ	NA		<u> </u>	NA	1	A		NA	<u> </u>	NA
Water Heating	NONE EE_0 525	NONE EE_0 822	1.2	NA 470/	16	570/	NA 10	66%	NA 22	750/	NA 25	9E0/	VA 29
vvater meating	EF=0.525	U=0.26 SHGC-0.20	6.3	41%	10	29%	19	34%	22	39%	20	00% 44%	28
Windows	A second seco	0-0.20, 01100-0.20	0.0	20/0	14	20/0	10	JT /0	<u> </u>	5570		77 /0	22
Windows Space Heating	Furnace 78% AFUE	Furnace 94% AFUE	3.1	37%	12	44%	15	52%	17	59%	20	66%	
Windows Space Heating Space Cooling	Furnace 78% AFUE 10 SEER, 9.5 EER Unitary AC	Furnace 94% AFUE 14 SEER, 12.5 EER Unitary AC	3.1 3.4	37% 35%	12 12	44% 43%	15 14	52% 50%	17 16	59% 57%	20 19	66% 64%	21
Windows Space Heating Space Cooling Lighting	Furnace 78% AFUE 10 SEER, 9.5 EER Unitary AC 1.50 watts/sqft	Furnace 94% AFUE 14 SEER, 12.5 EER Unitary AC None	3.1 3.4	37% 35% NA	12 12	44% 43%	15 14 NA	52% 50%	17 16 NA	59% 57%	20 19 NA	66% 64%	21 NA
Windows Space Heating Space Cooling Lighting Roof Insulation	Furnace 78% AFUE 10 SEER, 9.5 EER Unitary AC 1.50 watts/sqft None	Furnace 94% AFUE 14 SEER, 12.5 EER Unitary AC None None	3.1 3.4	37% 35% NA NA	12 12	44% 43% N	15 14 NA NA	52% 50% N	17 16 NA NA	59% 57% N	20 19 VA VA	66% 64%	21 NA NA
Windows Space Heating Space Cooling Lighting Roof Insulation Thermal Storage	Furnace 78% AFUE 10 SEER, 9.5 EER Unitary AC 1.50 watts/sqft None Tuning Aluminum Contain Will	Furnace 94% AFUE 14 SEER, 12.5 EER Unitary AC None None Deduced the cert balance	3.1 3.4	37% 35% NA NA NA	12 12	44% 43%	15 14 NA NA NA	52% 50%	17 16 NA NA NA	59% 57%	20 19 NA NA NA	66% 64%	21 NA NA NA

Intern	al Retail Shon - Type I Constr	uction (Qtv 34 Bldgs)		CT15. B	4U	CCT15	Mid-I ow	CCT1	5. Mid	CCT15.	Mid-Hiah	CCT1	5. Hiah
Measure	Baseline	Alternative	Pavback	Pen Rate	Total Pen	Pen Rate Total Pen		Pen Rate Total Pen		Pen Rate Total Pen		Pen Rate Total P	
Appliances	None	None		NA		1	NA	NA		ŇA		١	A
CHP	None	None		NA		1	٨٨	NA		NA		١	IA.
Roof Material	None	None		NA		2	A	NA		NA		٢	IA
Water Heating	EF=0.525	EF=0.823	1.2	47%	16	57%	19	66%	22	75%	25	85%	28
Windows	U=0.50, SHGC=0.35	U=0.26, SHGC=0.29	7.1	22%	45	27%	67	31%	70	36%	70	40%	92
Space Heating	Furnace 78% AFUE	Furnace 94% AFUE	3.5	35%	12	42%	14	49%	16	57%	19	64%	21
Space Cooling	10 SEER, 9.5 EER Unitary AC	14 SEER, 12.5 EER Unitary AC	3.4	36%	12	43%	14	50%	16	5/%	19	64%	21
Lighting Reaf Insulation	1.50 Walls/sqlt	None		NA		ľ		r		ľ		Г М	
Thormal Storage	None	None		NA				I N	14	N		I N	
Wall Insulation	Typical Aluminum Curtain Wall	Reduced thermal bridging	56.6	0%	45	0%	67	0%	70	0%	70	0%	02
Wall Insulation	Typical Aluminum Curtain Wall	Reduced thermal bridging	50.0	0%	40	076	07	0%	70	0%	70	0%	92
Corn	er Restaurant - Type I Constru	uction (Oty 30 Bldgs)		CT15 B	Δ11	CCT15	Mid-Low	CCT1	5 Mid	CCT15	Mid-High	CCT1	5 High
Mossuro	Baseline	Alternative	Pavback	Pon Pate	Total Ban	Don Pate	Total Bon	Pon Pate	Total Pan	Bon Pate	Total Bon	Pon Pate	Total Bon
Appliances	None	None	Гаураск	NA NA	Total Fell	ren Kale		ren Kale		ren Kale		ren Kale	
CHP	None	None		NA					14				
Roof Material	None	None	NA				NA	N	IA		A	N	IA
Water Heating	EE=0.800	EF=0.823	8.6	18%	6	22%	7	26%	8	29%	9	33%	11
Windows	U=0.50, SHGC=0.35	U=0.26. SHGC=0.29	7.6	21%	4	25%	5	29%	6	33%	6	38%	8
Space Heating	Furnace 78% AFUE	Furnace 94% AFUE	2.1	42%	14	51%	17	59%	20	68%	23	76%	25
Space Cooling	10 SEER, 9.5 EER Unitary AC	14 SEER, 12.5 EER Unitary AC	3.6	35%	11	42%	14	49%	16	56%	19	63%	21
Lighting	1.50 watts/sqft	None		NA		1	ŇA	N	A	1	NA .	N	A
Roof Insulation	None	None		NA		NA		١	IA	1	١A	NA	
Thermal Storage	None	None		NA		1	A	Ν	A	1	NA	Ν	A
Wall Insulation	Typical Aluminum Curtain Wall	Reduced thermal bridging	26.3 2% 4		2%	5	3% 6		3%	6	3%	8	
			-										
Corne	er Retail Shop - Type II Constru	uction (Qty 17 Bldgs)	CCT15, BAU		CCT15, Mid-Low CCT ⁴		5, Mid	CCT15,	Mid-High	CCT15, High			
Measure	Baseline	Alternative	Payback	Pen Rate	Total Pen	Pen Rate Total Pen Per		Pen Rate	Total Pen	Pen Rate	Total Pen	Pen Rate	Total Pen
Appliances	None	None		NA		NA		L L	IA	1	A	1	IA
CHP	None	None		NA		1	A	1	IA AI	1	A	1	A
Roof Material	None	None		NA		1	A	NA		NA		NA	
Water Heating	EF=0.525	EF=0.823	1.2	47%	8	57%	9	66%	11	75%	12	85%	14
Windows	U=0.50, SHGC=0.35	U=0.26, SHGC=0.29	8.3	19%	6	23%	9	27%	12	31%	12	35%	15
Space Heating	Furnace 78% AFUE	Furnace 94% AFUE	4.1	33%	5	39%	6	46%	/	52%	8	59%	10
Space Cooling	10 SEER, 9.5 EER Unitary AC	14 SEER, 12.5 EER Unitary AC	3.3	36%	6	43%	<u> </u>	51%	8	58%	9	65%	11
Lighting Roof Insulation	1.50 Watts/sqft	None		NA		NA		NA NA		ΝΔ		NA NA	
Thormal Storage	None	None		NA				I N	14	N		I N	
Wall Insulation	R11 2v4 16	R19 2v4 16	9.7	16%	6	10%	10 0	22%	12	26%	12	20%	15
waininsulation	111, 224.10	110, 244.10	5.1	1070	Ū	1370	ÿ	2270	12	2070	12	2370	10
Intern	al Retail Shon - Type II Constr	ruction (Oty 17 Bldgs)		CT15 B	Δ11	CCT15	Mid-Low	CCT1	5 Mid	CCT15	Mid-Hiah	CCT1	5 Hiah
Mossuro	Basolino	Alternative	Payback	Pon Pate	Total Pon	Pon Pate	Total Ban	Pon Pate	Total Pan	Bon Pate	Total Bon	Pon Pate	Total Bon
Appliances	None	None	Гаураск	NA	Total Fell	ren Kale		ren Kale		ren Kale	JA	ren Kale	JA
CHP	None	None		NA			NA	NA		NA		NA	
Roof Material	None	None		NA			NA		A	N	NA A		A
Water Heating	EF=0.525	EF=0.823	1.2	47%	8	57%	9	66%	11	76%	12	85%	14
Windows	U=0.50, SHGC=0.35	U=0.26, SHGC=0.29	7.6	21%	12	25%	18	29%	24	34%	24	38%	30
Space Heating	Furnace 78% AFUE	Furnace 94% AFUE	4.3	32%	5	38%	6	45%	7	51%	8	57%	9
Space Cooling	10 SEER, 9.5 EER Unitary AC	14 SEER, 12.5 EER Unitary AC	3.4	36%	6	43%	7	50%	8	57%	9	64%	10
Lighting	1.50 watts/sqft	None		NA		1	A	Ν	A	1	A	1	A
Roof Insulation	None	None		NA		1	A	Ν	A	1	A	Ν	A
Thermal Storage	None	None		NA		1	A	1	A	1	A	1	IA
Wall Insulation	R11, 2x4.16	R19, 2x4.16	15.8	7%	12	9%	18	10%	24	12%	24	13%	30
Corn	er Restaurant - Type II Constru	uction (Qty 17 Bldgs)	0	CT15, B	AU	CCT15,	Mid-Low	CCT1	5, Mid	CCT15,	Mid-High	CCT1	5, High
Measure	Baseline	Alternative	Payback	Pen Rate	Total Pen	Pen Rate	Total Pen	Pen Rate	Total Pen	Pen Rate	Total Pen	Pen Rate	Total Pen
Appliances	None	None		NA		1	A	N	IA	1	NA	1	A
CHP	None	None		NA		1	NA	1	IA	1	NA .	1	A
Roof Material	None	None	0.0	NA	_	1	NA ^	000/	A	1	NA .	1 0000	IA C
vvater Heating	EF=0.800	EF=0.823	8.6	18%	3	22%	3	26%	4	29%	4	33%	5
Windows	U=0.50, SHGU=0.35	U=0.26, SHGC=0.29	9.9	16%	2	19%	3	22%	4	25%	4	28%	5
Space meating	10 SEEP 0.5 EEP Unitary AC	14 SEEP 12.5 EEP Unitors AC	2.1	4∠% 35%	6	01% //2%	7	50%	1U 9	57%		6/9/	10
Lighting	1 50 watts/soft	None	5.5	- 3376 ΝΔ	U	40/0	14	JU /0	14	5170	3	0470 N	Δ
Roof Insulation	None	None		NΔ		N		N N		N	JΔ	N	
Thermal Storage	None	None		NA		Ň	NA A	N	IA	Ň	NA	N	IA
Wall Insulation	D11 0v4 16	P10. 2v4 16	75	21%	2	259/		200/	4	34%		200/	

	Prototype 01 - 56-story Highris	se Office (Qtv 1)	(CCT20. B	AU	CCT20.	Mid-Low	CCT2	0. Mid	CCT20.	Mid-Hiah	CCT2	0. Hiah
Measure	Baseline	Alternative	Payback	Pen Rate	Total Pen	Pen Rate	Total Pen	Pen Rate	Total Pen	Pen Rate	Total Pen	Pen Rate	Total Pen
Appliances	None	None	ŇA	1	ŇA	N	NA .	1	A	1	NA	1	ŇA
CHP	None	6500 kW, 1390 ton absorber	6.5	24%	0	29%	0	34%	0	39%	0	43%	0
Cool Roof	100% of roof at Abs=0.90	100% of roof at Abs=0.3	20.2	4%	0	5%	0	6%	0	7%	0	8%	0
Water Heating	Boiler Comb Eff = 80%	Boiler Comb Eff = 85%	NA	See Spa	ce Heating	See Space	ce Heating	See Spa	ce Heating	See Spa	ce Heating	See Spa	ce Heating
Windows Space Heating	U=0.50, SHGC=0.35 Boiler Comb Eff = 80%	U=0.26, SHGC=0.29 Boiler Comb Eff = 85%	0.0	24%	0	28%	0	33%	0	38%	0	43%	0
Space Cooling	0.576 kW/ton Centrifugal Chillers	0.461 kW/top Centrifugal Chillers	16	45%	0	54%	0	63%	0	72%	0	81%	0
Lighting	1 1 watts/soft	0.401 kW/ton Centinugar Chillens	9.5	16%	0	20%	0	23%	0	26%	0	29%	0
Roof Insulation	5" R19 XPS	6" R23 XPS	2.1	42%	Ő	50%	ŏ	59%	0	67%	ŏ	75%	Ő
Thermal Storage	None	25% of max load, 23376 ton-hrs	8.5	19%	0	22%	0	26%	0	30%	0	34%	0
Wall Insulation	Typical Aluminum Curtain Wall	Reduced thermal bridging	8.1	20%	0	24%	0	28%	0	31%	0	35%	0
					-		-				•		-
	Prototype 02 - 41-story Highris	se Office (Qty 6)	(CCT20, B/	AU	CCT20,	Mid-Low	CCT2	0, Mid	CCT20,	Mid-High	CCT2	0, High
Measure	Baseline	Alternative	Payback	Pen Rate	Total Pen	Pen Rate	Total Pen	Pen Rate	Total Pen	Pen Rate	Total Pen	Pen Rate	Total Pen
Appliances	None	None	NA	1	A	Ν	A	1	IA	1	A	1	A
CHP	None	5500 kW, 1150 ton absorber	6.3	25%	1	30%	1	34%	2	39%	2	44%	2
Roof Material	100% of roof at Abs=0.90	100% of roof at Abs=0.3	12.2	12%	0	14%	0	16%	0	19%	1	21%	1
Windowo	Boller Comb Eff = 80%	Boller Comb Eff = 85%	NA 6.6	See Spa	ce Heating	See Space	ce Heating	See Spa	ce Heating	See Spa	ce Heating	See Spa	ce Heating
Space Heating	0=0.50, SHGC=0.35 Boiler Comb Eff = 80%	0=0.26, SHGC=0.29 Boiler Comb Eff - 85%	17.6	6%	0	29%	0	33%	0	38%	2	43%	2
Space Cooling	0.576 kW/ton Centrifugal Chillers	0.461 kW/ton Centrifugal Chillers	17.0	44%	2	53%	3	62%	3	71%	4	79%	4
Lighting	1.1 watts/soft	0.9 watts/soft	9.7	16%	0	19%	Ĭ	22%	1	25%	1	29%	1
Roof Insulation	5" R19 XPS	6" R23 XPS	3.8	34%	2	41%	2	47%	2	54%	3	61%	3
Thermal Storage	None	25% of max load, 15073 ton-hrs	5.3	28%	1	34%	2	39%	2	45%	2	51%	3
Wall Insulation	Typical Aluminum Curtain Wall	Reduced thermal bridging	8.0	20%	1	24%	1	28%	1	32%	1	36%	2
	Prototype 03 - 34-story Highris	se Office (Qty 5)		CT20, B	AU	CCT20,	Mid-Low	CCT2	0, Mid	CCT20,	Mid-High	CCT2	0, High
Measure	Baseline	Alternative	Payback	Pen Rate	Total Pen	Pen Rate	Total Pen	Pen Rate	Total Pen	Pen Rate	Total Pen	Pen Rate	Total Pen
Appliances	None	None	NA	1	NA .	N 0000	A .	1	IA .	1	NA .	1	A
CHP	None	4500 kW, 1020 ton absorber	6.2	25%	1	30%	1	35%	1	40%		45%	2
Root Material	100% of roof at Abs=0.90	100% of roof at Abs=0.3	6.7	23%		28%		33%	1	37%		42%	
Windows			INA 6 F	240/	ue meating	200/	Le rreating	240/	Le rreating	300/	e neating	5ee Spa	ce meating
Space Heating	Boiler Comb Eff - 90%	Boiler Comb Eff - 95%	0.5	24% 6%	0	29%	0	04%	0	39% 10%	0	44%	2 0
Space Cooling	0.576 kW/ton Centrifugal Chillers	0.461 kW/ton Centrifugal Chillers	1.8	44%	2	52%	2	61%	3	70%	3	79%	3
Lighting	1.1 watts/soft	0.9 watts/soft	9.8	16%	0	19%	0	22%	1	25%	1	28%	1
Roof Insulation	5" R19 XPS	6" R23 XPS	7.1	22%	1	27%	1	31%	1	36%	1	40%	2
Thermal Storage	None	25% of max load, 16172 ton-hrs	6.4	24%	1	29%	1	34%	1	39%	1	44%	2
Wall Insulation	Typical Aluminum Curtain Wall	Reduced thermal bridging	7.8	20%	1	24%	1	29%	1	33%	1	37%	1
	Prototype 04 - 20-story Midris	se Office (Qty 3)	(CCT20, B/	AU	CCT20,	Mid-Low	CCT2	20, Mid	CCT20,	Mid-High	CCT2	0, High
Measure	Baseline	Alternative	Payback	Pen Rate	Total Pen	Pen Rate	Total Pen	Pen Rate	Total Pen	Pen Rate	Total Pen	Pen Rate	Total Pen
Appliances	None	None	NA	1	A	Ν	A	1	IA	1	A	1	A
CHP	None	3000 kW, 490 ton absorber	6.5	24%	0	29%	0	34%	1	38%	1	43%	1
Roof Material	100% of roof at Abs=0.90	100% of root at Abs=0.3	6.7	23%	U U	28%	0	33%	U	38%	1	42%	1 an Unation
Windows	LL0 50 SHCC-0 35	Doller Comb Ell = 85%	0.6	16%		10%		22%		26%		20%	
Space Heating	Boiler Comb Eff = 80%	Boiler Comb Eff = 85%	21.2	4%	0	4%	0	5%	0	6%	0	7%	0
Space Cooling	0.576 kW/ton Centrifugal Chillers	0.461 kW/ton Centrifugal Chillers	1.8	44%	1	53%	1	61%	1	70%	2	79%	2
Lighting	1.1 watts/sqft	0.9 watts/sqft	10.0	15%	0	19%	0	22%	0	25%	0	28%	0
Roof Insulation	5" R19 XPS	6" R23 XPS	6.0	26%	0	31%	0	36%	1	41%	1	46%	1
Thermal Storage	None	25% of max load, 7818 ton-hrs	5.0	29%	0	35%	1	41%	1	47%	1	52%	1
Wall Insulation	R11, 2x4.16	R19, 2x4.16	11.2	13%	0	16%	0	19%	0	21%	0	24%	0
	Prototype 05 - 33-story Highri	se Hotel (Qty 1)	(CCT20, B	AU	CCT20,	Mid-Low	CCT2	0, Mid	CCT20,	Mid-High	CCT2	0, High
Measure	Baseline	Alternative	Payback	Pen Rate	Total Pen	Pen Rate	Total Pen	Pen Rate	Total Pen	Pen Rate	Total Pen	Pen Rate	Total Pen
Appliances	None	None	4.0	NA 200/	0	200/		100/		400/		E 40/	
Roof Matorial	100% of roof at Abs=0.90	100% of roof at Abs=0.3	4.0	50%	0	7%	0	4Z 70 99/	0	40%	0	04%	0
Water Heating	Boiler Comb Eff – 80%	Boiler Comb Eff – 85%	17.4 Se	e Space He	ating	See Spar	ce Heating	See Spa	ce Heating	See Spa	ce Heating	See Spa	ce Heating
Windows	U=0.50, SHGC=0.35	U=0.26. SHGC=0.29	10.4	15%	0	18%	0	20%	0	23%	0	26%	0
Space Heating	Boiler Comb Eff = 80%	Boiler Comb Eff = 85%	3.1	37%	0	45%	0	52%	0	60%	0	67%	0
Space Cooling	0.576 kW/ton Centrifugal Chillers	0.461 kW/ton Centrifugal Chillers	1.9	43%	0	52%	0	61%	0	69%	0	78%	0
Lighting	1.3 watts/sqft	1.19 watts/sqft	35.4	1%	0	1%	0	1%	0	1%	0	1%	0
Roof Insulation	5" R19 XPS	6" R23 XPS	12.9	11%	0	13%	0	15%	0	17%	0	19%	0
Thermal Storage	None	15% of max load, 7799 ton-hrs	9.1	17%	0	21%	0	24%	0	28%	0	31%	0
vvaii irisulation	rypical Aluminum Curtain Wall	Reduced mermal bridging	12.1	12%	U	14%	U	10%	U	19%	U	∠1%	U
[Prototype 06 - 18-story Middle	se Hotel (Otv 5)		CT20 P	Δ11	CCT20	Mid-Low	COT	0 Mid	CCT20	Mid-Hiah	CCT2	0 Hiab
Magguro	Prototype 06 - 18-story wildris	Alternative	Baybaak	Don Boto	AU Total Ban	Bon Bata	Total Ban	Don Boto	Total Ban	Bon Boto	Total Ban	Don Boto	U, HIGH Total Ban
Appliances	None	None	гаураск	NA	i otal Peñ	r en rate N	NA NA	r en Rate	I i ocar Pen IA	ren Kate	A NA	r en Rate	VA
CHP	None	400 kW. 80 ton absorber	5.1	29%	1	35%	1	40%	2	46%	2	52%	2
Roof Material	100% of roof at Abs=0.90	100% of roof at Abs=0.3	12.3	11%	0	14%	0	16%	0	18%	0	21%	1
Water Heating	Boiler Comb Eff = 80%	Boiler Comb Eff = 85%	Se	e Space He	ating	See Space	ce Heating	See Spa	ce Heating	See Spa	ce Heating	See Spa	ce Heating
Windows	U=0.50, SHGC=0.35	U=0.26, SHGC=0.29	34.9	1%	0	1%	0	1%	0	1%	0	1%	0
Space Heating	Boiler Comb Eff = 80%	Boiler Comb Eff = 85%	3.0	37%	1	45%	2	52%	2	60%	2	67%	3
Space Cooling	0.576 kW/ton Centrifugal Chillers	0.461 kW/ton Centrifugal Chillers	1.6	45%	2	54%	2	63%	3	72%	3	81%	4
Lighting	1.3 watts/sqft	1.19 watts/sqft	33.8	1%	0	1%	0	1%	0	1%	0	1%	0
Thormal State	5° K19 XPS	6" K23 XPS	13.4	10%	0	12%	0	14%	Ú 4	16%	0	18%	0
Wall Insulation	R11 2v4 16	R10 2v4 46	0.3	19%	0	23% 4%	0	∠1% 5%	0	50/	0	54% 6%	0
wan moulduon	111, 234.10	1113, 234.10	44.4	370	U	470	U U	J 70	U	J 70	U	070	U U
Dr	ototype 07 - 55-story Highrise	Residential (Qtv 2)		CCT20 B	AU	CCT20	Mid-Low	CCT2	0. Mid	CCT20	Mid-Hiab	CCT2	0. High
Measure	Baseline	Alternative	Pavback	Pen Rate	Total Pen	Pen Rate	Total Pen	Pen Rate	Total Pen	Pen Rate	Total Pen	Pen Rate	Total Pen
Appliances	State Appliance Regulations	Energy Star Rated	190.9	0%	0	0%	0	0%	0	0%	0	0%	0
CHP	None	1500 kW, 300 ton absorber	6.0	26%	0	31%	0	36%	Ō	41%	Ō	46%	Ō
Roof Material	100% of roof at Abs=0.90	100% of roof at Abs=0.3	7.4	21%	0	26%	0	30%	0	34%	0	39%	0
Water Heating	Boiler Comb Eff = 80%	Boiler Comb Eff = 85%	Se	e Space He	ating	See Spa	ce Heating	See Spa	ce Heating	See Spa	ce Heating	See Spa	ce Heating
Windows	U=0.50, SHGC=0.35	U=0.26, SHGC=0.29	5.8	26%	0	32%	0	37%	0	42%	0	47%	0
Space Heating	Boiler Comb Eff = 80%	Boiler Comb Eff = 85%	4.6	31%	0	37%	0	43%	0	49%	0	55%	1
0	· · · · · · · · · · · · · · · · · · ·	 u #F1 kW//top Contritugal Chillora 	17	1/19/	. 0	53%	1 1	62%	1	/1%	I 1	80%	1
Space Cooling	0.5/6 kW/ton Centrifugal Chillers	0.401 KW/t011 Centinugai Crimers	101.2	44 /0	0	00%		00/	0	00/		00/0	0
Space Cooling Lighting	0.576 kW/ton Centrifugal Chillers 0.70 watts/sqft	0.675 watts/sqft	101.3	0%	0	0%	0	0%	0	0%	0	0%	0
Space Cooling Lighting Roof Insulation Thermal Storage	0.576 kW/ton Centrifugal Chillers 0.70 watts/sqft 5" R19 XPS None	0.461 KW/ton Centimetry 0.675 watts/sqft 6" R23 XPS 15% of max load. 3751 ton-bre	101.3 6.8 31.1	0% 23% 1%	0	0% 28% 1%	0	0% 32% 1%	0	0% 37% 2%	0	0% 42% 2%	0 0 0

Pre	ototype 08 - 43-story Highrise	Residential (Qty 4)	(CCT20, B	AU	CCT20,	Mid-Low	CCT2	20, Mid	CCT20,	Mid-High	CCT2	0, High
Measure	Baseline	Alternative	Payback	Pen Rate	Total Pen	Pen Rate	Total Pen	Pen Rate	Total Pen	Pen Rate	Total Pen	Pen Rate	Total Pen
Appliances	State Appliance Regulations	Energy Star Rated	199.4	0%	0	0%	0	0%	0	0%	0	0%	0
CHP	None	750 kW, 160 ton absorber	6.5	24%	0	29%	1	34%	1	38%	1	43%	1
Roof Material	100% of roof at Abs=0.90	100% of roof at Abs=0.3	8.4	19%	0	23%	0	26%	1	30%	1	34%	1
Windowo	Boller Comb Eff = 80%	Boller Comb Eff = 85%	56	e Space He	ating	See Space	ce Heating	See Spa	ce Heating	See Spa	ce Heating	See Spa	ce Heating
Space Heating	0=0.50, SHGC=0.35 Boiler Comb Eff = 80%	0=0.26, SHGC=0.29 Boiler Comb Eff - 85%	5.0 4.4	32%	1	32%	1	38%	1	43%	2	49%	2
Space Cooling	0.576 kW/ton Centrifugal Chillers	0.461 kW/ton Centrifugal Chillers	1.9	43%	1	52%	2	60%	2	69%	2	78%	3
Lighting	0.70 watts/soft	0.675 watts/sqft	106.5	0%	0	0%	0	0%	0	0%	0	0%	0
Roof Insulation	5" R19 XPS	6" R23 XPS	6.0	26%	1	31%	1	36%	1	41%	1	46%	1
Thermal Storage	None	15% of max load, 1820 ton-hrs	16.3	7%	0	8%	0	10%	0	11%	0	12%	0
Wall Insulation	Typical Aluminum Curtain Wall	Reduced thermal bridging	6.6	24%	0	29%	1	33%	1	38%	1	43%	1
Pro	ototype 09 - 34-story Highrise F	Residential (Qty 10)	(CCT20, B.	AU	CCT20,	Mid-Low	CCT2	20, Mid	CCT20,	Mid-High	CCT2	0, High
Measure	Baseline	Alternative	Payback	Pen Rate	Total Pen	Pen Rate	Total Pen	Pen Rate	Total Pen	Pen Rate	Total Pen	Pen Rate	Total Pen
Appliances	State Appliance Regulations	Energy Star Rated	200.3	0%	0	0%	0	0%	0	0%	0	0%	0
Roof Material	100% of roof at Abs-0.90	100% of roof at Abs-0.3	5.7	21%	2	32%	3	37%	3	43%	4	48%	4
Water Heating	Boiler Comb Eff = 80%	Boiler Comb Eff = 85%	0.1	e Space He	ating	See Spar	ce Heating	See Spar	ce Heating	See Sna	ce Heating	See Spa	ce Heating
Windows	U=0.50, SHGC=0.35	U=0.26, SHGC=0.29	5.7	27%	2	32%	3	37%	3	43%	4	48%	4
Space Heating	Boiler Comb Eff = 80%	Boiler Comb Eff = 85%	4.3	32%	3	38%	3	45%	4	51%	5	57%	5
Space Cooling	0.576 kW/ton Centrifugal Chillers	0.461 kW/ton Centrifugal Chillers	1.9	43%	4	52%	5	60%	6	69%	6	78%	7
Lighting	0.70 watts/sqft	0.675 watts/sqft	104.2	0%	0	0%	0	0%	0	0%	0	0%	0
Roof Insulation	5" R19 XPS	6" R23 XPS	7.4	21%	2	26%	2	30%	3	34%	3	39%	3
Thermal Storage	None	15% of max load, 2143 ton-hrs	16.7	1%	0	8%	0	9%	0	11%	1	12%	1
waii msulation	rypical Aluminum Curtain Wall	Reduced mermai bridging	0.7	23%	2	20%	2	33%	3	31%	3	42%	4
Dr	ototype 10 - 25-story Highrice	Residential (Qtv 5)		CCT20 B	AU	CCT20	Mid-Low	CCT2	0. Mid	CCT20	Mid-Hiab	CCT2	0. Hiah
Measure	Baseline	Alternative	Payhack	Pen Rate	Total Pen	Pen Rate	Total Pen	Pen Rate	Total Pen	Pen Rate	Total Pen	Pen Rate	Total Pen
Appliances	State Appliance Regulations	Energy Star Rated	192.7	0%	0	0%	0	0%	0	0%	0	0%	0
CHP	None	1500 kW, 250 ton absorber	5.3	28%	1	34%	1	39%	1	45%	2	51%	2
Roof Material	100% of roof at Abs=0.90	100% of roof at Abs=0.3	6.0	26%	1	31%	1	36%	1	41%	2	46%	2
Water Heating	Boiler Comb Eff = 80%	Boiler Comb Eff = 85%	Se	e Space He	ating	See Space	ce Heating	See Spa	ce Heating	See Spa	ce Heating	See Spa	ce Heating
Windows	U=0.50, SHGC=0.35	U=0.26, SHGC=0.29	6.0	26%	1	31%	1	36%	1	41%	2	46%	2
Space Heating	Boiler Comb Eff = 80%	Boiler Comb Eff = 85%	4.2	32%	1	39%	1	45%	2	52%	2	58%	2
Jighting	0.576 kW/ton Centinugal Chillers	0.461 kW/ton Centinugal Chillers	103.5	43%	2	0%	2	01%	3	09%	0	0%	0
Roof Insulation	5" R19 XPS	6" R23 XPS	8.3	19%	0	23%	1	27%	1	31%	1	34%	1
Thermal Storage	None	15% of max load, 3299 ton-hrs	19.6	5%	0	5%	0	6%	0	7%	0	8%	0
Wall Insulation	Typical Aluminum Curtain Wall	Reduced thermal bridging	7.1	22%	1	27%	1	31%	1	36%	1	40%	2
Pro	ototype 11 - 12-story Midrise R	lesidential (Qty 14)	0	CCT20, B.	AU	CCT20,	Mid-Low	CCT2	20, Mid	CCT20,	Mid-High	CCT2	0, High
Measure	Baseline	Alternative	Payback	Pen Rate	Total Pen	Pen Rate	Total Pen	Pen Rate	Total Pen	Pen Rate	Total Pen	Pen Rate	Total Pen
Appliances	State Appliance Regulations	Energy Star Rated	205.1	0%	0	0%	0	0%	0	0%	0	0%	0
CHP	None	250 kW, 40 ton absorber	7.8	20%	2	24%	3	28%	3	33%	4	37%	5
Water Heating	Boiler Comb Eff = 80%	Boiler Comb Eff = 85%	3.7	30% Space He	4	41% Soo Soo	5 Co Hosting	48% Soo Spor	0 Heating	500 Sp2	/	62% Soo Soo	o Heating
Windows	U=0.50_SHGC=0.35	U=0.26_SHGC=0.29	7.5	21%	2	25%	3	30%	2e Heating 4	34%	4	38%	5
Space Heating	Bojler Comb Eff = 80%	Boiler Comb Eff = 85%	4.1	33%	4	39%	5	46%	6	52%	7	59%	8
Space Cooling	0.576 kW/ton Centrifugal Chillers	0.461 kW/ton Centrifugal Chillers	1.8	44%	6	53%	7	61%	8	70%	9	79%	11
Lighting	0.70 watts/sqft	0.675 watts/sqft	103.4	0%	0	0%	0	0%	0	0%	0	0%	0
Roof Insulation	5" R19 XPS	6" R23 XPS	22.3	3%	0	4%	0	5%	0	5%	0	6%	0
Thermal Storage	None	15% of max load, 506 ton-hrs	13.5	10%	1	12%	1	14%	1	16%	2	18%	2
Wall Insulation	R11, 2x4.16	R19, 2x4.16	7.5	21%	2	26%	3	30%	4	34%	4	38%	5
Drete	tune 42 EE stemullishnise Min	ad Use Office (Otv 1)			A 1 1	00700	Midlow	COTO	o Mid	COTOO	Midllinh	COTO	0.111.mh
Magguro	type 12 - 55-story Highrise Wix	Alternative	Baybaak	Don Boto	AU Total Ban	Bon Bata	MIG-LOW	Bon Boto	Total Ban	Bon Boto	Mid-High	Don Boto	U, Fign
Appliances	None	None		Fell Kale		Fell Kale		Fell Kale		Fell Kale		Fell Kale	
CHP	None	3500 kW, 680 ton absorber	6.1	25%	0	30%	0	36%	0	41%	0	46%	0
Roof Material	100% of roof at Abs=0.90	None	NA	1	NA	N	NA .	N	A	1	NA	1	NA
Water Heating	Boiler Comb Eff = 80%	Boiler Comb Eff = 85%	Se	e Space He	eating	See Space	ce Heating	See Spa	ce Heating	See Spa	ce Heating	See Spa	ce Heating
Windows	U=0.50, SHGC=0.35	U=0.26, SHGC=0.29	6.4	24%	0	29%	0	34%	0	39%	0	44%	0
Space Heating	Boiler Comb Eff = 80%	Boiler Comb Eff = 85%	16.6	7%	0	8%	0	9%	0	11%	0	12%	0
Space Cooling	0.576 KW/ton Centrifugal Chillers	0.461 KW/ton Centritugal Chillers	1.8	44%	0	52%	0	b1%	0	70%	0	/8% 27%	0
Roof Insulation	5" R10 YPS	0.9 wdlts/sqit	NA	10%		10%		∠1% N	U U	24% N		21%	U U
Thermal Storage	None	25% of max load. 10798 ton-brs	5.3	28%	0	34%	0	39%	0	45%	0	51%	0
Wall Insulation	Typical Aluminum Curtain Wall	Reduced thermal bridging	7.6	21%	0	25%	0	29%	0	33%	0	37%	0
Prototyp	e 12 - 55-story Highrise Mixed	Use, Residential (Qty 1)		CCT20, B	AU	CCT20,	Mid-Low	CCT2	0, Mid	CCT20,	Mid-High	CCT2	0, High
Measure	Baseline	Alternative	Payback	Pen Rate	Total Pen	Pen Rate	Total Pen	Pen Rate	Total Pen	Pen Rate	Total Pen	Pen Rate	Total Pen
Appliances	State Appliance Regulations	Energy Star Rated	194.9	0%	0	0%	0	0%	0	0%	0	0%	0
CHP	None	1500 kW, 270 ton absorber	5.3	28%	0	34%	0	39%	0	45%	0	51%	0
Water Heating	Boiler Comb Eff – 80%	Boiler Comb Eff – 85%	0.3	e Space Hr	U U	See Spar	U Ce Heating	See Sport	U Ce Heating	40% See Sport	ce Heating	44% See Sea	Ce Heating
Windows	U=0,50. SHGC=0.35	U=0,26. SHGC=0.29	5.8	26%	0	31%	0	37%	0 nearing	42%	0	47%	0
Space Heating	Boiler Comb Eff = 80%	Boiler Comb Eff = 85%	4.2	32%	ŏ	39%	ŏ	45%	Ő	52%	ŏ	58%	ŏ
Space Cooling	0.576 kW/ton Centrifugal Chillers	0.461 kW/ton Centrifugal Chillers	1.8	44%	0	52%	0	61%	0	70%	0	78%	0
Lighting	0.70 watts/sqft	0.675 watts/sqft	99.2	0%	0	0%	0	0%	0	0%	0	0%	0
Roof Insulation	5" R19 XPS	6" R23 XPS	12.2	12%	0	14%	0	16%	0	19%	0	21%	0
Thermal Storage	None	15% of max load, 3472 ton-hrs	21.4	4%	0	4%	0	5%	0	6%	0	6%	0
vvaii Insulation	i ypical Aluminum Curtain Wall	Reduced thermal bridging	6.9	23%	0	27%	U	32%	U	31%	0	41%	U
Co	er Retail Shon - Tune I Constru	uction (Oty 34 Bldgs)		CT20 P	A11	CCTOO	Mid-Low	0070	Mid 0	CCTOO	Mid-Hiak	0070	0 Hiak
Measure	Baseline	Alternativa	Pavback	Pen Rate	Total Pen	Pen Rato	Total Pen	Pen Rato	Total Pen	Pen Rate	Total Pen	Pen Rato	Total Pen
Appliances	None	None	Tayback	NA	1 our en	N	A	. en Nale	A	N	VA	. en Nale	VA
CHP	None	None	1	NA		N N	NA	1	NA	i i	NA	i i	NA
Roof Material	None	None		NA		N N	A	1	A	1	A	1	A
Water Heating	EF=0.525	EF=0.823	1.2	47%	16	57%	19	66%	22	76%	25	85%	28
Windows	U=0.50, SHGC=0.35	U=0.26, SHGC=0.29	6.2	25%	15	30%	18	35%	21	40%	21	45%	30
Space Heating	Furnace /8% AFUE	Furnace 94% AFUE	3.1	37%	12	45%	15	52%	17	59%	20	67%	22
Lighting	1 50 watts/soft	NODE	3.4	30% NA	12	43% N	14 JA	5U%	JA I/	5/% N	19 VA	00%	<u> 21</u> NA
Roof Insulation	None	None	+	NA			NA	Г М	NA.		NA		NA
Thermal Storage	None	None	1	NA		i i	NA	Ň	NA	i i	NA A	i	NA
L MAR HILL AND	Turning Aluminum Curtain Mall	Deduced the small bridging	00 F	00/	45	00/	40	20/	04	20/	04	20/	20

	al Potail Shon - Type I Constr	uction (Oty 34 Bldgs)		CT20 B	A11	CCT20	Mid-Low	CCT2	0 Mid	CCT20	Mid-High	CCT2	0 ∐iah
Mossuro	Basolino	Alternative	Payback	Don Date	Total Ban	Bon Pate	Total Bon	Don Pate	Total Pon	Bon Pate	Total Bon	Don Pate	Total Bon
Appliances	None	None	Гаураск	NA	Total Fell	Fell Kale		NA		NA		NA	
CHP	None	None		NA		l i	JA	NA		, N	JA	N	A
Roof Material	None	None		NA			NA A	N	IA	Ň	JA .	N	A
Water Heating	EF=0.525	EF=0.823	1.2	47%	16	57%	19	66%	22	76%	25	85%	28
Windows	U=0.50, SHGC=0.35	U=0.26, SHGC=0.29	6.9	23%	66	27%	67	32%	70	37%	70	41%	112
Space Heating	Furnace 78% AFUE	Furnace 94% AFUE	3.4	36%	12	43%	14	50%	16	57%	19	64%	21
Space Cooling	10 SEER, 9.5 EER Unitary AC	14 SEER, 12.5 EER Unitary AC	3.3	36%	12	43%	14	50%	17	58%	19	65%	21
Lighting	1.50 watts/sqft	None		NA		1	A	N	IA	N	JA .	Ν	NA .
Roof Insulation	None	None		NA		NA NA			IA	N	IA	NA	
Thermal Storage	None	None		NA		NA		N	IA	Ν	IA	N	A
Wall Insulation	Typical Aluminum Curtain Wall	Reduced thermal bridging	55.6	0%	66	0%	67	0%	70	0%	70	0%	112
Corn	er Restaurant - Type I Constru	iction (Qty 30 Bldgs)	0	CT20, B/	AU	CCT20,	Mid-Low	CCT2	0, Mid	CCT20,	Mid-High	CCT2	0, High
Measure	Baseline	Alternative	Payback	Pen Rate	Total Pen	Pen Rate	Total Pen	Pen Rate	Total Pen	Pen Rate	Total Pen	Pen Rate	Total Pen
Appliances	None	None		NA			NA	N	IA	N	IA	N	NA
CHP	None	None		NA			A	N	IA		IA	N	A
Root Material	None	None	0.5	NA 40%	6	200/	NA 7	000/	A	200/	10 IO	240/	NA 44
Water Heating	EF=0.800	EF=0.823	8.5	19%	6	22%		26%	8	30%	10	34%	11
Space Heating	U=0.30, SHGC=0.35	U=0.20, SHGU=0.29 Furnace 04% AFUE	2.0	21% 42%	5 1/	20%	5 17	50%	20	54% 68%	22	39%	9 25
Space Cooling	10 SEER 9.5 EER Unitary AC	14 SEER 12.5 EER Unitary AC	2.0	35%	12	42%	14	50%	16	57%	10	64%	20
Lighting	1.50 watts/soft	None	5.5	NA	14	42.70	NA IN		A	5770 N	A	0470 N	A A
Roof Insulation	None	None		NA		i	NA	N	IA	Ň	NA	N	NA.
Thermal Storage	None	None		NA		i i	NA .	N	A	İ İ	IA.	N	NA A
Wall Insulation	Typical Aluminum Curtain Wall	Reduced thermal bridging	25.6 2% 5		3%	5	3%	6	3%	6	4%	9	
							•						
Corne	er Retail Shop - Type II Constr	uction (Qtv 17 Bldgs)	0	CT20. B/	AU	CCT20.	Mid-Low	CCT2	0. Mid	CCT20.	Mid-Hiah	CCT2	0. Hiah
Measure	Baseline	Alternative	Pavback	Payback Pen Rate Total Pen		Pen Rate	Rate Total Pen Pen Rate Total Per		Pen Rate	Total Pen	Pen Rate	Total Pen	
Appliances	None	None		NA		1	JA .	N	A	N	A	N	NA NA
CHP	None	None		NA		1	1A	Ν	IA	١	IA	Ν	٨٨
Roof Material	None	None		NA		1	1A	N	IA	١	IA	N	NA
Water Heating	EF=0.525	EF=0.823	1.2	47%	8	57%	9	66%	11	76%	12	85%	14
Windows	U=0.50, SHGC=0.35	U=0.26, SHGC=0.29	8.0	20%	6	24%	9	28%	12	32%	12	36%	15
Space Heating	Furnace 78% AFUE	Europeo 04% AELIE	4.0	000/	-	400/	<u>^</u>	400/	7				
		T UTTACE 34 /8 AT UL	4.0	33%	5	40%	6	40%	1	53%	8	59%	10
Space Cooling	10 SEER, 9.5 EER Unitary AC	14 SEER, 12.5 EER Unitary AC	3.2	33%	6	40% 44%	6 7	46% 51%	8	53% 59%	8 9	59% 66%	10 11
Space Cooling Lighting	10 SEER, 9.5 EER Unitary AC 1.50 watts/sqft	14 SEER, 12.5 EER Unitary AC None	3.2	33% 37% NA	6	40% 44%	6 7 NA	46% 51%	8 IA	53% 59%	8 9 IA	59% 66%	10 11 NA
Space Cooling Lighting Roof Insulation	10 SEER, 9.5 EER Unitary AC 1.50 watts/sqft None	14 SEER, 12.5 EER Unitary AC None None	3.2	33% 37% NA NA	6	40%	A A	46% 51% N	8 IA IA	53% 59% N	8 9 IA IA	59% 66% N	10 11 NA NA
Space Cooling Lighting Roof Insulation Thermal Storage	10 SEER, 9.5 EER Unitary AC 1.50 watts/sqft None None	14 SEER, 12.5 EER Unitary AC None None None	3.2	33% 37% NA NA NA	6		6 7 VA VA VA	46% 51% N	A IA IA IA	53% 59% N	8 9 IA IA IA	59% 66% N	10 11 NA NA NA
Space Cooling Lighting Roof Insulation Thermal Storage Wall Insulation	10 SEER, 9.5 EER Unitary AC 1.50 watts/sqft None None R11, 2x4.16	14 SEER. 12.5 EER Unitary AC None None None R19, 2x4.16	4.0 3.2 9.6	33% 37% NA NA NA 16%	5 6 6	40% 44%	6 7 NA NA NA 9	46% 51% N 23%	7 8 IA IA IA 12	53% 59% N 26%	8 9 IA IA IA 12	59% 66% N 29%	10 11 VA VA VA 15
Space Cooling Lighting Roof Insulation Thermal Storage Wall Insulation	10 SEER, 9.5 EER Unitary AC 1.50 watts/sqft None None R11, 2x4.16	14 SEER, 12.5 EER Unitary AC None None R19, 2x4.16	9.6	33% 37% NA NA NA 16%	6	40% 44%	6 7 VA VA VA 9	46% 51% N 23%	7 8 IA IA IA 12	53% 59% N 26%	8 9 VA VA VA 12	59% 66% N 29%	10 11 VA VA VA 15
Space Cooling Lighting Roof Insulation Thermal Storage Wall Insulation	10 SEER, 9.5 EER Unitary AC 1.50 watts/sqft None None R11, 2x4.16 al Retail Shop - Type II Constr	14 SEER, 12.5 EER Unitary AC None None None R19, 2x4.16 uction (Qty 17 Bldgs)	9.6	33% 37% NA NA 16%	6 6	40% 44% 19%	6 7 VA VA VA VA 9 Mid-Low	46% 51% N 23%	7 8 IA IA IA IA 12 0, Mid	53% 59% N 26%	8 9 VA VA VA 12 Mid-High	59% 66% N 29% CCT20	10 11 VA VA 15 0, High
Space Cooling Lighting Roof Insulation Thermal Storage Wall Insulation Intern Measure Appliances	10 SEER, 9.5 EER Unitary AC 1.50 watts/sqft None None R11, 2x4.16 al Retail Shop - Type II Constr Baseline None	14 SEER, 12.5 EER Unitary AC None None R19, 2x4.16 uction (Qty 17 Bldgs) Alternative None	4.0 3.2 9.6 Payback	33% 37% NA NA 16% CCT20, B/ Pen Rate	6 6 AU Total Pen	40% 44% 1 19% CCT20, Pen Rate	b 7 VA VA VA VA 9 Mid-Low Total Pen	46% 51% N 23% CCT2 Pen Rate	7 8 IA IA 12 0, Mid Total Pen	53% 59% N 26% CCT20, Pen Rate	8 9 JA JA JA 12 Mid-High Total Pen	59% 66% N 29% CCT20 Pen Rate	10 11 VA VA VA 15 0, High Total Pen
Space Cooling Lighting Roof Insulation Thermal Storage Wall Insulation Intern Measure Appliances	10 SEER, 9.5 EER Unitary AC 1.50 watts/sqft None R11, 2x4.16 None R11, 2x4.16 None Baseline None None	14 SEER, 12.5 EER Unitary AC None None R19, 2x4.16 uction (Qty 17 Bldgs) Alternative None	4.0 3.2 9.6 Payback	33% 37% NA NA 16% CCT20, B/ Pen Rate NA	6 6 AU Total Pen	40% 44%	6 7 VA VA VA VA Mid-Low Total Pen VA	46% 51% N 23% CCT2 Pen Rate	7 8 IA IA 12 0, Mid Total Pen IA	53% 59% N 26% CCT20, Pen Rate	8 9 IA IA IA 12 Mid-High Total Pen IA	59% 66% N 29% CCT2(Pen Rate	10 11 NA NA 15 0, High Total Pen NA
Space Cooling Lighting Roof Insulation Thermal Storage Wall Insulation Intern Measure Appliances CHP Poot Material	10 SEER, 9.5 EER Unitary AC 1.50 watts/sqft None R11, 2x4.16 al Retail Shop - Type II Constr Baseline None None None	14 SEER, 12.5 EER Unitary AC None None R19, 2x4.16 uction (Qty 17 Bldgs) Alternative None None None	4.0 3.2 9.6 Payback	333% NA NA 16% CCT20, B/ Pen Rate NA NA	6 6 AU Total Pen	40% 44%	Mid-Low Total Pen VA Total Pen VA	46% 51% N 23% CCT2 Pen Rate	7 8 IA 14 IA 12 0, Mid Total Pen IA 14	53% 59% N 26% CCT20, Pen Rate	8 9 JA JA JA JA Mid-High Total Pen JA	59% 66% N 29% CCT2(Pen Rate	10 11 VA VA VA 15 0, High Total Pen VA VA
Space Cooling Lighting Roof Insulation Thermal Storage Wall Insulation Intern Measure Appliances CHP Roof Material Water Heating	10 SEER, 9.5 EER Unitary AC 1.50 watts/sqft None R11, 2x4.16 al Retail Shop - Type II Constr Baseline None None None EE=0.525	I during an arrow of the constraints 14 SEER, 12.5 EER Unitary AC None None None None None None None None None Alternative None None None None None FE=0.823	4.0 3.2 9.6 Payback	333% NA NA 16% CCT20, B/ Pen Rate NA NA NA NA	6 AU Total Pen	40% 44% 19% CCT20, Pen Rate	b 7 VA VA VA VA VA Total Pen VA VA VA	46% 51% N 23% CCT2 Pen Rate N 66%	7 8 1A 1A 1A 12 0, Mid Total Pen 1A 1A 14	53% 59% N 26% CCT20, Pen Rate N N 76%	8 9 JA JA JA JA Mid-High Total Pen JA JA	59% 66% N 29% CCT20 Pen Rate N N 85%	10 11 VA VA VA 15 0, High Total Pen VA VA VA VA
Space Cooling Lighting Roof Insulation Thermal Storage Wall Insulation Intern Measure Appliances CHP Roof Material Water Heating Windows	10 SEER, 9.5 EER Unitary AC 1.50 watts/sqft None R11, 2x4.16 Mone R11, 2x4.16 Mone None None None None None None None Social EF=0.525 U=0.50, SHGC=0.35	I during a star Str JO 14 SEER, 12.5 EER Unitary AC None None None R19, 2x4.16 uction (Qty 17 Bldgs) Alternative None	4.0 3.2 9.6 Payback	333% NA NA 16% CCT20, B/ Pen Rate NA NA NA 47% 22%	6 6 AU Total Pen 8 12	40% 44% 19% CCT20, Pen Rate	ь 7 NA NA NA 9 Mid-Low Total Pen NA NA NA NA NA NA	46% 51% N 23% CCT2 Pen Rate N N 66% 31%	8 1A 1A 1A 12 0, Mid Total Pen 1A 1A 1A 1A 14 14 14 14 14 14 14 14 14 12 12 12 12 12 12 12 12 12 12	53% 59% 26% CCT20, Pen Rate N N 76%	8 9 1A 1A 1A 12 Mid-High Total Pen 1A 1A 1A 12 24	59% 66% N 29% CCT20 Pen Rate N N 85% 39%	10 11 VA VA VA VA VA Total Pen VA VA VA VA VA VA VA VA VA VA VA VA
Space Cooling Lighting Roof Insulation Thermal Storage Wall Insulation Intern Measure Appliances CHP Roof Material Water Heating Windows Space Heating	10 SEER, 9.5 EER Unitary AC 1.50 watts/sqft None R11, 2x4.16 al Retail Shop - Type II Constr Baseline None None EF=0.525 U=0.50, SHGC=0.35 Furmace 78% AFUE	Alternative 14 SEER None None None None R19, 2x4.16 uction (Qty 17 Bldgs) Alternative None None None None Understand None None None Understand None Uctor LF=0.823 U=0.26, SHGC=0.29 Furnace 94% AFUE	4.0 3.2 9.6 Payback 1.2 7.3 4.2	333% NA NA NA 16% CCT20, B/ Pen Rate NA NA NA 47% 22% 32%	6 6 AU Total Pen 8 12 5	40% 44% 19% CCT20, Pen Rate	6 7 VA VA VA Mid-Low Total Pen VA VA VA 10 VA VA 10 110 110 6	46% 51% N 23% CCT2 Pen Rate N M 66% 31% 45%	8 1A 1A 1A 12 0, Mid Total Pen 1A 1A 1A 1A 14 7	53% 59% N 26% CCT20, Pen Rate N 76% 35% 51%	8 9 1A 1A 1A 1A 12 Mid-High Total Pen 1A 1A 1A 1A 12 24 8	59% 66% N 29% CCT2(Pen Rate Pen Rate 85% 39% 58%	10 11 NA NA NA 15 0, High Total Pen NA NA NA NA 9
Space Cooling Lighting Roof Insulation Thermal Storage Wall Insulation Intern Measure Appliances CHP Roof Material Water Heating Windows Space Cooling Space Cooling	10 SEER, 9.5 EER Unitary AC 1.50 watts/sqft None R11, 2x4.16 al Retail Shop - Type II Constr Baseline None EF=0.525 U=0.50, SHGC=0.35 Furnace 78% AFUE 10 SEER, 9.5 EER Unitary AC	Idinate 34:03 r JOL 14 SEER, 12.5 EER Unitary AC None None None R19, 2x4.16 uction (Qty 17 Bldgs) Alternative None SEG, SHGC=0.29 Furnace 94% AFUE 14 SEER, 12.5 EER Unitary AC	4.0 3.2 9.6 Payback 1.2 7.3 4.2 3.3	333% NA NA NA 16% CCT20, B/ Pen Rate NA NA NA A7% 22% 32% 36%	6 6 AU Total Pen 8 12 5 6	40% 44% 1 19% CCT20, Pen Rate 57% 26% 39% 43%	b 7 VA VA VA VA VA VA VA Total Pen VA VA VA VA VA 18 6 7	46% 51% N 23% CCT2 Pen Rate N 66% 31% 45% 51%	7 8 IA 14 IA 12 0, Mid Total Pen IA 14 IA 14 IA 14 IA 14 IA 14 IA 14 IA 14 IA 14 IA 14 IA 14 IA 14 IA 14 IA 14 IA 14 IA 15 IA 16 IA 7 IA 14 IA <td>53% 59% 26% CCT20, Pen Rate N 76% 35% 51% 58%</td> <td>8 9 1A 1A 1A 12 Mid-High Total Pen 1A 1A 1A 12 24 9 9</td> <td>59% 66% N 29% CCT2(Pen Rate N 85% 39% 58% 65%</td> <td>10 11 NA NA NA 15 0, High Total Pen NA NA NA NA NA 14 30 9 11</td>	53% 59% 26% CCT20, Pen Rate N 76% 35% 51% 58%	8 9 1A 1A 1A 12 Mid-High Total Pen 1A 1A 1A 12 24 9 9	59% 66% N 29% CCT2(Pen Rate N 85% 39% 58% 65%	10 11 NA NA NA 15 0, High Total Pen NA NA NA NA NA 14 30 9 11
Space Cooling Lighting Roof Insulation Thermal Storage Wall Insulation Interm Measure Appliances CHP Roof Material Water Heating Windows Space Heating Space Cooling Lighting	10 SEER, 9.5 EER Unitary AC 1.50 watts/sqft None R11, 2x4.16 al Retail Shop - Type II Constr Baseline None None None EF=0.525 U=0.50, SHGC=0.35 Furnace 78% AFUE 10 SEER, 9.5 EER Unitary AC 1.50 watts/sqft	I during an 34 M Cl 14 SEER, 12.5 EER Unitary AC None None None R19, 2x4.16 uction (Qty 17 Bldgs) Alternative None None None None None None None None U=0.26, SHGC=0.29 Furnace 94% AFUE 14 SEER, 12.5 EER Unitary AC None	4.0 3.2 9.6 Payback 1.2 7.3 4.2 3.3	33% 37% NA NA NA 16% CCT20, BJ Pen Rate NA NA NA 47% 22% 32% 36% NA	6 6 AU Total Pen 8 12 5 6	40% 44% 1 19% CCT20, Pen Rate	6 7 VA VA VA VA VA VA Total Pen VA VA VA VA VA VA 18 6 7 VA	46% 51% N 23% CCT2 Pen Rate N N 66% 31% 45% 51%	7 8 IA	53% 59% N 26% CCT20, Pen Rate N N 76% 35% 51%	8 9 IA IA IA IA Mid-High Total Pen IA IA IA I2 24 8 9 IA	59% 66% N 29% CCT22 Pen Rate N N 85% 39% 58%	10 11 VA VA VA 15 0, High Total Pen VA VA VA 14 30 9 11 VA
Space Cooling Lighting Roof Insulation Thermal Storage Wall Insulation Intern Measure Appliances CHP Roof Material Water Heating Windows Space Heating Space Looling Lighting Roof Insulation	10 SEER, 9.5 EER Unitary AC 1.50 watts/sqft None R11, 2x4.16 al Retail Shop - Type II Constr Baseline None None EF=0.525 U=0.50, SHGC=0.35 Furmace 78% AFUE 10 SEER, 9.5 EER Unitary AC 1.50 watts/sqft None	Attempt 14 SEER, 12.5 EER Unitary AC None None None R19, 2x4.16 uction (Qty 17 Bldgs) Alternative None None Uotion (Qty 17 Bldgs) Alternative None None U=0.26, SHGC=0.29 Furnace 94% AFUE 14 SEER, 12.5 EER Unitary AC None None	4.0 3.2 9.6 C Payback	33% 37% NA NA NA 16% CCT20, B/ Pen Rate NA NA NA 47% 22% 32% 32% 36% NA NA	6 AU Total Pen 8 12 5 6	40% 44% 1 19% CCT20, Pen Rate 1 57% 26% 39% 43%	b 7 JA JA JA 9 Mid-Low Total Pen JA	40% 51% N 23% CCT2 Pen Rate N N N 66% 31% 51% N	7 8 1A 1A 12 12 10 10 10 10 11 11 14 11 24 7 8 14 11 24 7 8 14	53% 59% N 26% CCT20, Pen Rate N N N 76% 35% 51%	8 9 IA IA IA 12 Mid-High Total Pen IA IA 12 24 8 9 IA IA	59% 66% N 29% CCT2(Pen Rate N N N 85% 39% 58% 65% N	10 11 NA NA 15 0, High Total Pen NA NA 14 30 9 11 NA NA
Space Cooling Lighting Roof Insulation Thermal Storage Wall Insulation Intern Appliances CHP Roof Material Water Heating Space Cooling Space Cooling Space Cooling Lighting Roof Insulation Thermal Storage	10 SEER, 9.5 EER Unitary AC 1.50 watts/sqft None R11, 2x4.16 Mone R11, 2x4.16 Mone None None None EF=0.525 U=0.50, SHGC=0.35 Furmace 78% AFUE 10 SEER, 9.5 EER Unitary AC 1.50 watts/sqft None	Alternative 14 SEER None None None None None None None None None R19, 2x4.16 None Uction (Qty 17 Bldgs) Alternative None None None None None None 14 SEER, 12.5 EER Unitary AC None None None None None None None None None None None None None	4.0 3.2 9.6 C Payback	33% 37% NA NA NA 16% CCT20, BJ Pen Rate NA NA NA 47% 22% 32% 36% NA NA NA NA	6 6 AU Total Pen 8 12 5 6	40% 44% 19% CCT20, Pen Rate 19% CCT20, Pen Rate 19% 19% 19% 19% 19% 19% 19% 19% 19% 19%	ь 7 IA IA 9 Mid-Low Total Pen IA IA IA IA IA IA IA IA IA	46% 51% N 23% CCT2 Pen Rate N 66% 31% 45% 51% N N	7 8 A A A A A 12 0, Mid Total Pen A A A 11 24 7 7 8 A A A A A A A	53% 59% N 26% CCT20, Pen Rate N 76% 51% 58%	8 9 14 14 14 12 Mid-High 17 0 14 14 14 14 12 24 8 9 9 14 14 12	59% 66% N 29% 29% CCT2/ Pen Rate N N 85% 65% N N N	10 11 VA VA 15 0, High 15 0, High 1000 11 14 30 9 9 11 14 30 9 9 11 14 30 VA
Space Cooling Lighting Roof Insulation Thermal Storage Wall Insulation Interm Measure Appliances CHP Roof Material Water Heating Space Cooling Lighting Roof Insulation Thermal Storage Wall Insulation	10 SEER, 9.5 EER Unitary AC 1.50 watts/sqft None R11, 2x4.16 al Retail Shop - Type II Constr Baseline None None None None EF=0.525 U=0.50, SHGC=0.35 Furnace 78% AFUE 10 SEER, 9.5 EER Unitary AC 1.50 watts/sqft None R11, 2x4.16	I binke style Ar OK 14 SEER, 12.5 EER Unitary AC None None None R19, 2x4.16 uction (Qty 17 Bldgs) Alternative None V=0.26, SHGC=0.29 Furnace 94% AFUE 14 SEER, 12.5 EER Unitary AC None	4.0 3.2 9.6 Payback 1.2 7.3 4.2 3.3 14.9	33% 37% NA NA NA NA 16% CCT20, BJ Pen Rate NA NA NA 22% 32% 32% 32% 32% NA NA NA NA NA NA NA NA	5 6 AU Total Pen 8 12 5 6	40% 44% 1 19% CCT20, Pen Rate 1 57% 26% 39% 43% 1 1 10%	b 7 VA VA 9 Mid-Low Total Pen VA VA VA VA 18	46% 51% N 23% CCT2 Pen Rate N N N 66% 31% 45% 51% N N N N N N N N N 12%	7 8 8 14 15 17 12 10 11 10 11 10 11 11 24 7 8 14 11 24 7 8 14 12 11 24 24	53% 59% N 26% CCT20, Pen Rate N N 76% 35% 51% 58% 51% 58% N N	8 9 1A 1A 12 Mid-High Total Pen 1A 1A 14 12 24 8 9 14 14 14 12 24 24	59% 66% N 29% CCT22 Pen Rate N 85% 58% 65% N N 15%	10 11 NA NA 15 0, High Total Pen VA VA 14 30 9 11 14 30 9 11 VA VA VA VA VA VA
Space Cooling Lighting Roof Insulation Thermal Storage Wall Insulation Intern Measure Appliances CHP Roof Material Water Heating Windows Space Heating Space Looling Lighting Roof Insulation Thermal Storage Wall Insulation	10 SEER, 9.5 EER Unitary AC 1.50 watts/sqft None R11, 2x4.16 al Retail Shop - Type II Constr Baseline None None EF=0.525 U=0.50, SHGC=0.35 Furmace 78% AFUE 10 SEER, 9.5 EER Unitary AC 1.50 watts/sqft None R11, 2x4.16	14 SEER, 12.5 EER Unitary AC None None None R19, 2x4.16 uction (Qty 17 Bldgs) Alternative None None None Uotion (Qty 17 Bldgs) 4 Internative None None None None Second ArUe 14 SEER, 12.5 EER Unitary AC None None None Rune None Rune None Rune None None <	4.0 3.2 9.6 C Payback	33% 37% NA NA NA 16% CCT20, B/ Pen Rate NA NA NA 47% 32% 36% NA NA NA NA NA NA	6 6 AU Total Pen 8 12 5 6 12	40% 44% 1 19% CCT20, Pen Rate 1 57% 26% 39% 43%	ь 7 IA VA 9 Mid-Low Total Pen VA VA VA 18 6 7 VA VA VA VA VA VA VA VA	46% 51% N 23% CCT2 Pen Rate N N 66% 31% 51% 51% N N N 12%	7 8 A 1A IA 12 0, Mid Total Pen IA 1A IA 1A IA 1A IA 1A IA 1A IA 1A IA 1A IA 1A IA 1A IA 1A IA 1A IA 7 IA 7 IA 24	53% 53% 59% N N 26% CCT20, Pen Rate N N 76% 35% 51% 51% 51% N 13% N	8 9 14 14 12 Mid-High Total Pen 14 14 14 12 12 14 14 14 14 14 14 14 14 14 14 14 14 14	59% 66% N 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7	10 11 14 15 0, High Total Pen VA VA VA 14 30 9 9 11 11 VA VA VA VA 30 30
Space Cooling Lighting Roof Insulation Thermal Storage Wall Insulation Intern Appliances CHP Roof Material Water Heating Space Cooling Lighting Roof Insulation Lighting Roof Insulation Corn	10 SEER, 9.5 EER Unitary AC 1.50 watts/sqft None R11, 2x4.16 Mone R11, 2x4.16 Mone None None None None None EF=0.525 U=0.50, SHGC=0.35 Furmace 78% AFUE 10 SEER, 9.5 EER Unitary AC 1.50 watts/sqft None None R11, 2x4.16 er Restaurant - Type II Constru	14 SEER, 12.5 EER Unitary AC None None None None R19, 2x4.16 uction (Qty 17 Bldgs) Alternative None	4.0 3.2 9.6 Payback 1.2 7.3 3.3 14.9	33% 37% NA NA NA 16% CCT20, B/ Pen Rate NA NA NA 22% 32% 32% 32% 32% NA NA NA NA NA NA NA NA NA NA NA NA	5 6 AU Total Pen 8 12 5 6 4 12 5 6	40% 44% 19% CCT20, Pen Rate 19% CCT20, 26% 39% 43% 1 10% CCT20,	b c 7 7 VA 9 Mid-Low 1000 mid-1000 mid-100000000 mid-1000000000000000000000000000000000000	46% 51% N 23% CCT2 Pen Rate N 66% 31% 45% 51% N N 12%	Image: region of the system 0, Mid Total Pen A 12 0, Mid Total Pen A A 11 24 7 A A 11 24 7 A	53% 59% 9% 26% CCT20, Pen Rate N N N N N N N N N N N N N N N N N N N	8 9 IA II IA III IA III ITotal Pen III IA III IA IIII IA IIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIII	59% 66% N 29% CCT22 Pen Rate N N 85% 58% 65% N 15%	10 11 NA VA 15 0, High Total Pen VA VA VA 11 VA VA VA VA VA VA VA VA VA VA VA VA VA
Space Cooling Lighting Roof Insulation Thermal Storage Wall Insulation Interm Measure Appliances CHP Roof Material Water Heating Space Heating Space Heating Space Heating Roof Insulation Thermal Storage Wall Insulation Corn Measure	10 SEER, 9.5 EER Unitary AC 1.50 watts/sqft None R11, 2x4.16 al Retail Shop - Type II Constr Baseline None None None EF=0.525 U=0.50, SHGC=0.35 Furnace 78% AFUE 10 SEER, 9.5 EER Unitary AC 1.50 watts/sqft None R11, 2x4.16 er Restaurant - Type II Constru	14 SEER, 12.5 EER Unitary AC 14 SEER, 12.5 EER Unitary AC None None R19, 2x4.16 uction (Qty 17 Bldgs) Alternative None V=0.26, SHGC=0.29 Furnace 94% AFUE 14 SEER, 12.5 EER Unitary AC None Atternative	4.0 3.2 9.6 Payback 1.2 7.3 4.2 3.3 14.9 C Payback	33% 37% NA NA NA 16% CCT20, B/ Pen Rate NA NA NA 36% 32% 32% 32% 32% NA NA NA NA NA NA NA NA NA NA NA NA NA	6 6 AU Total Pen 8 12 5 6 12 12 AU Total Pen	40% 44% 1 19% CCT20, Pen Rate 1 57% 26% 39% 43% 1 10%	b b 7 7 VA 9 Mid-Low Total Pen VA 9 VA 9 VA 9 VA 9 VA 9 VA 18 6 7 VA 18 VA VA VA YA VA <	46% 51% N 23% CCT2 Pen Rate N N 66% 31% 45% 51% N N N 12% CCT2 Pen Rate	7 8 8 14 14 12 9 Mid 12 12 14 12 15 14 16 11 17 8 18 14 19 14 10 14 11 24 7 8 10 24 24 0, Mid Total Pen 14	53% 59% 26% CCT20, Pen Rate N N N 76% 51% 51% 51% 51% 51% 13% CCT20, Pen Rate	8 9 JA JA JA JA Total Pen JA JA	59% 66% N 29% CCT2/ Pen Rate N N N 85% 65% 58% 65% N N 15% CCT2/ Pen Rate	10 11 14 15 0, High Total Pen VA 14 14 30 9 11 30 9 11 30 30 0, High Total Pen
Space Cooling Lighting Roof Insulation Thermal Storage Wall Insulation Intern Appliances CHP Roof Material Water Heating Windows Space Cooling Lighting Roof Insulation Thermal Storage Wall Insulation Corn Measure Appliances	10 SEER, 9.5 EER Unitary AC 1.50 watts/sqft None R11, 2x4.16 al Retail Shop - Type II Constr Baseline None None EF=0.525 U=0.50, SHGC=0.35 Furmace 78% AFUE 10 SEER, 9.5 EER Unitary AC 1.50 watts/sqft None R11, 2x4.16 er Restaurant - Type II Constrr Baseline None	14 SEER, 12.5 EER Unitary AC None None None R19, 2x4.16 uction (Qty 17 Bldgs) Alternative None Furnace 94% AFUE 14 SEER, 12.5 EER Unitary AC None	4.0 3.2 9.6 C Payback	33% 37% NA NA NA 16% CCT20, B/ Pen Rate NA NA NA 32% 36% NA NA NA 8% CCT20, B/ Pen Rate NA	5 6 AU Total Pen 8 12 5 6 12 6 12 12 AU Total Pen	40% 44% 1 19% CCT20, Pen Rate 57% 26% 39% 43% 43% 10% CCT20, Pen Rate	b c 7 7 VA 9 Mid-Low Total Pen VA 9 VA 4 9 18 10 18 Mid-Low 18 Mid-Low Total Pen VA VA	46% 51% N 23% CCT2 Pen Rate N N 66% 51% 51% N 12% Pen Rate Pen Rate	Image: region of the system 0, Mid 12 0, Mid Total Pen A 11 24 7 8 A 1A 24 7 7 7 8 10 11 24 7 7 8 10 10 24 0, Mid Total Pen A	33% 59% 59% 59% 59% N 26% N CCT20, Pen Rate N N 76% S5% 51% S8% 13% N 13% CCT20, Pen Rate N 0 N 0 N 0 N 0 N	8 9 IA II IA II II III III IIII IIII IIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIII	59% 66% N 29% CCT22 Pen Rate N 85% 58% 68% 68% 68% 0 15% N N 15%	10 11 14 15 0, High Total Pen VA 14 30 9 9 11 14 30 9 9 11 14 30 9 9 11 14 30 30 VA VA VA
Space Cooling Lighting Roof Insulation Thermal Storage Wall Insulation Intern Appliances CHP Roof Material Water Heating Space Heating Space Heating Space Cooling Lighting Roof Insulation Thermal Storage Wall Insulation Corn Measure Appliances CHP	10 SEER, 9.5 EER Unitary AC 1.50 watts/sqft None R11, 2x4.16 al Retail Shop - Type II Constr Baseline None None None None EF=0.525 U=0.50, SHGC=0.35 Furmace 78% AFUE 10 SEER, 9.5 EER Unitary AC 1.50 watts/sqft None None R11, 2x4.16 er Restaurant - Type II Constru Baseline None None None None	14 SEER, 12.5 EER Unitary AC None None None None R19, 2x4.16 uction (Qty 17 Bldgs) Alternative None	4.0 3.2 9.6 Payback 1.2 7.3 4.2 3.3 3.3 14.9	33% 37% NA NA NA 16% CCT20, B/ Pen Rate NA NA 32% 32% 36% NA NA NA NA NA NA NA NA NA NA NA NA NA	6 6 AU Total Pen 8 12 5 6 12 12 AU Total Pen	40% 44% 19% 19% CCT20, Pen Rate 10% 39% 43% 10% CCT20, Pen Rate	b 7 A IA IA IA IA IA IA IA Total Pen VA IA	46% 51% N N 23% Pen Rate N N 66% 31% 51% N N 12% CCT2 Pen Rate N N N N N N N N N N N N N N N N N N N	7 8 A A JA A JA 12 JA A	53% 59% 26% CCT20, Pen Rate N N N 76% 35% 51% 58% N N 13% CCT20, Pen Rate	8 9 IA 12 Mid-High Total Pen IA 12 Mid-High 12 IA 14	59% 66% N 29% CCT22 Pen Rate N 85% 58% 65% N 15% CCT22 Pen Rate N N	10 11 NA I 5 0, High Total Pen VA VA I 14 30 9 11 VA VA VA VA 0, High Total Pen VA VA
Space Cooling Lighting Roof Insulation Thermal Storage Wall Insulation Interm Measure Appliances CHP Roof Material Water Heating Space Heating Space Heating Space Heating Roof Insulation Thermal Storage Wall Insulation Corn Measure Appliances CHP Roof Material	10 SEER, 9.5 EER Unitary AC 1.50 watts/sqft None R11, 2x4.16 al Retail Shop - Type II Constr Baseline None None None None EF=0.525 U=0.50, SHGC=0.35 Furnace 78% AFUE 10 SEER, 9.5 EER Unitary AC 1.50 watts/sqft None R11, 2x4.16 er Restaurant - Type II Constru Baseline None None None R11, 2x4.16	14 SEER, 12.5 EER Unitary AC None None None R19, 2x4.16 uction (Qty 17 Bldgs) Alternative None	4.0 3.2 9.6 C Payback 1.2 7.3 4.2 3.3 14.9 C Payback	33% 37% NA NA NA 16% CCT20, B/ Pen Rate NA NA 47% 22% 36% NA NA NA NA NA NA NA NA NA NA NA NA NA	6 AU Total Pen 8 12 6 12 6 12 12 AU Total Pen	40% 44% 19% CCT20, Pen Rate 157% 43% 43% 10% CCT20, Pen Rate	b 7 VA VA VA VA Mid-Low Total Pen VA	46% 51% N 23% CCT2 Pen Rate N 66% 31% 45% 51% N N 12% Pen Rate N N N N N N N N N N N N N N N N N N N	7 8 IA 12 IA 12 IA 12 IA 14 IA 24 O, Mid 24 IA 14 IA 14 IA 14 IA 14	33% 59% 59% N 26% N CCT20, Pen Rate 76% N 13% N N N N N N N N N N N	8 9 JA JA JA JA JA JA J12 JA Mid-High Total Pen JA JA	59% 66% N 29% CCT20 Pen Rate N N 85% 65% S8% 65% N N N N N N N N N N N N N N N N N N N	10 11 14 15 0, High Total Pen VA 14 30 9 11 14 30 9 11 14 30 9 0, High Total Pen VA VA VA VA VA VA VA VA VA VA
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