



FINAL REPORT

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

August 2008

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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. Coincidentally, 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 1 - Hudson Yards Predicted Peak Demands for Business-as-Usual and High Market Penetrations

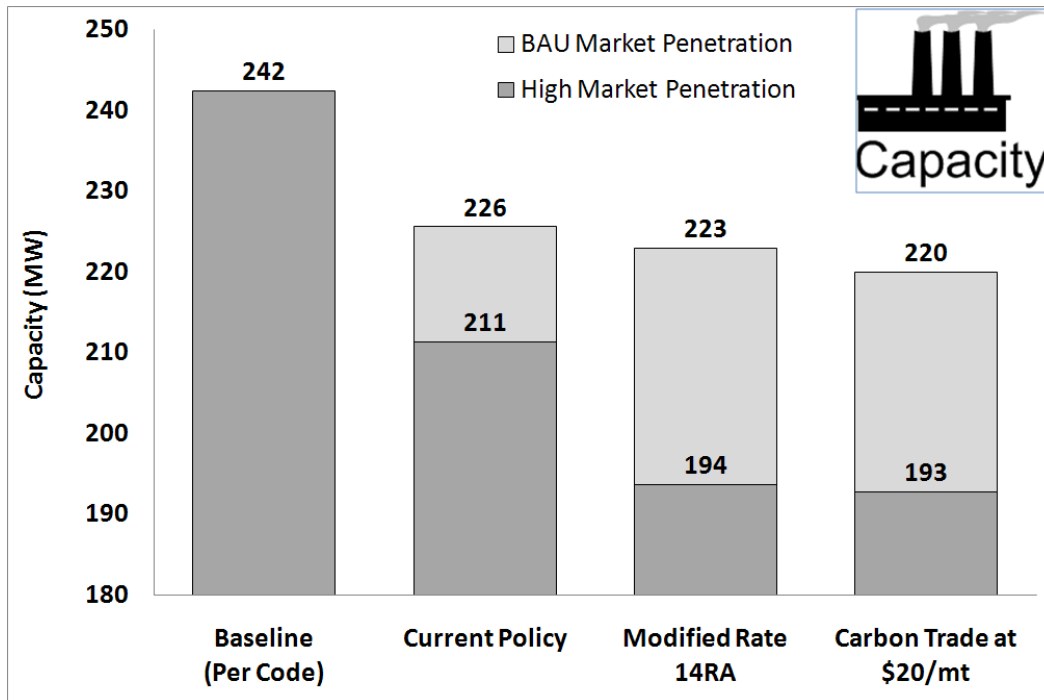
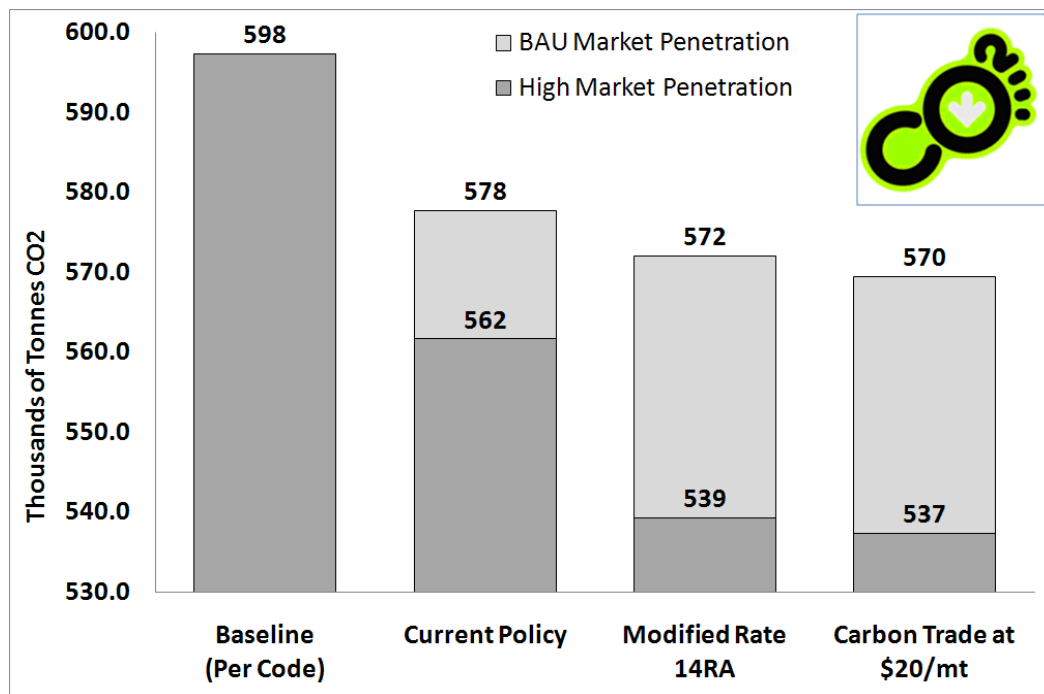


Figure 2 - Carbon Footprint for Business-as-Usual and High Market Penetrations



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 NYSEDA 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 NO_x and SO₂ cap and trade policies in New York do not allow building owners to obtain credit for their NO_x 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 NO_x 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

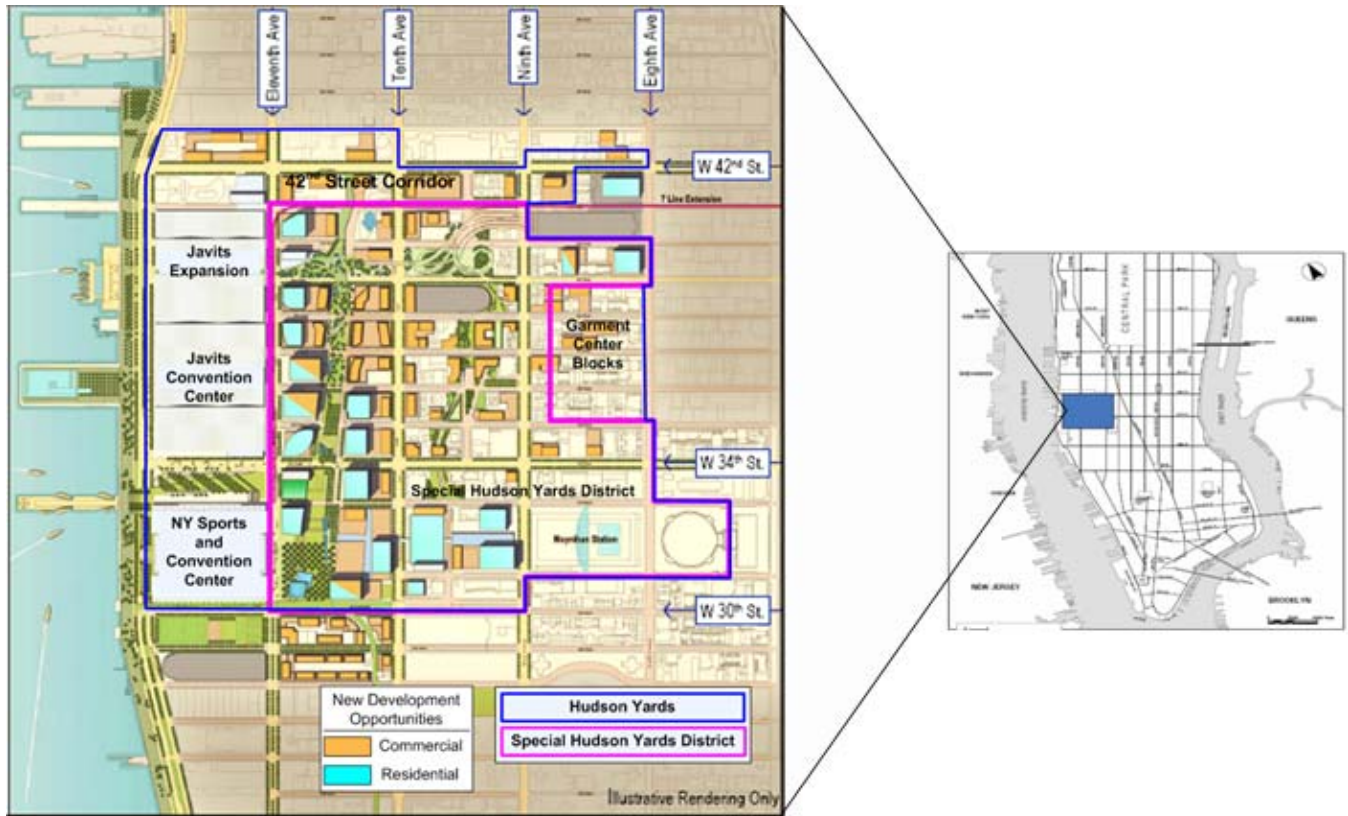
Under the auspices of the New York State Energy Research and Development Authority (NYSERDA) and the Oak Ridge National Laboratory representing the Office of Electricity of the U.S. Department of Energy, Gas Technology Institute (GTI) conducted this technology transfer study to help broaden the market 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

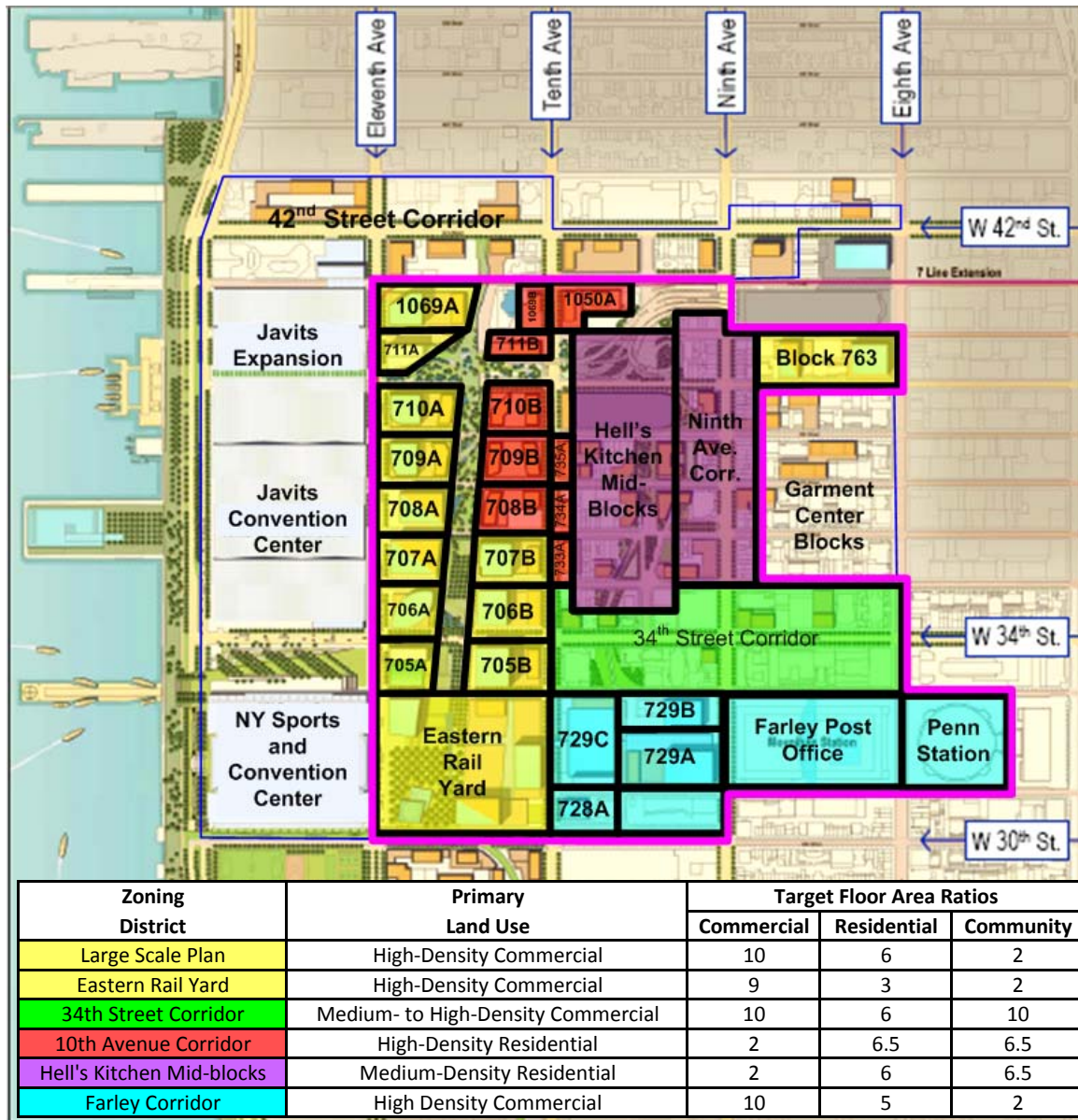
There are many assumptions associated with the building prototypes, the energy models, and the EE and DER strategies. Appendix A is a summary of the assumptions used to meet the objectives of this study.

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**



**Figure 5 - Special Hudson Yards District Development
Proposed New Buildings**

| Proposed New Building List | | | | |
|---|--|-------------|----------|---------|
| Site | Type | Total Sq-ft | GF Sq-ft | Stories |
| Eastern Rail Yard | Office | 3,420,000 | 93,000 | 46 |
| | 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 |
| | Residential | 436,000 | 11,000 | 51 |
| 706A | Mixed | 2,000,000 | 45,000 | 55 |
| 706B | Office | 2,500,000 | 89,000 | 35 |
| | 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 | Office | 960,000 | 34,000 | 35 |
| | Residential | 431,000 | 17,000 | 31 |
| 710B | Residential | 500,000 | 17,000 | 36 |
| | Residential | 332,000 | 9,000 | 44 |
| 711A | Office | 736,000 | 28,000 | 33 |
| 711B | Residential | 347,000 | 11,000 | 39 |
| 1069A | Office | 1,314,000 | 41,000 | 40 |
| | Residential | 516,000 | 21,000 | 31 |
| 1050A | Office | 172,000 | 17,000 | 13 |
| | 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 |
| Block 763 | Hotel | 257,000 | 18,000 | 18 |
| | Hotel | 257,000 | 18,000 | 18 |
| | 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 | | | 18 |
| Hell's Kitchen and Ninth Avenue Corridor | Residential | 67,000 | 10,000 | 8 |
| | Residential | 226,000 | 35,000 | 8 |
| | Residential | 138,000 | 22,000 | 8 |
| | Residential | 314,000 | 22,000 | 18 |
| | Residential | 338,000 | 26,000 | 16 |
| | Residential | 81,000 | 13,000 | 8 |
| | Residential | 38,000 | 6,000 | 8 |
| | Residential | 80,000 | 13,000 | 8 |
| 34th Street Corridor | Residential | 186,000 | 19,000 | 12 |
| | Residential | 73,000 | 8,000 | 12 |
| | Residential | 218,000 | 23,000 | 12 |
| 728A | Office | 362,000 | 21,000 | 22 |
| 729A | Office | 1,686,000 | 64,000 | 33 |
| | 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 transferred from Farley Post Office (Western Annex) | Residential or Residential plus Hotel | 1,100,000 | 120,000 | 58 |

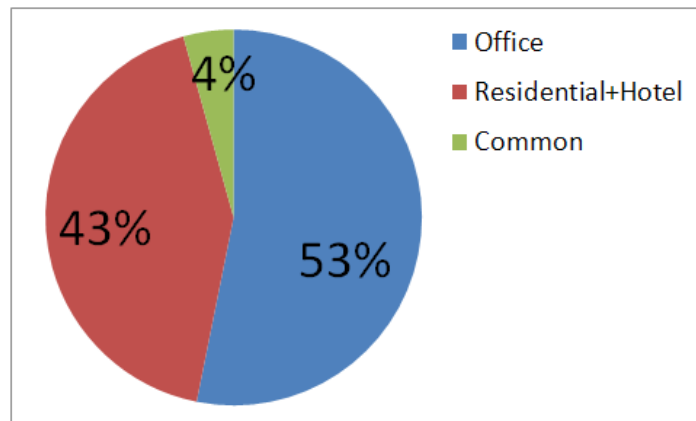
For the purpose of this study, 12 building prototype models were developed along with ground-floor models for corner retail shops, internal retail shops with only one external wall, and corner restaurant space. Furthermore, buildings greater than 20 stories were modeled as frame-wall type with structural 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:

Table 1- Special Hudson Yards District Prototype Model Summary

| Prototype | Type | 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 | - |

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-by-hour 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.

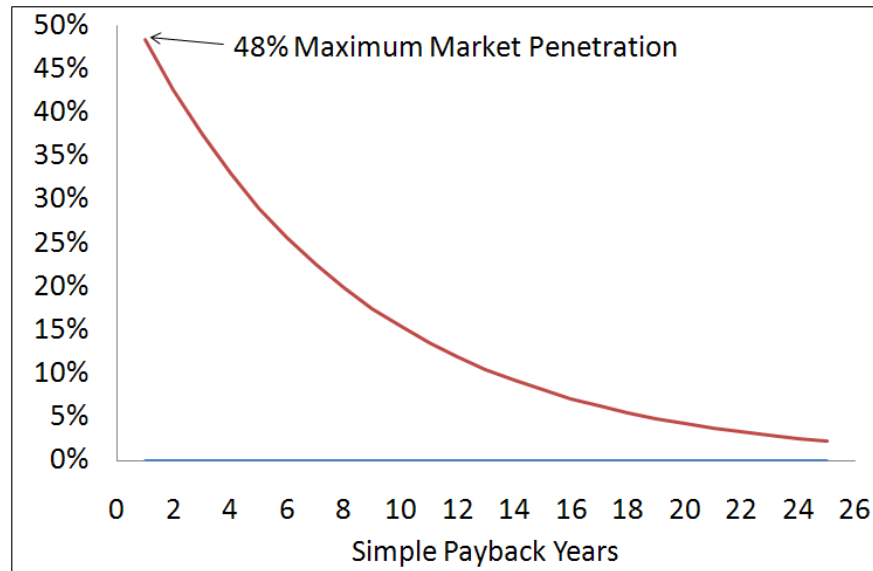
$$\text{Equation 1: Market penetration} = \frac{1.1 \times \text{penparm}}{e^{(0.24 \times PCF)}}$$

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.

1. 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:

Low Market Penetration: 48% (this is business-as-usual BAU)

Mid-Low Market Penetration: 58%

Mid Market Penetration: 68%

Mid-High Market Penetration: 77%

High 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

14RA Modified Con Edison Standby rate PSC2, SC14-RA, Rate II

CCT5 Carbon Cap & Trade policy at \$5/mt of CO₂

CCT10 Carbon Cap & Trade policy at \$10/mt of CO₂

CCT15 Carbon Cap & Trade policy at \$15/mt of CO₂

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 NO_x 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 associated emissions given Low 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**

| Figures | Tables | Held Constant | | Varied Parametrically |
|---------|--------|--------------------|------------------|--|
| | | Market penetration | Measures Applied | |
| 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% |
| CHP | 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% |

**Table 4 - The Range of Predicted Reductions from
Baseline Due to the Implementation of CHP and EE with
Market Penetrations Varied from BAU to High and CCT
Policy Varied from \$5 to \$20/mt**

| Measure | CCT | 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 5 – Predicted CHP Adoption Levels by Building
where Rate 14RA is Unmodified and there is no Carbon
Cap 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 | 5,500 x 1 | 5,500 x 1 | 5,500 x 1 | 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 | 1,500 x 1 | 1,500 x 1 | 1,500 x 1 | 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 | | 0 | 0 | 0 | 0 | 0 |
| Totals | 57 | 9,350 | 13,850 | 14,100 | 15,700 | 16,100 |

**Table 6 - Predicted CHP Adoption Levels by Building
where Rate 14RA is Modified and there is no Carbon Cap
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 | 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 | | 0 | 0 | 0 | 0 | 0 |
| Totals | 57 | 14,100 | 15,950 | 24,450 | 31,950 | 32,200 |

**Table 7 - Predicted CHP Adoption Levels by Building
where Rate 14RA is Unmodified and there is a Carbon
Cap 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 | 5,500 x 1 | 5,500 x 1 | 5,500 x 1 | 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 | | 0 | 0 | 0 | 0 | 0 |
| Totals | 57 | 9,350 | 14,100 | 15,700 | 15,950 | 20,850 |

**Table 8 - Predicted CHP Adoption Levels by Building
where Rate 14RA is Unmodified and there is a Carbon
Cap and Trade Policy at \$10/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 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 | | 0 | 0 | 0 | 0 | 0 |
| Totals | 57 | 14,100 | 14,850 | 15,950 | 26,350 | 27,450 |

**Table 9 - Predicted CHP Adoption Levels by Building
where Rate 14RA is Unmodified and there is a Carbon
Cap 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 | | 0 | 0 | 0 | 0 | 0 |
| Totals | 57 | 14,100 | 15,950 | 15,950 | 27,450 | 31,950 |

**Table 10 - Predicted CHP Adoption Levels by Building
where Rate 14RA is Unmodified and there is a Carbon
Cap and Trade Policy at \$20/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 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 |

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

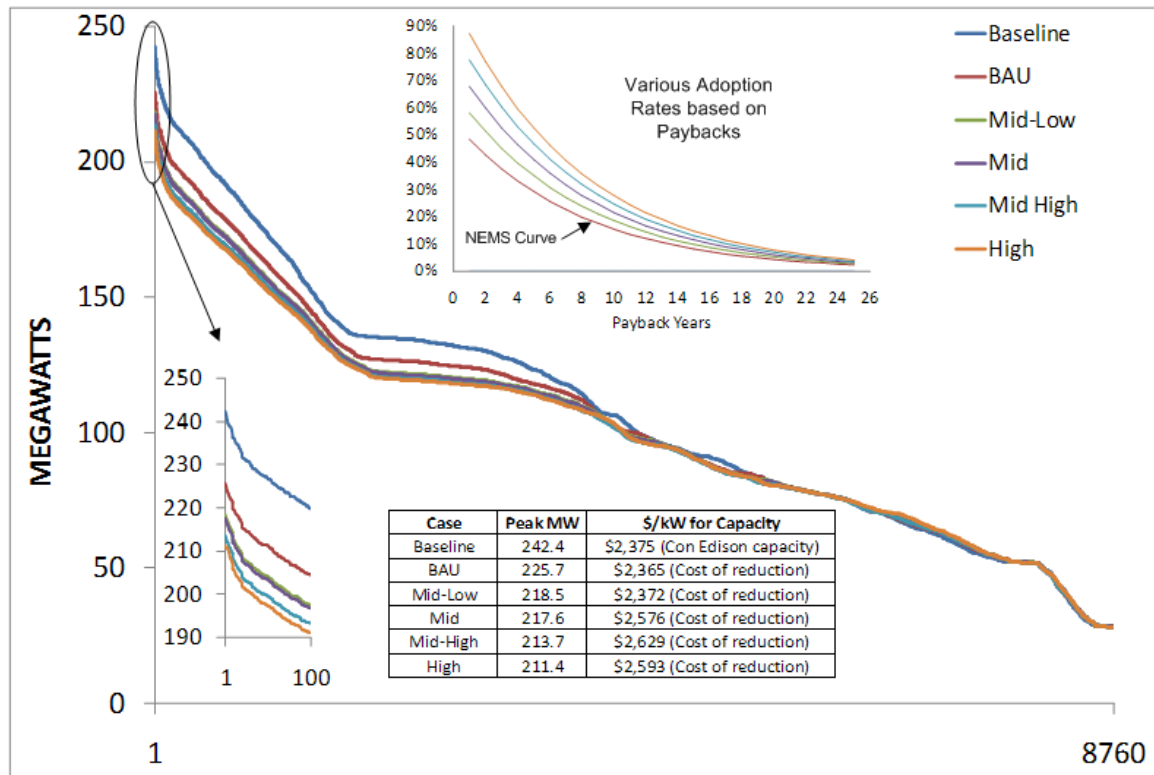


Table 11 – Percentages of Peak Demand Reduction from Baseline - Impact of Varying the Market Penetration Rates of EE and CHP

| 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



Figure 10 - Hudson Yards Aggregate Annual Electric Load Curves – Impact of Varying the Measures Applied to Achieve Load Reductions under a BAU Market Penetration Rate

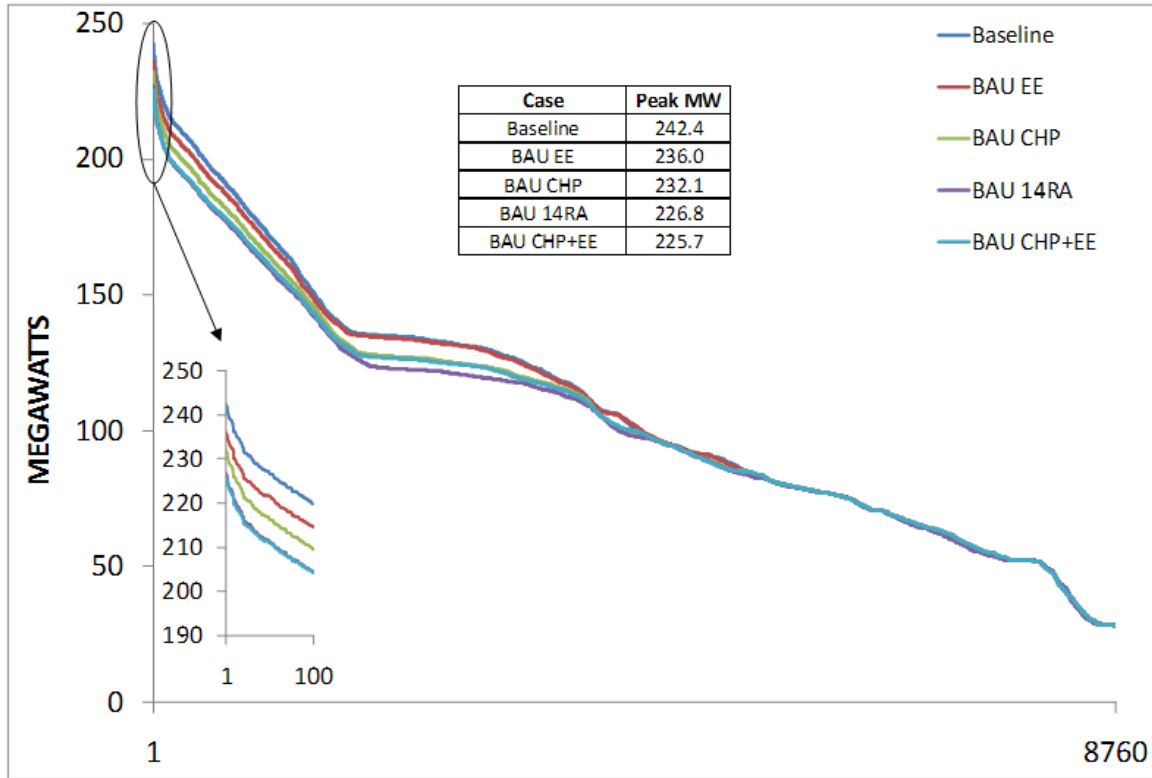


Table 12 - Peak Demand Reduction from Baseline - Impact of Varying the Measures Applied to Achieve Load Reductions under a BAU Market Penetration Rate

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

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

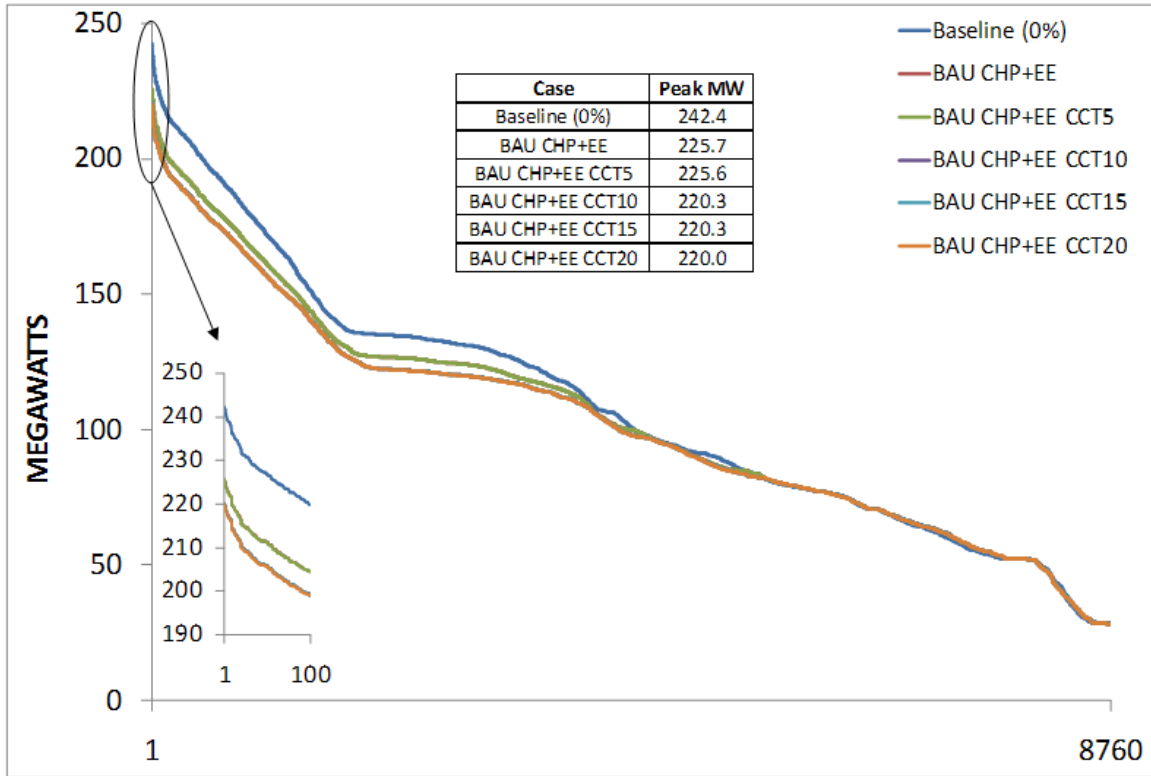


Table 13 - Peak Demand Reduction from Baseline – Impact of Varying the Carbon Cap and Trade Price under a BAU Market Penetration Rate for CHP & EE

| 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

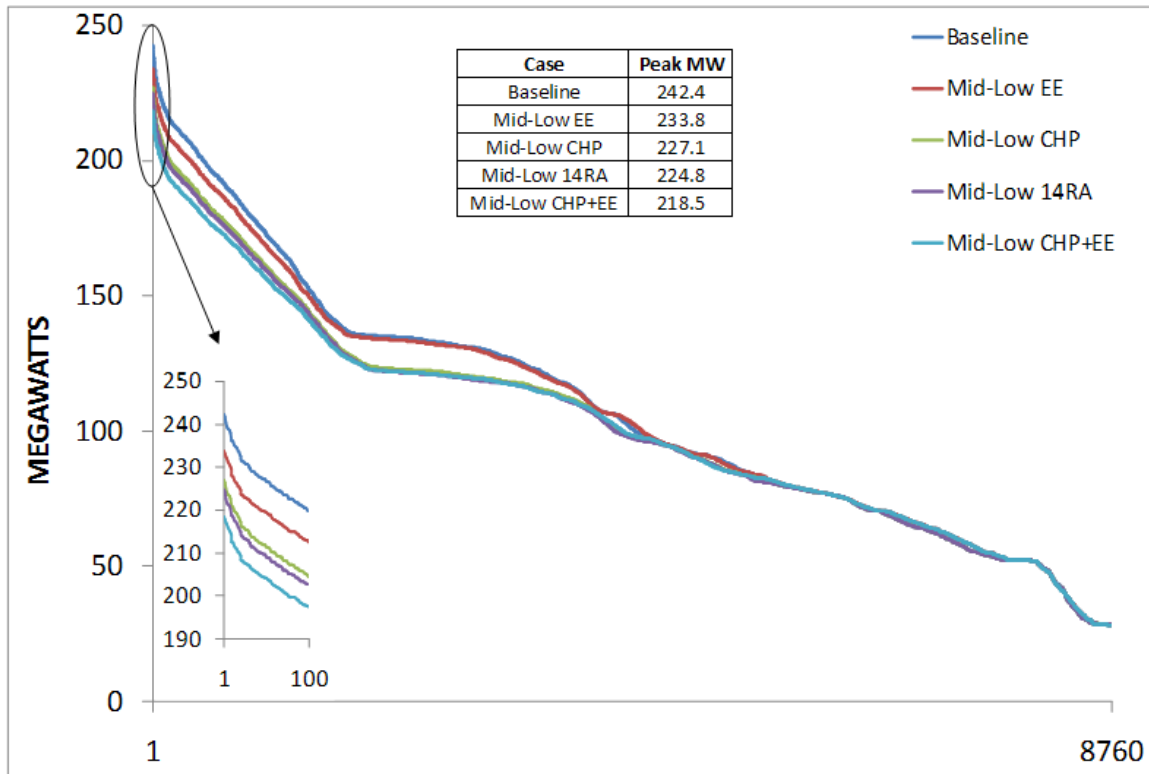


Table 14 - Percentages of Peak Demand Reduction from Baseline – Impact of Varying the Measures Applied to Achieve Load Reductions under a Mid-Low Market Penetration Rate

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

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



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

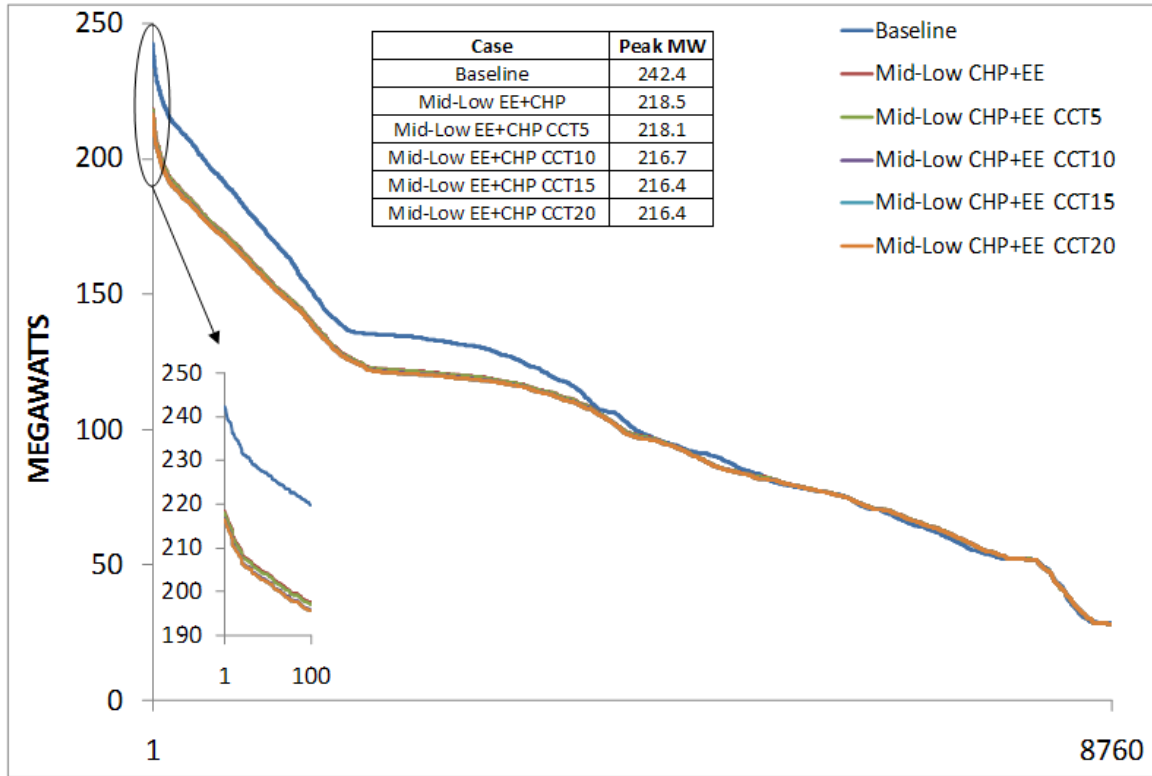


Table 15 - Percentages of Peak Demand Reduction from Baseline – Impact of Varying the Carbon Cap and Trade Price under a Mid-Low Market Penetration Rate for CHP & EE

| 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

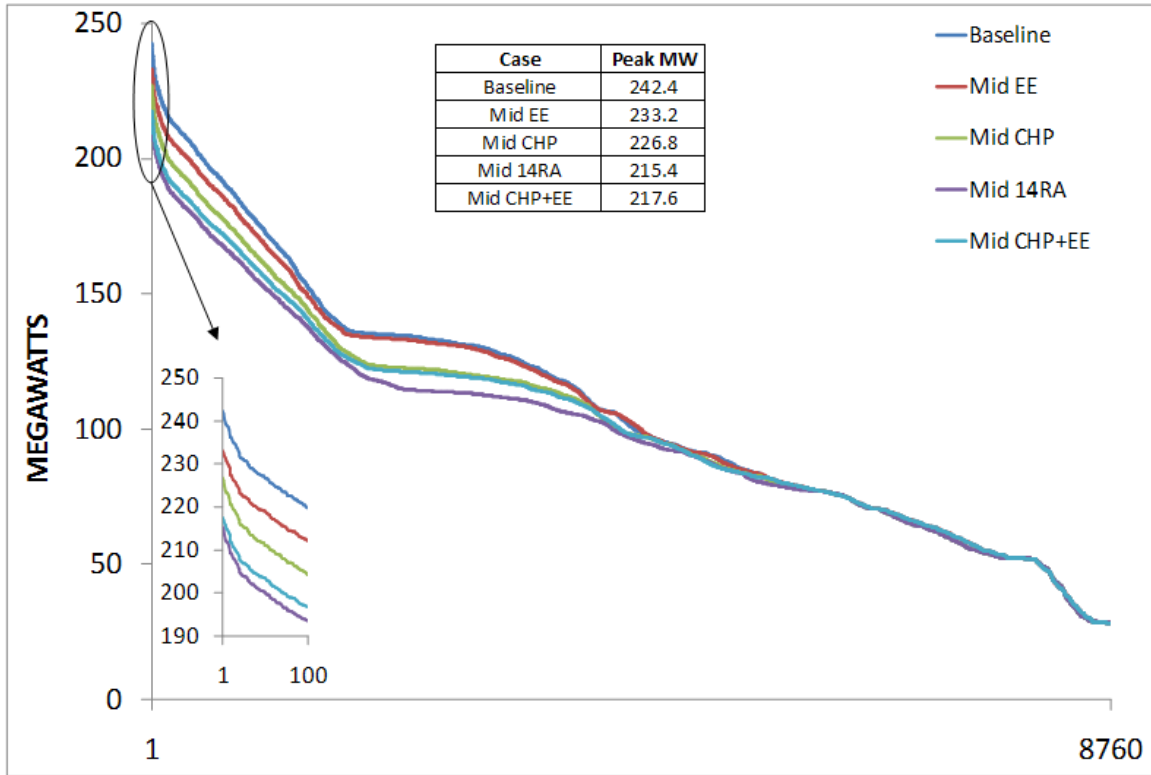


Table 16 - Percentages of Peak Demand Reduction from Baseline - Impact of Varying the Measures Applied to Achieve Load Reductions under a Mid Market Penetration Rate

| 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

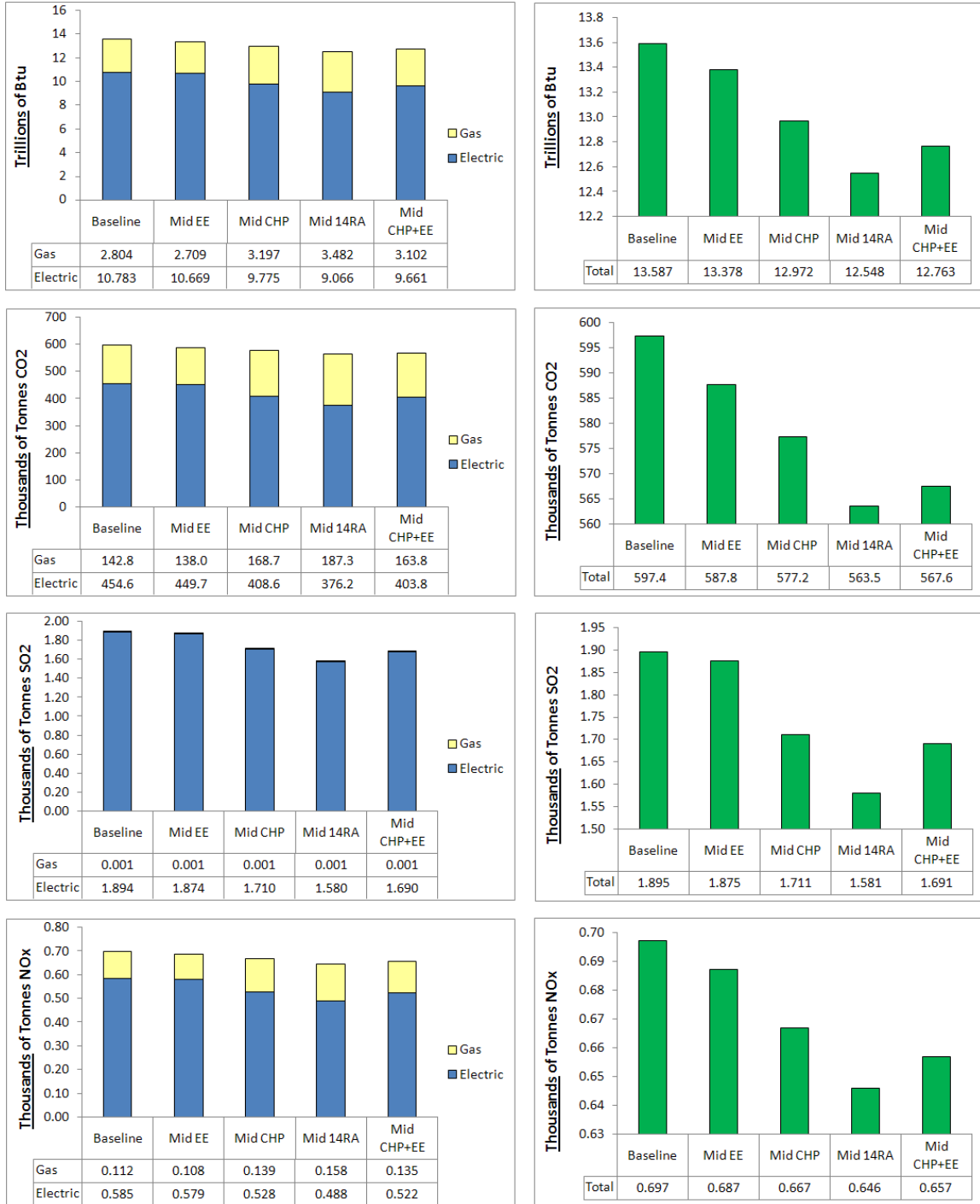


Figure 20 - Hudson Yards Aggregate Annual Electric Load Curves - Impact of Varying the Carbon Cap and Trade Price under a Mid Market Penetration Rate for CHP & EE

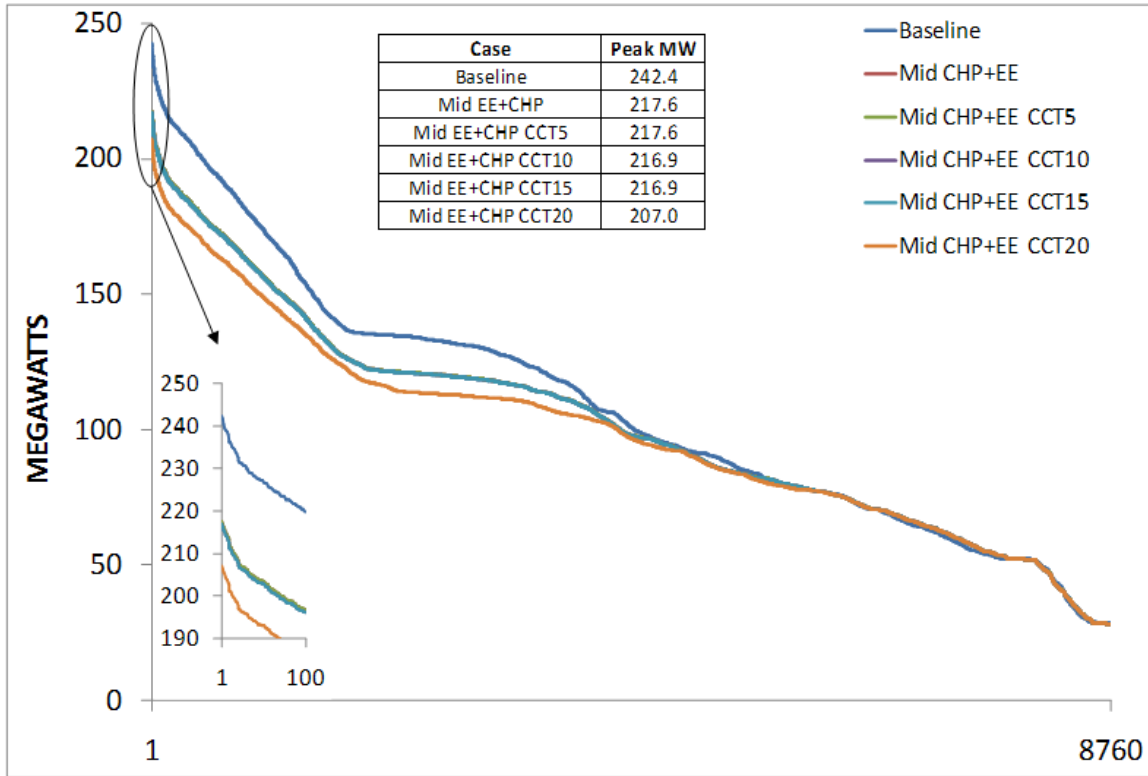


Table 17 - Percentages of Peak Demand Reduction from Baseline - Impact of Varying the Carbon Cap and Trade Price under a Mid Market Penetration Rate for CHP & EE

| 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

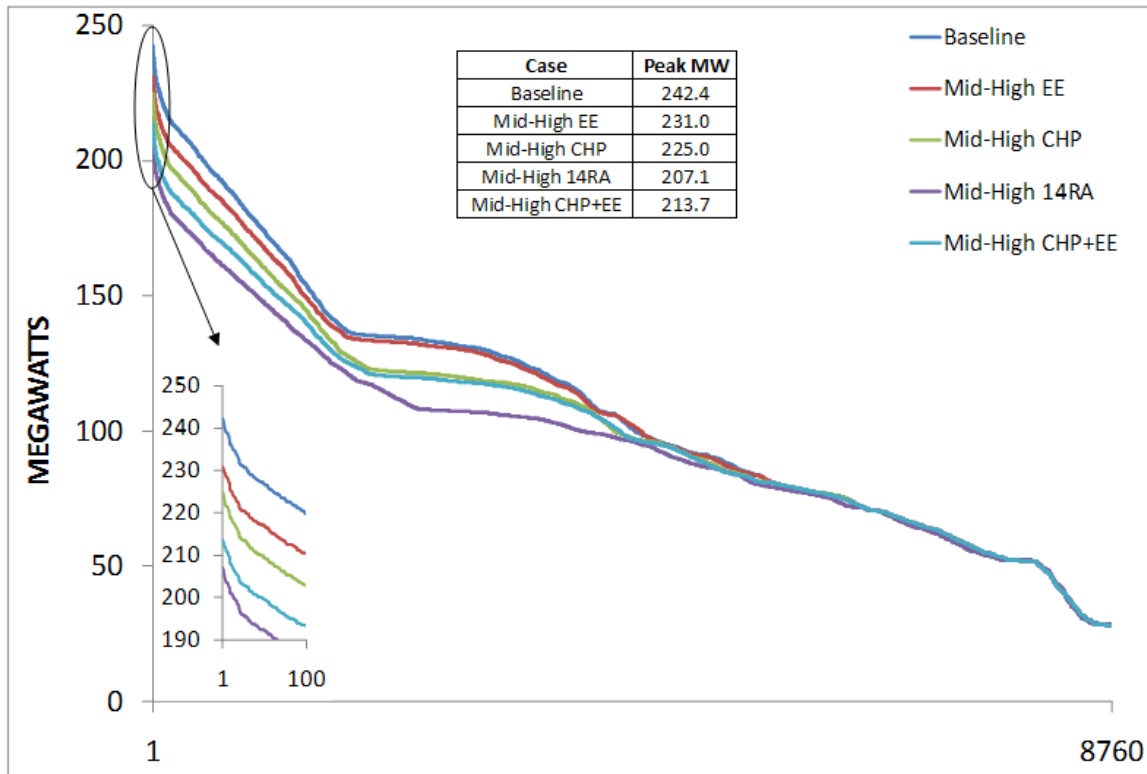


Table 18 - Percentages of Peak Demand Reduction from Baseline - Impact of Varying the Measures Applied to Achieve Load Reductions under a Mid-High Market Penetration Rate

| 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

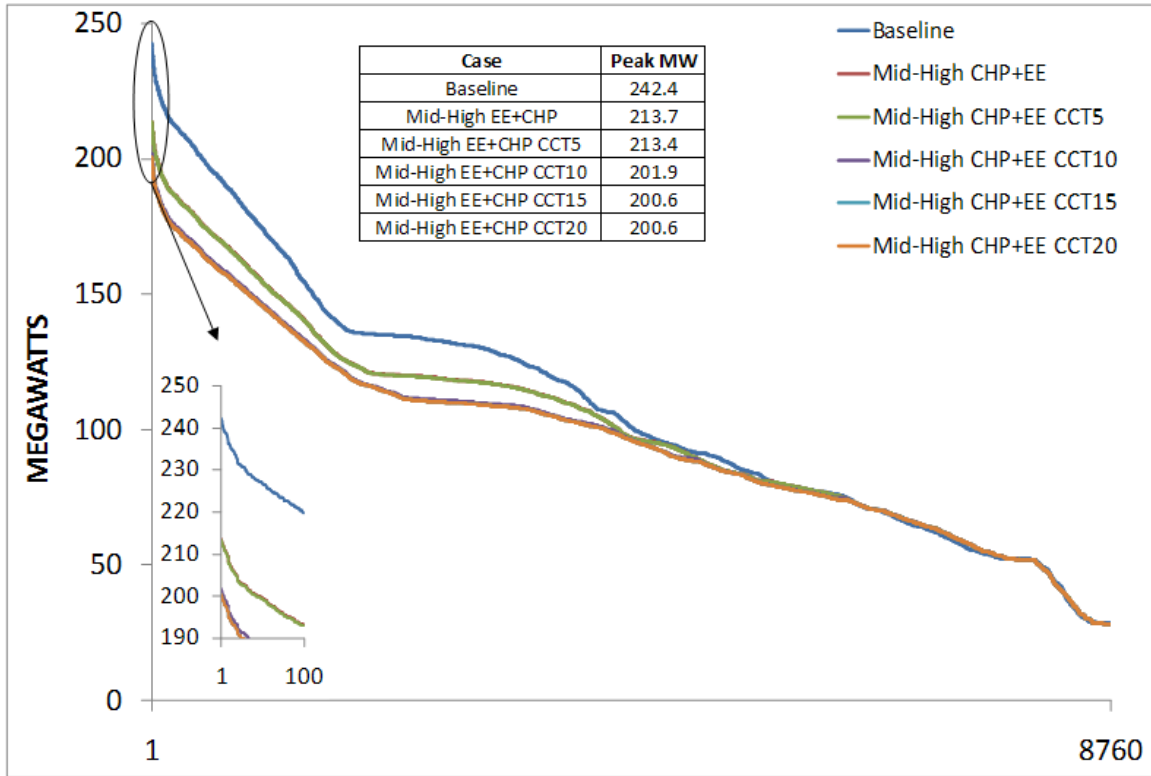


Table 19 - Percentages of Peak Demand Reduction from Baseline - Impact of Varying the Carbon Cap and Trade Price under a Mid-High Market Penetration Rate for CHP & EE

| 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

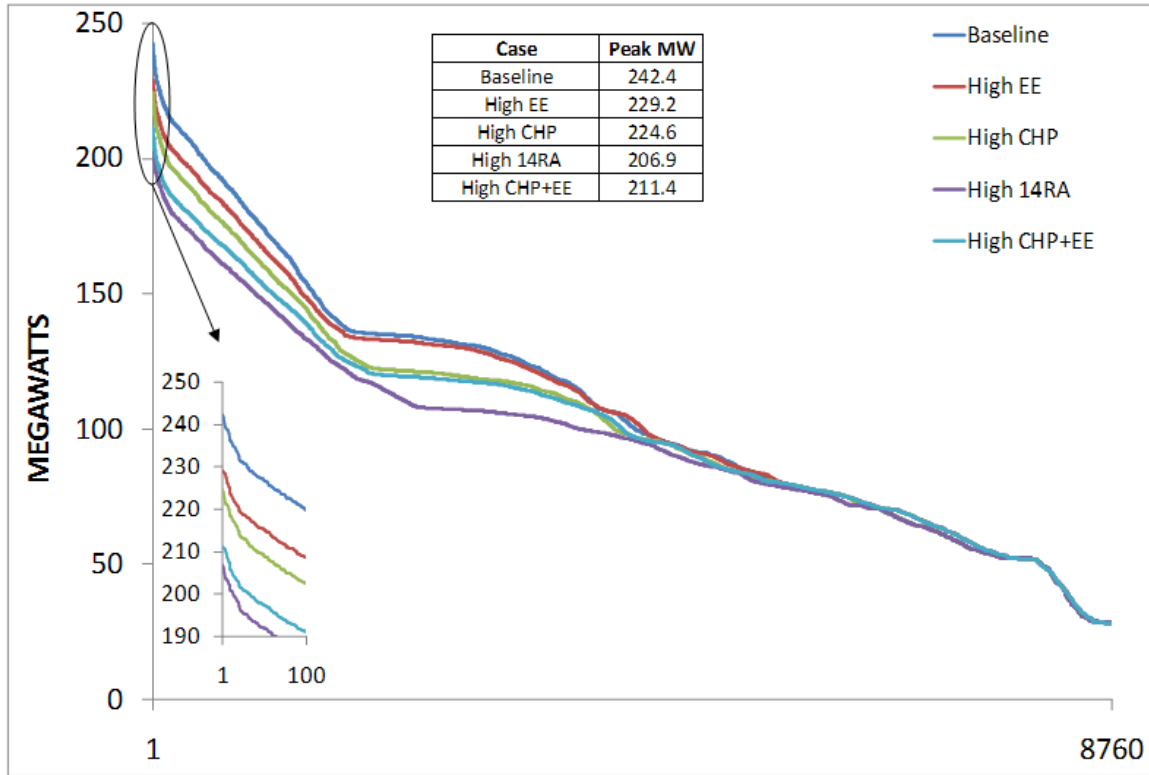


Table 20 - Percentages of Peak Demand Reduction from Baseline - Impact of Varying the Measures Applied to Achieve Load Reductions under a High Market Penetration Rate

| 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

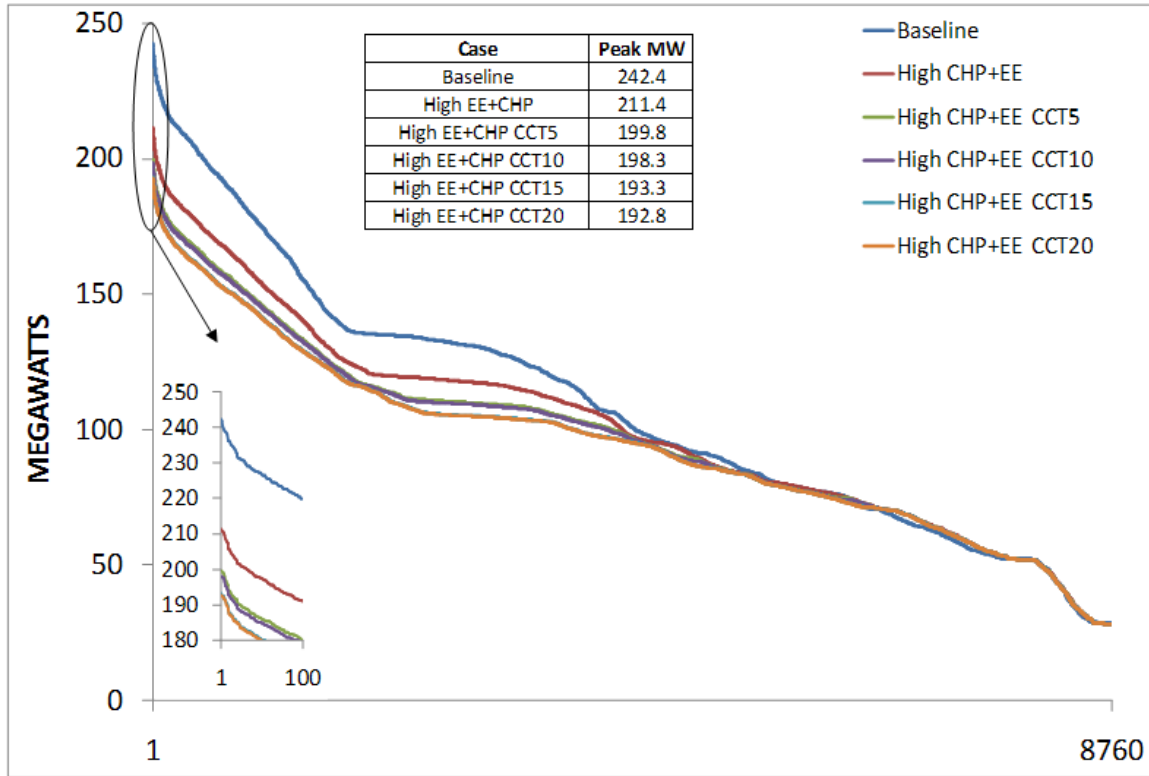


Table 21 - Percentages of Peak Demand Reduction from Baseline - Impact of Varying the Carbon Cap and Trade Price under a High Market Penetration Rate for CHP & EE

| 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:

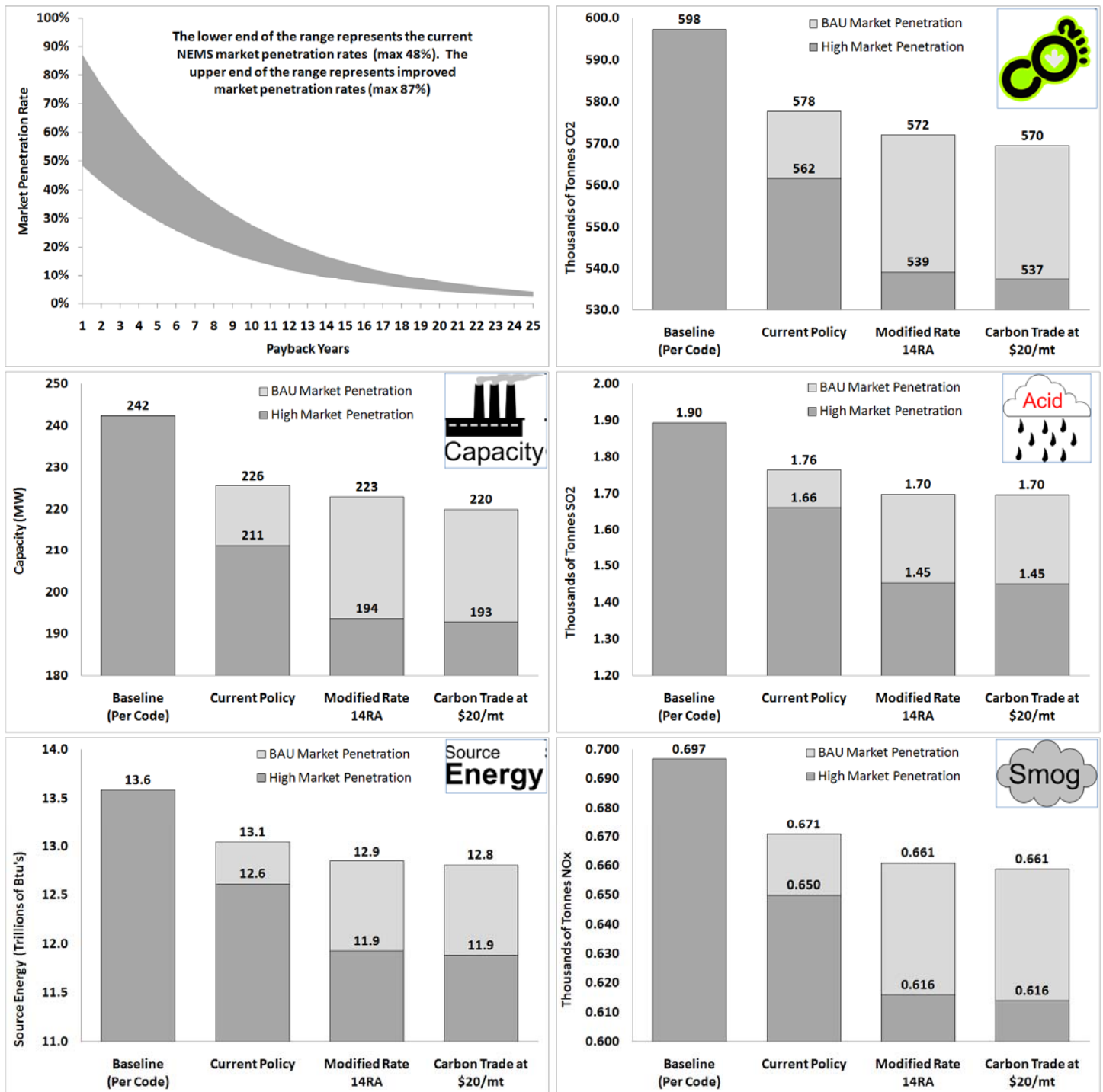
1. Baseline – All buildings built per code with no market penetration of CHP or energy efficiency strategies above code
2. Current Policy – Potential market as it exists today without modifications to energy rates or implementation of carbon trading policies
3. Modified Rate 14RA - Replace the contract 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 NO_x 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

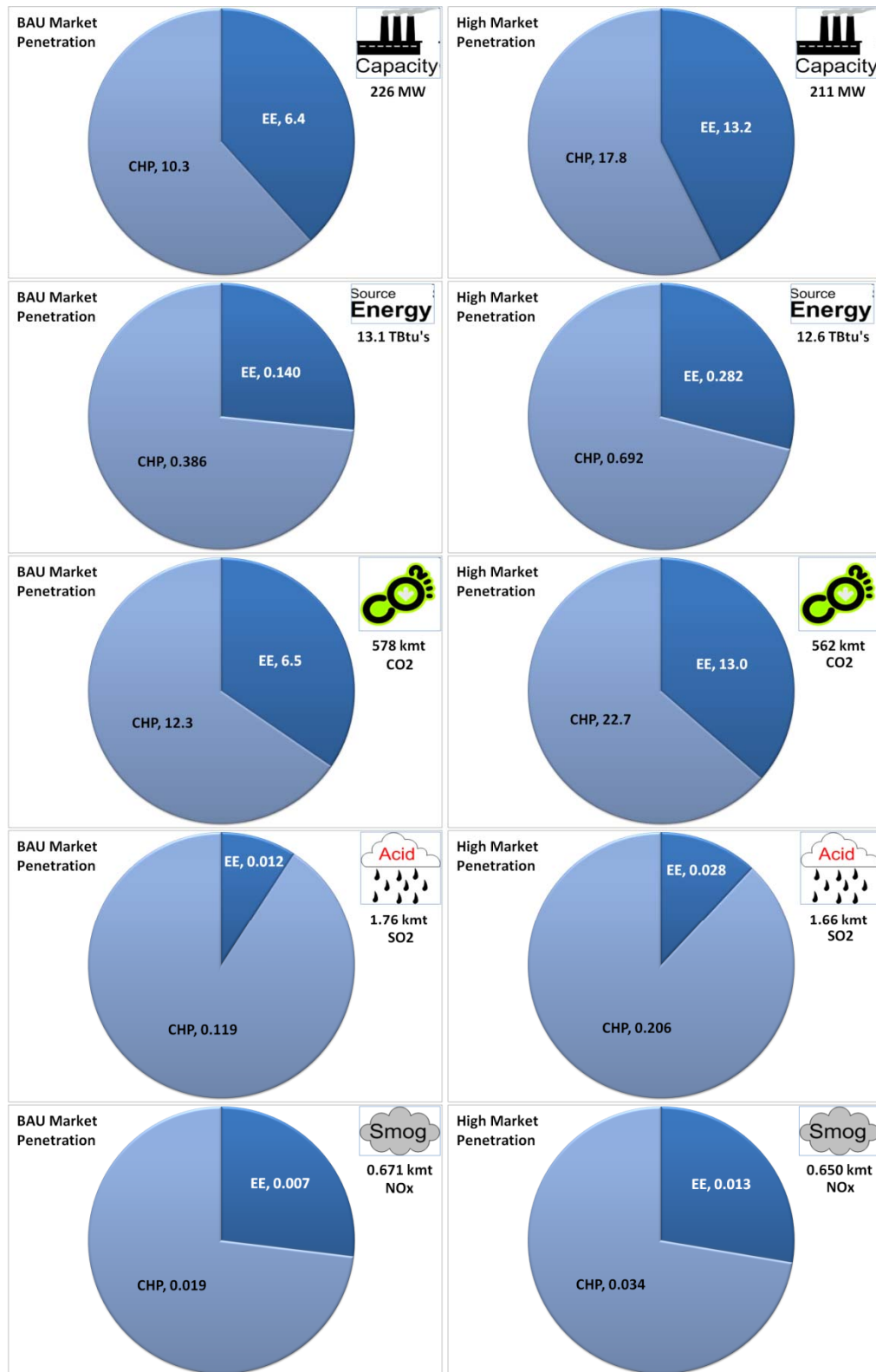


Energy Efficiency vs. CHP Impacts

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 given 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%.

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

| Annual Cost Component | No CHP | | 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% |
| Electric 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 | NA | | \$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 | | | \$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 | |

* 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.

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

| Policy Scenarios | CHP without Subsidy First Cost = \$19,500,000 | | CHP with \$2M Subsidy First Cost = \$17,500,000 | | CHP w/ \$2M Subsidy & no Inverters First Cost = \$16,700,000 | |
|-------------------|--|---------|--|---------|---|---------|
| | 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 |

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:

1. 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. Coincidentally, 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

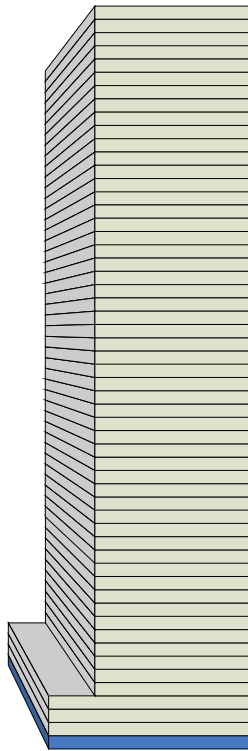
Prototypes 1-3 are Type I construction with an unconditioned basement below grade. The ground floor includes a 7,400 sqft corner restaurant and individual retail shops at approximately 2,000 sqft each. All but one floor above the ground floor are occupied by offices. The remaining floor is used for mechanical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

Prototype 1, High Rise Office Building; 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.

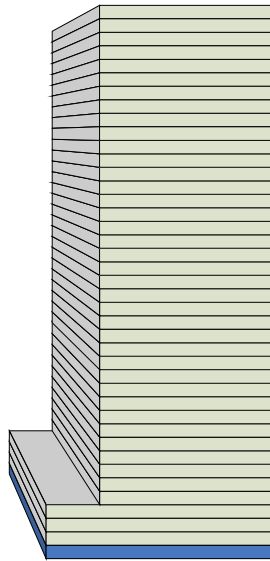
Prototype 2, High Rise Office Building; Approximately 1,706,000 sqft 41-story building with approximately 51,000 sqft of commercial space at ground level demised to

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.

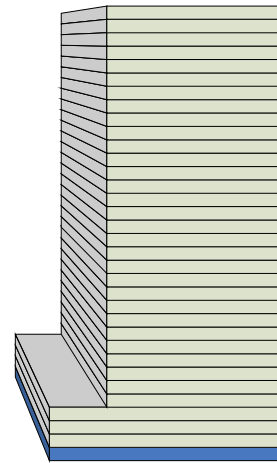
Prototype 3, High Rise Office Building; Approximately 1,544,000 sqft 34-story building with 56,000 sqft of commercial space at ground level demised to accommodate 24 individual retail shops and a corner restaurant. Approximately 1,443,000 sqft of conditioned office space including corridors is above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



Prototype 1



Prototype 2

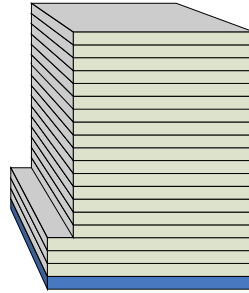


Prototype 3

Mid Rise Office Building – Prototype 4

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.

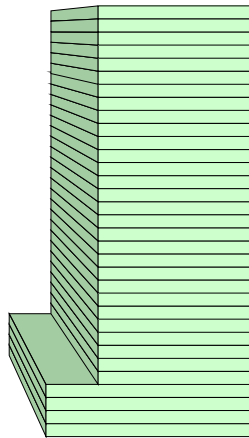


Prototype 4

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.

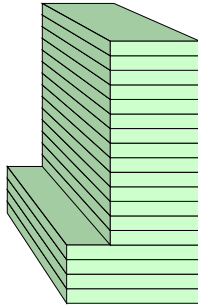


Prototype 5

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.



Prototype 6

High Rise Residential Buildings – Prototypes 7-10

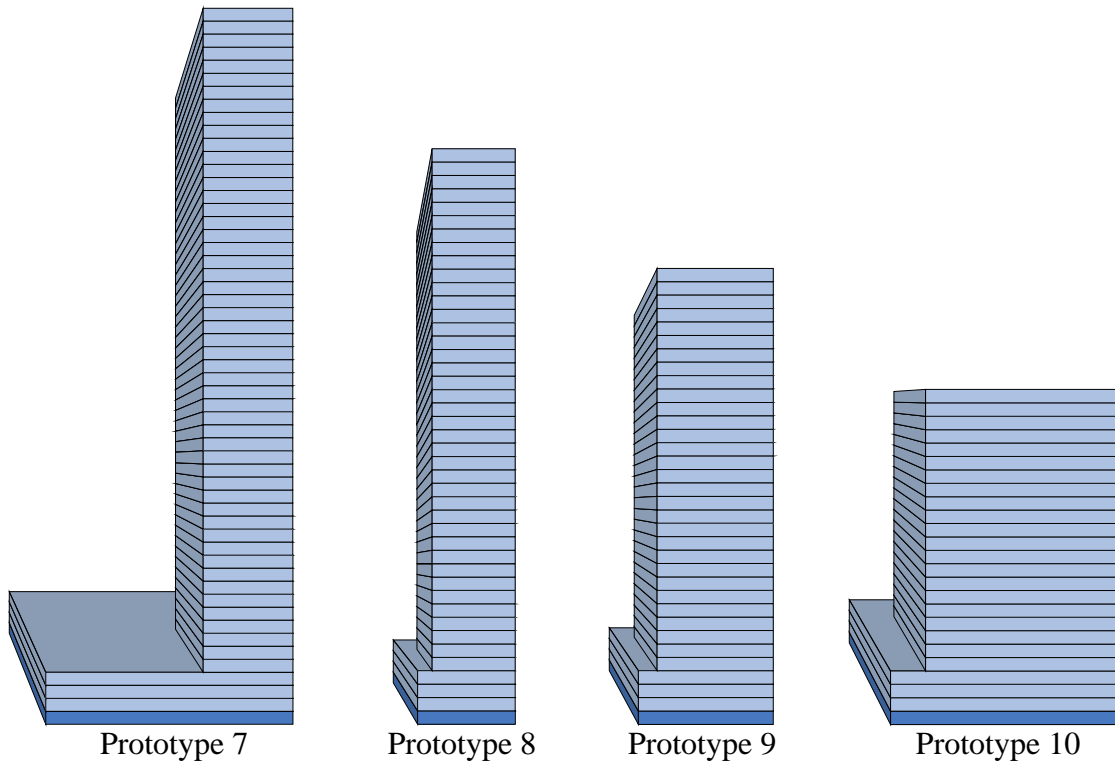
Prototypes 7-10 are Type I construction with an unconditioned basement below grade. The ground floor includes a 7,400 sqft corner restaurant and individual retail shops at approximately 2,000 sqft each. All but one floor above the ground floor are occupied by residential units at an average 1,000 sqft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

Prototype 7, High Rise Residential Building; 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.

Prototype 8, High Rise Residential Building; 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.

Prototype 9, High Rise Residential Building; 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.

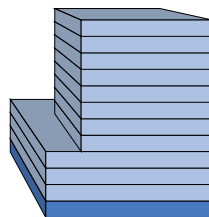
Prototype 10, High Rise Residential Building; Approximately 1,069,000 sqft 25-story building with approximately 54,000 sqft of commercial space at ground level demised to accommodate 23 individual retail shops and a corner restaurant. Approximately 973,000 sqft of conditioned residential space including 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.



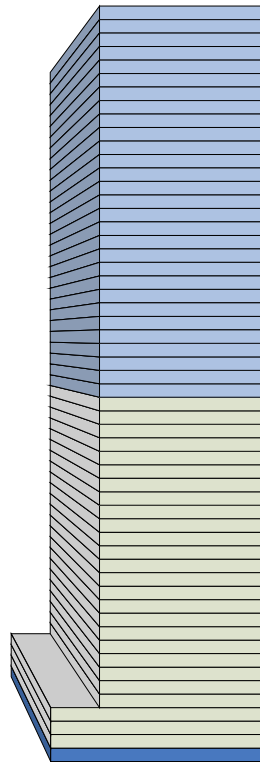
Prototype 11

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".

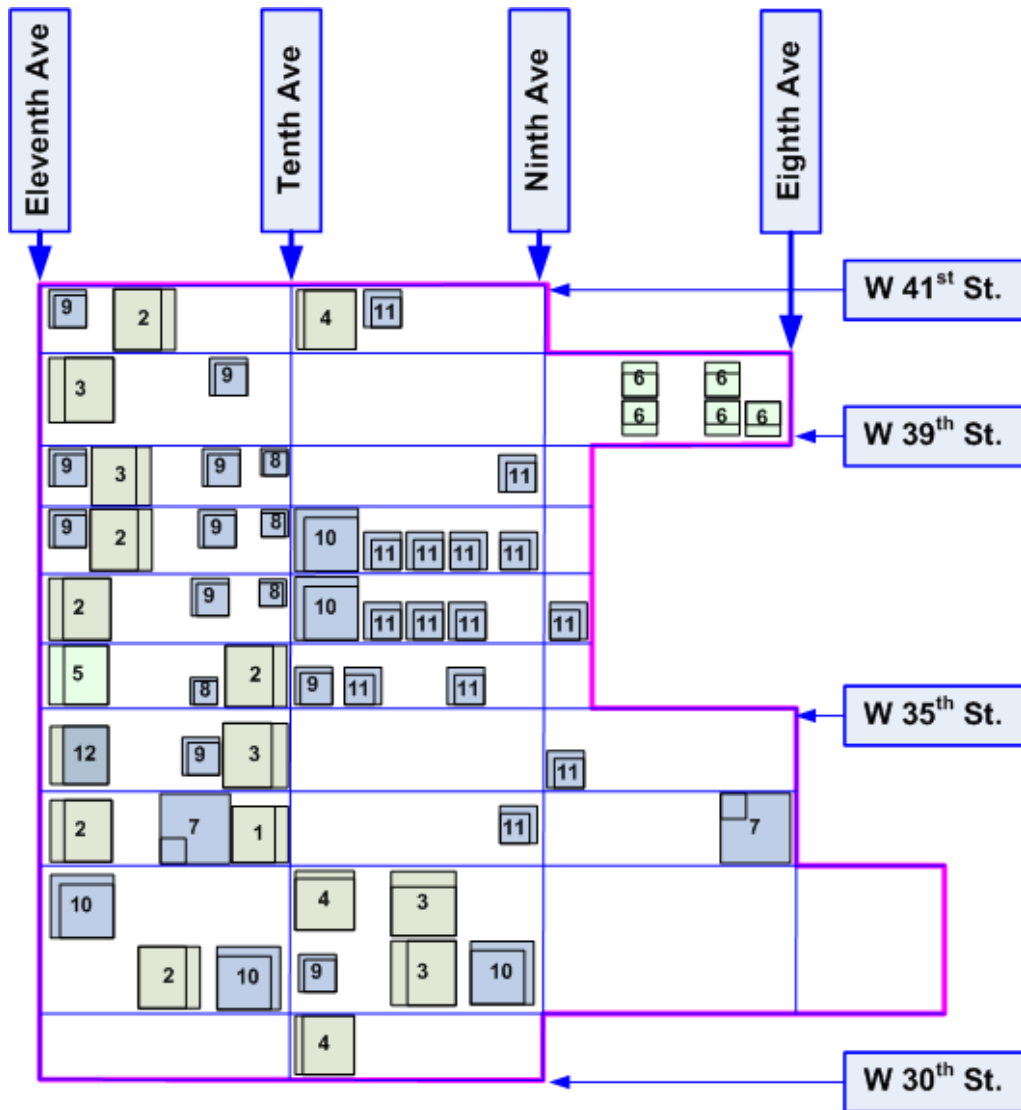
Prototype 12 is approximately 2,000,000 sqft 55-story building with approximately 45,000 sqft of commercial space at ground level demised to accommodate 19 individual retail shops and a corner restaurant. Approximately 869,000 sqft of conditioned residential space and 1,045,000 sqft of conditioned office 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.



Prototype 12

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

Integrated Building Model 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}

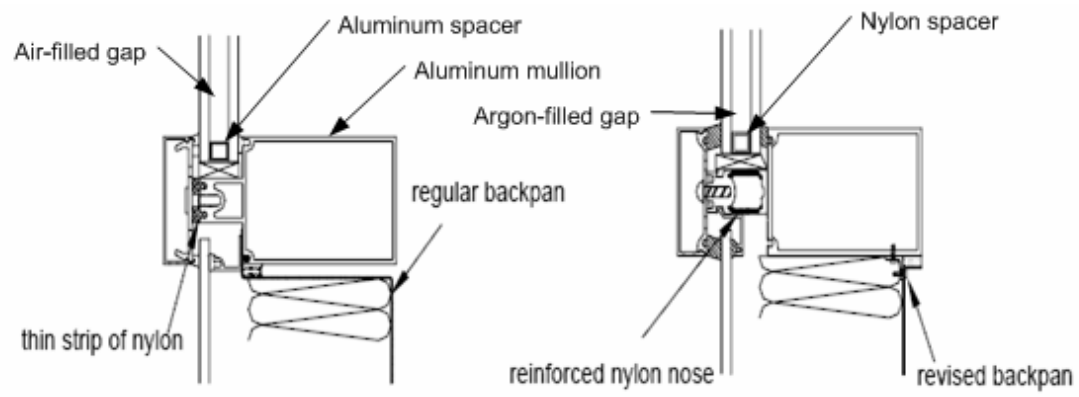
External Walls

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 |
|---|--------------------|



Baseline

Alternative

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 |

| Scenarios | | |
|---|---|---|
| NYS ECCC '07 | Baseline Model | Alternative 1 |
| Min cavity insul: R11 Min continuous insul: R0 | 4" Pre-cast concrete wall system, R11 cavity insulation within 2x4.16 metal-stud back-up wall assembly behind concrete, 5/8" gypsum board interior. | Same as Baseline Model, except R19 cavity insulation within 2x6.16 metal-stud back-up wall assembly |
| Overall U Not Available | Overall U = 0.132 | Overall U = 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 Requirements | No Cool Roof. Standard black exposed modified bitumen membrane | Same as Baseline except with White elastomeric reflective coating for modified 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 |

| | |
|--|-------------|
| Alternative Incremental Costs (Alternative – Baseline) | \$0.33/sqft |
|--|-------------|

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 | | |
|---------------------------------|---|--|
| NYS ECCC '07 | Baseline Model | Alternative |
| No Description | 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 = 0.50 | Window U = 0.26 |
| Window SHGC = 0.30 (PF < 0.25) | Window SHGC = 0.35 | Window SHGC = 0.29 |
| 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 |
|--|-------------|

HVAC

HVAC Summary

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

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, centrifugal chiller | Central water-cooled, electrically operated, centrifugal chillers | Central water-cooled, electrically operated, 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 per 1000 sqft | Office max occupant load: 10 people per 1000 sqft | Office max occupant load: 10 people per 1000 sqft |
| Residential max occupant load: 2.7 people per 1000 sqft | Residential max occupant load: 2.7 people per 1000 sqft | Residential max occupant load: 2.7 people per 1000 sqft |
| Hotel max occupant load: 20 people per 1000 sqft | Hotel max occupant load: 20 people per 1000 sqft | Hotel max occupant load: 20 people per 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: (70 dining, 20 kitchen) people per 1000 sqft | Restaurant max occupant load: (70 dining, 20 kitchen) people per 1000 sqft | Restaurant max occupant load: (70 dining, 20 kitchen) 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 Combustion Efficiency: 80% | > 2,500,000 Btu/hr Combustion Efficiency: 80% | > 2,500,000 Btu/hr Combustion Efficiency: 85% |
| Hotel: condenser heat recovery for service water heating | Hotel: condenser heat recovery for service water heating | Hotel: condenser heat recovery for service water heating |

| Alternative Incremental 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

Domestic (Service) Hot Water Summary

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

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 water heaters | Individual 50 gallon gas-fired storage water heaters | Individual 50 gallon equivalent gas-fired Instantaneous water heaters |
| Storage < 75,000 Btu/hr: EF = 0.62-0.0019V | Storage < 75,000 Btu/hr: EF = 0.62-0.0019V = 52.5% | Instantaneous 150,000 Btu/hr Thermal Efficiency = 82.3% (based on Takagi T-M199) |
| Storage 75,000-155,000 Btu/hr: Thermal Efficiency = 80% | Storage 75,000-155,000 Btu/hr: Thermal Efficiency = 80% | |
| Storage > 155,000 Btu/hr Thermal Efficiency = 80% | Storage > 155,000 Btu/hr 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: | Prototype # |
|-------------------------------------|-------------|
| High- and Mid-Rise Residential | 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 | Mix of 60 LPW screw-in CFL and dimmable incandescent 1.3 W/sqft | Replace CFLs w/ 69 LPW recessed fixtures with 4-pin triple tubes 1.19 W/sqft |
| Hotel Lobby: 1.1 W/sqft | | |
| Hotel Meeting Rooms: 1.3 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 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 Gen Efficiency | Jacket Water Heat Efficiency | Exhaust Heat Efficiency | Total 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.

| Load | Electric Power Gen Efficiency | Jacket Water Heat Efficiency | Exhaust 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

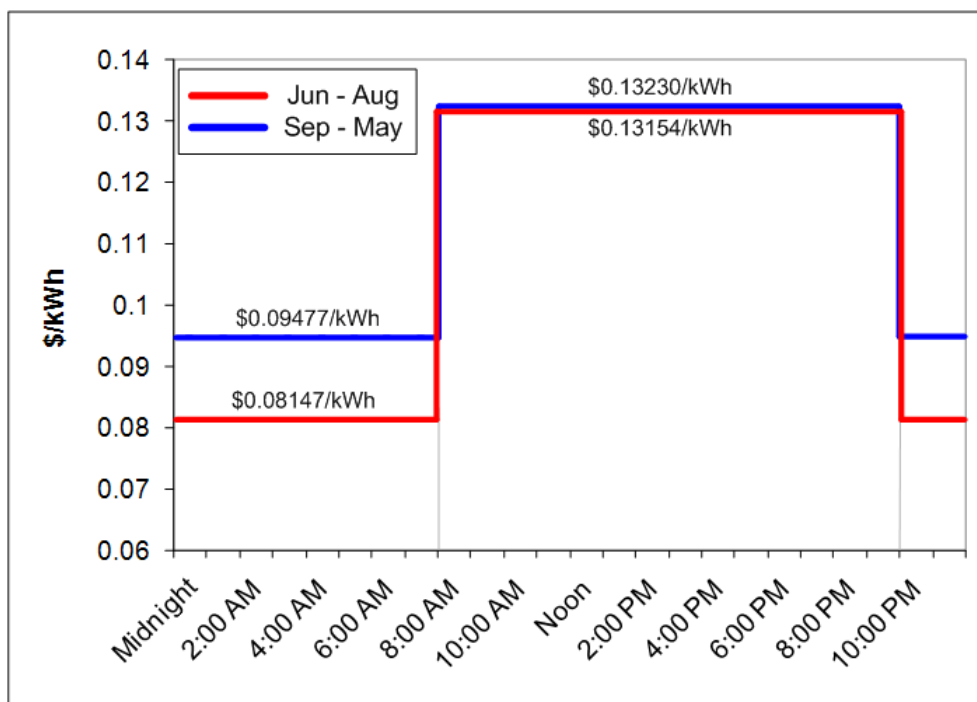
Charge during mid- and off-peak periods

Serves 15% to 25% of the cooling capacity (optimized on a case-by-case basis)

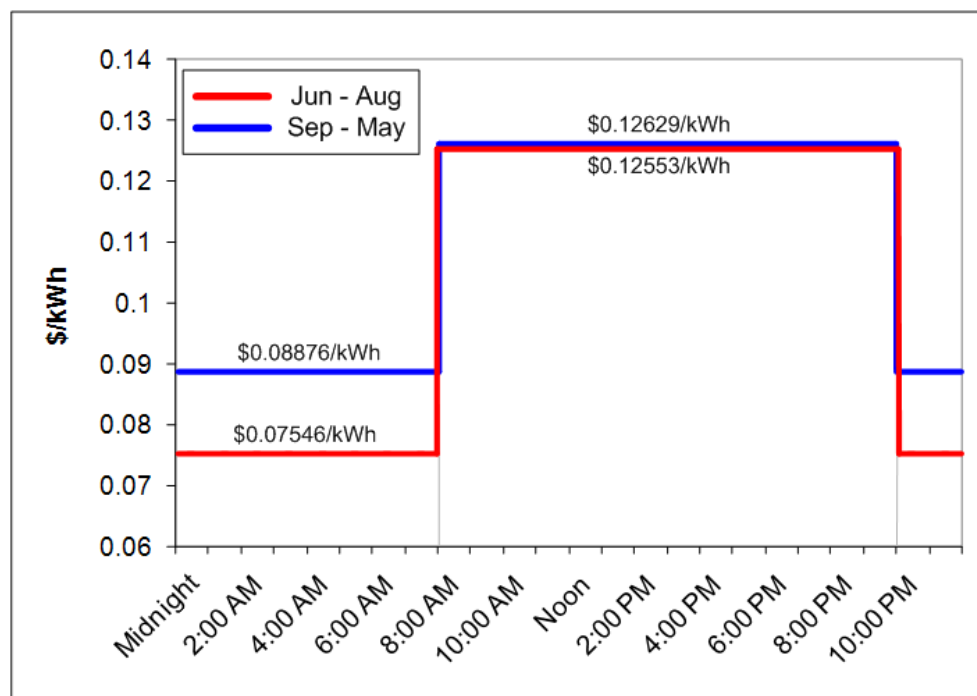
Starting efficiency equals baseline chiller efficiency. Ending efficiency equals approx. 40% lower.

Utility Rates^{xxv}

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

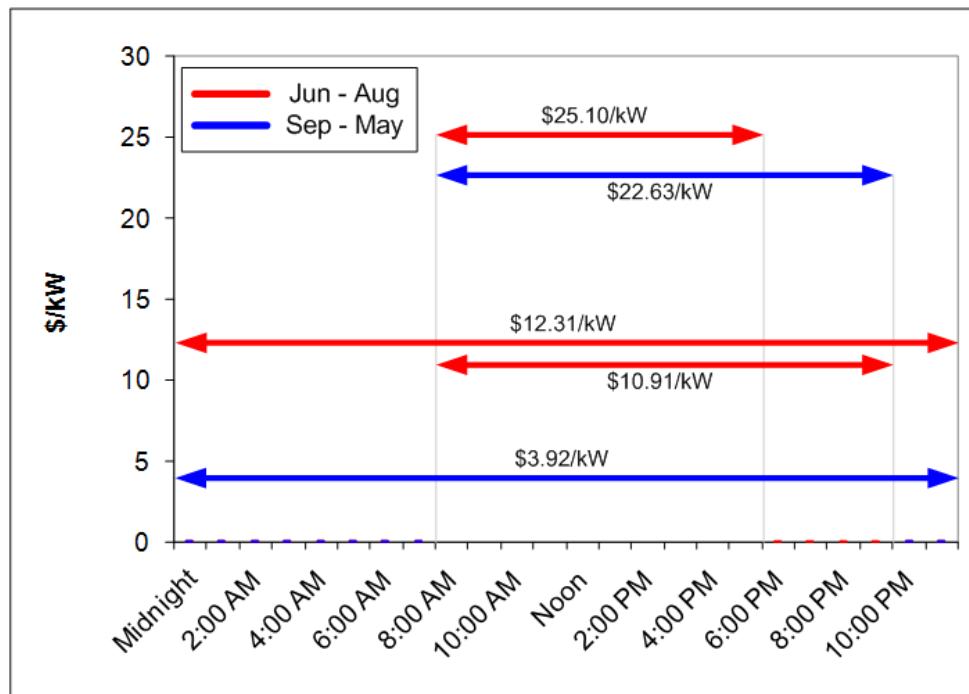


2007 PSC2, SC14-RA, Rate II Total Daily Summer and Winter Electric Energy Rates

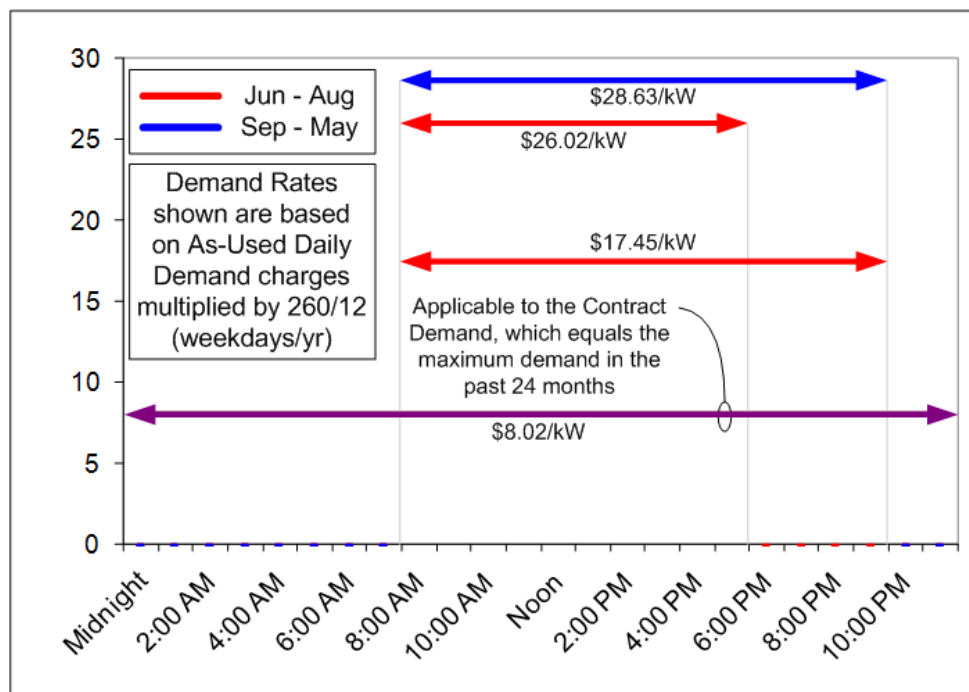


Note, this rate is essentially the same as PSC9, SC4, Rate II minus the delivery component of the charge (i.e. commodity charge only).

**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

2007 Summer and Winter Gas 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 |
|-----------------|--------|--------|----------|
| Less than 5 MW | 1.3294 | 1.3612 | \$/therm |

| Rider H, Rate II | Summer | Winter | Demand* | Units |
|-------------------|--------|--------|---------|----------|
| Greater than 5 MW | 1.2242 | 1.2299 | 22.12 | \$/therm |

*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 (lb/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

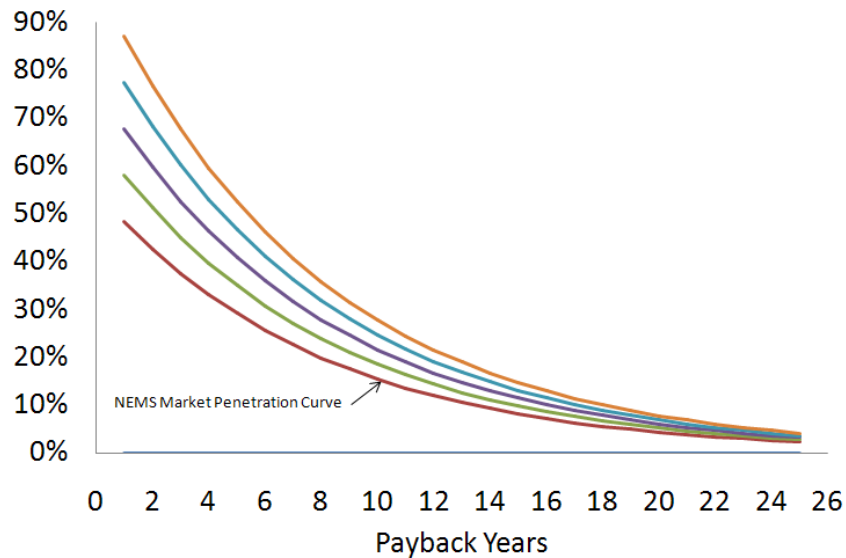
$$\text{Equation 2: Market penetration} = \frac{1.1 \times \text{penparm}}{e^{(0.24 \times \text{payback})}}$$

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.^{ix}

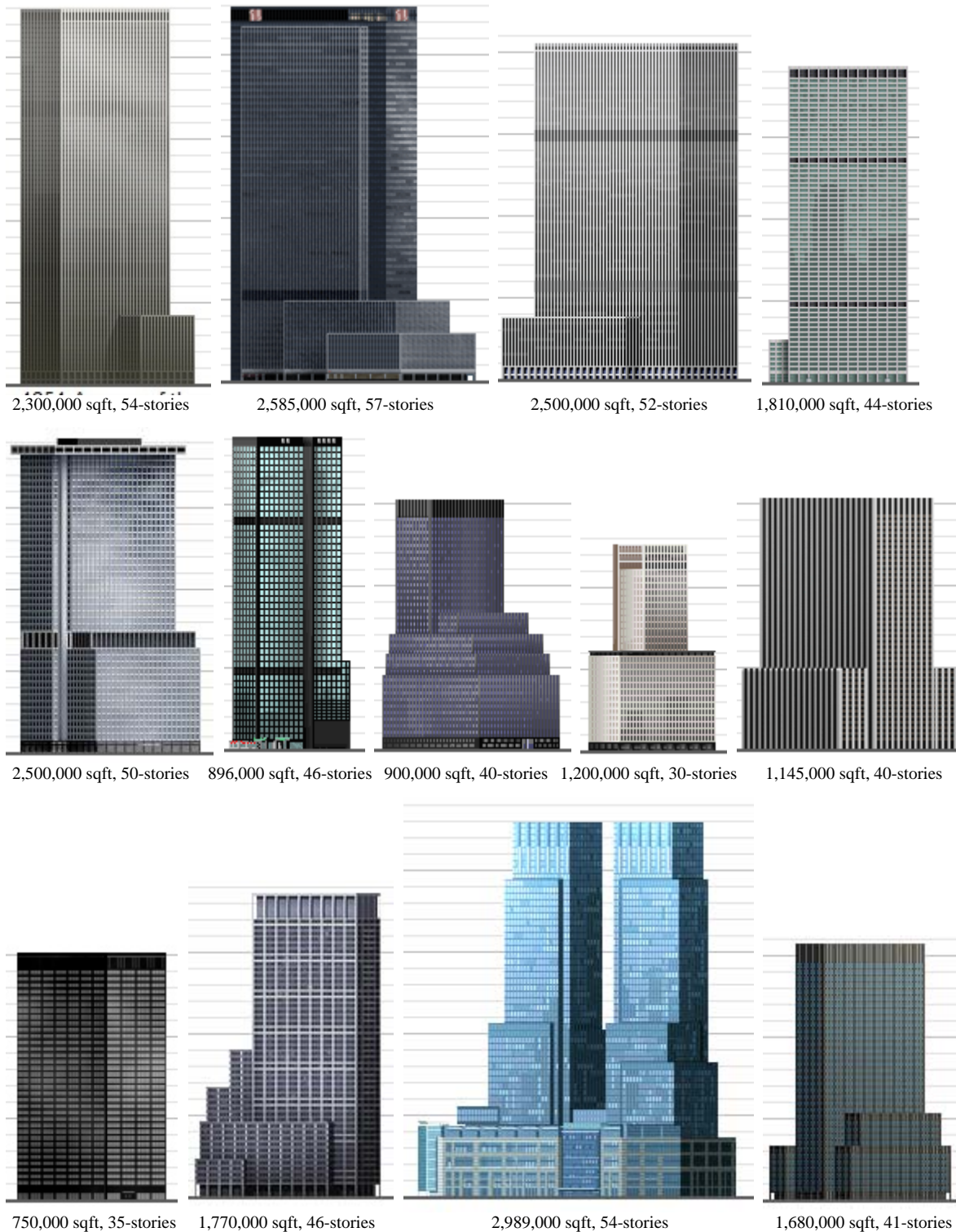


Current trading in Europe through the Chicago Climate Exchange is approximately \$38/ton.^{ix}

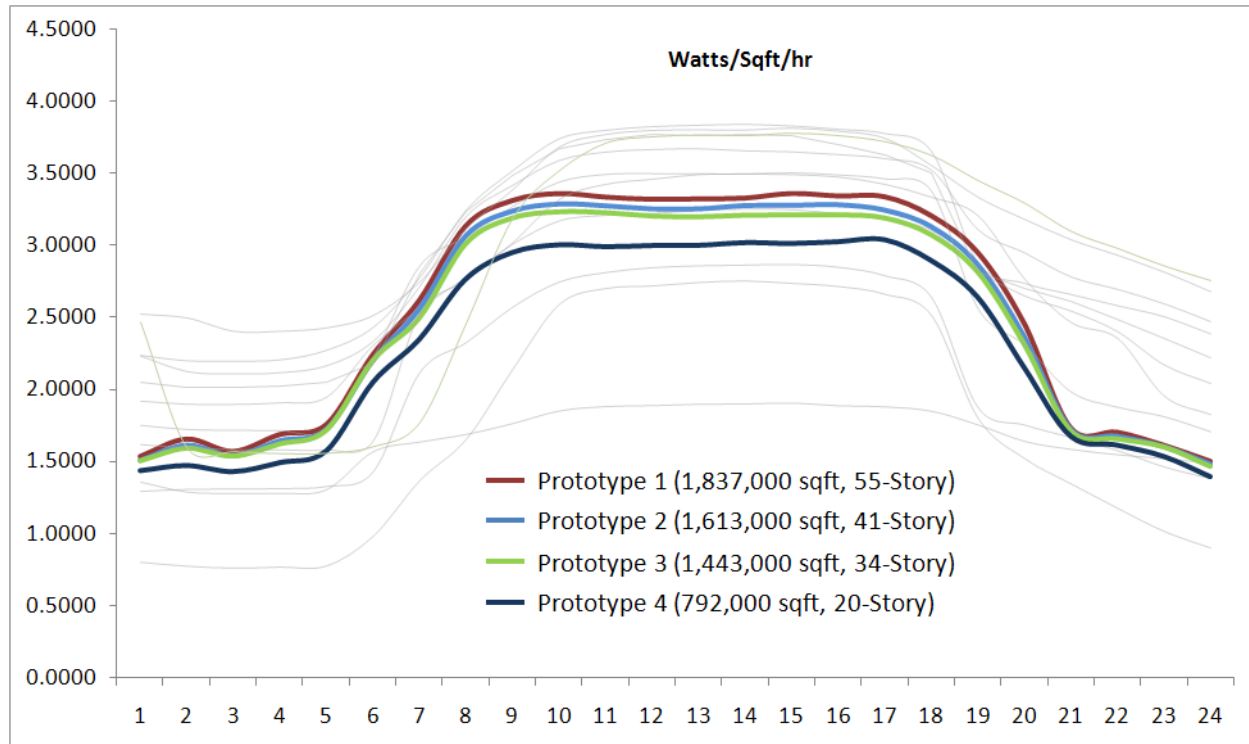


APPENDIX B – BUILDING CALIBRATIONS

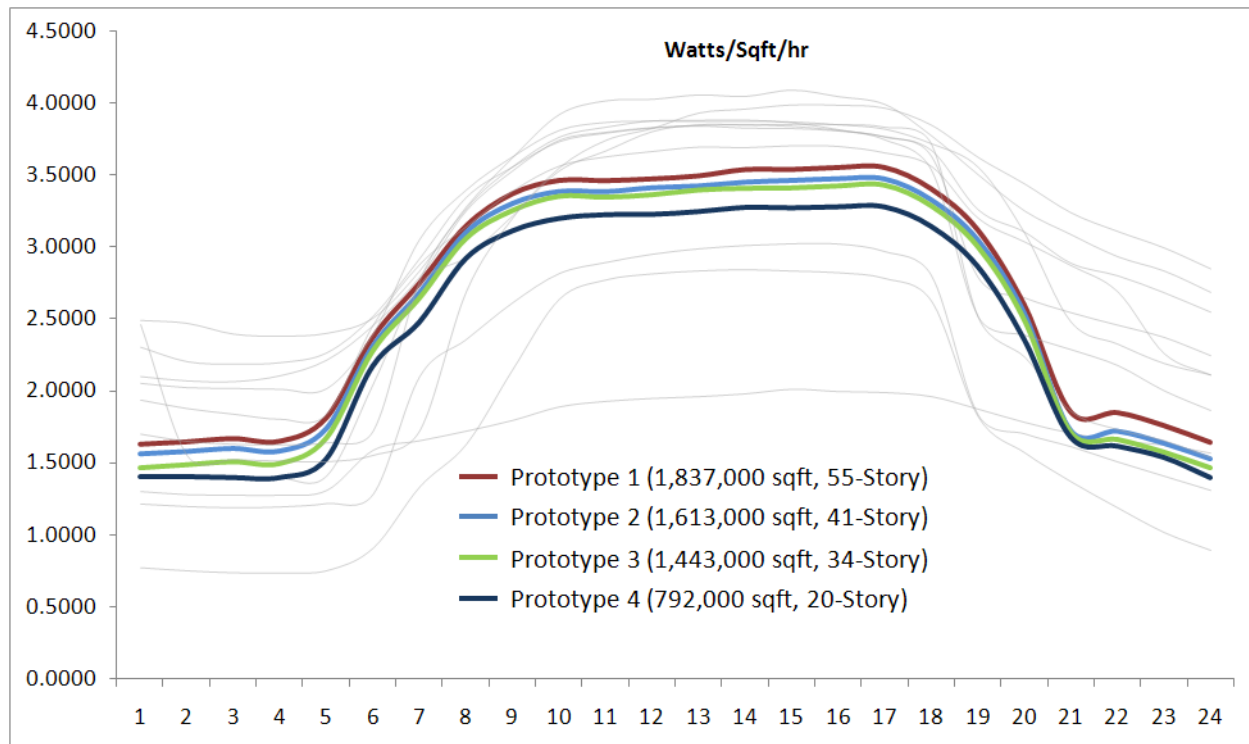
Illustrated below are Manhattan buildings that were built in the late 60's and early 70's. Annual hourly energy data (8,760) were acquired from the owners for each of these buildings and used for calibrating Hudson Yards prototype models. The hourly energy data for each individual building is shown in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



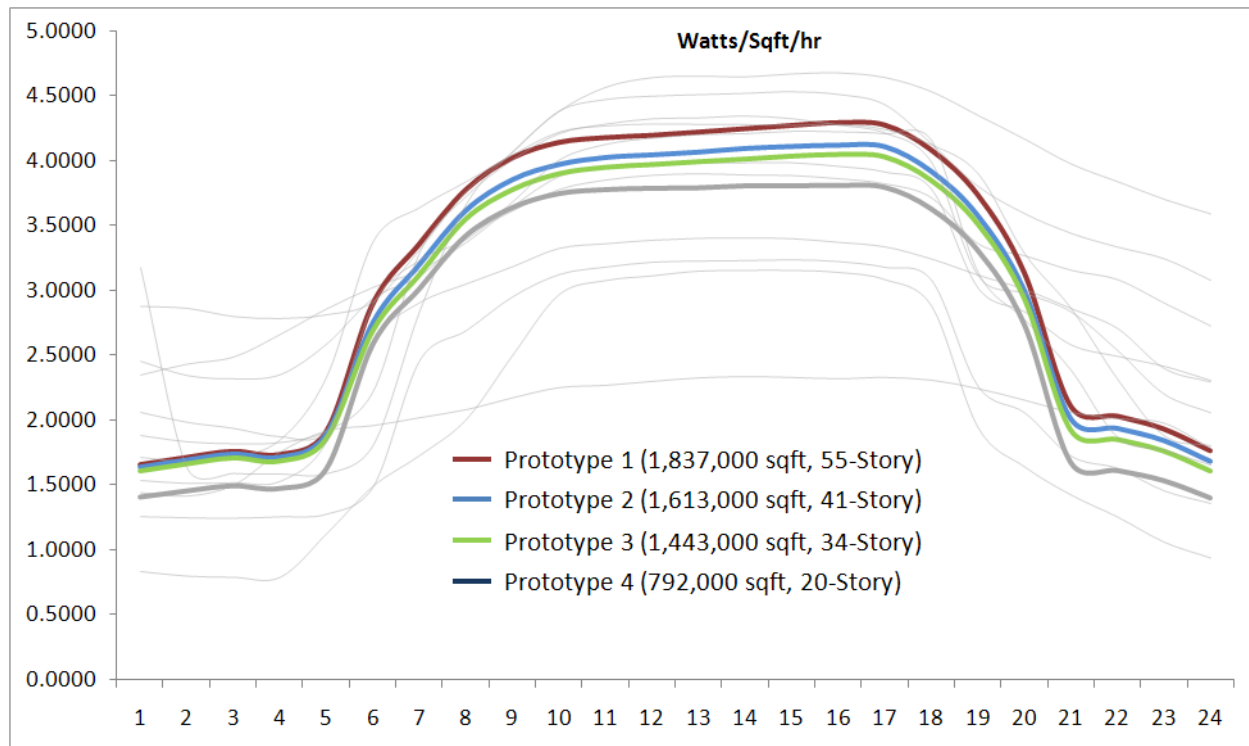
High Rise Office Buildings – Prototypes 1, 2, 3 and 4 Average Electricity for December – March



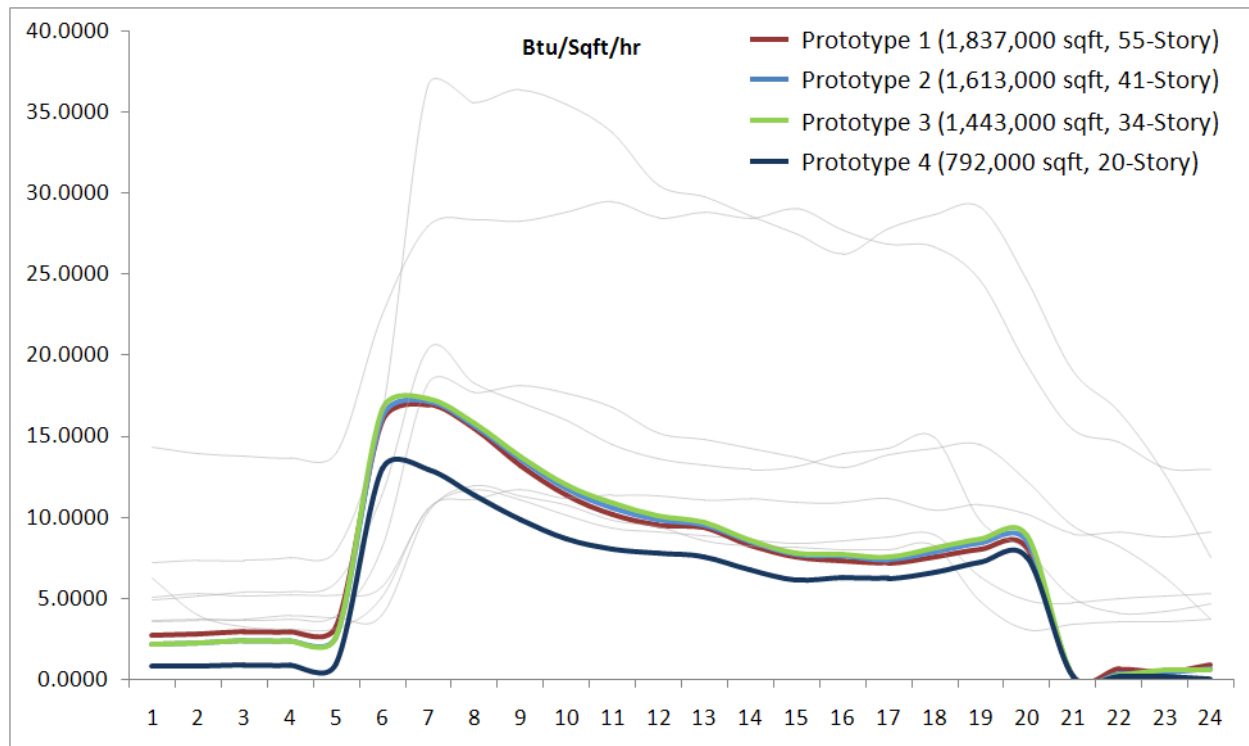
**High Rise Office Buildings – Prototypes 1, 2, 3 and 4 Average
Electricity for April – May and October - November**



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

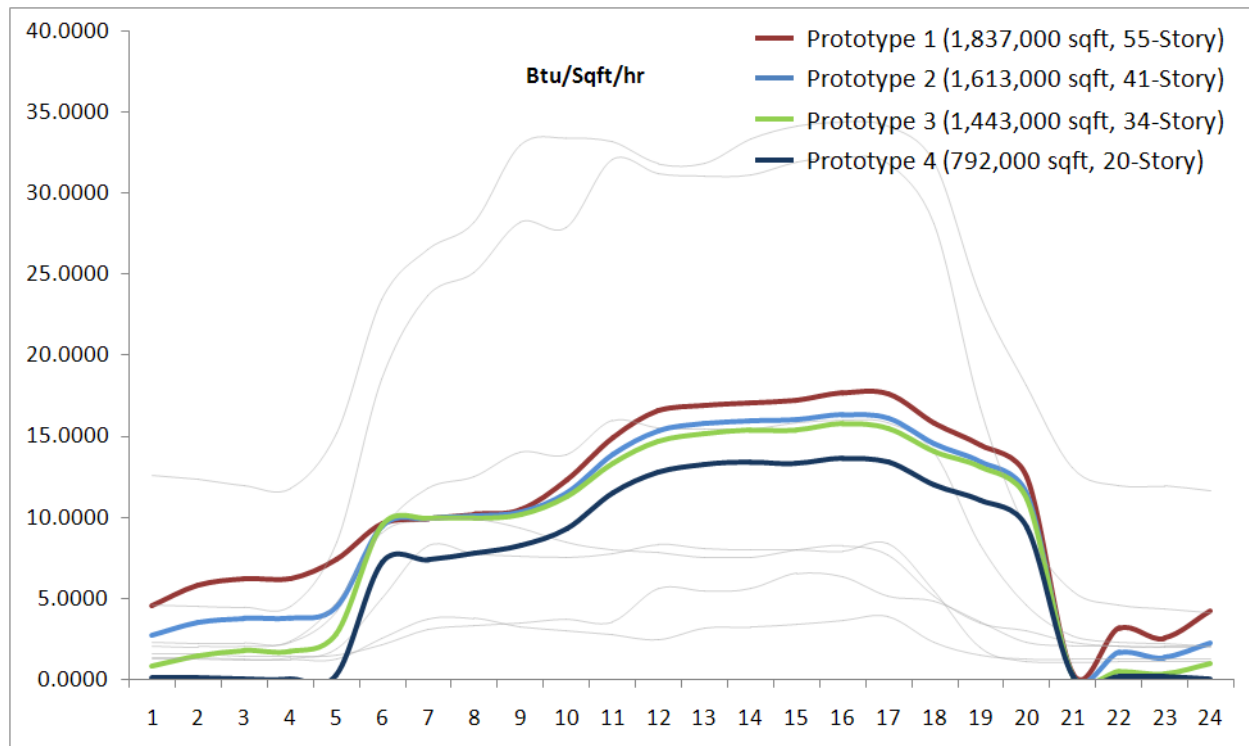


High Rise Office Buildings – Prototypes 1, 2, 3 and 4 Average Heat for December – March



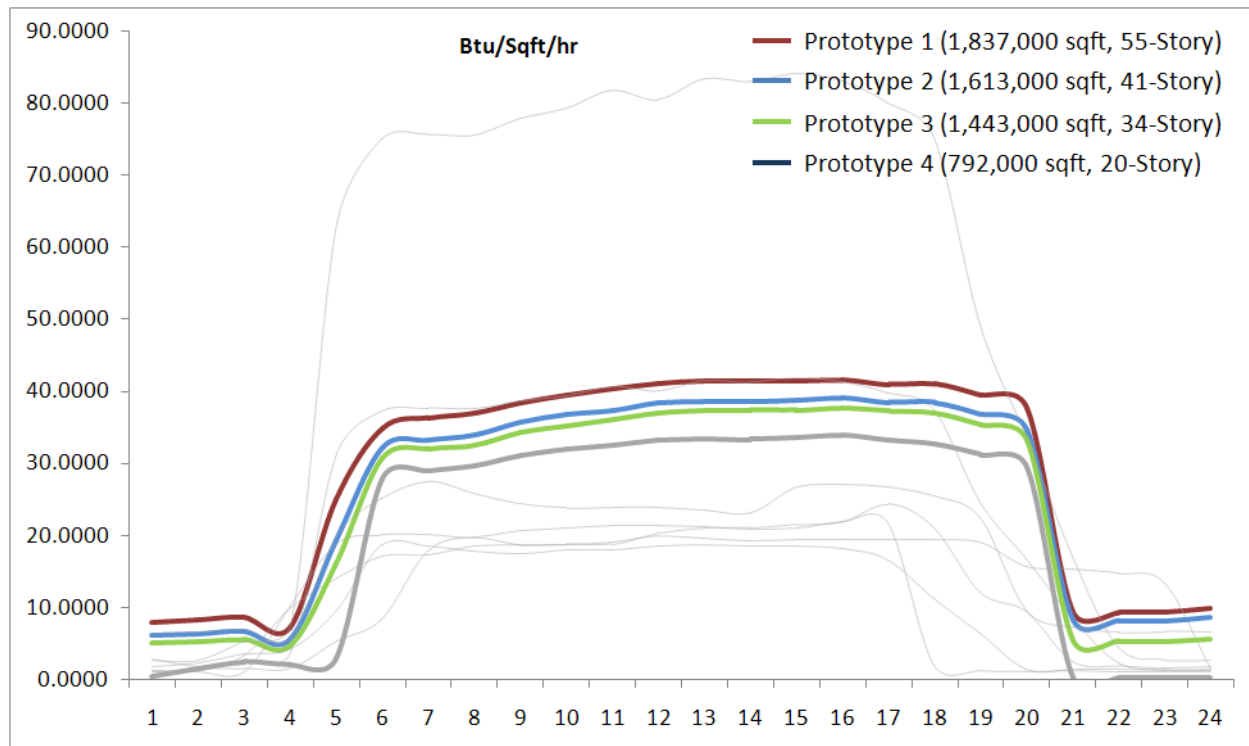
Building prototypes were calibrated assuming central steam heating and 50% steam-driven cooling.

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



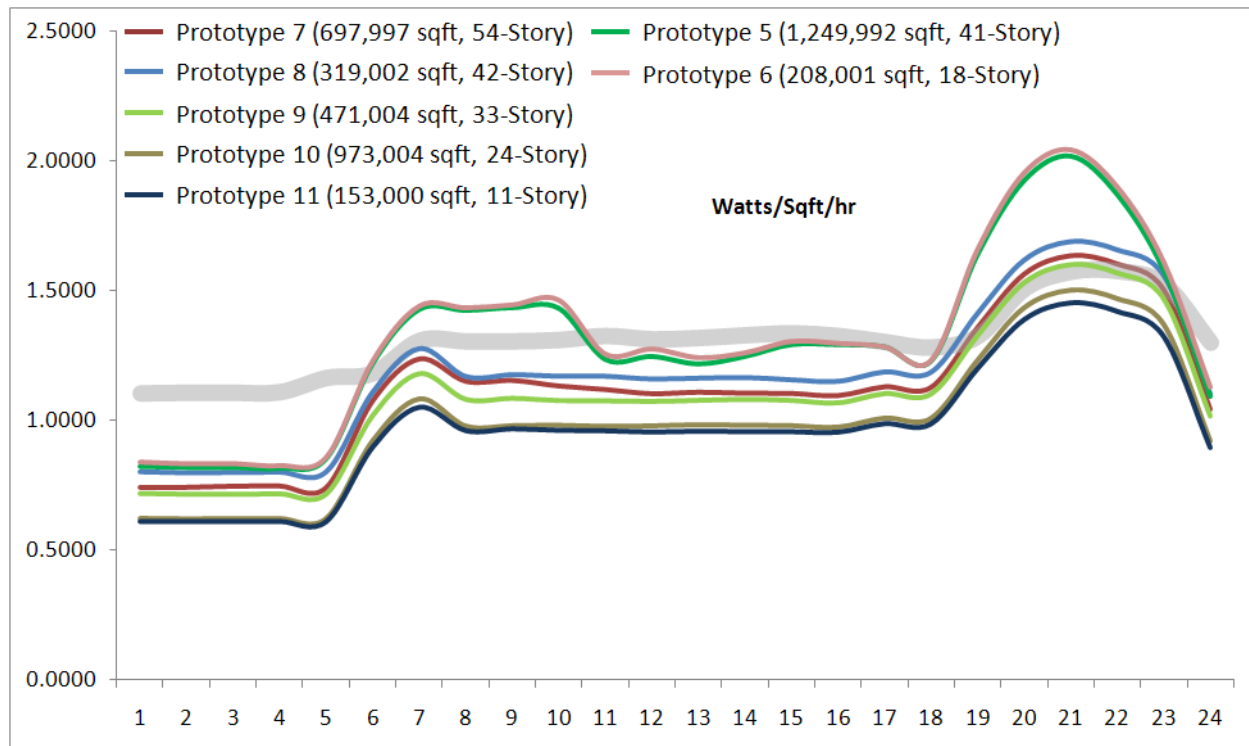
Building prototypes were calibrated assuming central steam heating and 50% steam-driven cooling.

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

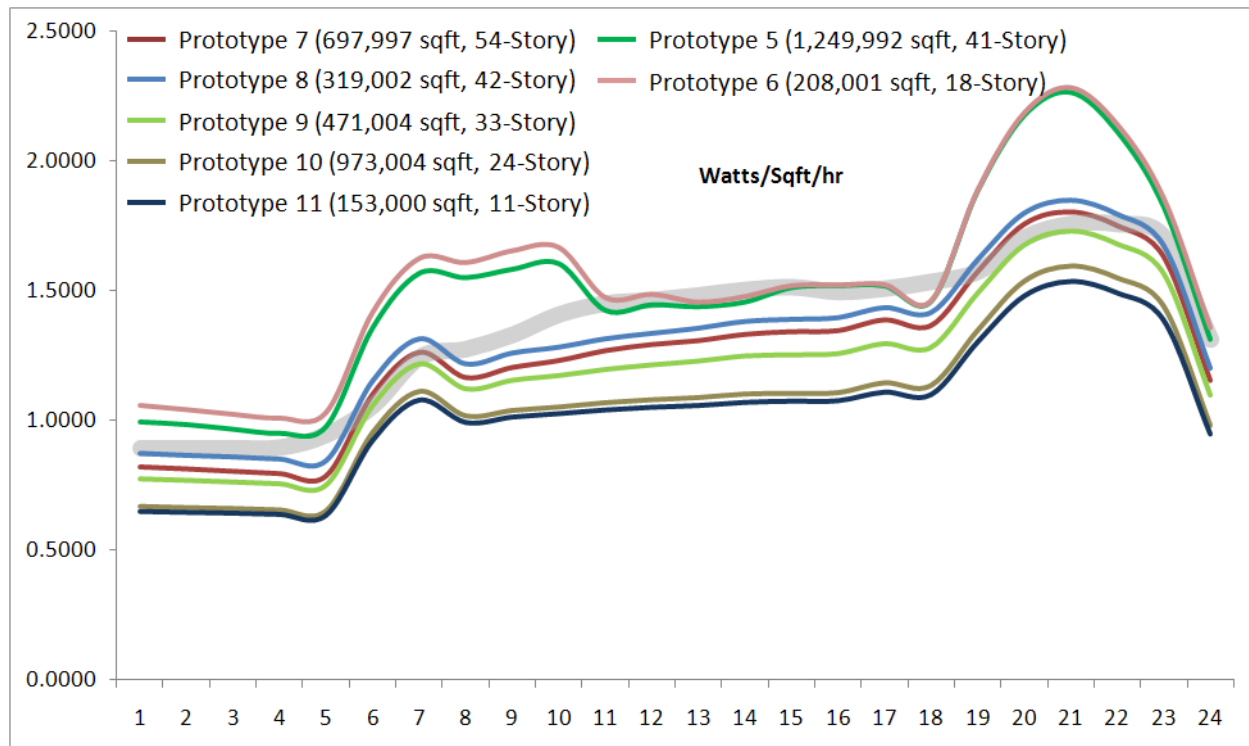


Building prototypes were calibrated assuming central steam heating and 50% steam-driven cooling.

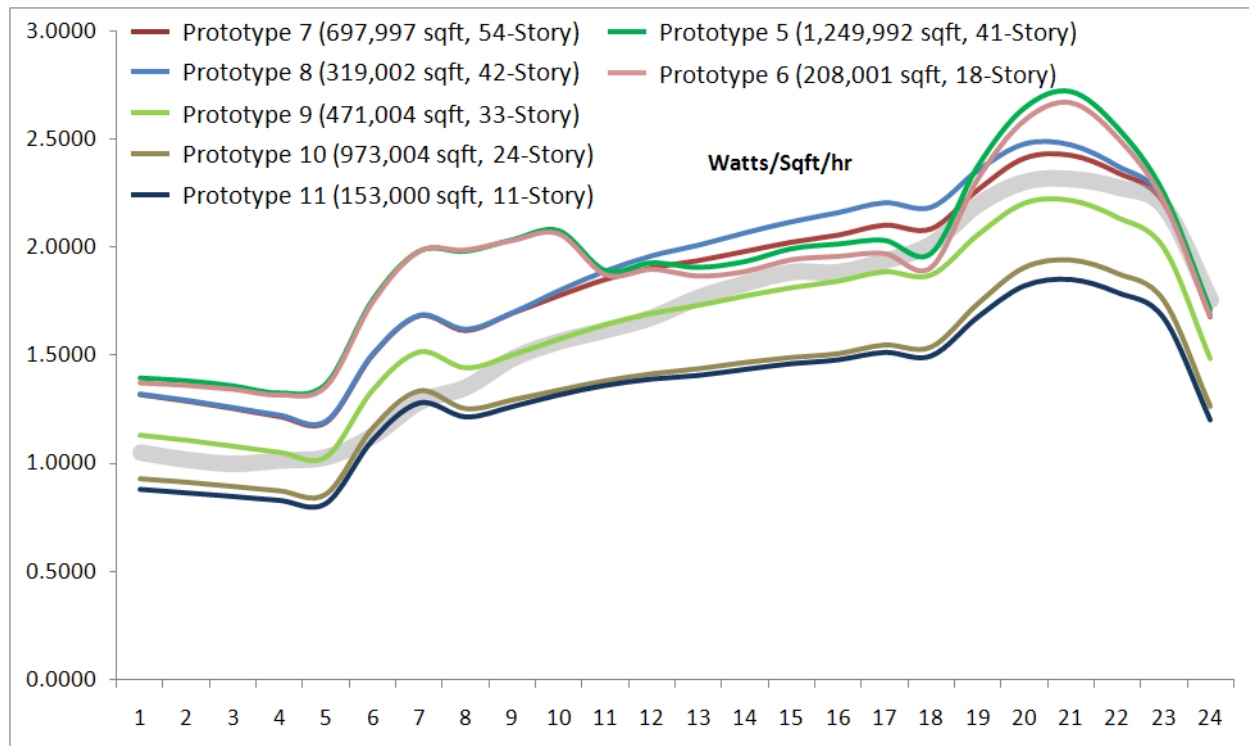
High Rise Residential & Hotel Buildings – Prototypes 5, 6, 7, 8, 9, 10 and 11 Average Electricity for December – March



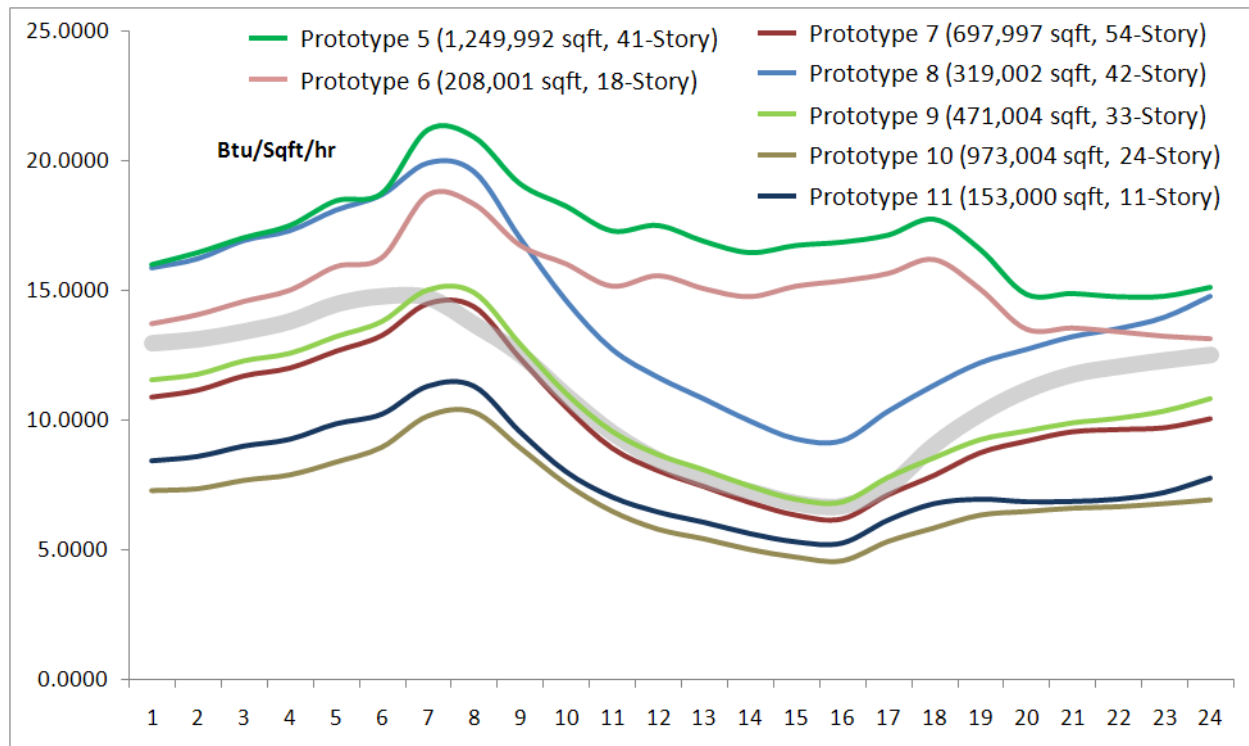
High Rise Residential & Hotel Buildings – Prototypes 5, 6, 7, 8, 9, 10 and 11 Average Electricity for April – May and October – November



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

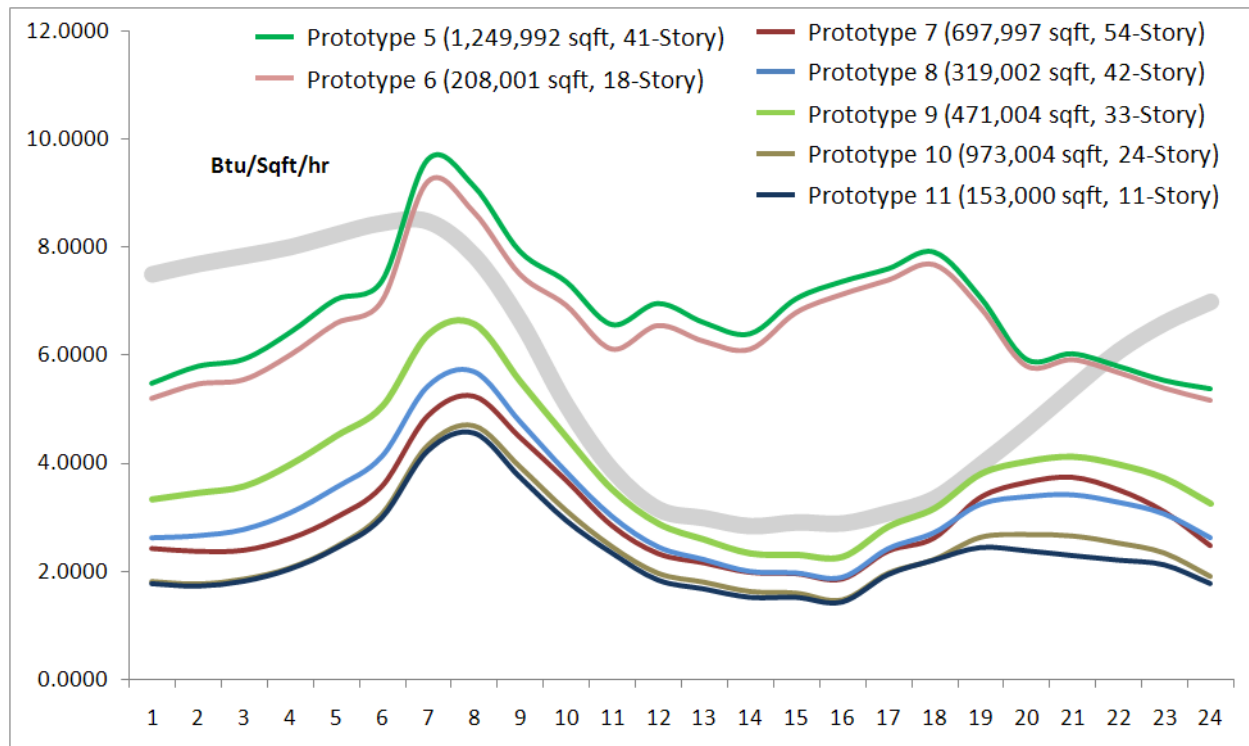


High Rise Residential & Hotel Buildings – Prototypes 5, 6, 7, 8, 9, 10 and 11 Average Heat for December – March



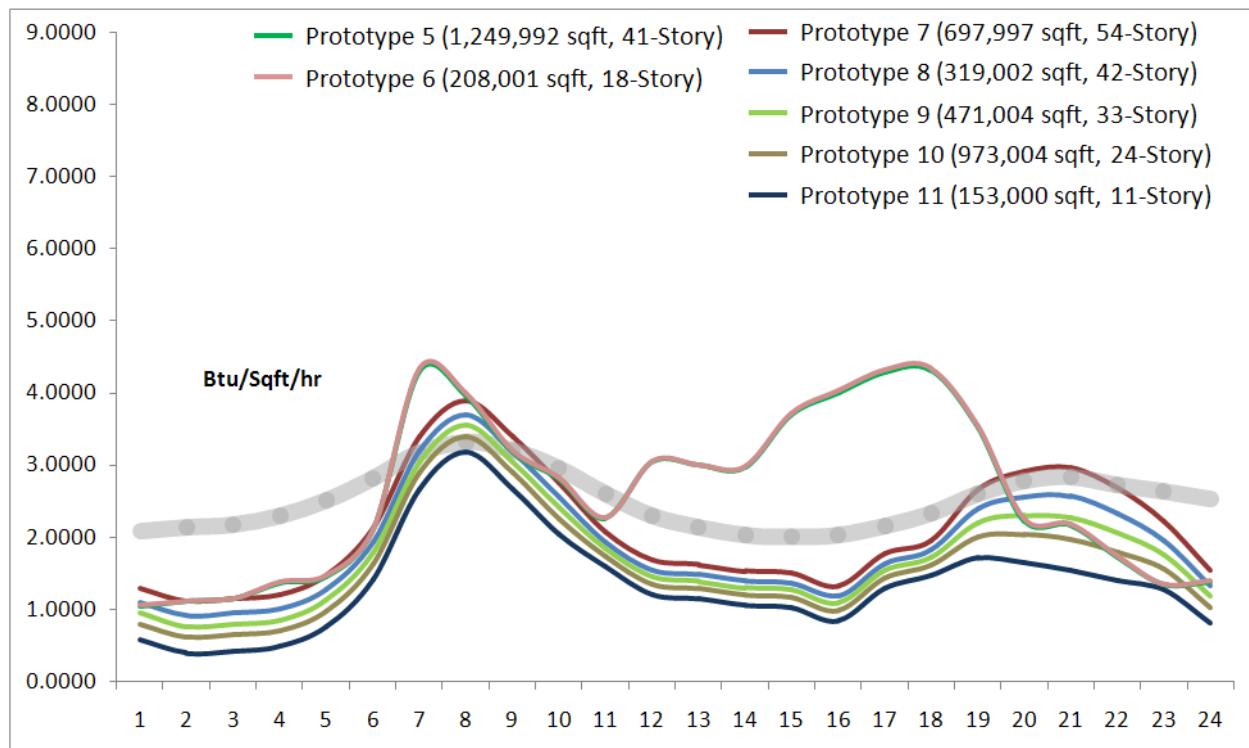
Building prototypes were calibrated assuming central steam heating and 50% steam-driven cooling.

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



Building prototypes were calibrated assuming central steam heating and 50% steam-driven cooling.

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



Building prototypes were calibrated assuming central steam heating and 50% steam-driven cooling.

APPENDIX C – DATA

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

| | Efficiency Measure | Quantity of Spaces that Adopt Efficiency Measure | | | | |
|------------------------|--------------------|--|---------|-----|----------|------|
| | | BAU | Mid-Low | Mid | Mid-High | High |
| Office (Total 16) | Appliances | 0 | 0 | 0 | 0 | 0 |
| | CHP | 1 | 2 | 2 | 2 | 2 |
| | 14RA (CHP only) | 2 | 2 | 4 | 5 | 5 |
| | Cool Roof | 1 | 1 | 1 | 3 | 3 |
| | Water Heating | 0 | 0 | 0 | 0 | 0 |
| | Glazing | 2 | 2 | 2 | 3 | 3 |
| | Space Heating | 0 | 0 | 0 | 0 | 0 |
| | Space Cooling | 5 | 6 | 6 | 9 | 9 |
| | 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 |
| | | | | | | |
| Hotel (Total 6) | 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 |
| | Water Heating | 0 | 0 | 0 | 0 | 0 |
| | Glazing | 0 | 0 | 0 | 0 | 0 |
| | Space Heating | 1 | 2 | 2 | 2 | 3 |
| | Space Cooling | 2 | 2 | 3 | 3 | 3 |
| | 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 |
| | | | | | | |
| Residential (Total 36) | Appliances | 0 | 0 | 0 | 0 | 0 |
| | CHP | 4 | 4 | 5 | 7 | 7 |
| | 14RA (CHP only) | 5 | 8 | 8 | 11 | 12 |
| | Cool Roof | 7 | 8 | 9 | 11 | 13 |
| | Water Heating | 0 | 0 | 0 | 0 | 0 |
| | Glazing | 5 | 7 | 8 | 9 | 11 |
| | Space Heating | 9 | 10 | 13 | 14 | 17 |
| | Space Cooling | 12 | 15 | 18 | 21 | 23 |
| | Lighting | 0 | 0 | 0 | 0 | 0 |
| | Roof Insulation | 1 | 3 | 4 | 4 | 5 |
| | Thermal Storage | 1 | 1 | 1 | 3 | 3 |
| | Wall Insulation | 5 | 7 | 7 | 9 | 9 |
| | | | | | | |
| Retail (Total 724) | Appliances | 0 | 0 | 0 | 0 | 0 |
| | CHP | 0 | 0 | 0 | 0 | 0 |
| | 14RA (CHP only) | 0 | 0 | 0 | 0 | 0 |
| | Cool Roof | 0 | 0 | 0 | 0 | 0 |
| | Water Heating | 44 | 56 | 66 | 74 | 84 |
| | Glazing | 75 | 112 | 112 | 127 | 127 |
| | Space Heating | 33 | 40 | 47 | 53 | 61 |
| | Space Cooling | 32 | 39 | 48 | 54 | 60 |
| | 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 |
| | | | | | | |
| Restaurant (Total 47) | Appliances | 0 | 0 | 0 | 0 | 0 |
| | CHP | 0 | 0 | 0 | 0 | 0 |
| | 14RA (CHP only) | 0 | 0 | 0 | 0 | 0 |
| | Cool Roof | 0 | 0 | 0 | 0 | 0 |
| | Water Heating | 7 | 10 | 12 | 13 | 15 |
| | Glazing | 6 | 8 | 8 | 10 | 10 |
| | Space Heating | 21 | 25 | 28 | 33 | 37 |
| | Space Cooling | 16 | 19 | 23 | 27 | 30 |
| | Lighting | 0 | 0 | 0 | 0 | 0 |
| | Roof Insulation | 0 | 0 | 0 | 0 | 0 |
| | Thermal Storage | 0 | 0 | 0 | 0 | 0 |
| | Wall Insulation | 6 | 8 | 8 | 10 | 10 |
| | | | | | | |

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

| | Efficiency Measure | Quantity of Spaces that Adopt Efficiency Measure | | | | |
|------------------------|--------------------|--|------|-------|-------|-------|
| | | No CCT | CCT5 | CCT10 | CCT15 | CCT20 |
| Office (Total 16) | Appliances | 0 | 0 | 0 | 0 | 0 |
| | CHP | 1 | 1 | 2 | 2 | 2 |
| | Cool Roof | 1 | 1 | 1 | 1 | 1 |
| | Water Heating | 0 | 0 | 0 | 0 | 0 |
| | Glazing | 2 | 2 | 2 | 2 | 2 |
| | Space Heating | 0 | 0 | 0 | 0 | 0 |
| | Space Cooling | 5 | 5 | 5 | 5 | 5 |
| | 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 |
| Hotel (Total 6) | Appliances | 0 | 0 | 0 | 0 | 0 |
| | CHP | 1 | 1 | 1 | 1 | 1 |
| | Cool Roof | 0 | 0 | 0 | 0 | 0 |
| | Water Heating | 0 | 0 | 0 | 0 | 0 |
| | Glazing | 0 | 0 | 0 | 0 | 0 |
| | Space Heating | 1 | 1 | 1 | 1 | 1 |
| | Space Cooling | 2 | 2 | 2 | 2 | 2 |
| | 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 |
| Residential (Total 36) | Appliances | 0 | 0 | 0 | 0 | 0 |
| | CHP | 4 | 4 | 5 | 5 | 5 |
| | Cool Roof | 7 | 7 | 7 | 7 | 7 |
| | Water Heating | 0 | 0 | 0 | 0 | 0 |
| | Glazing | 5 | 6 | 6 | 6 | 6 |
| | Space Heating | 9 | 9 | 9 | 9 | 9 |
| | Space Cooling | 12 | 12 | 13 | 13 | 13 |
| | Lighting | 0 | 0 | 0 | 0 | 0 |
| | Roof Insulation | 1 | 1 | 2 | 2 | 3 |
| | Thermal Storage | 1 | 1 | 1 | 1 | 1 |
| | Wall Insulation | 5 | 5 | 5 | 5 | 5 |
| Retail (Total 724) | Appliances | 0 | 0 | 0 | 0 | 0 |
| | CHP | 0 | 0 | 0 | 0 | 0 |
| | Cool Roof | 0 | 0 | 0 | 0 | 0 |
| | Water Heating | 44 | 45 | 45 | 48 | 48 |
| | Glazing | 75 | 75 | 75 | 75 | 99 |
| | Space Heating | 33 | 33 | 33 | 34 | 34 |
| | Space Cooling | 32 | 33 | 34 | 36 | 36 |
| | 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 |
| | CHP | 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 26 - Quantity of Spaces that Adopt Efficiency Measures at Mid-Low Market Penetrations with a CCT Policy of \$5 to \$20/MT

| | Efficiency Measure | Quantity of Spaces that Adopt Efficiency Measure | | | | |
|------------------------|--------------------|--|------|-------|-------|-------|
| | | No CCT | CCT5 | CCT10 | CCT15 | CCT20 |
| Office (Total 16) | Appliances | 0 | 0 | 0 | 0 | 0 |
| | CHP | 2 | 2 | 2 | 2 | 2 |
| | Cool Roof | 1 | 1 | 1 | 1 | 1 |
| | Water Heating | 0 | 0 | 0 | 0 | 0 |
| | 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 |
| | | | | | | |
| Hotel (Total 6) | Appliances | 0 | 0 | 0 | 0 | 0 |
| | CHP | 1 | 1 | 1 | 1 | 1 |
| | Cool Roof | 0 | 0 | 0 | 0 | 0 |
| | Water Heating | 0 | 0 | 0 | 0 | 0 |
| | Glazing | 0 | 0 | 0 | 0 | 0 |
| | Space Heating | 2 | 2 | 2 | 2 | 2 |
| | Space Cooling | 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 |
| | | | | | | |
| Residential (Total 36) | Appliances | 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 |
| | 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 | 4 |
| | Thermal Storage | 1 | 1 | 1 | 1 | 1 |
| | Wall Insulation | 7 | 7 | 7 | 7 | 7 |
| | | | | | | |
| Retail (Total 724) | Appliances | 0 | 0 | 0 | 0 | 0 |
| | CHP | 0 | 0 | 0 | 0 | 0 |
| | Cool 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 | 0 | 0 | 0 | 0 | 0 |
| | Thermal Storage | 0 | 0 | 0 | 0 | 0 |
| | Wall Insulation | 112 | 112 | 112 | 112 | 112 |
| | | | | | | |
| Restaurant (Total 47) | Appliances | 0 | 0 | 0 | 0 | 0 |
| | CHP | 0 | 0 | 0 | 0 | 0 |
| | Cool Roof | 0 | 0 | 0 | 0 | 0 |
| | Water Heating | 10 | 10 | 10 | 10 | 10 |
| | Glazing | 8 | 8 | 8 | 8 | 8 |
| | 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 |
| | Thermal Storage | 0 | 0 | 0 | 0 | 0 |
| | Wall Insulation | 8 | 8 | 8 | 8 | 8 |
| | | | | | | |

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

| | Efficiency Measure | Quantity of Spaces that Adopt Efficiency Measure | | | | |
|------------------------|--------------------|--|------|-------|-------|-------|
| | | No CCT | CCT5 | CCT10 | CCT15 | CCT20 |
| Office (Total 16) | Appliances | 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 |
| | Glazing | 2 | 2 | 2 | 2 | 2 |
| | Space Heating | 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 |
| | Thermal Storage | 4 | 4 | 4 | 4 | 4 |
| | Wall Insulation | 2 | 2 | 2 | 2 | 2 |
| Hotel (Total 6) | Appliances | 0 | 0 | 0 | 0 | 0 |
| | CHP | 1 | 1 | 1 | 1 | 2 |
| | Cool Roof | 0 | 0 | 0 | 0 | 0 |
| | Water Heating | 0 | 0 | 0 | 0 | 0 |
| | Glazing | 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 |
| | Wall Insulation | 0 | 0 | 0 | 0 | 0 |
| Residential (Total 36) | Appliances | 0 | 0 | 0 | 0 | 0 |
| | CHP | 5 | 7 | 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 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 |
| | Wall Insulation | 7 | 8 | 8 | 9 | 9 |
| Retail (Total 724) | 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 Heating | 47 | 47 | 47 | 47 | 47 |
| | Space Cooling | 48 | 48 | 48 | 48 | 50 |
| | 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 |
| Restaurant (Total 47) | Appliances | 0 | 0 | 0 | 0 | 0 |
| | CHP | 0 | 0 | 0 | 0 | 0 |
| | Cool Roof | 0 | 0 | 0 | 0 | 0 |
| | Water 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 |
| | Wall Insulation | 8 | 9 | 9 | 10 | 10 |

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

| | Efficiency Measure | Quantity of Spaces that Adopt Efficiency Measure | | | | |
|------------------------|--------------------|--|------|-------|-------|-------|
| | | No CCT | CCT5 | CCT10 | CCT15 | CCT20 |
| Office (Total 16) | Appliances | 0 | 0 | 0 | 0 | 0 |
| | CHP | 2 | 2 | 4 | 4 | 4 |
| | Cool Roof | 3 | 3 | 3 | 3 | 3 |
| | Water Heating | 0 | 0 | 0 | 0 | 0 |
| | Glazing | 3 | 3 | 3 | 3 | 3 |
| | Space Heating | 0 | 0 | 0 | 0 | 0 |
| | Space Cooling | 9 | 9 | 9 | 9 | 9 |
| | 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 |
| Hotel (Total 6) | Appliances | 0 | 0 | 0 | 0 | 0 |
| | CHP | 1 | 1 | 2 | 2 | 2 |
| | Cool Roof | 0 | 0 | 0 | 0 | 0 |
| | Water Heating | 0 | 0 | 0 | 0 | 0 |
| | Glazing | 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 |
| | Wall Insulation | 0 | 0 | 0 | 0 | 0 |
| Residential (Total 36) | Appliances | 0 | 0 | 0 | 0 | 0 |
| | CHP | 7 | 8 | 9 | 11 | 11 |
| | Cool Roof | 11 | 12 | 12 | 12 | 14 |
| | Water Heating | 0 | 0 | 0 | 0 | 0 |
| | Glazing | 9 | 9 | 10 | 11 | 11 |
| | Space Heating | 14 | 14 | 14 | 16 | 16 |
| | Space Cooling | 21 | 21 | 21 | 21 | 21 |
| | Lighting | 0 | 0 | 0 | 0 | 0 |
| | Roof Insulation | 4 | 5 | 5 | 5 | 5 |
| | Thermal Storage | 3 | 3 | 3 | 3 | 3 |
| | Wall Insulation | 9 | 9 | 9 | 9 | 9 |
| Retail (Total 724) | Appliances | 0 | 0 | 0 | 0 | 0 |
| | CHP | 0 | 0 | 0 | 0 | 0 |
| | Cool Roof | 0 | 0 | 0 | 0 | 0 |
| | Water Heating | 74 | 74 | 74 | 74 | 74 |
| | Glazing | 127 | 127 | 127 | 127 | 127 |
| | Space Heating | 53 | 53 | 54 | 55 | 55 |
| | Space Cooling | 54 | 54 | 56 | 56 | 56 |
| | Lighting | 0 | 0 | 0 | 0 | 0 |
| | Roof Insulation | 0 | 0 | 0 | 0 | 0 |
| | Thermal Storage | 0 | 0 | 0 | 0 | 0 |
| | Wall Insulation | 127 | 127 | 127 | 127 | 127 |
| Restaurant (Total 47) | Appliances | 0 | 0 | 0 | 0 | 0 |
| | CHP | 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 | 0 |
| | Roof Insulation | 0 | 0 | 0 | 0 | 0 |
| | Thermal Storage | 0 | 0 | 0 | 0 | 0 |
| | Wall Insulation | 10 | 10 | 10 | 10 | 10 |

Table 29 - Quantity of Spaces that Adopt Efficiency Measures at High Market Penetrations with a CCT Policy of \$5 to \$20/MT

| | Efficiency Measure | Quantity of Spaces that Adopt Efficiency Measure | | | | |
|------------------------|--------------------|--|------|-------|-------|-------|
| | | No CCT | CCT5 | CCT10 | CCT15 | CCT20 |
| Office (Total 16) | Appliances | 0 | 0 | 0 | 0 | 0 |
| | CHP | 2 | 4 | 4 | 5 | 5 |
| | Cool Roof | 3 | 4 | 4 | 4 | 4 |
| | Water Heating | 0 | 0 | 0 | 0 | 0 |
| | Glazing | 3 | 4 | 4 | 4 | 4 |
| | Space Heating | 0 | 0 | 0 | 0 | 0 |
| | Space Cooling | 9 | 9 | 9 | 9 | 9 |
| | 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 |
| Hotel (Total 6) | Appliances | 0 | 0 | 0 | 0 | 0 |
| | CHP | 2 | 2 | 2 | 2 | 2 |
| | Cool Roof | 0 | 0 | 0 | 0 | 1 |
| | Water Heating | 0 | 0 | 0 | 0 | 0 |
| | Glazing | 0 | 0 | 0 | 0 | 0 |
| | Space Heating | 3 | 3 | 3 | 3 | 3 |
| | Space Cooling | 3 | 3 | 3 | 3 | 4 |
| | 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 |
| Residential (Total 36) | Appliances | 0 | 0 | 0 | 0 | 0 |
| | CHP | 7 | 9 | 11 | 11 | 12 |
| | Cool Roof | 13 | 15 | 15 | 15 | 15 |
| | Water Heating | 0 | 0 | 0 | 0 | 0 |
| | Glazing | 11 | 11 | 12 | 12 | 12 |
| | Space Heating | 17 | 18 | 18 | 18 | 18 |
| | Space Cooling | 23 | 24 | 24 | 24 | 25 |
| | Lighting | 0 | 0 | 0 | 0 | 0 |
| | Roof Insulation | 5 | 5 | 5 | 5 | 5 |
| | Thermal Storage | 3 | 3 | 3 | 3 | 3 |
| | Wall Insulation | 9 | 9 | 11 | 11 | 12 |
| Retail (Total 724) | Appliances | 0 | 0 | 0 | 0 | 0 |
| | CHP | 0 | 0 | 0 | 0 | 0 |
| | Cool Roof | 0 | 0 | 0 | 0 | 0 |
| | Water Heating | 84 | 84 | 84 | 84 | 84 |
| | Glazing | 127 | 127 | 164 | 164 | 187 |
| | Space Heating | 61 | 61 | 61 | 62 | 62 |
| | Space Cooling | 60 | 62 | 62 | 63 | 64 |
| | Lighting | 0 | 0 | 0 | 0 | 0 |
| | Roof Insulation | 0 | 0 | 0 | 0 | 0 |
| | Thermal Storage | 0 | 0 | 0 | 0 | 0 |
| | Wall Insulation | 127 | 127 | 164 | 164 | 187 |
| Restaurant (Total 47) | Appliances | 0 | 0 | 0 | 0 | 0 |
| | CHP | 0 | 0 | 0 | 0 | 0 |
| | Cool Roof | 0 | 0 | 0 | 0 | 0 |
| | Water Heating | 15 | 15 | 16 | 16 | 16 |
| | Glazing | 10 | 10 | 13 | 13 | 14 |
| | Space Heating | 37 | 37 | 37 | 37 | 37 |
| | Space Cooling | 30 | 30 | 31 | 31 | 31 |
| | 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 |

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 |
| Baseline | 38,767,980 | 441,802 | 30,348 | 472,150 | 0 |
| Baseline + Combined Heat and Power, 6500 kW, 1390 ton absorber | 17,283,500 | 196,963 | 223,037 | 420,000 | 52,150 |
| Baseline + Cool Roof, 100% of roof at Abs=0.3 | 38,774,800 | 441,882 | 30,372 | 472,254 | -104 |
| Baseline + High Efficiency Glazing, U=0.26, SHGC=0.29 | 38,248,720 | 435,887 | 21,827 | 457,714 | 14,437 |
| Baseline + High Efficiency Heating, Boiler Comb Eff = 85% | 38,767,980 | 441,802 | 28,586 | 470,388 | 1,762 |
| Baseline + High Efficiency Cooling, 0.461 kW/ton Centrifugal Chillers | 37,746,150 | 430,159 | 30,348 | 460,507 | 11,643 |
| Baseline + High Efficiency Lighting, 0.9 watts/sqft | 36,913,150 | 420,666 | 31,218 | 451,885 | 20,265 |
| Baseline + Envelope Insulation - Roof, 6" R23 XPS | 38,752,680 | 441,628 | 30,332 | 471,960 | 190 |
| Baseline + Thermal Storage, 25% of max load, 23376 ton-hrs | 39,421,300 | 449,250 | 30,348 | 479,598 | -7,448 |
| Baseline + Envelope Insulation - Walls, Reduced thermal bridging | 38,376,280 | 437,340 | 22,407 | 459,746 | 12,404 |

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 |
| Baseline | 32,359,210 | 368,769 | 28,406 | 397,176 | 0 |
| Baseline + Combined Heat and Power, 5500 kW, 1150 ton absorber | 14,105,440 | 160,748 | 190,703 | 351,450 | 45,725 |
| Baseline + Cool Roof, 100% of roof at Abs=0.3 | 32,363,580 | 368,820 | 28,427 | 397,247 | -71 |
| Baseline + High Efficiency Glazing, U=0.26, SHGC=0.29 | 31,921,900 | 363,786 | 21,340 | 385,126 | 12,049 |
| Baseline + High Efficiency Heating, Boiler Comb Eff = 85% | 32,359,210 | 368,769 | 26,750 | 395,519 | 1,656 |
| Baseline + High Efficiency Cooling, 0.461 kW/ton Centrifugal Chillers | 31,611,400 | 360,246 | 28,406 | 388,652 | 8,524 |
| Baseline + High Efficiency Lighting, 0.9 watts/sqft | 30,726,770 | 350,166 | 29,276 | 379,442 | 17,734 |
| Baseline + Envelope Insulation - Roof, 6" R23 XPS | 32,349,180 | 368,653 | 28,391 | 397,044 | 132 |
| Baseline + Thermal Storage, 25% of max load, 15073 ton-hrs | 32,826,030 | 374,087 | 28,406 | 402,493 | -5,317 |
| Baseline + Envelope Insulation - Walls, Reduced thermal bridging | 32,029,310 | 365,009 | 21,806 | 386,814 | 10,361 |

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 |
| Baseline | 28,152,040 | 320,824 | 26,438 | 347,261 | 0 |
| Baseline + Combined Heat and Power, 4500 kW, 1020 ton absorber | 12,667,300 | 144,358 | 162,517 | 306,876 | 40,386 |
| Baseline + Cool Roof, 100% of roof at Abs=0.3 | 28,147,870 | 320,777 | 26,458 | 347,235 | 27 |
| Baseline + High Efficiency Glazing, U=0.26, SHGC=0.29 | 27,771,460 | 316,485 | 20,388 | 336,873 | 10,388 |
| Baseline + High Efficiency Heating, Boiler Comb Eff = 85% | 28,152,040 | 320,824 | 24,893 | 345,717 | 1,544 |
| Baseline + High Efficiency Cooling, 0.461 kW/ton Centrifugal Chillers | 27,530,860 | 313,743 | 26,438 | 340,181 | 7,081 |
| Baseline + High Efficiency Lighting, 0.9 watts/sqft | 26,688,450 | 304,144 | 27,330 | 331,474 | 15,788 |
| Baseline + Envelope Insulation - Roof, 6" R23 XPS | 28,146,790 | 320,764 | 26,424 | 347,188 | 74 |
| Baseline + Thermal Storage, 25% of max load, 16172 ton-hrs | 28,518,920 | 325,005 | 26,438 | 351,443 | -4,182 |
| Baseline + Envelope Insulation - Walls, Reduced thermal bridging | 27,860,100 | 317,497 | 20,777 | 338,274 | 8,988 |

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 |
| Baseline | 14,371,930 | 163,784 | 11,065 | 174,848 | 0 |
| Baseline + Combined Heat and Power, 3000 kW, 490 ton absorber | 5,542,578 | 63,163 | 92,572 | 155,734 | 19,114 |
| Baseline + Cool Roof, 100% of roof at Abs=0.3 | 14,366,120 | 163,717 | 11,096 | 174,813 | 35 |
| Baseline + High Efficiency Glazing, U=0.26, SHGC=0.29 | 14,226,000 | 162,120 | 9,032 | 171,153 | 3,696 |
| Baseline + High Efficiency Heating, Boiler Comb Eff = 85% | 14,371,930 | 163,784 | 10,418 | 174,201 | 647 |
| Baseline + High Efficiency Cooling, 0.461 kW/ton Centrifugal Chillers | 14,084,210 | 160,504 | 11,065 | 171,568 | 3,280 |
| Baseline + High Efficiency Lighting, 0.9 watts/sqft | 13,579,380 | 154,752 | 11,733 | 166,485 | 8,363 |
| Baseline + Envelope Insulation - Roof, 6" R23 XPS | 14,368,340 | 163,744 | 11,034 | 174,778 | 70 |
| Baseline + Thermal Storage, 25% of max load, 7818 ton-hrs | 14,485,280 | 165,076 | 11,065 | 176,141 | -1,293 |
| Baseline + Envelope Insulation - Walls, R19, 2x4.16 | 14,365,820 | 163,713 | 10,867 | 174,580 | 268 |

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 |
| Baseline | 17,289,660 | 197,033 | 96,974 | 294,007 | 0 |
| Baseline + Combined Heat and Power, 2500 kW, 500 ton absorber | 9,707,363 | 110,627 | 150,694 | 261,321 | 32,686 |
| Baseline + Cool Roof, 100% of roof at Abs=0.3 | 17,284,260 | 196,973 | 97,005 | 293,978 | 30 |
| Baseline + High Efficiency Glazing, U=0.26, SHGC=0.29 | 17,329,680 | 197,491 | 89,732 | 287,223 | 6,785 |
| Baseline + High Efficiency Heating, Boiler Comb Eff = 85% | 17,289,660 | 197,033 | 91,892 | 288,925 | 5,082 |
| Baseline + High Efficiency Cooling, 0.461 kW/ton Centrifugal Chillers | 16,822,640 | 191,713 | 96,974 | 288,687 | 5,321 |
| Baseline + High Efficiency Lighting, 1.19 watts/sqft | 16,881,320 | 192,381 | 97,508 | 289,889 | 4,119 |
| Baseline + Envelope Insulation - Roof, 6" R23 XPS | 17,289,770 | 197,037 | 96,942 | 293,978 | 29 |
| Baseline + Thermal Storage, 15% of max load, 7799 ton-hrs | 17,393,510 | 198,219 | 96,974 | 295,193 | -1,186 |
| Baseline + Envelope Insulation - Walls, Reduced thermal bridging | 17,378,830 | 198,052 | 89,881 | 287,933 | 6,075 |

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 | Gas MMBtu | Total MMBtu | Total MMBtu | MMBtu Diff |
| Baseline | 2,895,951 | 33,003 | 14,824 | 47,827 | 0 |
| Baseline + Combined Heat and Power, 400 kW, 80 ton absorber | 1,642,262 | 18,714 | 23,980 | 42,695 | 5,133 |
| Baseline + Cool Roof, 100% of roof at Abs=0.3 | 2,894,049 | 32,979 | 14,832 | 47,811 | 16 |
| Baseline + High Efficiency Glazing, U=0.26, SHGC=0.29 | 2,914,989 | 33,220 | 14,106 | 47,326 | 501 |
| Baseline + High Efficiency Heating, Boiler Comb Eff = 85% | 2,895,951 | 33,003 | 14,056 | 47,059 | 768 |
| Baseline + High Efficiency Cooling, 0.461 kW/ton Centrifugal Chillers | 2,814,202 | 32,071 | 14,824 | 46,895 | 932 |
| Baseline + High Efficiency Lighting, 1.19 watts/sqft | 2,826,321 | 32,208 | 14,890 | 47,098 | 729 |
| Baseline + Envelope Insulation - Roof, 6" R23 XPS | 2,895,858 | 33,003 | 14,815 | 47,818 | 9 |
| Baseline + Thermal Storage, 15% of max load, 1265 ton-hrs | 2,913,303 | 33,200 | 14,824 | 48,024 | -197 |
| Baseline + Envelope Insulation - Walls, R19, 2x4.16 | 2,898,873 | 33,036 | 14,733 | 47,769 | 58 |

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 | Gas MMBtu | Total MMBtu | Total MMBtu | MMBtu Diff |
| Baseline | 8,664,978 | 98,747 | 36,336 | 135,083 | 0 |
| Baseline + High Efficiency Appliances, Energy Star Rated | 8,660,950 | 98,700 | 36,339 | 135,040 | 44 |
| Baseline + Combined Heat and Power, 1500 kW, 300 ton absorber | 4,762,240 | 54,272 | 68,112 | 122,383 | 12,700 |
| Baseline + Cool Roof, 100% of roof at Abs=0.3 | 8,661,909 | 98,710 | 36,349 | 135,059 | 24 |
| Baseline + High Efficiency Glazing, U=0.26, SHGC=0.29 | 8,334,327 | 94,980 | 28,877 | 123,857 | 11,226 |
| Baseline + High Efficiency Heating, Boiler Comb Eff = 85% | 8,664,978 | 98,747 | 34,546 | 133,293 | 1,790 |
| Baseline + High Efficiency Cooling, 0.461 kW/ton Centrifugal Chillers | 8,407,912 | 95,818 | 36,336 | 132,154 | 2,929 |
| Baseline + High Efficiency Lighting, 0.675 watts/sqft | 8,585,753 | 97,845 | 36,400 | 134,245 | 838 |
| Baseline + Envelope Insulation - Roof, 6" R23 XPS | 8,664,109 | 98,737 | 36,327 | 135,064 | 19 |
| Baseline + Thermal Storage, 15% of max load, 3751 ton-hrs | 8,754,765 | 99,769 | 36,336 | 136,105 | -1,022 |
| Baseline + Envelope Insulation - Walls, Reduced thermal bridging | 8,435,743 | 96,135 | 29,454 | 125,589 | 9,494 |

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 | Gas MMBtu | Total MMBtu | Total MMBtu | MMBtu Diff |
| Baseline | 4,094,859 | 46,666 | 22,178 | 68,844 | 0 |
| Baseline + High Efficiency Appliances, Energy Star Rated | 4,093,069 | 46,646 | 22,179 | 68,825 | 19 |
| Baseline + Combined Heat and Power, 750 kW, 160 ton absorber | 2,239,767 | 25,524 | 37,403 | 62,927 | 5,917 |
| Baseline + Cool Roof, 100% of roof at Abs=0.3 | 4,093,093 | 46,646 | 22,187 | 68,833 | 11 |
| Baseline + High Efficiency Glazing, U=0.26, SHGC=0.29 | 3,889,771 | 44,328 | 17,492 | 61,821 | 7,023 |
| Baseline + High Efficiency Heating, Boiler Comb Eff = 85% | 4,094,859 | 46,666 | 20,995 | 67,662 | 1,182 |
| Baseline + High Efficiency Cooling, 0.461 kW/ton Centrifugal Chillers | 3,980,826 | 45,367 | 22,178 | 67,545 | 1,299 |
| Baseline + High Efficiency Lighting, 0.675 watts/sqft | 4,059,815 | 46,266 | 22,210 | 68,476 | 368 |
| Baseline + Envelope Insulation - Roof, 6" R23 XPS | 4,094,356 | 46,660 | 22,170 | 68,830 | 14 |
| Baseline + Thermal Storage, 15% of max load, 1820 ton-hrs | 4,132,463 | 47,094 | 22,178 | 69,272 | -428 |
| Baseline + Envelope Insulation - Walls, Reduced thermal bridging | 3,952,591 | 45,043 | 17,863 | 62,906 | 5,938 |

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 |
| Category and Measure | Elec kWh | Elec MMBtu | Gas MMBtu | Total MMBtu | MMBtu Diff |
| Baseline | 5,419,618 | 61,763 | 25,283 | 87,046 | 0 |
| Baseline + High Efficiency Appliances, Energy Star Rated | 5,416,972 | 61,733 | 25,285 | 87,018 | 28 |
| Baseline + Combined Heat and Power, 850 kW, 180 ton absorber | 2,996,552 | 34,148 | 44,579 | 78,727 | 8,319 |
| Baseline + Cool Roof, 100% of roof at Abs=0.3 | 5,415,965 | 61,720 | 25,296 | 87,015 | 31 |
| Baseline + High Efficiency Glazing, U=0.26, SHGC=0.29 | 5,200,928 | 59,272 | 20,313 | 79,584 | 7,462 |
| Baseline + High Efficiency Heating, Boiler Comb Eff = 85% | 5,419,618 | 61,763 | 23,939 | 85,702 | 1,344 |
| Baseline + High Efficiency Cooling, 0.461 kW/ton Centrifugal Chillers | 5,287,690 | 60,260 | 25,283 | 85,543 | 1,503 |
| Baseline + High Efficiency Lighting, 0.675 watts/sqft | 5,367,563 | 61,169 | 25,332 | 86,501 | 545 |
| Baseline + Envelope Insulation - Roof, 6" R23 XPS | 5,418,693 | 61,753 | 25,272 | 87,026 | 20 |
| Baseline + Thermal Storage, 15% of max load, 2143 ton-hrs | 5,463,198 | 62,258 | 25,283 | 87,541 | -494 |
| Baseline + Envelope Insulation - Walls, Reduced thermal bridging | 5,268,925 | 60,047 | 20,760 | 80,806 | 6,240 |

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 |
| Baseline | 9,816,055 | 111,863 | 36,286 | 148,149 | 0 |
| Baseline + High Efficiency Appliances, Energy Star Rated | 9,810,413 | 111,800 | 36,290 | 148,090 | 59 |
| Baseline + Combined Heat and Power, 1500 kW, 250 ton absorber | 5,429,196 | 61,870 | 69,878 | 131,748 | 16,401 |
| Baseline + Cool Roof, 100% of roof at Abs=0.3 | 9,803,718 | 111,723 | 36,315 | 148,038 | 111 |
| Baseline + High Efficiency Glazing, U=0.26, SHGC=0.29 | 9,560,870 | 108,957 | 30,518 | 139,475 | 8,674 |
| Baseline + High Efficiency Heating, Boiler Comb Eff = 85% | 9,816,055 | 111,863 | 34,366 | 146,229 | 1,920 |
| Baseline + High Efficiency Cooling, 0.461 kW/ton Centrifugal Chillers | 9,621,466 | 109,646 | 36,286 | 145,931 | 2,218 |
| Baseline + High Efficiency Lighting, 0.675 watts/sqft | 9,707,522 | 110,627 | 36,381 | 147,009 | 1,141 |
| Baseline + Envelope Insulation - Roof, 6" R23 XPS | 9,813,230 | 111,833 | 36,265 | 148,098 | 51 |
| Baseline + Thermal Storage, 15% of max load, 3299 ton-hrs | 9,888,220 | 112,688 | 36,286 | 148,974 | -825 |
| Baseline + Envelope Insulation - Walls, Reduced thermal bridging | 9,640,668 | 109,866 | 31,024 | 140,890 | 7,260 |

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 |
| Baseline | 1,522,627 | 17,351 | 6,047 | 23,399 | 0 |
| Baseline + High Efficiency Appliances, Energy Star Rated | 1,521,775 | 17,341 | 6,049 | 23,390 | 9 |
| Baseline + Combined Heat and Power, 250 kW, 40 ton absorber | 830,077 | 9,459 | 12,717 | 22,176 | 1,223 |
| Baseline + Cool Roof, 100% of roof at Abs=0.3 | 1,517,903 | 17,298 | 6,057 | 23,355 | 44 |
| Baseline + High Efficiency Glazing, U=0.26, SHGC=0.29 | 1,459,927 | 16,637 | 4,933 | 21,570 | 1,829 |
| Baseline + High Efficiency Heating, Boiler Comb Eff = 85% | 1,522,627 | 17,351 | 5,707 | 23,058 | 340 |
| Baseline + High Efficiency Cooling, 0.461 kW/ton Centrifugal Chillers | 1,491,627 | 16,997 | 6,047 | 23,045 | 354 |
| Baseline + High Efficiency Lighting, 0.675 watts/sqft | 1,506,623 | 17,171 | 6,069 | 23,240 | 158 |
| Baseline + Envelope Insulation - Roof, 6" R23 XPS | 1,522,280 | 17,348 | 6,046 | 23,394 | 4 |
| Baseline + Thermal Storage, 15% of max load, 506 ton-hrs | 1,525,671 | 17,388 | 6,047 | 23,436 | -37 |
| Baseline + Envelope Insulation - Walls, R19, 2x4.16 | 1,520,553 | 17,328 | 5,944 | 23,272 | 127 |

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 |
| Category and Measure | Elec kWh | Elec MMBtu | Gas MMBtu | Total MMBtu | MMBtu Diff |
| Baseline | 18,848,550 | 214,799 | 20,858 | 235,657 | 0 |
| Baseline + Combined Heat and Power, 3500 kW, 680 ton absorber | 7,758,062 | 88,413 | 118,310 | 206,723 | 28,934 |
| Baseline + High Efficiency Glazing, U=0.26, SHGC=0.29 | 18,567,840 | 211,599 | 16,250 | 227,850 | 7,808 |
| Baseline + High Efficiency Heating, Boiler Comb Eff = 85% | 18,848,550 | 214,799 | 19,638 | 234,436 | 1,221 |
| Baseline + High Efficiency Cooling, 0.461 kW/ton Centrifugal Chillers | 18,456,650 | 210,333 | 20,858 | 231,191 | 4,466 |
| Baseline + High Efficiency Lighting, 0.9 watts/sqft | 17,873,240 | 203,683 | 21,586 | 225,269 | 10,388 |
| Baseline + Thermal Storage, 25% of max load, 10798 ton-hrs | 19,028,540 | 216,850 | 20,858 | 237,708 | -2,051 |
| Baseline + Envelope Insulation - Walls, Reduced thermal bridging | 18,625,810 | 212,260 | 16,514 | 228,775 | 6,882 |

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

| Category and Measure | Elec Cost | Gas Cost | Total Cost | Alt Cost | Payback |
|---|-------------|------------|-------------|-------------|------------|
| 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 |
| Category and Measure | Elec kWh | Elec MMBtu | Gas MMBtu | Total MMBtu | MMBtu Diff |
| Baseline | 10,064,280 | 114,692 | 37,564 | 152,257 | 0 |
| Baseline + High Efficiency Appliances, Energy Star Rated | 10,058,920 | 114,632 | 37,566 | 152,199 | 58 |
| Baseline + Combined Heat and Power, 1500 kW, 270 ton absorber | 5,588,816 | 63,690 | 71,888 | 135,579 | 16,678 |
| Baseline + Cool Roof, 100% of roof at Abs=0.3 | 10,053,900 | 114,575 | 37,593 | 152,168 | 89 |
| Baseline + High Efficiency Glazing, U=0.26, SHGC=0.29 | 9,791,154 | 111,579 | 31,231 | 142,810 | 9,446 |
| Baseline + High Efficiency Heating, Boiler Comb Eff = 85% | 10,064,280 | 114,692 | 35,598 | 150,290 | 1,966 |
| Baseline + High Efficiency Cooling, 0.461 kW/ton Centrifugal Chillers | 9,854,940 | 112,308 | 37,564 | 149,872 | 2,385 |
| Baseline + High Efficiency Lighting, 0.675 watts/sqft | 9,954,384 | 113,440 | 37,605 | 151,045 | 1,212 |
| Baseline + Envelope Insulation - Roof, 6" R23 XPS | 10,062,010 | 114,669 | 37,560 | 152,229 | 28 |
| Baseline + Thermal Storage, 15% of max load, 3472 ton-hrs | 10,140,410 | 115,561 | 37,564 | 153,125 | -868 |
| Baseline + Envelope Insulation - Walls, Reduced thermal bridging | 9,876,738 | 112,555 | 31,780 | 144,334 | 7,922 |

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 |
| Baseline | 44,572 | 508 | 188 | 696 | 0 |
| Baseline + High Efficiency Domestic Hot Water, EF=0.823 | 44,572 | 508 | 170 | 677 | 19 |
| Baseline + High Efficiency Glazing, U=0.26, SHGC=0.29 | 42,964 | 491 | 177 | 668 | 28 |
| Baseline + High Efficiency Heating, Furnace 94% AFUE | 44,572 | 508 | 165 | 673 | 23 |
| Baseline + High Efficiency Cooling, 14 SEER, 12.5 EER Unitary AC | 42,399 | 484 | 188 | 673 | 23 |
| Baseline + Envelope Insulation - Walls, Reduced thermal bridging | 43,709 | 498 | 174 | 671 | 25 |

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 |
| Baseline | 376,430 | 4,289 | 2,933 | 7,221 | 0 |
| Baseline + High Efficiency Domestic Hot Water, EF=0.823 | 376,430 | 4,289 | 2,922 | 7,211 | 10 |
| Baseline + High Efficiency Glazing, U=0.26, SHGC=0.29 | 374,525 | 4,269 | 2,900 | 7,169 | 52 |
| Baseline + High Efficiency Heating, Furnace 94% AFUE | 376,430 | 4,289 | 2,706 | 6,995 | 226 |
| Baseline + High Efficiency Cooling, 14 SEER, 12.5 EER Unitary AC | 369,577 | 4,212 | 2,933 | 7,144 | 77 |
| Baseline + Envelope Insulation - Walls, Reduced thermal bridging | 374,653 | 4,269 | 2,904 | 7,173 | 48 |

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 kWh | Elec MMBtu | Gas MMBtu | Total MMBtu | MMBtu Diff |
| Baseline | 41,614 | 474 | 133 | 607 | 0 |
| Baseline + High Efficiency Domestic Hot Water, EF=0.823 | 41,614 | 474 | 115 | 589 | 18 |
| Baseline + High Efficiency Glazing, U=0.26, SHGC=0.29 | 40,421 | 461 | 125 | 586 | 22 |
| Baseline + High Efficiency Heating, Furnace 94% AFUE | 41,614 | 474 | 119 | 594 | 14 |
| Baseline + High Efficiency Cooling, 14 SEER, 12.5 EER Unitary AC | 39,613 | 451 | 133 | 584 | 23 |
| Baseline + Envelope Insulation - Walls, R19, 2x4.16 | 41,495 | 474 | 130 | 604 | 3 |

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 |
| Baseline | 38,274 | 438 | 116 | 554 | 0 |
| Baseline + High Efficiency Domestic Hot Water, EF=0.823 | 38,274 | 438 | 97 | 535 | 19 |
| Baseline + High Efficiency Glazing, U=0.26, SHGC=0.29 | 37,636 | 428 | 111 | 539 | 15 |
| Baseline + High Efficiency Heating, Furnace 94% AFUE | 38,274 | 438 | 105 | 542 | 12 |
| Baseline + High Efficiency Cooling, 14 SEER, 12.5 EER Unitary AC | 36,617 | 418 | 116 | 534 | 20 |
| Baseline + Envelope Insulation - Walls, R19, 2x4.16 | 38,197 | 434 | 113 | 547 | 6 |

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 |
| Baseline | 370,202 | 4,218 | 2,822 | 7,040 | 0 |
| Baseline + High Efficiency Domestic Hot Water, EF=0.823 | 370,202 | 4,218 | 2,810 | 7,029 | 12 |
| Baseline + High Efficiency Glazing, U=0.26, SHGC=0.29 | 368,631 | 4,202 | 2,798 | 6,999 | 41 |
| Baseline + High Efficiency Heating, Furnace 94% AFUE | 370,202 | 4,218 | 2,613 | 6,832 | 208 |
| Baseline + High Efficiency Cooling, 14 SEER, 12.5 EER Unitary AC | 363,708 | 4,145 | 2,822 | 6,967 | 73 |
| Baseline + Envelope Insulation - Walls, R19, 2x4.16 | 369,779 | 4,215 | 2,814 | 7,029 | 11 |

| Prototype 01 - 56-story Highrise Office (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 | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 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 Space Heating | See Space Heating | See Space Heating | See Space Heating | See Space Heating | See Space Heating | See Space Heating | See Space Heating | See Space Heating | See Space 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 |

| Prototype 02 - 41-story Highrise Office (Qty 6) | | | 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 | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| CHP | None | 5500 kW, 1150 ton absorber | 8.8 | 18% | 1 | 22% | 1 | 25% | 1 | 29% | 1 | 32% | 1 |
| 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 Heating | See Space Heating | See Space Heating | See Space Heating | See Space Heating | See Space Heating | See Space Heating | See Space Heating | See Space Heating | See Space Heating |
| Windows | U=0.50, SHGC=0.35 | U=0.26, SHGC=0.29 | 7.4 | 21% | 1 | 26% | 1 | 30% | 1 | 34% | 2 | 39% | 2 |
| Space Heating | Boiler Comb Eff = 80% | Boiler Comb Eff = 85% | 19.0 | 5% | 0 | 6% | 0 | 7% | 0 | 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 Highrise Office (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 | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 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 Space Heating | See Space Heating | See Space Heating | See Space Heating | See Space Heating | See Space Heating | See Space Heating | See Space Heating | See Space Heating | See Space 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 Midrise Office (Qty 3) | | | 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 | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 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 Space Heating | See Space Heating | See Space Heating | See Space Heating | See Space Heating | See Space Heating | See Space Heating | See Space Heating | See Space Heating | See Space 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 Highrise 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 | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| CHP | None | 2500 kW, 500 ton absorber | 6.5 | 24% | 0 | 29% | 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% | NA | See Space Heating | See Space Heating | See Space Heating | See Space Heating | See Space Heating | See Space Heating | See Space Heating | See Space Heating | See Space Heating | See Space 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 Midrise 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 | NA | NA | NA | NA | NA | NA | NA | NA | NA | 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% | NA | See Space Heating | See Space Heating | See Space Heating | See Space Heating | See Space Heating | See Space Heating | See Space Heating | See Space Heating | See Space Heating | See Space 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 |

| Prototype 07 - 55-story Highrise Residential (Qty 2) | | | 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 | 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% | NA | See Space Heating | See Space Heating | See Space Heating | See Space Heating | See Space Heating | See Space Heating | See Space Heating | See Space Heating | See Space Heating | See Space 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 |

| Prototype 08 - 43-story Highrise Residential (Qty 4) | | | 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 | 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 |
| Roof Material | 100% of roof at Abs=0.90 | 100% of roof at Abs=0.3 | 10.4 | 15% | 0 | 18% | 0 | 21% | 0 | 23% | 0 | 26% | 1 |
| Water Heating | Boiler Comb Eff = 80% | Boiler Comb Eff = 85% | See Space Heating | | | See Space Heating | | See Space Heating | | See Space Heating | | See Space 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 |
| Roof Insulation | 5" R19 XPS | 6" R23 XPS | 6.9 | 23% | 0 | 27% | 1 | 32% | 1 | 36% | 1 | 41% | 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 | 7.3 | 22% | 0 | 26% | 1 | 30% | 1 | 35% | 1 | 39% | 1 |

| Prototype 09 - 34-story Highrise Residential (Qty 10) | | | 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 | State Appliance Regulations | Energy Star Rated | 246.6 | 0% | 0 | 0% | 0 | 0% | 0 | 0% | 0 | 0% | 0 |
| CHP | None | 850 kW, 180 ton absorber | 7.9 | 20% | 2 | 24% | 2 | 28% | 2 | 32% | 3 | 36% | 3 |
| Roof Material | 100% of roof at Abs=0.90 | 100% of roof at Abs=0.3 | 7.4 | 21% | 2 | 26% | 2 | 30% | 2 | 34% | 3 | 38% | 3 |
| Water Heating | Boiler Comb Eff = 80% | Boiler Comb Eff = 85% | See Space Heating | | | See Space Heating | | See Space Heating | | See Space Heating | | See Space 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/sqft | 0.675 watts/sqft | 125.8 | 0% | 0 | 0% | 0 | 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 |

| Prototype 10 - 25-story Highrise Residential (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 | 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% | See Space Heating | | | See Space Heating | | See Space Heating | | See Space Heating | | See Space 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 |
| 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 |
| 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 |

| Prototype 11 - 12-story Midrise Residential (Qty 14) | | | 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 | State Appliance Regulations | Energy Star Rated | 254.8 | 0% | 0 | 0% | 0 | 0% | 0 | 0% | 0 | 0% | 0 |
| CHP | None | 250 kW, 40 ton absorber | 12.1 | 12% | 1 | 14% | 1 | 17% | 2 | 19% | 2 | 21% | 2 |
| Roof Material | 100% of roof at Abs=0.90 | 100% of roof at Abs=0.3 | 4.2 | 32% | 4 | 38% | 5 | 45% | 6 | 51% | 7 | 58% | 8 |
| Water Heating | Boiler Comb Eff = 80% | Boiler Comb Eff = 85% | See Space Heating | | | See Space Heating | | See Space Heating | | See Space Heating | | See Space 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 | 0.70 watts/sqft | 0.675 watts/sqft | 122.7 | 0% | 0 | 0% | 0 | 0% | 0 | 0% | 0 | 0% | 0 |
| Roof Insulation | 5" R19 XPS | 6" R23 XPS | 25.0 | 2% | 0 | 3% | 0 | 3% | 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 |

| Prototype 12 - 55-story Highrise Mixed Use, Office (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 | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 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 | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| Water Heating | Boiler Comb Eff = 80% | Boiler Comb Eff = 85% | See Space Heating | | | See Space Heating | | See Space Heating | | See Space Heating | | See Space Heating | |
| Windows | U=0.50, SHGC=0.35 | U=0.26, SHGC=0.29 | 7.2 | 22% | 0 | 26% | 0 | 31% | 0 | 35% | 0 | 39% | 0 |
| Space Heating | Boiler Comb Eff = 80% | Boiler Comb Eff = 85% | 17.8 | 6% | 0 | 7% | 0 | 8% | 0 | 9% | 0 | 10% | 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 | 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 | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 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 | 8.6 | 18% | 0 | 22% | 0 | 26% | 0 | 30% | 0 | 33% | 0 |

| Prototype 12 - 55-story Highrise Mixed Use, Residential (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 | State Appliance Regulations | Energy Star Rated | 237.0 | 0% | 0 | 0% | 0 | 0% | 0 | 0% | 0 | 0% | 0 |
| CHP | None | 1500 kW, 270 ton absorber | 7.2 | 22% | 0 | 26% | 0 | 31% | 0 | 35% | 0 | 39% | 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 |
| Water Heating | Boiler Comb Eff = 80% | Boiler Comb Eff = 85% | See Space Heating | | | See Space Heating | | See Space Heating | | See Space Heating | | See Space 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 |
| Lighting | 0.70 watts/sqft | 0.675 watts/sqft | 119.3 | 0% | 0 | 0% | 0 | 0% | 0 | 0% | 0 | 0% | 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% | 0 | 4% | 0 | 5% | 0 | 6% | 0 | 6% | 0 |
| Wall Insulation | Typical Aluminum Curtain Wall | Reduced thermal bridging | 7.7 | 21% | 0 | 25% | 0 | 29% | 0 | 33% | 0 | 37% | 0 |

| Corner Retail Shop - Type I Construction (Qty 34 Bldgs) | | | 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 | | | NA | | NA | | NA | | NA | |
| CHP | None | None | NA | | | NA | | NA | | NA | | NA | |
| Roof Material | None | None | NA | | | NA | | NA | | NA | | NA | |
| Water Heating | EF=0.525 | EF=0.823 | 1.3 | 47% | 15 | 56% | 19 | 65% | 22 | 75% | 25 | 84% | 28 |
| Windows | U=0.50, SHGC=0.35 | U=0.26, SHGC=0.29 | 6.9 | 23% | 12 | 27% | 18 | 32% | 18 | 36% | 21 | 41% | 21 |
| Space Heating | Furnace 78% AFUE | Furnace 94% AFUE | 3.3 | 36% | 12 | 43% | 14 | 51% | 17 | 58% | 19 | 65% | 22 |
| Space Cooling | 10 SEER, 9.5 EER Unitary AC | 14 SEER, 12.5 EER Unitary AC | 3.7 | 34% | 11 | 41% | 13 | 48% | 16 | 55% | 18 | 62% | 20 |
| Lighting | 1.50 watts/sqft | None | NA | | | NA | | NA | | NA | | NA | |
| Roof Insulation | None | None | NA | | | NA | | NA | | NA | | NA | |
| Thermal Storage | None | None | NA | | | NA | | NA | | NA | | NA | |
| Wall Insulation | Typical Aluminum Curtain Wall | Reduced thermal bridging | 29.7 | 1% | 12 | 2% | 18 | 2% | 18 | 2% | 21 | 2% | 21 |

| Internal Retail Shop - Type I Construction (Qty 34 Bldgs) | | | 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 | | | NA | | NA | | NA | | NA |
| CHP | None | None | | NA | | | NA | | NA | | NA | | NA |
| Roof Material | None | None | | NA | | | NA | | NA | | NA | | NA |
| Water Heating | EF=0.525 | EF=0.823 | 1.3 | 47% | 15 | 56% | 19 | 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/sqft | None | | NA | | | NA | | NA | | NA | | NA |
| Roof Insulation | None | None | | NA | | | NA | | NA | | NA | | NA |
| Thermal Storage | None | None | | NA | | | NA | | NA | | NA | | NA |
| Wall Insulation | Typical Aluminum Curtain Wall | Reduced thermal bridging | 60.1 | 0% | 45 | 0% | 67 | 0% | 67 | 0% | 70 | 0% | 70 |

| Corner Restaurant - Type I Construction (Qty 30 Bldgs) | | | 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 | | | NA | | NA | | NA | | NA |
| CHP | None | None | | NA | | | NA | | NA | | NA | | NA |
| Roof Material | None | None | | NA | | | NA | | NA | | NA | | NA |
| 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/sqft | None | | NA | | | NA | | NA | | NA | | NA |
| Roof Insulation | None | None | | NA | | | NA | | NA | | NA | | NA |
| Thermal Storage | None | None | | NA | | | NA | | NA | | NA | | NA |
| Wall Insulation | Typical Aluminum Curtain Wall | Reduced thermal bridging | 28.7 | 1% | 4 | 2% | 5 | 2% | 5 | 2% | 6 | 3% | 6 |

| Corner Retail Shop - Type II Construction (Qty 17 Bldgs) | | | 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 | | | NA | | NA | | NA | | NA |
| CHP | None | None | | NA | | | NA | | NA | | NA | | NA |
| Roof Material | None | None | | NA | | | NA | | NA | | NA | | NA |
| Water Heating | EF=0.525 | EF=0.823 | 1.3 | 47% | 7 | 56% | 9 | 66% | 11 | 75% | 12 | 84% | 14 |
| Windows | U=0.50, SHGC=0.35 | U=0.26, SHGC=0.29 | 9.1 | 17% | 6 | 21% | 9 | 24% | 9 | 28% | 12 | 31% | 12 |
| 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 | 3.6 | 35% | 5 | 42% | 7 | 49% | 8 | 56% | 9 | 63% | 10 |
| Lighting | 1.50 watts/sqft | None | | NA | | | NA | | NA | | NA | | NA |
| Roof Insulation | None | None | | NA | | | NA | | NA | | NA | | NA |
| Thermal Storage | None | None | | NA | | | NA | | NA | | NA | | NA |
| Wall Insulation | R11, 2x4.16 | R19, 2x4.16 | 10.0 | 15% | 6 | 19% | 9 | 22% | 9 | 25% | 12 | 28% | 12 |

| Internal Retail Shop - Type II Construction (Qty 17 Bldgs) | | | 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 | | | NA | | NA | | NA | | NA |
| CHP | None | None | | NA | | | NA | | NA | | NA | | NA |
| Roof Material | None | None | | NA | | | NA | | NA | | NA | | NA |
| Water Heating | EF=0.525 | EF=0.823 | 1.2 | 47% | 7 | 56% | 9 | 66% | 11 | 75% | 12 | 85% | 14 |
| Windows | U=0.50, SHGC=0.35 | U=0.26, SHGC=0.29 | 8.6 | 19% | 12 | 22% | 18 | 26% | 18 | 30% | 24 | 33% | 24 |
| Space Heating | Furnace 78% AFUE | Furnace 94% AFUE | 4.5 | 31% | 5 | 37% | 6 | 43% | 7 | 50% | 8 | 56% | 9 |
| Space Cooling | 10 SEER, 9.5 EER Unitary AC | 14 SEER, 12.5 EER Unitary AC | 3.7 | 34% | 5 | 41% | 6 | 48% | 8 | 55% | 9 | 62% | 10 |
| Lighting | 1.50 watts/sqft | None | | NA | | | NA | | NA | | NA | | NA |
| Roof Insulation | None | None | | NA | | | NA | | NA | | NA | | NA |
| Thermal Storage | None | None | | NA | | | NA | | NA | | NA | | NA |
| Wall Insulation | R11, 2x4.16 | R19, 2x4.16 | 19.4 | 5% | 12 | 6% | 18 | 6% | 18 | 7% | 24 | 8% | 24 |

| Corner Restaurant - Type II Construction (Qty 17 Bldgs) | | | 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 | | | NA | | NA | | NA | | NA |
| CHP | None | None | | NA | | | NA | | NA | | NA | | NA |
| Roof Material | None | None | | NA | | | NA | | NA | | NA | | NA |
| Water Heating | EF=0.800 | EF=0.823 | 9.1 | 17% | 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 | 17% | 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 | 47% | 8 | 54% | 9 | 61% | 10 |
| Lighting | 1.50 watts/sqft | None | | NA | | | NA | | NA | | NA | | NA |
| Roof Insulation | None | None | | NA | | | NA | | NA | | NA | | NA |
| Thermal Storage | None | None | | NA | | | NA | | NA | | NA | | NA |
| Wall Insulation | R11, 2x4.16 | R19, 2x4.16 | 8.1 | 20% | 2 | 24% | 3 | 28% | 3 | 32% | 4 | 35% | 4 |

| Prototype 01 - 56-story Highrise Office (Qty 1) | | | Mod 14-RA, BAU | | | Mod 14RA Mid-Low | | | Mod 14RA Mid | | | Mod 14RA Mid-High | | | Mod 14RA 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 | Pen Rate | Total Pen | Pen Rate | Total Pen |
| Appliances | None | None | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| CHP | None | 6500 kW, 1390 ton absorber | 6.4 | 24% | 0 | 29% | 0 | 34% | 0 | 39% | 0 | 44% | 0 | 44% | 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 | 8% | 0 | 8% | 0 |
| Water Heating | Boiler Comb Eff = 80% | Boiler Comb Eff = 85% | NA | See Space Heating | NA | See Space Heating | NA | See Space Heating | NA | See Space Heating | NA | See Space Heating | NA | See Space Heating | NA | See Space Heating | NA |
| 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 | 38% | 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 | 9% | 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 | 78% | 0 | 78% | 0 |
| Lighting | 1.1 watts/sqft | 0.9 watts/sqft | 11.1 | 13% | 0 | 16% | 0 | 19% | 0 | 21% | 0 | 24% | 0 | 24% | 0 | 24% | 0 |
| Roof Insulation | 5" R19 XPS | 6" R23 XPS | 2.7 | 39% | 0 | 47% | 0 | 54% | 0 | 62% | 0 | 70% | 0 | 70% | 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 | 34% | 0 | 34% | 0 |
| Wall Insulation | Typical Aluminum Curtain Wall | Reduced thermal bridging | 9.0 | 17% | 0 | 21% | 0 | 24% | 0 | 28% | 0 | 31% | 0 | 31% | 0 | 31% | 0 |

| Prototype 02 - 41-story Highrise Office (Qty 6) | | | Mod 14-RA, BAU | | | Mod 14RA Mid-Low | | | Mod 14RA Mid | | | Mod 14RA Mid-High | | | Mod 14RA 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 | Pen Rate | Total Pen | Pen Rate | Total Pen |
| Appliances | None | None | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| CHP | None | 5500 kW, 1150 ton absorber | 6.2 | 25% | 1 | 30% | 1 | 35% | 2 | 40% | 2 | 45% | 2 | 45% | 2 | 45% | 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 | 21% | 1 | 21% | 1 |
| Water Heating | Boiler Comb Eff = 80% | Boiler Comb Eff = 85% | NA | See Space Heating | NA | See Space Heating | NA | See Space Heating | NA | See Space Heating | NA | See Space Heating | NA | See Space Heating | NA | See Space Heating | NA |
| Windows | U=0.50, SHGC=0.35 | U=0.26, SHGC=0.29 | 7.4 | 21% | 1 | 26% | 1 | 30% | 1 | 34% | 2 | 39% | 2 | 39% | 2 | 39% | 2 |
| Space Heating | Boiler Comb Eff = 80% | Boiler Comb Eff = 85% | 19.0 | 5% | 0 | 6% | 0 | 7% | 0 | 8% | 0 | 9% | 0 | 9% | 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 | 77% | 4 | 77% | 4 |
| Lighting | 1.1 watts/sqft | 0.9 watts/sqft | 11.4 | 13% | 0 | 15% | 0 | 18% | 1 | 21% | 1 | 23% | 1 | 23% | 1 | 23% | 1 |
| Roof Insulation | 5" R19 XPS | 6" R23 XPS | 4.9 | 30% | 1 | 35% | 2 | 41% | 2 | 47% | 2 | 53% | 3 | 53% | 3 | 53% | 3 |
| Thermal Storage | None | 25% of max load, 15073 ton-hrs | 5.3 | 28% | 1 | 34% | 2 | 39% | 2 | 45% | 2 | 51% | 3 | 51% | 3 | 51% | 3 |
| Wall Insulation | Typical Aluminum Curtain Wall | Reduced thermal bridging | 9.0 | 17% | 1 | 21% | 1 | 24% | 1 | 28% | 1 | 31% | 1 | 31% | 1 | 31% | 1 |

| Prototype 03 - 34-story Highrise Office (Qty 5) | | | Mod 14-RA, BAU | | | Mod 14RA Mid-Low | | | Mod 14RA Mid | | | Mod 14RA Mid-High | | | Mod 14RA 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 | Pen Rate | Total Pen | Pen Rate | Total Pen |
| Appliances | None | None | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| CHP | None | 4500 kW, 1020 ton absorber | 6.1 | 25% | 1 | 30% | 1 | 35% | 1 | 41% | 2 | 46% | 2 | 46% | 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 | 40% | 1 | 40% | 1 |
| Water Heating | Boiler Comb Eff = 80% | Boiler Comb Eff = 85% | NA | See Space Heating | NA | See Space Heating | NA | See Space Heating | NA | See Space Heating | NA | See Space Heating | NA | See Space Heating | NA | See Space Heating | NA |
| 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 | 39% | 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 | 10% | 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 | 76% | 3 | 76% | 3 |
| Lighting | 1.1 watts/sqft | 0.9 watts/sqft | 11.5 | 13% | 0 | 15% | 0 | 18% | 0 | 20% | 1 | 23% | 1 | 23% | 1 | 23% | 1 |
| Roof Insulation | 5" R19 XPS | 6" R23 XPS | 8.8 | 18% | 0 | 22% | 1 | 25% | 1 | 29% | 1 | 33% | 1 | 33% | 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 | 44% | 2 | 44% | 2 |
| Wall Insulation | Typical Aluminum Curtain Wall | Reduced thermal bridging | 8.8 | 18% | 0 | 22% | 1 | 25% | 1 | 29% | 1 | 32% | 1 | 32% | 1 | 32% | 1 |

| Prototype 04 - 20-story Midrise Office (Qty 3) | | | Mod 14-RA, BAU | | | Mod 14RA Mid-Low | | | Mod 14RA Mid | | | Mod 14RA Mid-High | | | Mod 14RA 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 | Pen Rate | Total Pen | Pen Rate | Total Pen |
| Appliances | None | None | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| CHP | None | 3000 kW, 490 ton absorber | 6.5 | 24% | 0 | 29% | 0 | 34% | 1 | 38% | 1 | 43% | 1 | 43% | 1 | 43% | 1 |
| 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 | 39% | 1 | 39% | 1 |
| Water Heating | Boiler Comb Eff = 80% | Boiler Comb Eff = 85% | NA | See Space Heating | NA | See Space Heating | NA | See Space Heating | NA | See Space Heating | NA | See Space Heating | NA | See Space Heating | NA | See Space Heating | NA |
| 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 | 25% | 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 | 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 | 77% | 2 | 77% | 2 |
| Lighting | 1.1 watts/sqft | 0.9 watts/sqft | 11.7 | 12% | 0 | 15% | 0 | 17% | 0 | 20% | 0 | 22% | 0 | 22% | 0 | 22% | 0 |
| Roof Insulation | 5" R19 XPS | 6" R23 XPS | 6.9 | 23% | 0 | 27% | 0 | 32% | 0 | 36% | 1 | 41% | 1 | 41% | 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 | 52% | 1 | 52% | 1 |
| Wall Insulation | R11, 2x4.16 | R19, 2x4.16 | 12.6 | 11% | 0 | 13% | 0 | 16% | 0 | 18% | 0 | 20% | 0 | 20% | 0 | 20% | 0 |

| Prototype 05 - 33-story Highrise Hotel (Qty 1) | | | Mod 14-RA, BAU | | | Mod 14RA Mid-Low | | | Mod 14RA Mid | | | Mod 14RA Mid-High | | | Mod 14RA 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 | Pen Rate | Total Pen | Pen Rate | Total Pen |
| Appliances | None | None | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| CHP | None | 2500 kW, 500 ton absorber | 5.0 | 29% | 0 | 35% | 0 | 41% | 0 | 47% | 0 | 52% | 0 | 52% | 0 | 52% | 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 | 5% | 0 | 5% | 0 |
| Water Heating | Boiler Comb Eff = 80% | Boiler Comb Eff = 85% | NA | See Space Heating | NA | See Space Heating | NA | See Space Heating | NA | See Space Heating | NA | See Space Heating | NA | See Space Heating | NA | See Space Heating | NA |
| 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 | 24% | 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 | 65% | 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 | 75% | 0 | 75% | 0 |
| Lighting | 1.3 watts/sqft | 1.19 watts/sqft | 42.6 | 0% | 0 | 0% | 0 | 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 | 18% | 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 | 31% | 0 | 31% | 0 |
| Wall Insulation | Typical Aluminum Curtain Wall | Reduced thermal bridging | 12.1 | 12% | 0 | 14% | 0 | 16% | 0 | 19% | 0 | 21% | 0 | 21% | 0 | 21% | 0 |

| Prototype 06 - 18-story Midrise Hotel (Qty 5) | | | Mod 14-RA, BAU | | | Mod 14RA Mid-Low | | | Mod 14RA Mid | | | Mod 14RA Mid-High | | | Mod 14RA 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 | Pen Rate | Total Pen | Pen Rate | Total Pen |
| Appliances | None | None | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| CHP | None | 2500 kW, 500 ton absorber | 5.0 | 29% | 0 | 35% | 0 | 41% | 0 | 47% | 0 | 52% | 0 | 52% | 0 | 52% | 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 | 5% | 0 | 5% | 0 |
| Water Heating | Boiler Comb Eff = 80% | Boiler Comb Eff = 85% | NA | See Space Heating | NA | See Space Heating | NA | See Space Heating | NA | See Space Heating | NA | See Space Heating | NA | See Space Heating | NA | See Space Heating | NA |
| 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 | 24% | 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 | 65% | 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 | 75% | 0 | 75% | 0 |
| Lighting | 1.3 watts/sqft | 1.19 watts/sqft | 42.6 | 0% | 0 | 0% | 0 | 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 | 18% | 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 | 31% | 0 | 31% | 0 |
| Wall Insulation | Typical Aluminum Curtain Wall | Reduced thermal bridging | 12.1 | 12% | 0 | 14% | 0 | 16% | 0 | 19% | 0 | 21% | 0 | 21% | 0 | 21% | 0 |

| Prototype 07 - 55-story Highrise Residential (Qty 2) | | | Mod 14-RA, BAU | | | Mod 14RA Mid-Low | | | Mod 14RA Mid | | | Mod 14RA Mid-High | | | Mod 14RA 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 | 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 | 0% | 0 | 0% | 0 |
| CHP | None | 1500 kW, 300 ton absorber | 6.1 | 25% | 0 | 30% | 0 | 35% | 0 | 41% | 0 | 46% | 0 | 46% | 0 | 46% | 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 | 31% | 0 | 31% | 0 |
| Water Heating | Boiler Comb Eff = 80% | Boiler Comb Eff = 85% | NA | See Space Heating | NA | See Space Heating | NA | See Space Heating | | | | | | | | | |

| Prototype 08 - 43-story Highrise Residential (Qty 4) | | | Mod 14-RA, BAU | | | Mod 14RA Mid-Low | | Mod 14RA Mid | | Mod 14RA Mid-High | | Mod 14RA 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 |
| Roof Material | 100% of roof at Abs=0.90 | 100% of roof at Abs=0.3 | 10.4 | 15% | 0 | 18% | 0 | 21% | 0 | 23% | 0 | 26% | 1 |
| Water Heating | Boiler Comb Eff = 80% | Boiler Comb Eff = 85% | See Space Heating | | | See Space Heating | | | See Space Heating | | | See Space 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 |
| Roof Insulation | 5" R19 XPS | 6" R23 XPS | 6.9 | 23% | 0 | 27% | 1 | 32% | 1 | 36% | 1 | 41% | 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 | 7.3 | 22% | 0 | 26% | 1 | 30% | 1 | 35% | 1 | 39% | 1 |

| Prototype 09 - 34-story Highrise Residential (Qty 10) | | | Mod 14-RA, BAU | | | Mod 14RA Mid-Low | | Mod 14RA Mid | | Mod 14RA Mid-High | | Mod 14RA 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 | None | 850 kW, 180 ton absorber | 5.7 | 27% | 2 | 32% | 3 | 37% | 3 | 43% | 4 | 48% | 4 |
| Roof Material | 100% of roof at Abs=0.90 | 100% of roof at Abs=0.3 | 7.4 | 21% | 2 | 26% | 2 | 30% | 2 | 34% | 3 | 38% | 3 |
| Water Heating | Boiler Comb Eff = 80% | Boiler Comb Eff = 85% | See Space Heating | | | See Space Heating | | See Space Heating | | See Space Heating | | See Space 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/sqft | 0.675 watts/sqft | 125.8 | 0% | 0 | 0% | 0 | 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 |

| Prototype 10 - 25-story Highrise Residential (Qty 5) | | | Mod 14-RA, BAU | | | Mod 14RA Mid-Low | | Mod 14RA Mid | | Mod 14RA Mid-High | | Mod 14RA 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 |
| CHP | None | 1500 kW, 250 ton absorber | 5.4 | 28% | 1 | 33% | 1 | 39% | 1 | 44% | 2 | 50% | 2 |
| 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% | See Space Heating | | | See Space Heating | | See Space Heating | | See Space Heating | | See Space 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 |
| 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 |
| 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 |

| Prototype 11 - 12-story Midrise Residential (Qty 14) | | | Mod 14-RA, BAU | | | Mod 14RA Mid-Low | | Mod 14RA Mid | | Mod 14RA Mid-High | | Mod 14RA 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 | 254.8 | 0% | 0 | 0% | 0 | 0% | 0 | 0% | 0 | 0% | 0 |
| CHP | None | 250 kW, 40 ton absorber | 8.0 | 20% | 2 | 24% | 3 | 28% | 3 | 32% | 4 | 36% | 5 |
| Roof Material | 100% of roof at Abs=0.90 | 100% of roof at Abs=0.3 | 4.2 | 32% | 4 | 38% | 5 | 45% | 6 | 51% | 7 | 58% | 8 |
| Water Heating | Boiler Comb Eff = 80% | Boiler Comb Eff = 85% | See Space Heating | | | See Space Heating | | | See Space Heating | | | See Space 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 | 58% | 8 | 67% | 9 | 76% | 10 |
| Lighting | 0.70 watts/sqft | 0.675 watts/sqft | 122.7 | 0% | 0 | 0% | 0 | 0% | 0 | 0% | 0 | 0% | 0 |
| Roof Insulation | 5" R19 XPS | 6" R23 XPS | 25.0 | 2% | 0 | 3% | 0 | 3% | 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 |

| Prototype 12 - 55-story Highrise Mixed Use, Office (Qty 1) | | | Mod 14-RA, BAU | | | Mod 14RA Mid-Low | | Mod 14RA Mid | | Mod 14RA Mid-High | | Mod 14RA 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 | | NA | | NA | | NA | | NA | |
| CHP | None | 3500 kW, 680 ton absorber | 6.1 | 25% | 0 | 30% | 0 | 35% | 0 | 41% | 0 | 46% | 0 |
| Roof Material | 100% of roof at Abs=0.90 | None | NA | NA | | 0 | | NA | 0 | NA | 0 | NA | 0 |
| Water Heating | Boiler Comb Eff = 80% | Boiler Comb Eff = 85% | See Space Heating | | | See Space Heating | | | See Space Heating | | | See Space Heating | |
| Windows | U=0.50, SHGC=0.35 | U=0.26, SHGC=0.29 | 7.2 | 22% | 0 | 26% | 0 | 31% | 0 | 35% | 0 | 39% | 0 |
| Space Heating | Boiler Comb Eff = 80% | Boiler Comb Eff = 85% | 17.8 | 6% | 0 | 7% | 0 | 8% | 0 | 9% | 0 | 10% | 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 | 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 | NA | | NA | 0 | NA | 0 | NA | 0 | NA | 0 |
| 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 | 8.6 | 18% | 0 | 22% | 0 | 26% | 0 | 30% | 0 | 33% | 0 |

| Prototype 12 - 55-story Highrise Mixed Use, Residential (Qty 1) | | | Mod 14-RA, BAU | | | Mod 14RA Mid-Low | | Mod 14RA Mid | | Mod 14RA Mid-High | | Mod 14RA 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 | 237.0 | 0% | 0 | 0% | 0 | 0% | 0 | 0% | 0 | 0% | 0 |
| CHP | None | 1500 kW, 270 ton absorber | 5.4 | 28% | 0 | 33% | 0 | 39% | 0 | 44% | 0 | 50% | 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 |
| Water Heating | Boiler Comb Eff = 80% | Boiler Comb Eff = 85% | See Space Heating | | | See Space Heating | | See Space Heating | | See Space Heating | | See Space 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 |
| Lighting | 0.70 watts/sqft | 0.675 watts/sqft | 119.3 | 0% | 0 | 0% | 0 | 0% | 0 | 0% | 0 | 0% | 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% | 0 | 4% | 0 | 5% | 0 | 6% | 0 | 6% | 0 |
| Wall Insulation | Typical Aluminum Curtain Wall | Reduced thermal bridging | 7.7 | 21% | 0 | 25% | 0 | 29% | 0 | 33% | 0 | 37% | 0 |

| Prototype 01 - 56-story Highrise Office (Qty 1) | | | CCT5, BAU | | | CCT5, Mid-Low | | CCT5 Mid | | CCT5, Mid-High | | CCT5, 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 | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| CHP | None | None | 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 Space Heating | See Space Heating | See Space Heating | See Space Heating | See Space Heating | See Space Heating | See Space Heating | See Space Heating | See Space Heating | See Space 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 Highrise Office (Qty 6) | | | CCT5, BAU | | | CCT5, Mid-Low | | CCT5 Mid | | CCT5, Mid-High | | CCT5, 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 | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 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 Heating | See Space Heating | See Space Heating | See Space Heating | See Space Heating | See Space Heating | See Space Heating | See Space Heating | See Space Heating | See Space 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 |

| Prototype 03 - 34-story Highrise Office (Qty 5) | | | CCT5, BAU | | | CCT5, Mid-Low | | CCT5 Mid | | CCT5, Mid-High | | CCT5, 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 | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| CHP | None | 4500 kW, 1020 ton absorber | 8.0 | 20% | 0 | 24% | 1 | 28% | 1 | 32% | 1 | 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% | 1 | 40% | 2 |
| Water Heating | Boiler Comb Eff = 80% | Boiler Comb Eff = 85% | NA | See Space Heating | See Space Heating | See Space Heating | See Space Heating | See Space Heating | See Space Heating | See Space Heating | See Space Heating | See Space Heating | See Space Heating |
| Windows | U=0.50, SHGC=0.35 | U=0.26, SHGC=0.29 | 7.0 | 22% | 1 | 27% | 1 | 31% | 1 | 36% | 1 | 40% | 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 | 2.0 | 43% | 2 | 51% | 2 | 60% | 2 | 68% | 3 | 77% | 3 |
| Lighting | 1.1 watts/sqft | 0.9 watts/sqft | 11.1 | 13% | 0 | 16% | 0 | 19% | 0 | 22% | 1 | 24% | 1 |
| Roof Insulation | 5" R19 XPS | 6" R23 XPS | 8.3 | 19% | 0 | 23% | 1 | 27% | 1 | 31% | 1 | 35% | 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 | 8.5 | 19% | 0 | 22% | 1 | 26% | 1 | 30% | 1 | 34% | 1 |

| Prototype 04 - 20-story Midrise Office (Qty 3) | | | CCT5, BAU | | | CCT5, Mid-Low | | CCT5 Mid | | CCT5, Mid-High | | CCT5, 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 | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| CHP | None | 3000 kW, 490 ton absorber | 8.2 | 19% | 0 | 23% | 0 | 27% | 0 | 31% | 0 | 35% | 1 |
| Roof Material | 100% of roof at Abs=0.90 | 100% of roof at Abs=0.3 | 7.2 | 22% | 0 | 26% | 0 | 31% | 0 | 35% | 1 | 40% | 1 |
| Water Heating | Boiler Comb Eff = 80% | Boiler Comb Eff = 85% | NA | See Space Heating | See Space Heating | See Space Heating | See Space Heating | See Space Heating | See Space Heating | See Space Heating | See Space Heating | See Space Heating | See Space Heating |
| Windows | U=0.50, SHGC=0.35 | U=0.26, SHGC=0.29 | 10.4 | 15% | 0 | 17% | 0 | 20% | 0 | 23% | 0 | 26% | 0 |
| Space Heating | Boiler Comb Eff = 80% | Boiler Comb Eff = 85% | 22.3 | 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 | 60% | 1 | 69% | 2 | 77% | 2 |
| Lighting | 1.1 watts/sqft | 0.9 watts/sqft | 11.2 | 13% | 0 | 16% | 0 | 18% | 0 | 21% | 0 | 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-hrs | 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 Highrise Hotel (Qty 1) | | | CCT5, BAU | | | CCT5, Mid-Low | | CCT5 Mid | | CCT5, Mid-High | | CCT5, 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 | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| CHP | None | 2500 kW, 500 ton absorber | 5.9 | 26% | 0 | 31% | 0 | 36% | 0 | 41% | 0 | 47% | 0 |
| Roof Material | 100% of roof at Abs=0.90 | 100% of roof at Abs=0.3 | 21.2 | 4% | 0 | 4% | 0 | 5% | 0 | 6% | 0 | 7% | 0 |
| Water Heating | Boiler Comb Eff = 80% | Boiler Comb Eff = 85% | NA | See Space Heating | See Space Heating | See Space Heating | See Space Heating | See Space Heating | See Space Heating | See Space Heating | See Space Heating | See Space Heating | See Space Heating |
| Windows | U=0.50, SHGC=0.35 | U=0.26, SHGC=0.29 | 10.8 | 14% | 0 | 17% | 0 | 19% | 0 | 22% | 0 | 25% | 0 |
| Space Heating | Boiler Comb Eff = 80% | Boiler Comb Eff = 85% | 3.2 | 36% | 0 | 44% | 0 | 51% | 0 | 58% | 0 | 66% | 0 |
| Space Cooling | 0.576 kW/ton Centrifugal Chillers | 0.461 kW/ton Centrifugal Chillers | 2.1 | 42% | 0 | 50% | 0 | 59% | 0 | 67% | 0 | 76% | 0 |
| Lighting | 1.3 watts/sqft | 1.19 watts/sqft | 40.5 | 0% | 0 | 0% | 0 | 0% | 0 | 1% | 0 | 1% | 0 |
| Roof Insulation | 5" R19 XPS | 6" R23 XPS | 13.3 | 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 Midrise Hotel (Qty 5) | | | CCT5, BAU | | | CCT5, Mid-Low | | CCT5 Mid | | CCT5, Mid-High | | CCT5, 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 | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| CHP | None | 400 kW, 80 ton absorber | 6.4 | 24% | 1 | 29% | 1 | 34% | 1 | 39% | 1 | 44% | 2 |
| Roof Material | 100% of roof at Abs=0.90 | 100% of roof at Abs=0.3 | 14.9 | 8% | 0 | 10% | 0 | 12% | 0 | 13% | 0 | 15% | 0 |
| Water Heating | Boiler Comb Eff = 80% | Boiler Comb Eff = 85% | NA | See Space Heating | See Space Heating | See Space Heating | See Space Heating | See Space Heating | See Space Heating | See Space Heating | See Space Heating | See Space Heating | See Space 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 | 37% | 1 | 44% | 2 | 51% | 2 | 59% | 2 | 66% | 3 |
| Space Cooling | 0.576 kW/ton Centrifugal Chillers | 0.461 kW/ton Centrifugal Chillers | 1.8 | 44% | 2 | 52% | 2 | 61% | 3 | 70% | 3 | 78% | 3 |
| 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 | 14.0 | 9% | 0 | 11% | 0 | 13% | 0 | 15% | 0 | 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 |

| Prototype 07 - 55-story Highrise Residential (Qty 2) | | | CCT5, BAU | | | CCT5, Mid-Low | | CCT5 Mid | | CCT5, Mid-High | | CCT5, 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 | 222.2 | 0% | 0 | 0% | 0 | 0% | 0 | 0% | 0 | 0% | 0 |
| CHP | None | 1500 kW, 300 ton absorber | 7.6 | 21% | 0 | 25% | 0 | 29% | 0 | 34% | 0 | 38% | 0 |
| Roof Material | 100% of roof at Abs=0.90 | 100% of roof at Abs=0.3 | 8.6 | 18% | 0 | 22% | 0 | 26% | 0 | 29% | 0 | 33% | 0 |
| Water Heating | Boiler Comb Eff = 80% | Boiler Comb Eff = 85% | NA | See Space Heating | See Space Heating | See Space Heating | See Space Heating | See Space Heating | See Space Heating | See Space Heating | See Space Heating | See Space Heating | See Space Heating |
| Windows | U=0.50, SHGC=0.35 | U=0.26, SHGC=0.29 | 6.3 | 25% | 0 | 30% | 0 | 35% | 0 | 39% | 0 | 44% | 0 |
| Space Heating | Boiler Comb Eff = 80% | Boiler Comb Eff = 85% | 4.9 | 30% | 0 | 35% | 0 | 41% | 0 | 47% | 0 | 53% | 1 |
| Space Cooling | 0.576 kW/ton Centrifugal Chillers | 0.461 kW/ton Centrifugal Chillers | 1.9 | 43% | 0 | 52% | 1 | 60% | 1 | 69% | 1 | 78% | 1 |
| Lighting | 0.70 watts/sqft | 0.675 watts/sqft | 116.2 | 0% | 0 | 0% | 0 | 0% | 0 | 0% | 0 | 0% | 0 |
| Roof Insulation | 5" R19 XPS | 6" R23 XPS | 7.5 | 21% | 0 | 25% | 0 | 30% | 0 | 34% | 0 | 38% | 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 | 7.4 | 22% | 0 | 26% | 0 | 30% | 0 | 34% | 0 | 39% | 0 |

| Prototype 08 - 43-story Highrise Residential (Qty 4) | | | CCT5, BAU | | | CCT5, Mid-Low | | CCT5 Mid | | CCT5, Mid-High | | CCT5, 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 |
| Water Heating | Boiler Comb Eff = 80% | Boiler Comb Eff = 85% | See Space Heating | | | See Space Heating | | | See Space Heating | | | See Space Heating | |
| Windows | U=0.50, SHGC=0.35 | U=0.26, SHGC=0.29 | 6.1 | 25% | 1 | 30% | 1 | 35% | 1 | 40% | 1 | 46% | 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 |
| Wall Insulation | Typical Aluminum Curtain Wall | Reduced thermal bridging | 7.1 | 22% | 0 | 27% | 1 | 31% | 1 | 36% | 1 | 40% | 1 |

| Prototype 09 - 34-story Highrise Residential (Qty 10) | | | CCT5, BAU | | | CCT5, Mid-Low | | CCT5 Mid | | CCT5, Mid-High | | CCT5, 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% | See Space Heating | | | See Space Heating | | See Space Heating | | See Space Heating | | See Space Heating | |
| Windows | U=0.50, SHGC=0.35 | U=0.26, SHGC=0.29 | 6.2 | 25% | 2 | 30% | 2 | 35% | 3 | 40% | 3 | 45% | 4 |
| Space Heating | Boiler Comb Eff = 80% | Boiler Comb Eff = 85% | 4.5 | 31% | 3 | 37% | 3 | 43% | 4 | 49% | 4 | 56% | 5 |
| 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 |

| Prototype 10 - 25-story Highrise Residential (Qty 5) | | | CCT5, BAU | | | CCT5, Mid-Low | | CCT5 Mid | | CCT5, Mid-High | | CCT5, 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 | 223.7 | 0% | 0 | 0% | 0 | 0% | 0 | 0% | 0 | 0% | 0 |
| 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% | See Space Heating | | | See Space Heating | | See Space Heating | | See Space Heating | | See Space 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 Heating | Boiler Comb Eff = 80% | Boiler Comb Eff = 85% | 4.4 | 31% | 1 | 38% | 1 | 44% | 2 | 50% | 2 | 57% | 2 |
| Space Cooling | 0.576 kW/ton Centrifugal Chillers | 0.461 kW/ton Centrifugal Chillers | 2.1 | 42% | 2 | 51% | 2 | 59% | 2 | 67% | 3 | 76% | 3 |
| Lighting | 0.70 watts/sqft | 0.675 watts/sqft | 118.8 | 0% | 0 | 0% | 0 | 0% | 0 | 0% | 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 |

| Prototype 11 - 12-story Midrise Residential (Qty 14) | | | CCT5, BAU | | | CCT5, Mid-Low | | CCT5 Mid | | CCT5, Mid-High | | CCT5, 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 | 240.2 | 0% | 0 | 0% | 0 | 0% | 0 | 0% | 0 | 0% | 0 |
| 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% | See Space Heating | | | See Space Heating | | | See Space Heating | | | See Space 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% | 7 | 60% | 8 | 68% | 9 | 77% | 10 |
| Lighting | 0.70 watts/sqft | 0.675 watts/sqft | 117.2 | 0% | 0 | 0% | 0 | 0% | 0 | 0% | 0 | 0% | 0 |
| 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 |

| Prototype 12 - 55-story Highrise Mixed Use, Office (Qty 1) | | | CCT5, BAU | | | CCT5, Mid-Low | | CCT5 Mid | | CCT5, Mid-High | | CCT5, 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 | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 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 | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| Water Heating | Boiler Comb Eff = 80% | Boiler Comb Eff = 85% | See Space Heating | | | See Space Heating | | See Space Heating | | See Space Heating | | See Space 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 | 7% | 0 | 8% | 0 | 10% | 0 | 11% | 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 | 1.1 watts/sqft | 0.9 watts/sqft | 11.4 | 13% | 0 | 16% | 0 | 18% | 0 | 21% | 0 | 23% | 0 |
| Roof Insulation | 5" R19 XPS | None | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 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 |

| Prototype 12 - 55-story Highrise Mixed Use, Residential (Qty 1) | | | CCT5, BAU | | | CCT5, Mid-Low | | CCT5 Mid | | CCT5, Mid-High | | CCT5, 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 | 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% | See Space Heating | | | See Space Heating | | | See Space Heating | | | See Space 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% | 4.4 | 31% | 0 | 38% | 0 | 44% | 0 | 50% | 0 | 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 | Typical Aluminum Curtain Wall | Reduced thermal bridging | 7.4 | 21% | 0 | 26% | 0 | 30% | 0 | 34% | 0 | 38% | 0 |

| Corner Retail Shop - Type I Construction (Qty 34 Bldgs) | | | CCT5, BAU | | | CCT5, Mid-Low | | CCT5 Mid | | CCT5, Mid-High | | CCT5, 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 | | NA | | NA | | NA | |
| CHP | None | None | NA | | | NA | | NA | | NA | | NA | |
| Roof Material | None | None | NA | | | NA | | NA | | NA | | NA | |
| Water Heating | EF=0.525 | EF=0.823 | 1.3 | 47% | 15 | 56% | 19 | 66% | 22 | 75% | 25 | 84% | 28 |
| Windows | U=0.50, SHGC=0.35 | U=0.26, SHGC=0.29 | 6.7 | 23% | 12 | 28% | 18 | 33% | 21 | 37% | 21 | 42% | 21 |
| Space Heating | Furnace 78% AFUE | Furnace 94% AFUE | 3.2 | 36% | 12 | 44% | 14 | 51% | 17 | 58% | 19 | 65% | 22 |
| 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 | | | NA | | NA | | NA | | NA | |
| Roof Insulation | None | None | NA | | | NA | | NA | | NA | | NA | |
| Thermal Storage | None | None | NA | | | NA | | NA | | NA | | NA | |
| Wall Insulation | Typical Aluminum Curtain Wall | Reduced thermal bridging | 28.8 | 1% | 12 | 2% | 18 | 2% | 21 | 2% | 21 | 3% | 21 |

| Internal Retail Shop - Type I Construction (Qty 34 Bldgs) | | | CCT5, BAU | | | CCT5, Mid-Low | | CCT5 Mid | | CCT5, Mid-High | | CCT5, 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 | | NA | | NA | | NA |
| CHP | None | None | | NA | | | NA | | NA | | NA | | NA |
| Roof Material | None | None | | NA | | | NA | | NA | | NA | | NA |
| 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 | | | NA | | NA | | NA | | NA |
| Roof Insulation | None | None | | NA | | | NA | | NA | | NA | | NA |
| Thermal Storage | None | None | | NA | | | NA | | NA | | NA | | NA |
| Wall Insulation | Typical Aluminum Curtain Wall | Reduced thermal bridging | 58.9 | 0% | 45 | 0% | 67 | 0% | 70 | 0% | 70 | 0% | 70 |

| Corner Restaurant - Type I Construction (Qty 30 Bldgs) | | | CCT5, BAU | | | CCT5, Mid-Low | | CCT5 Mid | | CCT5, Mid-High | | CCT5, 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 | | NA | | NA | | NA |
| CHP | None | None | | NA | | | NA | | NA | | NA | | NA |
| Roof Material | None | None | | NA | | | NA | | NA | | NA | | 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% | 17 | 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 |
| Lighting | 1.50 watts/sqft | None | | NA | | | NA | | NA | | NA | | NA |
| Roof Insulation | None | None | | NA | | | NA | | NA | | NA | | NA |
| Thermal Storage | None | None | | NA | | | NA | | NA | | NA | | NA |
| Wall Insulation | Typical Aluminum Curtain Wall | Reduced thermal bridging | 27.9 | 2% | 4 | 2% | 5 | 2% | 6 | 3% | 6 | 3% | 6 |

| Corner Retail Shop - Type II Construction (Qty 17 Bldgs) | | | CCT5, BAU | | | CCT5, Mid-Low | | CCT5 Mid | | CCT5, Mid-High | | CCT5, 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 | | NA | | NA | | NA |
| CHP | None | None | | NA | | | NA | | NA | | NA | | NA |
| Roof Material | None | None | | NA | | | NA | | NA | | NA | | NA |
| 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 | | | NA | | NA | | NA | | NA |
| Roof Insulation | None | None | | NA | | | NA | | NA | | NA | | NA |
| Thermal Storage | None | None | | NA | | | NA | | NA | | NA | | NA |
| Wall Insulation | R11, 2x4.16 | R19, 2x4.16 | 9.9 | 16% | 6 | 19% | 9 | 22% | 9 | 25% | 12 | 28% | 12 |

| Internal Retail Shop - Type II Construction (Qty 17 Bldgs) | | | CCT5, BAU | | | CCT5, Mid-Low | | CCT5 Mid | | CCT5, Mid-High | | CCT5, 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 | | NA | | NA | | NA |
| CHP | None | None | | NA | | | NA | | NA | | NA | | NA |
| Roof Material | None | None | | NA | | | NA | | 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 | 8.2 | 19% | 12 | 23% | 18 | 27% | 18 | 31% | 24 | 35% | 24 |
| Space Heating | Furnace 78% AFUE | Furnace 94% AFUE | 4.4 | 31% | 5 | 38% | 6 | 44% | 7 | 50% | 8 | 56% | 9 |
| 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 | | | NA | | NA | | NA | | NA |
| Roof Insulation | None | None | | NA | | | NA | | NA | | NA | | NA |
| Thermal Storage | None | None | | NA | | | NA | | NA | | NA | | NA |
| Wall Insulation | R11, 2x4.16 | R19, 2x4.16 | 18.1 | 6% | 12 | 7% | 18 | 8% | 18 | 9% | 24 | 10% | 24 |

| Corner Restaurant - Type II Construction (Qty 17 Bldgs) | | | CCT5, BAU | | | CCT5, Mid-Low | | CCT5 Mid | | CCT5, Mid-High | | CCT5, 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 | | NA | | NA | | NA |
| CHP | None | None | | NA | | | NA | | NA | | NA | | NA |
| Roof Material | None | None | | NA | | | NA | | NA | | NA | | NA |
| Water Heating | EF=0.800 | EF=0.823 | 8.9 | 18% | 3 | 21% | 3 | 25% | 4 | 28% | 4 | 32% | 5 |
| 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 | | | NA | | NA | | NA | | NA |
| Roof Insulation | None | None | | NA | | | NA | | NA | | NA | | NA |
| Thermal Storage | None | None | | NA | | | NA | | NA | | NA | | NA |
| Wall Insulation | R11, 2x4.16 | R19, 2x4.16 | 7.9 | 20% | 2 | 24% | 3 | 28% | 3 | 32% | 4 | 36% | 4 |

| Prototype 01 - 56-story Highrise Office (Qty 1) | | | CCT10, BAU | | | CCT10, Mid-Low | | CCT10 Mid | | CCT10, Mid-High | | CCT10, 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 | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 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 Space Heating | | See Space Heating | | See Space Heating | | See Space Heating | | See Space 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% | 18.2 | 5% | 0 | 6% | 0 | 8% | 0 | 9% | 0 | 10% | 0 |
| Space Cooling | 0.576 kW/ton Centrifugal Chillers | 0.461 kW/ton Centrifugal Chillers | 1.7 | 44% | 0 | 53% | 0 | 62% | 0 | 71% | 0 | 79% | 0 |
| 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 | 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 |

| Prototype 02 - 41-story Highrise Office (Qty 6) | | | CCT10, BAU | | | CCT10, Mid-Low | | CCT10 Mid | | CCT10, Mid-High | | CCT10, 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 | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| CHP | None | 5500 kW, 1150 ton absorber | 7.4 | 22% | 1 | 26% | 1 | 30% | 1 | 35% | 2 | 39% | 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 Heating | | See Space Heating | | See Space Heating | | See Space Heating | | See Space 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 |
| 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 | 8.5 | 19% | 1 | 22% | 1 | 26% | 1 | 30% | 1 | 34% | 2 |

| Prototype 03 - 34-story Highrise Office (Qty 5) | | | CCT10, BAU | | | CCT10, Mid-Low | | CCT10 Mid | | CCT10, Mid-High | | CCT10, 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 | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 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 | 32% | 1 | 36% | 1 | 41% | 2 |
| Water Heating | Boiler Comb Eff = 80% | Boiler Comb Eff = 85% | NA | See Space Heating | | See Space Heating | | See Space Heating | | See Space Heating | | See Space Heating | |
| Windows | U=0.50, SHGC=0.35 | U=0.26, SHGC=0.29 | 6.8 | 23% | 1 | 28% | 1 | 32% | 1 | 37% | 1 | 42% | 2 |
| Space Heating | Boiler Comb Eff = 80% | Boiler Comb Eff = 85% | 17.7 | 6% | 0 | 7% | 0 | 8% | 0 | 9% | 0 | 10% | 0 |
| Space Cooling | 0.576 kW/ton Centrifugal Chillers | 0.461 kW/ton Centrifugal Chillers | 1.9 | 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 Midrise Office (Qty 3) | | | CCT10, BAU | | | CCT10, Mid-Low | | CCT10 Mid | | CCT10, Mid-High | | CCT10, 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 | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| CHP | None | 3000 kW, 490 ton absorber | 7.6 | 21% | 0 | 25% | 0 | 29% | 0 | 34% | 1 | 38% | 1 |
| 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% | 1 | 41% | 1 |
| Water Heating | Boiler Comb Eff = 80% | Boiler Comb Eff = 85% | NA | See Space Heating | | See Space Heating | | See Space Heating | | See Space Heating | | See Space 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 |
| 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 | 11.8 | 12% | 0 | 15% | 0 | 17% | 0 | 20% | 0 | 22% | 0 |

| Prototype 05 - 33-story Highrise Hotel (Qty 1) | | | CCT10, BAU | | | CCT10, Mid-Low | | CCT10 Mid | | CCT10, Mid-High | | CCT10, 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 | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 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 |
| Water Heating | Boiler Comb Eff = 80% | Boiler Comb Eff = 85% | NA | See Space Heating | | See Space Heating | | See Space Heating | | See Space Heating | | See Space Heating | |
| Windows | U=0.50, SHGC=0.35 | U=0.26, SHGC=0.29 | 10.7 | 14% | 0 | 17% | 0 | 20% | 0 | 23% | 0 | 25% | 0 |
| Space Heating | Boiler Comb Eff = 80% | Boiler Comb Eff = 85% | 3.2 | 37% | 0 | 44% | 0 | 51% | 0 | 59% | 0 | 66% | 0 |
| Space Cooling | 0.576 kW/ton Centrifugal Chillers | 0.461 kW/ton Centrifugal Chillers | 2.0 | 42% | 0 | 51% | 0 | 59% | 0 | 68% | 0 | 76% | 0 |
| 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 |
| 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 Midrise Hotel (Qty 5) | | | CCT10, BAU | | | CCT10, Mid-Low | | CCT10 Mid | | CCT10, Mid-High | | CCT10, 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 | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 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% | NA | See Space Heating | | See Space Heating | | See Space Heating | | See Space Heating | | See Space 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 | 44% | 2 | 52% | 2 | 59% | 2 | 67% | 3 |
| Space Cooling | 0.576 kW/ton Centrifugal Chillers | 0.461 kW/ton Centrifugal Chillers | 1.8 | 44% | 2 | 53% | 2 | 62% | 3 | 70% | 3 | 79% | 3 |
| Lighting | 1.3 watts/sqft | 1.19 watts/sqft | 36.9 | 1% | 0 | 1% | 0 | 1% | 0 | 1% | 0 | 1% | 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, 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 |

| Prototype 07 - 55-story Highrise Residential (Qty 2) | | | CCT10, BAU | | | CCT10, Mid-Low | | CCT10 Mid | | CCT10, Mid-High | | CCT10, 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 | 0% | 0 |
| CHP | None | 1500 kW, 300 ton absorber | 7.0 | 23% | 0 | 27% | 0 | 32% | 0 | 36% | 0 | 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% | NA | See Space Heating | | See Space Heating | | See Space Heating | | See Space Heating | | See Space 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 | 0.70 watts/sqft | 0.675 watts/sqft | 110.8 | 0% | 0 | 0% | 0 | 0% | 0 | 0% | 0 | 0% | 0 |
| Roof Insulation | 5" R19 XPS | 6" R23 XPS | 7.3 | 22% | 0 | 26% | 0 | 30% | 0 | 35% | 0 | 39% | 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 | 7.2 | 22% | 0 | 26% | 0 | 31% | 0 | 35% | 0 | 40% | 0 |

| Prototype 08 - 43-story Highrise Residential (Qty 4) | | | CCT10, BAU | | | CCT10, Mid-Low | | CCT10 Mid | | CCT10, Mid-High | | CCT10, 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 |
| Water Heating | Boiler Comb Eff = 80% | Boiler Comb Eff = 85% | See Space Heating | | | See Space Heating | | | See Space Heating | | | See Space Heating | |
| Windows | U=0.50, SHGC=0.35 | U=0.26, SHGC=0.29 | 5.9 | 26% | 1 | 31% | 1 | 36% | 1 | 41% | 1 | 47% | 1 |
| Space Heating | Boiler Comb Eff = 80% | Boiler Comb Eff = 85% | 4.5 | 31% | 1 | 37% | 1 | 43% | 1 | 50% | 1 | 56% | 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/sqft | 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 |

| Prototype 09 - 34-story Highrise Residential (Qty 10) | | | CCT10, BAU | | | CCT10, Mid-Low | | CCT10 Mid | | CCT10, Mid-High | | CCT10, 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 |
| CHP | None | 850 kW, 180 ton absorber | 6.6 | 24% | 2 | 29% | 2 | 33% | 3 | 38% | 3 | 43% | 4 |
| Roof Material | 100% of roof at Abs=0.90 | 100% of roof at Abs=0.3 | 6.7 | 23% | 2 | 28% | 2 | 33% | 3 | 37% | 3 | 42% | 4 |
| Water Heating | Boiler Comb Eff = 80% | Boiler Comb Eff = 85% | See Space Heating | | | See Space Heating | | | See Space Heating | | | See Space 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 |
| 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 | 7.1 | 22% | 2 | 27% | 2 | 31% | 3 | 36% | 3 | 40% | 4 |

| Prototype 10 - 25-story Highrise Residential (Qty 5) | | | CCT10, BAU | | | CCT10, Mid-Low | | CCT10 Mid | | CCT10, Mid-High | | CCT10, 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 | 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% | See Space Heating | | | See Space Heating | | | See Space Heating | | | See Space 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 | Boiler Comb Eff = 80% | Boiler Comb Eff = 85% | 4.3 | 32% | 1 | 38% | 1 | 45% | 2 | 51% | 2 | 57% | 2 |
| Space Cooling | 0.576 kW/ton Centrifugal Chillers | 0.461 kW/ton Centrifugal Chillers | 2.0 | 43% | 2 | 51% | 2 | 60% | 2 | 68% | 3 | 77% | 3 |
| Lighting | 0.70 watts/sqft | 0.675 watts/sqft | 113.2 | 0% | 0 | 0% | 0 | 0% | 0 | 0% | 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 |

| Prototype 11 - 12-story Midrise Residential (Qty 14) | | | CCT10, BAU | | | CCT10, Mid-Low | | CCT10 Mid | | CCT10, Mid-High | | CCT10, 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 | None | 250 kW, 40 ton absorber | 9.5 | 16% | 2 | 20% | 2 | 23% | 3 | 26% | 3 | 30% | 4 |
| Roof Material | 100% of roof at Abs=0.90 | 100% of roof at Abs=0.3 | 3.9 | 33% | 4 | 40% | 5 | 47% | 6 | 53% | 7 | 60% | 8 |
| Water Heating | Boiler Comb Eff = 80% | Boiler Comb Eff = 85% | See Space Heating | | | See Space Heating | | | See Space Heating | | | See Space 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 | 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 | 7.8 | 20% | 2 | 24% | 3 | 28% | 3 | 33% | 4 | 37% | 5 |

| Prototype 12 - 55-story Highrise Mixed Use, Office (Qty 1) | | | CCT10, BAU | | | CCT10, Mid-Low | | CCT10 Mid | | CCT10, Mid-High | | CCT10, 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 | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 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 | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| Water Heating | Boiler Comb Eff = 80% | Boiler Comb Eff = 85% | See Space Heating | | | See Space Heating | | | See Space Heating | | | See Space 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 | Boiler Comb Eff = 80% | Boiler Comb Eff = 85% | 17.2 | 6% | 0 | 7% | 0 | 9% | 0 | 10% | 0 | 11% | 0 |
| Space Cooling | 0.576 kW/ton Centrifugal Chillers | 0.461 kW/ton Centrifugal Chillers | 1.9 | 43% | 0 | 52% | 0 | 60% | 0 | 69% | 0 | 77% | 0 |
| Lighting | 1.1 watts/sqft | 0.9 watts/sqft | 10.9 | 14% | 0 | 17% | 0 | 19% | 0 | 22% | 0 | 25% | 0 |
| Roof Insulation | 5" R19 XPS | None | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 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 |

| Prototype 12 - 55-story Highrise Mixed Use, Residential (Qty 1) | | | CCT10, BAU | | | CCT10, Mid-Low | | CCT10 Mid | | CCT10, Mid-High | | CCT10, 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 | 213.9 | 0% | 0 | 0% | 0 | 0% | 0 | 0% | 0 | 0% | 0 |
| CHP | None | 1500 kW, 270 ton absorber | 6.1 | 25% | 0 | 30% | 0 | 36% | 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% | See Space Heating | | | See Space Heating | | | See Space Heating | | | See Space 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 | 0.70 watts/sqft | 0.675 watts/sqft | 108.3 | 0% | 0 | 0% | 0 | 0% | 0 | 0% | 0 | 0% | 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, 3472 ton-hrs | 21.4 | 4% | 0 | 4% | 0 | 5% | 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 |

| Corner Retail Shop - Type I Construction (Qty 34 Bldgs) | | | CCT10, BAU | | | CCT10, Mid-Low | | CCT10 Mid | | CCT10, Mid-High | | CCT10, 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 | | | NA | | | NA | |
| CHP | None | None | NA | | | NA | | | NA | | | NA | |
| Roof Material | None | None | NA | | | NA | | | NA | | | NA | |
| 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 | 6.5 | 24% | 12 | 29% | 18 | 34% | 21 | 38% | 21 | 43% | 27 |
| Space Heating | Furnace 78% AFUE | Furnace 94% AFUE | 3.2 | 37% | 12 | 44% | 14 | 51% | 17 | 59% | 19 | 66% | 22 |
| 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 | NA | | | NA | | | NA | | | NA | |
| Roof Insulation | None | None | NA | | | NA | | | NA | | | NA | |
| Thermal Storage | None | None | NA | | | NA | | | NA | | | NA | |
| Wall Insulation | Typical Aluminum Curtain Wall | Reduced thermal bridging | 28.0 | 2% | 12 | 2% | 18 | 2% | 21 | 3% | 21 | 3% | 27 |

| Internal Retail Shop - Type I Construction (Qty 34 Bldgs) | | | CCT10, BAU | | | CCT10, Mid-Low | | CCT10 Mid | | CCT10, Mid-High | | CCT10, 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 | | NA | | NA | | NA | |
| CHP | None | None | | NA | | NA | | NA | | NA | | NA | |
| Roof Material | None | None | | NA | | NA | | NA | | NA | | NA | |
| 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 | 1.50 watts/sqft | None | | NA | | NA | | NA | | NA | | NA | |
| Roof Insulation | None | None | | NA | | NA | | NA | | NA | | NA | |
| Thermal Storage | None | None | | NA | | NA | | NA | | NA | | NA | |
| Wall Insulation | Typical Aluminum Curtain Wall | Reduced thermal bridging | 57.7 | 0% | 45 | 0% | 67 | 0% | 70 | 0% | 70 | 0% | 92 |

| Corner Restaurant - Type I Construction (Qty 30 Bldgs) | | | CCT10, BAU | | | CCT10, Mid-Low | | CCT10 Mid | | CCT10, Mid-High | | CCT10, 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 | | NA | | NA | | NA | |
| CHP | None | None | | NA | | NA | | NA | | NA | | NA | |
| Roof Material | None | None | | NA | | NA | | NA | | NA | | NA | |
| 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 | | NA | | NA | | NA | | NA | |
| Roof Insulation | None | None | | NA | | NA | | NA | | NA | | NA | |
| Thermal Storage | None | None | | NA | | NA | | NA | | NA | | NA | |
| Wall Insulation | Typical Aluminum Curtain Wall | Reduced thermal bridging | 27.1 | 2% | 4 | 2% | 5 | 2% | 6 | 3% | 6 | 3% | 8 |

| Corner Retail Shop - Type II Construction (Qty 17 Bldgs) | | | CCT10, BAU | | | CCT10, Mid-Low | | CCT10 Mid | | CCT10, Mid-High | | CCT10, 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 | | NA | | NA | | NA | |
| CHP | None | None | | NA | | NA | | NA | | NA | | NA | |
| Roof Material | None | None | | NA | | NA | | NA | | NA | | NA | |
| Water Heating | EF=0.525 | EF=0.823 | 1.2 | 47% | 7 | 56% | 9 | 66% | 11 | 75% | 12 | 85% | 14 |
| Windows | U=0.50, SHGC=0.35 | U=0.26, SHGC=0.29 | 8.5 | 19% | 6 | 22% | 9 | 26% | 9 | 30% | 12 | 33% | 15 |
| Space Heating | Furnace 78% AFUE | Furnace 94% AFUE | 4.1 | 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 | 3.4 | 36% | 6 | 43% | 7 | 50% | 8 | 57% | 9 | 64% | 10 |
| Lighting | 1.50 watts/sqft | None | | NA | | NA | | NA | | NA | | NA | |
| Roof Insulation | None | None | | NA | | NA | | NA | | NA | | NA | |
| Thermal Storage | None | None | | NA | | NA | | NA | | NA | | NA | |
| Wall Insulation | R11, 2x4.16 | R19, 2x4.16 | 9.8 | 16% | 6 | 19% | 9 | 22% | 9 | 25% | 12 | 28% | 15 |

| Internal Retail Shop - Type II Construction (Qty 17 Bldgs) | | | CCT10, BAU | | | CCT10, Mid-Low | | CCT10 Mid | | CCT10, Mid-High | | CCT10, 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 | | NA | | NA | | NA | |
| CHP | None | None | | NA | | NA | | NA | | NA | | NA | |
| Roof Material | None | None | | NA | | NA | | NA | | NA | | 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 | 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 | | NA | | NA | | NA | | NA | |
| Roof Insulation | None | None | | NA | | NA | | NA | | NA | | NA | |
| Thermal Storage | None | None | | NA | | NA | | NA | | NA | | NA | |
| Wall Insulation | R11, 2x4.16 | R19, 2x4.16 | 16.9 | 6% | 12 | 8% | 18 | 9% | 18 | 10% | 24 | 12% | 30 |

| Corner Restaurant - Type II Construction (Qty 17 Bldgs) | | | CCT10, BAU | | | CCT10, Mid-Low | | CCT10 Mid | | CCT10, Mid-High | | CCT10, 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 | | NA | | NA | | NA | |
| CHP | None | None | | NA | | NA | | NA | | NA | | NA | |
| Roof Material | None | None | | NA | | NA | | NA | | NA | | NA | |
| 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 | | NA | | NA | | NA | | NA | |
| Roof Insulation | None | None | | NA | | NA | | NA | | NA | | NA | |
| Thermal Storage | None | None | | NA | | NA | | NA | | NA | | NA | |
| Wall Insulation | R11, 2x4.16 | R19, 2x4.16 | 7.7 | 21% | 2 | 25% | 3 | 29% | 3 | 33% | 4 | 37% | 5 |

| Prototype 01 - 56-story Highrise Office (Qty 1) | | | CCT15, BAU | | | CCT15, Mid-Low | | CCT15, Mid | | CCT15, Mid-High | | CCT15, 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 | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 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 |
| Water Heating | Boiler Comb Eff = 80% | Boiler Comb Eff = 85% | NA | See Space Heating | | See Space Heating | | See Space Heating | | See Space Heating | | See Space 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 | Boiler Comb Eff = 80% | Boiler Comb Eff = 85% | 17.9 | 6% | 0 | 7% | 0 | 8% | 0 | 9% | 0 | 10% | 0 |
| Space Cooling | 0.576 kW/ton Centrifugal Chillers | 0.461 kW/ton Centrifugal Chillers | 1.7 | 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 Highrise Office (Qty 6) | | | CCT15, BAU | | | CCT15, Mid-Low | | CCT15, Mid | | CCT15, Mid-High | | CCT15, 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 | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| CHP | None | 5500 kW, 1150 ton absorber | 6.8 | 23% | 1 | 28% | 1 | 32% | 1 | 37% | 2 | 42% | 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 Heating | | See Space Heating | | See Space Heating | | See Space Heating | | See Space 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 |
| 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 | 8.3 | 19% | 1 | 23% | 1 | 27% | 1 | 31% | 1 | 35% | 2 |

| Prototype 03 - 34-story Highrise Office (Qty 5) | | | CCT15, BAU | | | CCT15, Mid-Low | | CCT15, Mid | | CCT15, Mid-High | | CCT15, 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 | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 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 Space Heating | | See Space Heating | | See Space Heating | | See Space Heating | | See Space Heating | |
| Windows | U=0.50, SHGC=0.35 | U=0.26, SHGC=0.29 | 6.6 | 24% | 1 | 28% | 1 | 33% | 1 | 38% | 1 | 43% | 2 |
| Space Heating | Boiler Comb Eff = 80% | Boiler Comb Eff = 85% | 17.4 | 6% | 0 | 7% | 0 | 8% | 0 | 10% | 0 | 11% | 0 |
| Space Cooling | 0.576 kW/ton Centrifugal Chillers | 0.461 kW/ton Centrifugal Chillers | 1.9 | 43% | 2 | 52% | 2 | 61% | 3 | 69% | 3 | 78% | 3 |
| Lighting | 1.1 watts/sqft | 0.9 watts/sqft | 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 |

| Prototype 04 - 20-story Midrise Office (Qty 3) | | | CCT15, BAU | | | CCT15, Mid-Low | | CCT15, Mid | | CCT15, Mid-High | | CCT15, 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 | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| CHP | None | 3000 kW, 490 ton absorber | 7.0 | 23% | 0 | 27% | 0 | 32% | 0 | 36% | 1 | 41% | 1 |
| Roof Material | 100% of roof at Abs=0.90 | 100% of roof at Abs=0.3 | 6.8 | 23% | 0 | 28% | 0 | 32% | 0 | 37% | 1 | 41% | 1 |
| Water Heating | Boiler Comb Eff = 80% | Boiler Comb Eff = 85% | NA | See Space Heating | | See Space Heating | | See Space Heating | | See Space Heating | | See Space 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 | 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 | 11.5 | 13% | 0 | 15% | 0 | 18% | 0 | 20% | 0 | 23% | 0 |

| Prototype 05 - 33-story Highrise Hotel (Qty 1) | | | CCT15, BAU | | | CCT15, Mid-Low | | CCT15, Mid | | CCT15, Mid-High | | CCT15, 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 | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 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% | NA | See Space Heating | | See Space Heating | | See Space Heating | | See Space Heating | | See Space 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 | Boiler Comb Eff = 80% | Boiler Comb Eff = 85% | 3.1 | 37% | 0 | 44% | 0 | 52% | 0 | 59% | 0 | 67% | 0 |
| Space Cooling | 0.576 kW/ton Centrifugal Chillers | 0.461 kW/ton Centrifugal Chillers | 2.0 | 43% | 0 | 51% | 0 | 60% | 0 | 69% | 0 | 77% | 0 |
| Lighting | 1.3 watts/sqft | 1.19 watts/sqft | 36.9 | 1% | 0 | 1% | 0 | 1% | 0 | 1% | 0 | 1% | 0 |
| Roof Insulation | 5" R19 XPS | 6" R23 XPS | 13.1 | 10% | 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 |
| 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 Midrise Hotel (Qty 5) | | | CCT15, BAU | | | CCT15, Mid-Low | | CCT15, Mid | | CCT15, Mid-High | | CCT15, 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 | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| CHP | None | 400 kW, 80 ton absorber | 5.5 | 27% | 1 | 33% | 1 | 38% | 1 | 44% | 2 | 49% | 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% | 0 | 19% | 0 |
| Water Heating | Boiler Comb Eff = 80% | Boiler Comb Eff = 85% | NA | See Space Heating | | See Space Heating | | See Space Heating | | See Space Heating | | See Space 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 |
| Roof Insulation | 5" R19 XPS | 6" R23 XPS | 13.6 | 10% | 0 | 12% | 0 | 14% | 0 | 16% | 0 | 18% | 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 |

| Prototype 07 - 55-story Highrise Residential (Qty 2) | | | CCT15, BAU | | | CCT15, Mid-Low | | CCT15, Mid | | CCT15, Mid-High | | CCT15, 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 |
| Water Heating | Boiler Comb Eff = 80% | Boiler Comb Eff = 85% | NA | See Space Heating | | See Space Heating | | See Space Heating | | See Space Heating | | See Space 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 | Boiler Comb Eff = 80% | Boiler Comb Eff = 85% | 4.7 | 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 | 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 | Typical Aluminum Curtain Wall | Reduced thermal bridging | 7.0 | 23% | 0 | 27% | 0 | 32% | 0 | 36% | 0 | 41% | 0 |

| Prototype 08 - 43-story Highrise Residential (Qty 4) | | | CCT15, BAU | | | CCT15, Mid-Low | | CCT15, Mid | | CCT15, Mid-High | | CCT15, 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 |
| Water Heating | Boiler Comb Eff = 80% | Boiler Comb Eff = 85% | See Space Heating | | | See Space Heating | | | See Space Heating | | | See Space Heating | |
| Windows | U=0.50, SHGC=0.35 | U=0.26, SHGC=0.29 | 5.8 | 26% | 1 | 32% | 1 | 37% | 1 | 42% | 1 | 48% | 1 |
| Space Heating | Boiler Comb Eff = 80% | Boiler Comb Eff = 85% | 4.4 | 31% | 1 | 38% | 1 | 44% | 1 | 50% | 2 | 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 |

| Prototype 09 - 34-story Highrise Residential (Qty 10) | | | CCT15, BAU | | | CCT15, Mid-Low | | CCT15, Mid | | CCT15, Mid-High | | CCT15, 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 | None | 850 kW, 180 ton absorber | 6.1 | 25% | 2 | 30% | 3 | 35% | 3 | 41% | 4 | 46% | 4 |
| Roof Material | 100% of roof at Abs=0.90 | 100% of roof at Abs=0.3 | 6.4 | 24% | 2 | 29% | 2 | 34% | 3 | 39% | 3 | 44% | 4 |
| Water Heating | Boiler Comb Eff = 80% | Boiler Comb Eff = 85% | See Space Heating | | | See Space Heating | | | See Space Heating | | | See Space 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 | 27% | 2 | 32% | 3 | 36% | 3 | 41% | 4 |

| Prototype 10 - 25-story Highrise Residential (Qty 5) | | | CCT15, BAU | | | CCT15, Mid-Low | | CCT15, Mid | | CCT15, Mid-High | | CCT15, 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 | 202.0 | 0% | 0 | 0% | 0 | 0% | 0 | 0% | 0 | 0% | 0 |
| 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% | See Space Heating | | | See Space Heating | | | See Space Heating | | | See Space 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 | 0.70 watts/sqft | 0.675 watts/sqft | 108.1 | 0% | 0 | 0% | 0 | 0% | 0 | 0% | 0 | 0% | 0 |
| Roof Insulation | 5" R19 XPS | 6" R23 XPS | 8.6 | 18% | 0 | 22% | 1 | 26% | 1 | 29% | 1 | 33% | 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 | 7.2 | 22% | 1 | 26% | 1 | 31% | 1 | 35% | 1 | 39% | 1 |

| Prototype 11 - 12-story Midrise Residential (Qty 14) | | | CCT15, BAU | | | CCT15, Mid-Low | | CCT15, Mid | | CCT15, Mid-High | | CCT15, 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% | See Space Heating | | | See Space Heating | | | See Space Heating | | | See Space 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 Heating | Boiler Comb Eff = 80% | Boiler Comb Eff = 85% | 4.1 | 32% | 4 | 39% | 5 | 45% | 6 | 52% | 7 | 58% | 8 | |
| Space Cooling | 0.576 kW/ton Centrifugal Chillers | 0.461 kW/ton Centrifugal Chillers | 1.9 | 43% | 6 | 52% | 7 | 61% | 8 | 69% | 9 | 78% | 10 | |
| Lighting | 0.70 watts/sqft | 0.675 watts/sqft | 107.7 | 0% | 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 | |

| Prototype 12 - 55-story Highrise Mixed Use, Office (Qty 1) | | | CCT15, BAU | | | CCT15, Mid-Low | | CCT15, Mid | | CCT15, Mid-High | | CCT15, 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 | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| CHP | None | 3500 kW, 680 ton absorber | 6.5 | 24% | 0 | 29% | 0 | 34% | 0 | 38% | 0 | 43% | 0 |
| Roof Material | 100% of roof at Abs=0.90 | None | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| Water Heating | Boiler Comb Eff = 80% | Boiler Comb Eff = 85% | See Space Heating | | | See Space Heating | | | See Space Heating | | | See Space Heating | |
| 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 | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 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 | 7.9 | 20% | 0 | 24% | 0 | 28% | 0 | 32% | 0 | 36% | 0 |

| Prototype 12 - 55-story Highrise Mixed Use, Residential (Qty 1) | | | CCT15, BAU | | | CCT15, Mid-Low | | CCT15, Mid | | CCT15, Mid-High | | CCT15, 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 | 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% | See Space Heating | | | See Space Heating | | | See Space Heating | | | See Space 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 | Boiler Comb Eff = 80% | Boiler Comb Eff = 85% | 4.3 | 32% | 0 | 38% | 0 | 45% | 0 | 51% | 0 | 58% | 0 |
| Space Cooling | 0.576 kW/ton Centrifugal Chillers | 0.461 kW/ton Centrifugal Chillers | 1.9 | 43% | 0 | 52% | 0 | 60% | 0 | 69% | 0 | 78% | 0 |
| Lighting | 0.70 watts/sqft | 0.675 watts/sqft | 103.5 | 0% | 0 | 0% | 0 | 0% | 0 | 0% | 0 | 0% | 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% | 0 | 4% | 0 | 5% | 0 | 6% | 0 | 6% | 0 |
| Wall Insulation | Typical Aluminum Curtain Wall | Reduced thermal bridging | 7.1 | 22% | 0 | 27% | 0 | 31% | 0 | 36% | 0 | 40% | 0 |

| Corner Retail Shop - Type I Construction (Qty 34 Bldgs) | | | CCT15, BAU | | | CCT15, Mid-Low | | CCT15, Mid | | CCT15, Mid-High | | CCT15, 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 | | NA | | NA | |
| CHP | None | None | | | | NA | | NA | | NA | | NA | |
| Roof Material | None | None | | | | NA | | NA | | NA | | NA | |
| 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 | 6.3 | 25% | 12 | 29% | 18 | 34% | 21 | 39% | 21 | 44% | 27 |
| Space Heating | Furnace 78% AFUE | Furnace 94% AFUE | 3.1 | 37% | 12 | 44% | 15 | 52% | 17 | 59% | 20 | 66% | 22 |
| Space Cooling | 10 SEER, 9.5 EER Unitary AC | 14 SEER, 12.5 EER Unitary AC | 3.4 | 35% | 12 | 43% | 14 | 50% | 16 | 57% | 19 | 64% | 21 |
| Lighting | 1.50 watts/sqft | None | | | | NA | | NA | | NA | | NA | |
| Roof Insulation | None | None | | | | NA | | NA | | NA | | NA | |
| Thermal Storage | None | None | | | | NA | | NA | | NA | | NA | |
| Wall Insulation | Typical Aluminum Curtain Wall | Reduced thermal bridging | 27.2 | 2% | 12 | 2% | 18 | 2% | 21 | 3% | 21 | 3% | 27 |

| Internal Retail Shop - Type I Construction (Qty 34 Bldgs) | | | CCT15, BAU | | | CCT15, Mid-Low | | CCT15, Mid | | CCT15, Mid-High | | CCT15, 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 | | NA | | NA | | NA | |
| CHP | None | None | | NA | | NA | | NA | | NA | | NA | |
| Roof Material | None | None | | NA | | NA | | NA | | NA | | NA | |
| 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 | 57% | 19 | 64% | 21 |
| Lighting | 1.50 watts/sqft | None | | NA | | NA | | NA | | NA | | NA | |
| Roof Insulation | None | None | | NA | | NA | | NA | | NA | | NA | |
| Thermal Storage | None | None | | NA | | NA | | NA | | NA | | NA | |
| Wall Insulation | Typical Aluminum Curtain Wall | Reduced thermal bridging | 56.6 | 0% | 45 | 0% | 67 | 0% | 70 | 0% | 70 | 0% | 92 |

| Corner Restaurant - Type I Construction (Qty 30 Bldgs) | | | CCT15, BAU | | | CCT15, Mid-Low | | CCT15, Mid | | CCT15, Mid-High | | CCT15, 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 | | NA | | NA | | NA | |
| CHP | None | None | | NA | | NA | | NA | | NA | | NA | |
| Roof Material | None | None | | NA | | NA | | NA | | NA | | NA | |
| Water Heating | EF=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 | | NA | | NA | | NA | | NA | |
| Roof Insulation | None | None | | NA | | NA | | NA | | NA | | NA | |
| Thermal Storage | None | None | | NA | | NA | | NA | | NA | | NA | |
| Wall Insulation | Typical Aluminum Curtain Wall | Reduced thermal bridging | 26.3 | 2% | 4 | 2% | 5 | 3% | 6 | 3% | 6 | 3% | 8 |

| Corner Retail Shop - Type II Construction (Qty 17 Bldgs) | | | CCT15, BAU | | | CCT15, Mid-Low | | CCT15, Mid | | CCT15, Mid-High | | CCT15, 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 | | NA | | NA | | NA | |
| CHP | None | None | | NA | | NA | | NA | | NA | | NA | |
| Roof Material | None | None | | NA | | NA | | 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% | 7 | 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% | 7 | 51% | 8 | 58% | 9 | 65% | 11 |
| Lighting | 1.50 watts/sqft | None | | NA | | NA | | NA | | NA | | NA | |
| Roof Insulation | None | None | | NA | | NA | | NA | | NA | | NA | |
| Thermal Storage | None | None | | NA | | NA | | NA | | NA | | NA | |
| Wall Insulation | R11, 2x4.16 | R19, 2x4.16 | 9.7 | 16% | 6 | 19% | 9 | 22% | 12 | 26% | 12 | 29% | 15 |

| Internal Retail Shop - Type II Construction (Qty 17 Bldgs) | | | CCT15, BAU | | | CCT15, Mid-Low | | CCT15, Mid | | CCT15, Mid-High | | CCT15, 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 | | NA | | NA | | NA | |
| CHP | None | None | | NA | | NA | | NA | | NA | | NA | |
| Roof Material | None | None | | NA | | NA | | NA | | NA | | 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 | 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 | | NA | | NA | | NA | | NA | |
| Roof Insulation | None | None | | NA | | NA | | NA | | NA | | NA | |
| Thermal Storage | None | None | | NA | | NA | | NA | | NA | | NA | |
| Wall Insulation | R11, 2x4.16 | R19, 2x4.16 | 15.8 | 7% | 12 | 9% | 18 | 10% | 24 | 12% | 24 | 13% | 30 |

| Corner Restaurant - Type II Construction (Qty 17 Bldgs) | | | CCT15, BAU | | | CCT15, Mid-Low | | CCT15, Mid | | CCT15, Mid-High | | CCT15, 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 | | NA | | NA | | NA | |
| CHP | None | None | | NA | | NA | | NA | | NA | | NA | |
| Roof Material | None | None | | NA | | NA | | NA | | NA | | NA | |
| Water Heating | EF=0.800 | EF=0.823 | 8.6 | 18% | 3 | 22% | 3 | 26% | 4 | 29% | 4 | 33% | 5 |
| Windows | U=0.50, SHGC=0.35 | U=0.26, SHGC=0.29 | 9.9 | 16% | 2 | 19% | 3 | 22% | 4 | 25% | 4 | 28% | 5 |
| Space Heating | Furnace 78% AFUE | Furnace 94% AFUE | 2.1 | 42% | 7 | 51% | 8 | 59% | 10 | 68% | 11 | 76% | 12 |
| Space Cooling | 10 SEER, 9.5 EER Unitary AC | 14 SEER, 12.5 EER Unitary AC | 3.5 | 35% | 6 | 43% | 7 | 50% | 8 | 57% | 9 | 64% | 10 |
| Lighting | 1.50 watts/sqft | None | | NA | | NA | | NA | | NA | | NA | |
| Roof Insulation | None | None | | NA | | NA | | NA | | NA | | NA | |
| Thermal Storage | None | None | | NA | | NA | | NA | | NA | | NA | |
| Wall Insulation | R11, 2x4.16 | R19, 2x4.16 | 7.5 | 21% | 2 | 25% | 3 | 30% | 4 | 34% | 4 | 38% | 5 |

| Prototype 01 - 56-story Highrise Office (Qty 1) | | | CCT20, BAU | | | CCT20, Mid-Low | | CCT20, Mid | | CCT20, Mid-High | | CCT20, 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 | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 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 Space Heating | | See Space Heating | | See Space Heating | | See Space Heating | | See Space Heating | |
| 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% | 17.6 | 6% | 0 | 7% | 0 | 8% | 0 | 9% | 0 | 11% | 0 |
| Space Cooling | 0.576 kW/ton Centrifugal Chillers | 0.461 kW/ton Centrifugal Chillers | 1.6 | 45% | 0 | 54% | 0 | 63% | 0 | 72% | 0 | 81% | 0 |
| Lighting | 1.1 watts/sqft | 0.9 watts/sqft | 9.5 | 16% | 0 | 20% | 0 | 23% | 0 | 26% | 0 | 29% | 0 |
| Roof Insulation | 5" R19 XPS | 6" R23 XPS | 2.1 | 42% | 0 | 50% | 0 | 59% | 0 | 67% | 0 | 75% | 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 | 8.1 | 20% | 0 | 24% | 0 | 28% | 0 | 31% | 0 | 35% | 0 |

| Prototype 02 - 41-story Highrise Office (Qty 6) | | | CCT20, BAU | | | CCT20, Mid-Low | | CCT20, Mid | | CCT20, Mid-High | | CCT20, 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 | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 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 |
| Water Heating | Boiler Comb Eff = 80% | Boiler Comb Eff = 85% | NA | See Space Heating | | See Space Heating | | See Space Heating | | See Space Heating | | See Space Heating | |
| Windows | U=0.50, SHGC=0.35 | U=0.26, SHGC=0.29 | 6.6 | 24% | 1 | 29% | 1 | 33% | 1 | 38% | 2 | 43% | 2 |
| Space Heating | Boiler Comb Eff = 80% | Boiler Comb Eff = 85% | 17.6 | 6% | 0 | 7% | 0 | 8% | 0 | 9% | 0 | 10% | 0 |
| Space Cooling | 0.576 kW/ton Centrifugal Chillers | 0.461 kW/ton Centrifugal Chillers | 1.7 | 44% | 2 | 53% | 3 | 62% | 3 | 71% | 4 | 79% | 4 |
| Lighting | 1.1 watts/sqft | 0.9 watts/sqft | 9.7 | 16% | 0 | 19% | 1 | 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 Highrise Office (Qty 5) | | | CCT20, BAU | | | CCT20, Mid-Low | | CCT20, Mid | | CCT20, Mid-High | | CCT20, 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 | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| CHP | None | 4500 kW, 1020 ton absorber | 6.2 | 25% | 1 | 30% | 1 | 35% | 1 | 40% | 1 | 45% | 2 |
| Roof Material | 100% of roof at Abs=0.90 | 100% of roof at Abs=0.3 | 6.7 | 23% | 1 | 28% | 1 | 33% | 1 | 37% | 1 | 42% | 2 |
| Water Heating | Boiler Comb Eff = 80% | Boiler Comb Eff = 85% | NA | See Space Heating | | See Space Heating | | See Space Heating | | See Space Heating | | See Space Heating | |
| Windows | U=0.50, SHGC=0.35 | U=0.26, SHGC=0.29 | 6.5 | 24% | 1 | 29% | 1 | 34% | 1 | 39% | 1 | 44% | 2 |
| Space Heating | Boiler Comb Eff = 80% | Boiler Comb Eff = 85% | 17.1 | 6% | 0 | 7% | 0 | 9% | 0 | 10% | 0 | 11% | 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/sqft | 0.9 watts/sqft | 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 Midrise Office (Qty 3) | | | CCT20, BAU | | | CCT20, Mid-Low | | CCT20, Mid | | CCT20, Mid-High | | CCT20, 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 | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 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 roof at Abs=0.3 | 6.7 | 23% | 0 | 28% | 0 | 33% | 0 | 38% | 1 | 42% | 1 |
| Water Heating | Boiler Comb Eff = 80% | Boiler Comb Eff = 85% | NA | See Space Heating | | See Space Heating | | See Space Heating | | See Space Heating | | See Space Heating | |
| Windows | U=0.50, SHGC=0.35 | U=0.26, SHGC=0.29 | 9.6 | 16% | 0 | 19% | 0 | 23% | 0 | 26% | 0 | 29% | 0 |
| 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 Highrise Hotel (Qty 1) | | | CCT20, BAU | | | CCT20, Mid-Low | | CCT20, Mid | | CCT20, Mid-High | | CCT20, 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 | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| CHP | None | 2500 kW, 500 ton absorber | 4.8 | 30% | 0 | 36% | 0 | 42% | 0 | 48% | 0 | 54% | 0 |
| Roof Material | 100% of roof at Abs=0.90 | 100% of roof at Abs=0.3 | 17.4 | 6% | 0 | 7% | 0 | 8% | 0 | 10% | 0 | 11% | 0 |
| Water Heating | Boiler Comb Eff = 80% | Boiler Comb Eff = 85% | NA | See Space Heating | | See Space Heating | | See Space Heating | | See Space Heating | | See Space 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 |
| 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 Midrise Hotel (Qty 5) | | | CCT20, BAU | | | CCT20, Mid-Low | | CCT20, Mid | | CCT20, Mid-High | | CCT20, 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 | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 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% | NA | See Space Heating | | See Space Heating | | See Space Heating | | See Space Heating | | See Space 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 |
| Roof Insulation | 5" R19 XPS | 6" R23 XPS | 13.4 | 10% | 0 | 12% | 0 | 14% | 0 | 16% | 0 | 18% | 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 |

| Prototype 07 - 55-story Highrise Residential (Qty 2) | | | CCT20, BAU | | | CCT20, Mid-Low | | CCT20, Mid | | CCT20, Mid-High | | CCT20, 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 | 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% | 0 | 41% | 0 | 46% | 0 |
| 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% | NA | See Space Heating | | See Space Heating | | See Space Heating | | See Space Heating | | See Space 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 |
| Space Cooling | 0.576 kW/ton Centrifugal Chillers | 0.461 kW/ton Centrifugal Chillers | 1.7 | 44% | 0 | 53% | 1 | 62% | 1 | 71% | 1 | 80% | 1 |
| Lighting | 0.70 watts/sqft | 0.675 watts/sqft | 101.3 | 0% | 0 | 0% | 0 | 0% | 0 | 0% | 0 | 0% | 0 |
| Roof Insulation | 5" R19 XPS | 6" R23 XPS | 6.8 | 23% | 0 | 28% | 0 | 32% | 0 | 37% | 0 | 42% | 0 |
| Thermal Storage | None | 15% of max load, 3751 ton-hrs | 31.1 | 1% | 0 | 1% | 0 | 2% | 0 | 2% | 0 | 2% | 0 |
| Wall Insulation | Typical Aluminum Curtain Wall | Reduced thermal bridging | 6.8 | 23% | 0 | 28% | 0 | 32% | 0 | 37% | 0 | 42% | 0 |

| Prototype 08 - 43-story Highrise Residential (Qty 4) | | | CCT20, BAU | | | CCT20, Mid-Low | | CCT20, Mid | | CCT20, Mid-High | | CCT20, 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 |
| Water Heating | Boiler Comb Eff = 80% | Boiler Comb Eff = 85% | See Space Heating | | | See Space Heating | | | See Space Heating | | | See Space Heating | |
| Windows | U=0.50, SHGC=0.35 | U=0.26, SHGC=0.29 | 5.6 | 27% | 1 | 32% | 1 | 38% | 1 | 43% | 1 | 49% | 1 |
| Space Heating | Boiler Comb Eff = 80% | Boiler Comb Eff = 85% | 4.4 | 32% | 1 | 38% | 1 | 44% | 1 | 51% | 2 | 57% | 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/sqft | 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 |

| Prototype 09 - 34-story Highrise Residential (Qty 10) | | | CCT20, BAU | | | CCT20, Mid-Low | | CCT20, Mid | | CCT20, Mid-High | | CCT20, 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 | 850 kW, 180 ton absorber | 5.7 | 27% | 2 | 32% | 3 | 37% | 3 | 43% | 4 | 48% | 4 |
| Roof Material | 100% of roof at Abs=0.90 | 100% of roof at Abs=0.3 | 6.1 | 25% | 2 | 30% | 3 | 35% | 3 | 40% | 4 | 45% | 4 |
| Water Heating | Boiler Comb Eff = 80% | Boiler Comb Eff = 85% | See Space Heating | | | See Space Heating | | | See Space Heating | | | See Space 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 | 7% | 0 | 8% | 0 | 9% | 0 | 11% | 1 | 12% | 1 |
| Wall Insulation | Typical Aluminum Curtain Wall | Reduced thermal bridging | 6.7 | 23% | 2 | 28% | 2 | 33% | 3 | 37% | 3 | 42% | 4 |

| Prototype 10 - 25-story Highrise Residential (Qty 5) | | | CCT20, BAU | | | CCT20, Mid-Low | | CCT20, Mid | | CCT20, Mid-High | | CCT20, 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 | 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% | See Space Heating | | | See Space Heating | | | See Space Heating | | | See Space 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 |
| Space Cooling | 0.576 kW/ton Centrifugal Chillers | 0.461 kW/ton Centrifugal Chillers | 1.9 | 43% | 2 | 52% | 2 | 61% | 3 | 69% | 3 | 78% | 3 |
| Lighting | 0.70 watts/sqft | 0.675 watts/sqft | 103.5 | 0% | 0 | 0% | 0 | 0% | 0 | 0% | 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 |

| Prototype 11 - 12-story Midrise Residential (Qty 14) | | | CCT20, BAU | | | CCT20, Mid-Low | | CCT20, Mid | | CCT20, Mid-High | | CCT20, 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 |
| Roof Material | 100% of roof at Abs=0.90 | 100% of roof at Abs=0.3 | 3.7 | 35% | 4 | 41% | 5 | 48% | 6 | 55% | 7 | 62% | 8 |
| Water Heating | Boiler Comb Eff = 80% | Boiler Comb Eff = 85% | See Space Heating | | | See Space Heating | | | See Space Heating | | | See Space Heating | |
| Windows | U=0.50, SHGC=0.35 | U=0.26, SHGC=0.29 | 7.5 | 21% | 2 | 25% | 3 | 30% | 4 | 34% | 4 | 38% | 5 |
| Space Heating | Boiler 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 |

| Prototype 12 - 55-story Highrise Mixed Use, Office (Qty 1) | | | CCT20, BAU | | | CCT20, Mid-Low | | CCT20, Mid | | CCT20, Mid-High | | CCT20, 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 | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 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 | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| Water Heating | Boiler Comb Eff = 80% | Boiler Comb Eff = 85% | See Space Heating | | | See Space Heating | | | See Space Heating | | | See Space 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 Centrifugal Chillers | 1.8 | 44% | 0 | 52% | 0 | 61% | 0 | 70% | 0 | 78% | 0 |
| Lighting | 1.1 watts/sqft | 0.9 watts/sqft | 10.1 | 15% | 0 | 18% | 0 | 21% | 0 | 24% | 0 | 27% | 0 |
| Roof Insulation | 5" R19 XPS | None | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 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 | 7.6 | 21% | 0 | 25% | 0 | 29% | 0 | 33% | 0 | 37% | 0 |

| Prototype 12 - 55-story Highrise Mixed Use, Residential (Qty 1) | | | CCT20, BAU | | | CCT20, Mid-Low | | CCT20, Mid | | CCT20, Mid-High | | CCT20, 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 |
| Roof Material | 100% of roof at Abs=0.90 | 100% of roof at Abs=0.3 | 6.3 | 25% | 0 | 30% | 0 | 35% | 0 | 40% | 0 | 44% | 0 |
| Water Heating | Boiler Comb Eff = 80% | Boiler Comb Eff = 85% | See Space Heating | | | See Space Heating | | | See Space Heating | | | See Space Heating | |
| Windows | U=0.50, SHGC=0.35 | U=0.26, SHGC=0.29 | 5.8 | 26% | 0 | 31% | 0 | 37% | 0 | 42% | 0 | 47% | 0 |
| Space Heating | Boiler Comb Eff = 80% | Boiler Comb Eff = 85% | 4.2 | 32% | 0 | 39% | 0 | 45% | 0 | 52% | 0 | 58% | 0 |
| 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 |
| Wall Insulation | Typical Aluminum Curtain Wall | Reduced thermal bridging | 6.9 | 23% | 0 | 27% | 0 | 32% | 0 | 37% | 0 | 41% | 0 |

| Corner Retail Shop - Type I Construction (Qty 34 Bldgs) | | | CCT20, BAU | | | CCT20, Mid-Low | | CCT20, Mid | | CCT20, Mid-High | | CCT20, 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 | | | NA | | | NA | |
| CHP | None | None | NA | | | NA | | | NA | | | NA | |
| Roof Material | None | None | NA | | | NA | | | NA | | | NA | |
| 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 78% AFUE | Furnace 94% AFUE | 3.1 | 37% | 12 | 45% | 15 | 52% | 17 | 59% | 20 | 67% | 22 |
| Space Cooling | 10 SEER, 9.5 EER Unitary AC | 14 SEER, 12.5 EER Unitary AC | 3.4 | 36% | 12 | 43% | 14 | 50% | 17 | 57% | 19 | 65% | 21 |
| Lighting | 1.50 watts/sqft | None | NA | | | NA | | | NA | | | NA | |
| Roof Insulation | None | None | NA | | | NA | | | NA | | | NA | |
| Thermal Storage | None | None | NA | | | NA | | | NA | | | NA | |
| Wall Insulation | Typical Aluminum Curtain Wall | Reduced thermal bridging | 26.5 | 2% | 15 | 2% | 18 | 3% | 21 | 3% | 21 | 3% | 30 |

| Internal Retail Shop - Type I Construction (Qty 34 Bldgs) | | | CCT20, BAU | | | CCT20, Mid-Low | | CCT20, Mid | | CCT20, Mid-High | | CCT20, 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 | | NA | | NA | | NA | |
| CHP | None | None | | NA | | NA | | NA | | NA | | NA | |
| Roof Material | None | None | | NA | | NA | | NA | | NA | | NA | |
| 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 | | NA | | NA | | NA | | NA | |
| Roof Insulation | None | None | | NA | | NA | | NA | | NA | | NA | |
| Thermal Storage | None | None | | NA | | NA | | NA | | NA | | NA | |
| Wall Insulation | Typical Aluminum Curtain Wall | Reduced thermal bridging | 55.6 | 0% | 66 | 0% | 67 | 0% | 70 | 0% | 70 | 0% | 112 |

| Corner Restaurant - Type I Construction (Qty 30 Bldgs) | | | CCT20, BAU | | | CCT20, Mid-Low | | CCT20, Mid | | CCT20, Mid-High | | CCT20, 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 | | NA | | NA | | NA | |
| CHP | None | None | | NA | | NA | | NA | | NA | | NA | |
| Roof Material | None | None | | NA | | NA | | NA | | NA | | NA | |
| Water Heating | EF=0.800 | EF=0.823 | 8.5 | 19% | 6 | 22% | 7 | 26% | 8 | 30% | 10 | 34% | 11 |
| Windows | U=0.50, SHGC=0.35 | U=0.26, SHGC=0.29 | 7.4 | 21% | 5 | 26% | 5 | 30% | 6 | 34% | 6 | 39% | 9 |
| Space Heating | Furnace 78% AFUE | Furnace 94% AFUE | 2.0 | 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 | 3.5 | 35% | 12 | 42% | 14 | 50% | 16 | 57% | 19 | 64% | 21 |
| Lighting | 1.50 watts/sqft | None | | NA | | NA | | NA | | NA | | NA | |
| Roof Insulation | None | None | | NA | | NA | | NA | | NA | | NA | |
| Thermal Storage | None | None | | NA | | NA | | NA | | NA | | NA | |
| Wall Insulation | Typical Aluminum Curtain Wall | Reduced thermal bridging | 25.6 | 2% | 5 | 3% | 5 | 3% | 6 | 3% | 6 | 4% | 9 |

| Corner Retail Shop - Type II Construction (Qty 17 Bldgs) | | | CCT20, BAU | | | CCT20, Mid-Low | | CCT20, Mid | | CCT20, Mid-High | | CCT20, 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 | | NA | | NA | | NA | |
| CHP | None | None | | NA | | NA | | NA | | NA | | NA | |
| Roof Material | None | None | | NA | | NA | | NA | | NA | | 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 | Furnace 94% AFUE | 4.0 | 33% | 5 | 40% | 6 | 46% | 7 | 53% | 8 | 59% | 10 |
| Space Cooling | 10 SEER, 9.5 EER Unitary AC | 14 SEER, 12.5 EER Unitary AC | 3.2 | 37% | 6 | 44% | 7 | 51% | 8 | 59% | 9 | 66% | 11 |
| Lighting | 1.50 watts/sqft | None | | NA | | NA | | NA | | NA | | NA | |
| Roof Insulation | None | None | | NA | | NA | | NA | | NA | | NA | |
| Thermal Storage | None | None | | NA | | NA | | NA | | NA | | NA | |
| Wall Insulation | R11, 2x4.16 | R19, 2x4.16 | 9.6 | 16% | 6 | 19% | 9 | 23% | 12 | 26% | 12 | 29% | 15 |

| Internal Retail Shop - Type II Construction (Qty 17 Bldgs) | | | CCT20, BAU | | | CCT20, Mid-Low | | CCT20, Mid | | CCT20, Mid-High | | CCT20, 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 | | NA | | NA | | NA | |
| CHP | None | None | | NA | | NA | | NA | | NA | | NA | |
| Roof Material | None | None | | NA | | NA | | NA | | NA | | 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 | 7.3 | 22% | 12 | 26% | 18 | 31% | 24 | 35% | 24 | 39% | 30 |
| Space Heating | Furnace 78% AFUE | Furnace 94% AFUE | 4.2 | 32% | 5 | 39% | 6 | 45% | 7 | 51% | 8 | 58% | 9 |
| Space Cooling | 10 SEER, 9.5 EER Unitary AC | 14 SEER, 12.5 EER Unitary AC | 3.3 | 36% | 6 | 43% | 7 | 51% | 8 | 58% | 9 | 65% | 11 |
| Lighting | 1.50 watts/sqft | None | | NA | | NA | | NA | | NA | | NA | |
| Roof Insulation | None | None | | NA | | NA | | NA | | NA | | NA | |
| Thermal Storage | None | None | | NA | | NA | | NA | | NA | | NA | |
| Wall Insulation | R11, 2x4.16 | R19, 2x4.16 | 14.9 | 8% | 12 | 10% | 18 | 12% | 24 | 13% | 24 | 15% | 30 |

| Corner Restaurant - Type II Construction (Qty 17 Bldgs) | | | CCT20, BAU | | | CCT20, Mid-Low | | CCT20, Mid | | CCT20, Mid-High | | CCT20, 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 | | NA | | NA | | NA | |
| CHP | None | None | | NA | | NA | | NA | | NA | | NA | |
| Roof Material | None | None | | NA | | NA | | NA | | NA | | NA | |
| Water Heating | EF=0.800 | EF=0.823 | 8.5 | 19% | 3 | 22% | 3 | 26% | 4 | 30% | 5 | 34% | 5 |
| Windows | U=0.50, SHGC=0.35 | U=0.26, SHGC=0.29 | 9.7 | 16% | 2 | 19% | 3 | 22% | 4 | 26% | 4 | 29% | 5 |
| Space Heating | Furnace 78% AFUE | Furnace 94% AFUE | 2.0 | 42% | 7 | 51% | 8 | 59% | 10 | 68% | 11 | 76% | 12 |
| Space Cooling | 10 SEER, 9.5 EER Unitary AC | 14 SEER, 12.5 EER Unitary AC | 3.3 | 36% | 6 | 43% | 7 | 50% | 8 | 57% | 9 | 65% | 10 |
| Lighting | 1.50 watts/sqft | None | | NA | | NA | | NA | | NA | | NA | |
| Roof Insulation | None | None | | NA | | NA | | NA | | NA | | NA | |
| Thermal Storage | None | None | | NA | | NA | | NA | | NA | | NA | |
| Wall Insulation | R11, 2x4.16 | R19, 2x4.16 | 7.3 | 22% | 2 | 26% | 3 | 30% | 4 | 35% | 4 | 39% | 5 |

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