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CITY OF
HAYWARD
HEART OF THE BAY

DATE: November 3, 2009

TO: Mayor and City Council

FROM: Development Services Director

SUBJECT: Ordinance Amending Article 22 of Chapter 10 of the Hayward Municipal Code Relating to Hayward's Green Building Ordinance for Private Development

RECOMMENDATION

That Council adopts the attached resolution (Attachment I), finding that the adoption of the attached ordinance (Attachment II), is categorically exempt from the California Environmental Quality Act, and approves the ordinance amending Hayward's Green Building Ordinance for Private Development so as to allow establishment of mandatory energy efficiency standards that would exceed those of the State Building Standards Code, including responses to comments from California Energy Commission staff and relating to a cost-effectiveness study by Stopwaste.org.

SUMMARY

The City Council adopted a green building ordinance for private development in December of last year (Attachment III). The revised ordinance, shown in a red-lined, edited format as Attachment II, contains revisions that incorporate comments from the California Energy Commission (CEC) staff and incorporates revisions and findings associated with a cost effectiveness study by Stopwaste.org. The revisions and findings associated with the cost-effectiveness study were incorporated into an ordinance introduced by City Council in June. The revisions shown in Attachment II incorporate those same findings and revisions, along with comments recently received from CEC staff. According to the City Attorney's office, in accordance with the provisions of the City Charter, an ordinance that is amended after it is introduced that does not involve strictly typographical errors must be reintroduced, and adopted at a meeting held at least one week after the date of the alteration.

BACKGROUND

After engaging the development community, the City of Hayward adopted a green building ordinance for private development in December of last year (see Attachment III). The development of the ordinance was informed and shaped by input from community stakeholders, who encouraged staff to include language in the ordinance that would exempt entitled projects

from mandatory green building standards and to provide incentives to encourage voluntary green building. To address entitled projects, the ordinance exempts projects that would have vesting tentative map approval by January 1, 2009, and would defer compliance for entitled projects without vesting tentative map approval, but subject to an approved Development Agreement, to January 1, 2011. The revisions to the ordinance do not change such exemptions.

Concerning incentives to encourage voluntary "green building", staff will present in early 2010 a set of recommendations and associated ordinances to City Council for consideration mainly involving allowing deferral of payment of certain fees, as part of an incentives package.

Since the Green Building Ordinance indicates covered residential projects will be required to meet certain standards and be "GreenPoint Rated" (see later discussion) and requires energy efficiency standards for covered non-residential projects that exceed those of the State, it mandates exceeding the new 2008 State energy efficiency standards. State law indicates that in order to mandate green building measures that exceed State energy efficiency standards, a cost effectiveness study and findings must be submitted to the California Energy Commission (CEC) for approval. Findings related to local climatic, geological, or topographical conditions, must also be filed with the California Building Standards Commission (BSC). Related to that process, and after receiving support for the proposed ordinance revisions from CEC staff in June, City staff recommended and the City Council adopted a resolution and introduced an ordinance on June 23 of this year that entailed findings and a new section associated with Stopwaste.org's cost effectiveness study. See later discussion regarding the conclusions of that study.

A cost-effectiveness study and associated ordinance amendments must be done whenever the State energy efficiency standards are updated and as long as Hayward's ordinance mandates exceeding those standards. Typically, the State's energy efficiency standards are revised every three years. As part of that process, the associated filings with the CEC and BSC must also occur. Hayward's existing ordinance indicates that mandatory requirements will not be effective until August 1, 2009, or until after the Energy Commission and Building Standards Commission approve the requirements of the ordinance. Originally, the new State energy efficiency standards were to be effective August 1, but that effective date was moved by the State to January 1, 2010; therefore, the ordinance effective date becomes January 1, 2010 as well.

The comments received from the CEC staff that are incorporated into Attachment II primarily relate to language that states the obvious: projects will at least need to comply with the new Title 24 State energy efficiency standards that will be effective January 1, 2010. Because CEC staff had previously indicated the ordinance introduced in June was acceptable, staff had anticipated that the Energy Commission would have acted on the ordinance introduced in June by now.

DISCUSSION

Overview of Hayward's Existing Green Building Ordinance - The ordinance indicates that covered new residential projects will be required to be GreenPoint Rated; meaning they will need to score at least 50 on *Build It Green's* most current GreenPoint Rated checklist. *Build It Green* is the entity that oversees the GreenPoint Rated program, which includes independent third party raters to verify green building compliance. A GreenPoint Rated home is graded on five

categories: energy efficiency, resource conservation, indoor air quality, water conservation, and community. If the home meets minimum point requirements in each category and scores at least 50 points as verified by a certified GreenPoint Rater, it earns the right to bear the GreenPoint Rated label. GreenPoint Rating also entails providing a numerical score which allows buyers to evaluate and compare the environmental performance of different homes. *Build It Green* is developing new checklists and guidelines, which will become effective on January 1, 2010. The new guidelines will require that in order to be GreenPoint Rated, residential projects must achieve a minimum score of 50 on the checklists and exceed the new (2008) State Title 24 energy efficiency standards by at least 15 percent. Current checklists require energy efficiency at 15 percent above current State standards. The attached study analyzes costs for various building types that exceed new State standards by 10, 15, 20, and 35 percent.

For covered non-residential projects (see attached City of Hayward checklist, Attachment IV), which include new buildings, or remodels/additions of 1,000 square feet or more that entail replacement of at least half of light fixtures, the ordinance requires incorporation of energy efficiency in one of three ways:

1. the lighting load for fixtures shall be reduced by at least 15 percent below new State energy efficiency standards;
2. 15 percent of lighting loads of such fixtures shall be provided by a renewable energy source; or
3. the project must show compliance for overall energy budget at 5 percent below the new State energy efficiency standards.

Also, for those projects that entail new bathrooms or new water closets or urinals, indoor water use must be reduced by 20 percent below baseline per the 2007 California Plumbing Code, for each fixture.

Stopwaste.org's Cost Effectiveness Study – A cost-effectiveness study was developed for Stopwaste.org by Gabel Associates, LLC, for the two climate zones within Alameda County as part of the consideration of the impacts of a Green Building Ordinance (see the study's Executive Summary by Stopwaste.org staff, Attachment V). The Stopwaste.org Board adopted the study at its meeting of April 22, 2009. The study considers the incremental first costs associated with new development to achieve the required percentage above State 2008 Title 24 energy efficiency standards, as compared to the annual energy cost savings for various building types. As Stopwaste.org is a joint power authority representing the fourteen cities and unincorporated Alameda County, its approval and adoption of this study has allowed all member agencies, including the City of Hayward, to reference the cost-effectiveness study in their respective local green building ordinances. The goal of the study is to provide relatively real-world, order-of-magnitude results for local jurisdictions attempting to understand and calibrate energy and cost impacts of local energy or green building ordinances.

The data in the cost-effectiveness study (see Attachment VI) was developed and compiled to consider code change cost implications to new construction projects in Climate Zones 3 and 12 for a variety of building types, as summarized below:

1. single-family residential (one-story 1,582 sq. ft. home);
2. single-family residential (two-story 2,025 sq. ft. home);
3. multifamily low-rise residential (2-story, 8-unit, 8,442 sq. ft. building);
4. multifamily high-rise residential (5-story, 40-unit, 26,800 sq. ft. building);
5. low-rise office building (2-story, 21,160 sq. ft. building); and
6. high-rise office building (5-story, 42,900 sq. ft. high rise office building).

Except for its most eastern portions, which are in Climate Zone 12, Hayward is in Climate Zone 3. For each prototype new construction building, the specific measures and associated incremental cost necessary to reach 2008 standards, and to reach 10%, 15%, 20%, and 35% efficiency levels above 2008 code standards are itemized in detail in the full study, and the cost-effectiveness for each scenario is presented in graph format (see graphs on pages.30 to 59 in the attached full study for Climate Zone 3 analyses).

Starting with a set of measures that just meet 2008 T-24 standards, various items are changed to just reach the next increment of energy performance (e.g., 2005 to 2008 standards, 10% better than 2008 Title 24 standards, 15% better, etc.). The energy measures chosen are not all prescriptive measures, but are a combination of measures that reflect how designers, builders, and developers are likely to achieve a specified level of performance. A minimum and maximum range of incremental costs of added energy measures is established by a variety of research and surveys to obtain accurate and current measures of cost.

For Climate Zone 3, as indicated in the various tables of the attached Executive Summary of the study (Attachment V), the additional costs to achieve an energy efficiency of 15% above 2008 T-24 standards compared with meeting 2008 standards are shown below. The graphs beginning on page 42 of the full study (Attachment VI) indicate what the payback in years would be for the added energy efficiency measures, along with the annual reduction in CO_2 emissions per year per square foot. Such information is also shown below for each building prototype analyzed.

Building Prototype	**1,582 sq. ft. One-story Home**	**2,025 sq. ft. Two-story Home**	**2-story Multifamily Project**	**5-story Multifamily Project**	**2-story Office Building**	**5-story Office Building**
Incremental Added Cost[1]	$1.19 per sq. ft.	$0.77 per sq. ft.	$1.42 per sq. ft.	$1.18 per sq. ft.	$2.35 per sq. ft.	$1.74 per sq. ft.
Payback for Energy Measures	29+ years	12+ years	25+ years	21+years	16+ years	9+ years
Annual Reduction in CO_2 Emissions	0.3+ lbs. per sq. ft.	0.5+ lbs. per sq. ft.	0.4+ lbs. per sq. ft.	<0.2 lbs. per sq. ft.	0.3+ lbs. per sq. ft.	0.7+ lbs. per sq. ft.

[1]to achieve energy efficiency 15% above 2008 T-24 standards compared with meeting 2008 standards

If the average cost for new construction in Hayward for these building types ranges from $250 to $400 per square foot, the added incremental cost to achieve energy efficiency 15% above 2008 standards would represent approximately 0.19% to 0.94% of total construction costs.

ECONOMIC IMPACT

Staff anticipates minimal economic impacts associated with adoption of this ordinance, given the minimal relative construction costs associated with exceeding State energy efficiency standards. Such construction related to energy efficiency is typically the most expensive construction component associated with "green building." Also, more and more cities in the Bay area have adopted or will be adopting green building ordinances, many of which are relying on the GreenPoint rating system or similar standards. Therefore, Hayward's ordinance would not represent an undue burden on developers who wish to build in Hayward.

FISCAL IMPACT

There are no fiscal impacts associated with adoption of this ordinance.

PUBLIC CONTACT

A copy of this report was forwarded to the developers' group, with whom staff met prior to the formation of the adopted ordinance. No comments were received to date in regards to that action.

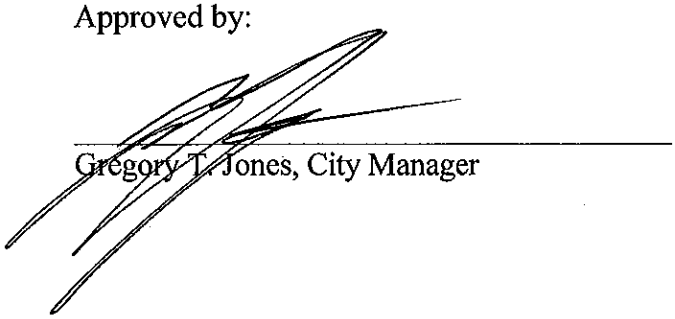
SCHEDULE

Upon Council's introduction of the ordinance, staff will file both a copy of the revised ordinance and the cost-effectiveness study with the California Energy Commission. The Commission is expected to take action on the revised ordinance during its business meeting on November 18.

Upon approval of the findings and acceptance of the study by the Energy Commission, staff will bring the ordinance back to Council for adoption, and then file the ordinance and related findings with the Building Standards Commission.

Prepared by:
David Rizk, AICP
Development Services Director

Approved by:



Gregory T. Jones, City Manager

Attachments:

Attachment I:	Draft Resolution Finding the Private Development Green Building Ordinance is Categorically Exempt from the California Environmental Quality Act
Attachment II:	Draft Ordinance Amending Green Building Requirements for Private Development (red-lined version)
Attachment III:	Ordinance 08-20: City of Hayward's Green Building Ordinance for Private Development
Attachment IV:	City of Hayward's Green Building Checklist for Private Non-Residential Development
Attachment V:	Energy Cost-Effectiveness Study Executive Summary by Stopwaste.org staff
Attachment VI:	Energy Cost-Effectiveness Case Studies Using the 2008 Title 24 Building Energy Efficiency Standards, by Gabel Associates, LLC, dated January 31, 2009

ATTACHMENT I

HAYWARD CITY COUNCIL

RESOLUTION NO._____

Introduced by Council Member_____

RESOLUTION FINDING THAT THE ENACTION OF THE PRIVATE DEVELOPMENT GREEN BUILDING ORDINANCE IS CATEGORICALLY EXEMPT FROM ENVIRONMENTAL REVIEW UNDER THE CALIFORNIA ENVIRONMENTAL QUALITY ACT

BE IT RESOLVED by the City Council of the City of Hayward that the City Council finds that the enaction of the Private Development Green Building Ordinance, Article 22 of Chapter 10 of the Hayward Municipal Code, is categorically exempt from environmental review under the California Environmental Quality Act, pursuant to Section 15308 of the CEQA Guidelines, Actions by Regulatory Agencies for Protection of the Environment.

IN COUNCIL, HAYWARD, CALIFORNIA_____, 2009

ADOPTED BY THE FOLLOWING VOTE:

AYES: COUNCIL MEMBERS:
MAYOR:

NOES: COUNCIL MEMBERS:

ABSTAIN: COUNCIL MEMBERS:

ABSENT: COUNCIL MEMBERS:

ATTEST:
City Clerk of the City of Hayward

APPROVED AS TO FORM:

_____
City Attorney of the City of Hayward

ORDINANCE NO. 09-

AN ORDINANCE AMENDING ARTICLE 22 TO CHAPTER 10 OF THE HAYWARD MUNICIPAL CODE ESTABLISHING GREEN BUILDING REQUIREMENTS FOR PRIVATE DEVELOPMENT

THE CITY COUNCIL OF THE CITY OF HAYWARD DOES ORDAIN AS FOLLOWS:

Section 1. Purpose. The purpose of this Article is to promote the health, safety and welfare of Hayward residents, workers and visitors by minimizing the use and waste of energy, water and other natural resources in the construction and operation of the City's building stock and by providing a healthy indoor environment. The green building practices required by this Article will encourage resource conservation, reduce waste generated by construction projects, increase energy efficiency and promote the health and productivity of residents, workers, and visitors of the City.

The City is proposing to adopt various enumerated changes and modifications to the California Building Standards Code ("Code"), as set forth in Section 3 below. Health and Safety Code Sections 17958, 17958.5 and 17958.7 permit cities and counties to make such changes or modifications in the Code as they determine are reasonably necessary because of "local climatic, geological, or topographical conditions". The City Council does hereby find and declare that the changes or modifications are reasonably necessary because of local climatic, geological, or topographical conditions in accordance with Health and Safety Code Sections 17958.5 and 17958.7.

Section 2. Findings. The City Council of the City of Hayward hereby finds that:

a. The design, construction, and maintenance of buildings and structures within the City can have a significant impact on the City's environmental sustainability, resource usage, energy efficiency, waste management, and the health and productivity of residents, workers, and visitors.

b. Green building design, construction, and operation can have a significant, positive effect on resource conservation, energy efficiency, waste and pollution generation, and the health and productivity of a building's occupants over the life of the building.

c. Green building benefits are spread throughout the systems and features of the building. Green buildings can include, among other things, the use of certified sustainable wood products; extensive use of high-recycled-content products; recycling of waste that occurs during deconstruction, demolition, and construction; orientation and design of a building to reduce the demand on the heating, ventilating, and air conditioning systems; the use of heating, ventilating, and air conditioning systems that provide energy efficiency and improved indoor air quality; enhancement of indoor air quality by selection and use of construction materials that do not emit

chemicals that are toxic or irritating to building occupants; the use of water conserving methods and equipment; and installation of alternative energy methods for supplemental energy production.

d. In recent years, green building design, construction and operational techniques have become increasingly widespread. Many homeowners, businesses, and building professionals have voluntarily sought to incorporate green building techniques into their projects. A number of local and national systems have been developed to serve as guides to green building practices. Requiring commercial and new residential projects to incorporate green building measures is appropriate to help achieve the public health and welfare benefits of green building.

~~e. A cost-effectiveness study, adopted by the County of Alameda on April 22, 2009, has determined that the standards in this ordinance are cost effective and will require the diminution of energy consumption levels permitted by the current statewide standards.~~

Section 3. Findings Required by California Health & Safety Code Section 17958.5.

a. The City of Hayward is located in Climate Zones 3 and 12, which is characterized by periods of extremely hot, dry weather during the summer and fall months. In addition, during the winter, the City of Hayward frequently experiences cold days with temperature inversions that trap certain air pollutants near the ground and exacerbate conditions leading to respiratory disease and other health risks. Hayward extends from the San Francisco Bay at its western edge eastward to the foothills near the City of Pleasanton. Average temperatures range from a low of 41 degrees in January to a high of 74 degrees in August, with even higher temperatures above 100 degrees recorded in the eastern portion of the City. Topography ranges from sea level at the Bay edge to over 1,800 feet in the highest portions in the eastern portion of the City. Hayward has a relatively high potential for air quality impacts during the summer and fall. When high pressure dominates, low mixing depths and bay and ocean wind patterns can concentrate and carry pollutants from other cities to Hayward, adding to the locally emitted pollutant mix. In winter and spring the air pollution potential in Hayward is moderate. These local features contribute to the Bay Area's status as a "nonattainment area" under the federal Clean Air Act for ozone and particulate matter.

b. In June 2006, ICLEI – Local Governments for Sustainability, in partnership with the Alameda County Waste Management Authority & Recycling Board (StopWaste.Org) and the Alameda County Conference of Mayors, launched the Alameda County Climate Protection Project. The City of Hayward committed to the project and embarked on an ongoing, coordinated effort to reduce the emissions that cause global warming, improve air quality, reduce waste, cut energy use and save money. As reflected in Hayward's Climate Action Plan, the City of Hayward is committed to reducing community-wide greenhouse gas emissions by 12½ percent below its 2005 emissions level by 2020 and 82½ percent below such levels by 2050. While climate change is a global problem influenced by an array of interrelated factors, climate change is also a local problem with serious impacts foreseen for California, the Bay Area, and City of Hayward. Local impacts include:

i. *Sea level rise*: According to the Union of Concerned Scientists, the sea

level in the State of California is expected to rise up to 12 inches over the next hundred years. The Pew Center on Climate Change has reported that this would result in the erosion of beaches, bay shores and river deltas, marshes and wetlands and increased salinity of estuaries, marshes, rivers and aquifers. This increased salinity has the potential to damage or destroy crops in low-lying farmlands. Infrastructure at or near sea level, such as harbors, bridges, roads and even the San Francisco International and Oakland International Airports are at risk of damage and destruction. The San Francisco Bay Area Conservation Commission has modeled the impact of a sea level rise of 3 feet (approximately 1 meter) on the San Francisco Bay Area. Areas such as the Oakland Airport would be under water, as would parts of Hayward along its shoreline, including portions of the City's wastewater treatment facilities.

ii. *Impacts on water*: Water quality and quantity are at risk as a result of changing temperatures. With warmer average temperatures, more winter precipitation will fall in the form of rain instead of snow, shortening the winter snowfall season and accelerating the rate at which the snowpack melts in the spring. Not only does such snow melt increase the threat for spring flooding, it will decrease the Sierras' capacity as a natural water tower, resulting in decreased water availability for agricultural irrigation, hydroelectric generation and the general needs of a growing population. The Sierra snowpack is the origin of the Mokelumne River, the primary source of water for the jurisdictions within Alameda County.

iii. *Natural disasters:* Climate models predict a 4°F temperature increase in the next 20 to 40 years, with an increase in the number of long dry spells, as well as a 20-30% increase in precipitation in the spring and fall. More frequent and heavier precipitation causes flooding and mudslides, which would result in considerable cost incurrence associated with damage to property, infrastructure and even human life. In addition, the increase of wildfires due to continued dry periods and high temperatures is another expected impact of continued climate change. In these conditions, fires burn hotter and spread faster. Portions of Hayward are located in an urban/wildland interface area.

iv. *Public health impact:* Warming temperatures and increased precipitation can also encourage mosquito-breeding, thus engendering diseases that come with mosquitoes, such as the West Nile Virus, a disease of growing concern in the City of Hayward and the surrounding region. Heat waves are also expected to have a major impact on public health and be a contributing factor of mortality. Increased temperatures also pose a risk to human health when coupled with high concentrations of ground-level ozone and other air pollutants, which may lead to increased rates of asthma and other pulmonary diseases. The incidence of bad air days in California's urban areas has increased, mostly in hot summer days. In the summer of 2006, the Bay Area Air Quality Management District (BAAQMD) registered 11 Spare the Air days for the region and exceeded the California 1-hour standard for ozone (set at 90 ppb) 18 times.

v. *Impacts on plants and vegetation*: Native plants and animals are also at risk as temperatures rise. Scientists are reporting more species moving to higher elevations or more northerly latitudes in response. Increased temperatures also provide a foothold for invasive species of weeds, insects and other threats to native species. The increased flow and salinity of water resources could also seriously affect the food web and mating conditions for fish that are of both economic and recreational interest to residents. In addition, the natural cycle of plant's flowering and pollination, as well as the temperature conditions necessary for a thriving locally adapted agriculture could be affected, with perennial crops such as grapes taking years to recover.

c. The City of Hayward's local climatic, topographic and geological conditions exacerbate the impacts of global climate change in several ways to make the adoption of green building requirements reasonable necessary:

i. Increasing summer temperatures increase the need for air conditioning, thereby increasing average load demand and peak load demand for energy within the City of Hayward. This heightened demand increases the risk of power outages and power shortages, with associated adverse public safety and economic impacts. Increased energy demand and usage also increases local and regional air pollution impacts. Decreasing energy consumption through energy efficiency and other green building techniques reduces each of these impacts.

ii. Increasing summer and year-round temperatures also adversely affects the City of Hayward's water supply, which is already subject to periodic drought conditions and potential water cutback. Decreasing water usage through conservation, sustainable landscaping (such as Bay-Friendly Landscaping), use of drought-tolerant and native plants, and other green building techniques reduces these adverse impacts.

d. The City of Hayward finds that the design, construction, and maintenance of buildings and landscapes within Hayward can have a significant impact on Hayward's environmental sustainability, resource usage and efficiency, waste management, and the health and productivity of residents, workers and visitors to the City of Hayward.

e. Green buildings play a significant role in reducing the amount of waste sent to landfills. Construction and demolition debris comprise up to 30% of all materials disposed of in California's landfills and over 21% of materials disposed of in Alameda County. Many of these materials have greenhouse gas implications once they are placed in landfills, related to both the process of organic materials breaking down in the landfill and producing methane and other greenhouse gasses, and the energy needed to produce more building materials from raw materials.

f. This green building ordinance furthers Hayward's efforts to enhance the community's social, economic, and environmental well-being and to mitigate the efforts of

global warming on Hayward's weather, water supply, physical infrastructure, ecological diversity, human health and economy.

Section 4. The City of Hayward's Municipal Code is hereby amended to repeal Article 22 to Chapter 10 in its entirety and replace it with the following:

"GREEN BUILDING REQUIREMENTS FOR PRIVATE DEVELOPMENT

SECTION 10- 22.100 TITLE. This Article shall be known and may be cited as the Private Development Green Building Ordinance of the City of Hayward.

SECTION 10-22.110 DEFINITIONS. For the purposes of this Article, certain terms are defined as follows:

a. "Applicant" means any individual, firm, Limited Liability Company, association, partnership, political subdivision, government agency, industry, public or private corporation or any other entity that applies to the City of Hayward for permit(s) to construct a Project subject to the provisions of this Article.

b. "Build It Green" is a non-profit membership organization which developed the GreenPoint Rating Systems for Residential and Mixed Use occupancies in order to promote sustainable buildings.

c. California Building Energy Efficiency Standard (Title 24, part 6) refers to the most recent enforced version of the coded section of the California Building Code.

~~c~~d. "City" means the City of Hayward.

~~d~~e. "Commercial" means any building or space used for retail, industrial, office or other non-residential use.

~~e~~f. "Covered Project" means any privately funded construction project, except as otherwise provided herein, for which an application for a building permit is received after August 1, 2009, or after the date the California Energy Commission and California Building Standards Commission approve green building standards required by this Article, whichever date is later, consisting of:

i. new construction, additions or remodels over 500 square feet for residential projects, or

ii. new construction, additions or remodels entailing 1,000 square feet or more of new or remodeled Commercial space.

~~f~~g. "Green building" means a whole systems approach to the design, construction, and operation of buildings and structures that helps mitigate the environmental, economic, and social impacts of construction, demolition and renovation. Green building practices recognize the relationship between natural and built environments and seek to minimize the use of energy, water, and other natural resources and provide a healthy, productive indoor environment.

~~g~~h. "GreenPoint Rated" is a third party rating system for homes based on a set of green building measures incorporated from Build It Green's Green Building Guidelines and used to evaluate a home's environmental performance. City staff shall maintain the most recent version of Build It Green's GreenPoint Rated Checklists for Single Family, Multi-Family and Existing Homes and Residential Green Building Guidelines for New Home Construction, Home Remodeling and Multifamily Green Building.

~~h~~i. "Historical Building" means any structure or collection of structures deemed of importance to the history, architecture or culture of an area by an appropriate local or state governmental jurisdiction, pursuant to Section 18955 of the California Health and Safety Code and Section 8-201 of the 2007 California Historical Building Code, Title 24, Part 8.

~~i~~j. "LEED ™" and "LEED ™ Checklist" mean the Leadership in Energy and Environmental Design rating system, certification methodology, and checklist used by the United States Green Building Council (USGBC). City staff shall maintain the most recent version of the LEED ™ Rating system at all times.

~~j~~k. "Multi-family Residential Building" means a single residential building that has more than two dwelling units.

~~k~~l. "Mixed-Use" means a building with residential and commercial uses.

SECTION 10- 22.120 APPLICATION.

The provisions of this Article apply to Covered Projects, with the following exemptions or exceptions:

a. Historical Buildings, as defined by this Article.

b. Permits issued only for foundation repair, re-roofing, repair of fire damage, work required by termite reports, upgrades for accessibility, or other items of building or structural maintenance~~,~~ as determined by the Building Official provided that these building projects comply with or are not subject to the California Building Energy Efficiency Standard (Title 24, part 6).

c. Provided that projects still fully comply with the California Building Energy Efficiency Standard (Title 24, part 6), hardship exemptions may be granted by the Building Official for projects valued at less than $50,000 where the Project Applicant can demonstrate the cost of complete compliance will exceed 20.0% of construction costs. In these cases, the applicant may limit compliance to 20.0% of the construction cost of the project.

d. Provided that projects still fully comply with the California Building Energy Efficiency Standard (Title 24, part 6), exemptions or partial exemptions may be granted by the City Council for other projects where it can be demonstrated that complete compliance is not possible due to unusual building circumstances. This exemption is for other than economic considerations.

e. Projects for which a Vesting Tentative Map has been approved by January 1, 2009 and for which there is full compliance with the California Building Energy Efficiency Standard (Title 24, part 6).

f. Projects subject to a Development Agreement approved by January 1, 2009 and for which full compliance with the California Building Energy Efficiency Standard (Title 24, part 6) at the time of permitting has been documented, but without a Vesting Tentative Map, shall comply with the requirements of this Article if a building permit application is received on or after January 1, 2011.

SECTION 10-22.130 ALTERNATIVE GREEN BUILDING REQUIREMENTS.

The following green building requirements shall apply to all Covered Projects. Wherever reference is made to the Hayward checklist or Green Point Rated systems, a comparable equivalent rating system may be used if the Building Official finds the proposed alternate method is satisfactory and complies with the intent of this Article. The applicable systems are those in effect at the time a complete application for the Project is submitted to the Building or Planning Division. All Covered Projects must submit all required documentation to demonstrate compliance with the California Building Energy Efficiency Standard (Title 24, part 6).

SECTION 10 -22.140 STANDARDS FOR COMPLIANCE.

a. Multi-Family Residential and Mixed-Use Buildings.

Applicants for new Multi-Family Residential Covered Projects, prior to obtaining a Certificate of Occupancy, shall submit documentation demonstrating the building(s) has/have been GreenPoint Rated as well as all required documentation to demonstrate full compliance with the California Building Energy Efficiency Standard (Title 24, part 6) at the time of permitting. The Certificate of Occupancy shall state that the project complies with the City's Private Development Green Building Ordinance.

Prior to August 1, 2009, in order to promote familiarity with green building standards, applicants are encouraged to have their projects GeenPoint Rated, or to incorporate items, if any, from the checklist; however, only completing the list and submitting it is mandatory in addition to all required documentation to demonstrate full compliance with the California Building Energy Efficiency

Standard (Title 24, part 6) at the time of permitting. For such projects that are GreenPoint Rated, the Certificate of Occupancy shall state that the project complies with the City's Private Development Green Building Ordinance.

These requirements shall also apply to Mixed-Use Covered Projects.

b. New Single Family Dwellings.

Applicants for new Single Family Covered Projects prior to obtaining a Certificate of Occupancy, shall submit documentation demonstrating the building(s) has/have been GreenPoint Rated as well as all required documentation to demonstrate full compliance with the California Building Energy Efficiency Standard (Title 24, part 6) at the time of permitting. The Certificate of Occupancy shall state that the project complies with the City's Private Development Green Building Ordinance.

Prior to August 1, 2009, in order to promote familiarity with green building standards, applicants are encouraged to have their projects GeenPoint Rated, or to incorporate items, if any, from the checklist; however, only completing the list and submitting it is mandatory in addition to all documentation required to demonstrate full compliance with the California Building Energy Efficiency Standard (Title 24, part 6) at the time of permitting. For such projects that are GreenPoint Rated, the Certificate of Occupancy shall state that the project complies with the City's Private Development Green Building Ordinance.

c. Residential Additions/Remodels Greater Than 500 Square Feet.

Applicants for residential Covered Projects consisting of remodels and/or additions greater than 500 square feet to existing residential single family or multi-family dwellings, shall submit, with their permit application, the GreenPoint Rated Existing Homes Checklist. The Applicant shall indicate on the plans and checklist if any of the items on the checklist have been incorporated into the project. Applicants are encouraged to have their projects GeenPoint Rated, or to incorporate items from the checklist; however, only completing the list and submitting it is mandatory in addition to all documentation required to demonstrate full compliance with the California Building Energy Efficiency Standard (Title 24, part 6) at the time of permitting. For such projects that are GreenPoint Rated, the Certificate of Occupancy shall state that the project complies with the City's Private Development Green Building Ordinance.

d. Commercial Covered Projects.

Applicants for new Commercial Covered projects shall submit with their permit application the City of Hayward checklist for Private Non-Residential Development. The plans shall clearly show where each item has been incorporated into the project. The plan review, to be conducted by City staff,

shall verify the incorporation of checklist items into the plans. The building inspection process, to be conducted by City staff, shall verify the inclusion of these items in the construction. A Certificate of Occupancy shall not be issued until the incorporation of the checklist items and full compliance with the California Building Energy Efficiency Standard (Title 24, part 6) at the time of permitting is verified by City staff. The Certificate of Occupancy shall state that the project complies with the City's Private Development Green Building Ordinance.

Prior to August 1, 2009, applicants are encouraged to incorporate measures from the City of Hayward Checklist for Private Non-Residential Development into their projects in addition to submitting all required documentation to demonstrate full compliance with the California Building Energy Efficiency Standard (Title 24, part 6) at the time of permitting. For such projects that incorporate such measures, the Certificate of Occupancy shall state that the project complies with the City's Private Development Green Building Ordinance.

SECTION 10-22.150 PROMULGATION OF IMPLEMENTING REGULATIONS.

The City Manager shall promulgate any rules and regulations necessary or appropriate to achieve compliance with the requirements of this Article. The initial rules and regulations shall be promulgated after securing and reviewing comments from affected City departments. These rules and regulations shall ensure that the City of Hayward fully enforces both California Building Energy Efficiency Standard (Title 24, part 6) and this ordinance.

SECTION 10-22.160. COST EFFECTIVENESS STUDY.

Based upon the findings of a January 21, 2009, study entitled, "Energy Cost Effectiveness Case Studies Using the 2008 Title 24 Building Energy Efficiency Standards", adopted by the Stopwaste.org Board on April 22, 2009, the City Council has determined that the standards in this Article are cost effective and will require the diminution of energy consumption levels permitted by the 2008 Statewide energy efficiency standards."

Section 5. Severance. Should any part of this ordinance be declared by a final decision by a court or tribunal of competent jurisdiction to be unconstitutional, invalid, or beyond the authority of the City, such decision shall not affect the validity of the remainder of this ordinance, which shall continue in full force and effect, provided that the remainder of the ordinance, absent the unexcised portion, can be reasonably interpreted to give effect to the intentions of the City Council.

Section 6. Annual Review. The City Council shall review this ordinance at least annually to determine whether it needs to be updated because of new legislation enacted by the State or new standards developed by the California Energy Commission, or other applicable organizations, such as StopWaste.org, Build It Green, and LEED (Leadership in Energy and

Environmental Design). The Building Official shall annually report to the City Manager the number and types of projects built under this ordinance.

Section 7. In accordance with the provisions of Section 620 of the City Charter, this ordinance shall become effective thirty days after adoption.

INTRODUCED at a regular meeting of the City Council of the City of Hayward, held the ____day of _____, 2009, by Council Member _____.

ADOPTED at a regular meeting of the City Council of the City of Hayward held The _____ day of _____, 2009, by the following votes of members of said City Council.

AYES: COUNCIL MEMBERS:

NOES: COUNCIL MEMBERS:

ABSTAIN: COUNCIL MEMBERS:

ABSENT: COUNCIL MEMBERS:

APPROVED:
Mayor of the City of Hayward

DATE:

ATTEST:
City Clerk of the City of Hayward

ORDINANCE NO. 08-20

AN ORDINANCE ADDING ARTICLE 22 TO CHAPTER 10 OF THE HAYWARD MUNICIPAL CODE ESTABLISHING GREEN BUILDING REQUIREMENTS FOR PRIVATE DEVELOPMENT

THE CITY COUNCIL OF THE CITY OF HAYWARD DOES ORDAIN AS FOLLOWS:

Section 1. Purpose. The purpose of this Article is to promote the health, safety and welfare of Hayward residents, workers and visitors by minimizing the use and waste of energy, water and other natural resources in the construction and operation of the City's building stock and by providing a healthy indoor environment.

The green building practices required by this Article will encourage resource conservation, reduce waste generated by construction projects, increase energy efficiency and promote the health and productivity of residents, workers, and visitors of the City.

Section 2. Findings. The City Council of the City of Hayward hereby finds that:

a. The design, construction, and maintenance of buildings and structures within the City can have a significant impact on the City's environmental sustainability, resource usage, energy efficiency, waste management, and the health and productivity of residents, workers, and visitors.

b. Green building design, construction, and operation can have a significant, positive effect on resource conservation, energy efficiency, waste and pollution generation, and the health and productivity of a building's occupants over the life of the building.

c. Green building benefits are spread throughout the systems and features of the building. Green buildings can include, among other things, the use of certified sustainable wood products; extensive use of high-recycled-content products; recycling of waste that occurs during deconstruction, demolition, and construction; orientation and design of a building to reduce the demand on the heating, ventilating, and air conditioning systems; the use of heating, ventilating, and air conditioning systems that provide energy efficiency and improved indoor air quality; enhancement of indoor air quality by selection and use of construction materials that do not emit chemicals that are toxic or irritating to building occupants; the use of water conserving methods and equipment; and installation of alternative energy methods for supplemental energy production.

d. In recent years, green building design, construction and operational techniques have become increasingly widespread. Many homeowners, businesses, and building professionals have voluntarily sought to incorporate green building techniques into their projects. A number of local and national systems have been developed to serve as guides to green building practices. Requiring commercial and new residential projects to incorporate

green building measures is appropriate to help achieve the public health and welfare benefits of green building.

Section 3. The City of Hayward's Municipal Code is hereby amended to add Article 22 to Chapter 10 as follows:

"GREEN BUILDING REQUIREMENTS FOR PRIVATE DEVELOPMENT

SECTION 10- 22.100 TITLE. This Article shall be known and may be cited as the Private Development Green Building Ordinance of the City of Hayward.

SECTION 10-22.110 DEFINITIONS. For the purposes of this Article, certain terms are defined as follows:

a. "Applicant" means any individual, firm, Limited Liability Company, association, partnership, political subdivision, government agency, industry, public or private corporation or any other entity that applies to the City of Hayward for permit(s) to construct a Project subject to the provisions of this Article.

b. "Build It Green" is a non-profit membership organization which developed the GreenPoint Rating Systems for Residential and Mixed Use occupancies in order to promote sustainable buildings.

c. "City" means the City of Hayward.

d. "Commercial" means any building or space used for retail, industrial, office or other non-residential use.

e. "Covered Project" means any privately funded construction project, except as otherwise provided herein, for which an application for a building permit is received after August 1, 2009, or after the date the California Energy Commission and California Building Standards Commission approve green building standards required by this Article, whichever date is later, consisting of:

i. new construction, additions or remodels over 500 square feet for residential projects, or

ii. new construction, additions or remodels entailing 1,000 square feet or more of new or remodeled Commercial space.

f. "Green building" means a whole systems approach to the design, construction, and operation of buildings and structures that helps mitigate the environmental, economic, and social impacts of construction, demolition and renovation. Green building practices recognize the relationship between natural and built environments and seek to minimize the use of energy, water, and other natural resources and provide a healthy, productive indoor environment.

g. "GreenPoint Rated" is a third party rating system for homes based on a set of green building measures incorporated from Build It Green's Green Building Guidelines and used to evaluate a home's environmental performance. City staff shall maintain the most recent version of Build It Green's GreenPoint Rated Checklists for Single Family, Multi-Family and Existing Homes and Residential Green Building Guidelines for New Home Construction, Home Remodeling and Multifamily Green Building.

h. "Historical Building" means any structure or collection of structures deemed of importance to the history, architecture or culture of an area by an appropriate local or state governmental jurisdiction, pursuant to Section 18955 of the California Health and Safety Code and Section 8-201 of the 2007 California Historical Building Code, Title 24, Part 8.

i. "LEED ™" and "LEED ™ Checklist" mean the Leadership in Energy and Environmental Design rating system, certification methodology, and checklist used by the United States Green Building Council (USGBC). City staff shall maintain the most recent version of the LEED ™ Rating system at all times.

j. "Multi-family Residential Building" means a single residential building that has more than two dwelling units.

k. "Mixed-Use" means a building with residential and commercial uses.

SECTION 10- 22.120 APPLICATION.

The provisions of this Article apply to Covered Projects, with the following exemptions or exceptions:

a. Historical Buildings, as defined by this Article.

b. Permits issued only for foundation repair, re-roofing, repair of fire damage, work required by termite reports, upgrades for accessibility , or other items of building or structural maintenance, as determined by the Building Official.

c. Hardship exemptions may be granted by the Building Official for projects valued at less than $50,000 where the Project Applicant can demonstrate the cost of complete

compliance will exceed 20.0% of construction costs. In these cases, the applicant may limit compliance to 20.0% of the cost of the project.

d. Exemptions or partial exemptions may be granted by the City Council for other projects where it can be demonstrated that complete compliance is not possible due to unusual building circumstances. This exemption is for other than economic considerations.

e. Projects for which a Vesting Tentative Map has been approved by January 1, 2009.

f. Projects subject to a Development Agreement approved by January 1, 2009, but without a Vesting Tentative Map, shall comply with the requirements of this Article if a building permit application is received on or after January 1, 2011.

SECTION 10-22.130 ALTERNATIVE GREEN BUILDING REQUIREMENTS.

The following green building requirements shall apply to all Covered Projects. Wherever reference is made to the Hayward checklist or GreenPoint Rated systems, a comparable equivalent rating system may be used if the Building Official finds the proposed alternate method is satisfactory and complies with the intent of this Article. The applicable systems are those in effect at the time a complete application for the Project is submitted to the Building or Planning Division.

SECTION 10 -22.140 STANDARDS FOR COMPLIANCE.

a. Multi-Family Residential and Mixed-Use Buildings.

Applicants for new Multi-Family Residential Covered Projects, prior to obtaining a Certificate of Occupancy, shall submit documentation demonstrating the building(s) has/have been GreenPoint Rated. The Certificate of Occupancy shall state that the project complies with the City's Private Development Green Building Ordinance.

Prior to August 1, 2009, in order to promote familiarity with green building standards, applicants are encouraged to have their projects GreenPoint Rated, or to incorporate items, if any, from the checklist; however, only completing the list and submitting it is mandatory. For such projects that are GreenPoint Rated, the Certificate of Occupancy shall state that the project complies with the City's Private Development Green Building Ordinance.

These requirements shall also apply to Mixed-Use Covered Projects.

b. New Single Family Dwellings.

Applicants for new Single Family Covered Projects prior to obtaining a Certificate of Occupancy, shall submit documentation demonstrating the building(s) has/have been GreenPoint Rated. The Certificate of Occupancy shall state that the project complies with the City's Private Development Green Building Ordinance.

Prior to to August 1, 2009, in order to promote familiarity with green building standards, applicants are encouraged to have their projects GreenPoint Rated, or to incorporate items, if any, from the checklist; however, only completing the list and submitting it is mandatory. For such projects that are GreenPoint Rated, the Certificate of Occupancy shall state that the project complies with the City's Private Development Green Building Ordinance.

c. Residential Additions/Remodels Greater Than 500 Square Feet.

Applicants for residential Covered Projects consisting of remodels and/or additions greater than 500 square feet to existing residential single family or multi-family dwellings, shall submit, with their permit application, the GreenPoint Rated Existing Homes Checklist. The Applicant shall indicate on the plans and checklist if any of the items on the checklist have been incorporated into the project. Applicants are encouraged to have their projects GreenPoint Rated, or to incorporate items from the checklist; however, only completing the list and submitting it is mandatory. For such projects that are GreenPoint Rated, the Certificate of Occupancy shall state that the project complies with the City's Private Development Green Building Ordinance.

d. Commercial Covered Projects.

Applicants for new Commercial Covered projects shall submit with their permit application the City of Hayward checklist for Private Non-Residential Development. The plans shall clearly show where each item has been incorporated into the project. The plan review, to be conducted by City staff, shall verify the incorporation of checklist items into the plans. The building inspection process, to be conducted by City staff, shall verify the inclusion of these items in the construction. A Certificate of Occupancy shall not be issued until the incorporation of the checklist items is verified by City staff. The Certificate of Occupancy shall state that the project complies with the City's Private Development Green Building Ordinance.

Prior to to August 1, 2009, applicants are encouraged to incorporate measures from the City of Hayward Checklist for Private Non-Residential Development into their projects. For such projects that incorporate such measures, the Certificate of Occupancy shall state that the project complies with the City's Private Development Green Building Ordinance.

SECTION 10-22.150 PROMULGATION OF IMPLEMENTING REGULATIONS.

The City Manager shall promulgate any rules and regulations necessary or appropriate to achieve compliance with the requirements of this Article. The initial rules and regulations shall be promulgated after securing and reviewing comments from affected City departments.

Section 4. Severance. Should any part of this ordinance be declared by a final decision by a court or tribunal of competent jurisdiction to be unconstitutional, invalid, or beyond the authority of the City, such decision shall not affect the validity of the remainder of this ordinance, which shall continue in full force and effect, provided that the remainder of the ordinance, absent the unexcised portion, can be reasonably interpreted to give effect to the intentions of the City Council.

Section 5. Annual Review. The City Council shall review this ordinance at least annually to determine whether it needs to be updated because of new legislation enacted by the State or new standards developed by applicable organizations, such as StopWaste.org, Build It Green, and LEED (Leadership in Energy and Environmental Design). The Building Official shall annually report to the City Manager the number and types of projects built under this ordinance.

Section 6. In accordance with the provisions of Section 620 of the City Charter, this ordinance shall become effective thirty days after adoption.

INTRODUCED at a regular meeting of the City Council of the City of Hayward, held the 25th day of November, 2008, by Council Member Quirk.

ADOPTED at a regular meeting of the City Council of the City of Hayward held the 2nd day of December, 2008, by the following votes of members of said City Council.

AYES: COUNCIL MEMBERS: Zermeño, Quirk, Halliday, Dowling, Henson
MAYOR: Sweeney

NOES: COUNCIL MEMBERS: May

ABSTAIN: COUNCIL MEMBERS: None

ABSENT: COUNCIL MEMBERS: None

APPROVED: _____
Mayor of the City of Hayward

DATE: Dec. 9, 2008

ATTEST: Angelina Reyes
City Clerk of the City of Hayward

APPROVED AS TO FORM:
_____
City Attorney of the City of Hayward

Energy Efficiency

For non-residential projects entailing 1,000 square feet or more of new or remodeled space, and where at least half of the light fixtures are new or replaced:

1. **the lighting load for such fixtures shall be reduced by at least 15% below 2008 Title 24 Building Energy Efficiency Standards, or**
2. **15% of the lighting loads of such fixtures shall be provided by solar, wind, or other renewable energy source, as approved by the Building Official, or**
3. **the project must show compliance for overall energy budget at 5% below 2008 Title 24 Building Energy Efficiency Standards, using the performance method.**

When tailored method is used for retail sales lighting compliance, such 15% reduction shall apply only to LTG-6-C part 1, but not to LTG-6-C parts 2 & 3 for display lighting.

Background:
According to the U.S. Department of Energy, buildings use about 68% of the electricity generated in the country on an annual basis. The California Energy Commission estimates that about one third of the energy used in commercial buildings is dedicated to lighting. This makes commercial lighting one of the single biggest energy users nationally. Reducing lighting power demand is an essential step in making buildings "green".

The California Energy Commission establishes the maximum allowed lighting power for commercial buildings and the city enforces this through the T-24 energy report. All designers and contractors are familiar with the process of calculating the allowed lighting power for a project.

This measure is based on *LEED Energy and Atmosphere Credit 2*. In the LEED system, however, the renewable energy percentage is only based on the total electricity demand of the building.

Water Conservation

For non-residential projects entailing 1,000 square feet or more of new or remodeled space, and where a new bathroom is proposed or a bathroom is proposed to be remodeled and involves new water closets or urinals:

☐ **Reduce indoor water use by 20% below baseline, per 2007 California Plumbing Code, for each water closet or urinal that is installed or replaced**

Background:
Reducing water use in commercial buildings is relatively easy to achieve. Technologies such as waterless urinals*, occupant sensors and ultra low-flow toilets are available and provide instant savings. This measure is base on the LEED Water Efficiency Credit 2. In the LEED system additional credit is given for a 30% reduction as well. For the Hayward ordinance it will probably be sufficient to start with a 20% reduction initially and see if a higher threshold is appropriate at a later time.

***Waterless Urinals:** These units utilize a trap insert filled with a sealant liquid instead of water. The lighter-than-water sealant floats on top of the urine collected in the U-bend, preventing odors from being released into the air. Although the cartridge and sealant must be periodically replaced, the system saves anywhere between 15,000 and 45,000 gallons of water per urinal per year.

Design Process:

Instead of 1.6 gallons per flush (gpf) toilets/water closets, 1.28 gpf units will be installed. For urinals, either 0.5 gpf or waterless units will replace the standard 1.0 gpf units.

References:

- 2007 California Plumbing Code
- LEED Reference Manual
- LEED WE Credit 2 (20% reduction below baseline)

GREEN BUILDING in Alameda County

Energy Cost-effectiveness Study*

Executive Summary

Purpose of the Study:

Stopwaste.Org's Green Building in Alameda County program commissioned this Energy Cost-effectiveness study on behalf of their member agencies. This report can be used by Alameda County jurisdictions wishing to adopt mandatory energy policy(ies) that exceed the State's Building Energy Efficiency Standards 2008 Title 24 part 6 (T-24 2008) scheduled to be effective on August 1st, 2009. In order to adopt policies requiring energy efficiency beyond T-24 2008, a cost effectiveness study and findings must be approved by the California Energy Commission (CEC) and filed with the California Building Standards Commission (BSC).

It's important to note that separate local climatic, geological, or topographical findings must be filed with the BSC for adopted local policies that require building standards that are different and more restrictive than the California Green Building Standards Code.

This report can be referenced in the CEC/BSC filing process and should eliminate the need for each individual City in Alameda County to replicate this analysis. The report includes energy cost-effectiveness analysis using case studies of several building designs that meet and exceed T-24 in the two California climate zones within Alameda County: 3 & 12. Gabel Associates, LLC was contracted to conduct the energy analysis and summary report, and Building Advisory, LLC was contracted to conduct cost research referenced in the report.

Summary of Methodology:

The data in this cost-effectiveness study has been developed and compiled to consider code change cost implications to new construction projects in Climate Zones 3 and 12 for single family residential, multifamily low-rise residential, multifamily high-rise residential and non-residential office buildings. For each prototype new construction building the measures and associated incremental cost necessary to reach 10%, 15%, 20%, and 35% above code are itemized, and the cost-effectiveness for each scenario is presented in graph format.

The percent better than code compliance is per the T-24 performance approach in the T-24 2008 code beta versions of the MICROPAS and EnergyPro compliance alternative calculations method (ACM) software programs. These ACM software programs report energy savings in the metric of time dependent valuation (TDV) kBtu/sf-year. TDV kBtu/sf-year is the energy savings metric from which site energy in KWh and Therms is calculated for each performance scenario to establish the annual energy savings, energy cost savings and CO2-equivalent reductions in greenhouse gases.

* This document summarizes a more comprehensive document authored by Gabel and Associates, LLC.

Starting with a 2008 Standards minimally compliant set of measures, various items are changed to just reach the next increment of energy performance (e.g., 10% better than Title 24). The energy measures chosen are not all the prescriptive measures, but are a combination of measures, which reflect how designers, builders and developers are likely to achieve a specified level of performance. A minimum and maximum range of incremental costs of added energy measures is established by a variety of research and surveys to obtain accurate and current measure cost.

Results of the Study:

The case study analysis provides a limited set of data representing the impact that the T-24 2008 code update will have on the cost for projects to go beyond minimum code compliance. Figures 1-5 on the following pages summarize the cost/square foot and the average cost for projects to meet these thresholds above the new code.

The goal of these case studies is to provide relatively real-world order-of-magnitude results for local jurisdictions attempting to understand and calibrate energy and cost impacts of local energy ordinances or local green building ordinances. In this limited study, no attempt has been made to gather statistically significant data that can be applied to all new construction projects.

Single Family Home Cost Effectiveness Summary

Two Homes at 10%, 15%, 20% & 35% above the T-24 2008 Standards in Climate Zones 3 & 12

Home # 1 = 1,582 square feet
Home # 2 = 2,025 square feet

Climate Zone 3										
Home Size (square feet)		#1 =	1,582				#2 =	2,025		
% > T-24		**10%**	**15%**	**20%**	**35%**		**10%**	**15%**	**20%**	**35%**
Ave. $/s.f.****		$0.64	$1.19	$1.33	$2.14		$0.69	$0.77	$0.87	$2.03
Ave. $/home		$1,012.48	$1,882.58	$2,104.06	$3,385.48		$1,397.25	$1,559.25	$1,761.75	$4,110.75
CZ 3 Average of Home #1 & #2										
%> T-24		10%	15%	20%	35%					
Ave. of Both Homes		$1,204.87	$1,720.92	$1,932.91	$3,748.12					

Climate Zone 12										
Home Size (square feet)		#1 =	1,582				#2 =	2,025		
% > T-24		**10%**	**15%**	**20%**	**35%**		**10%**	**15%**	**20%**	**35%**
Ave. $/s.f.****		$0.60	$1.10	$1.94	$5.38		$0.60	$1.18	$1.69	$4.92
Ave. $/home		$949.20	$1,740.20	$3,069.08	$8,511.16		$1,215.00	$2,389.50	$3,422.25	$9,963.00
CZ 12 Average of Home #1 & #2										
%> T-24		**10%**	**15%**	**20%**	**35%**					
Ave. of Both Homes		$1,082.10	$2,064.85	$3,245.67	$9,237.08					

Average of Climate Zones 3 & 12					
%> T-24		**10%**	**15%**	**20%**	**35%**
Ave. of Both Climate Zones		**$1,143.48**	**$1,892.88**	**$2,589.29**	**$6,492.60**
	~$850	~$1,150	**~$1,900**	~$2,600	~$6,500

On Average, the incremental cost per single family home to exceed T-24 2008 by 15% is $1,900.

The "Meet Code" columns show the incremental cost per single family home to go from minimally compliant T-24 2005 to minimally compliant T-24 2008. On average, the incremental cost to meet the new code is $850.

Figure 1

Low-rise Multifamily Cost Effectiveness Summary

One prototype multifamily building at 10%, 15%, 20% & 35% above the T-24 2008 Standards in Climate Zones 3 & 12

2 story, 8 units, 8,442 s.f.

Climate Zone 3					
Building Size (square feet)	8,442				
% > T-24 2008	[redacted]	**10%**	**15%**	**20%**	**35%**
Ave. $/s.f.	[redacted]	$0.54	$1.42	$1.58	$1.86
Ave. $/unit (8 units/building)	[redacted]	$569.84	$1,498.46	$1,667.30	$1,962.77

Climate Zone 12					
Building Size (square feet)	8,442				
% > T-24 2008	[redacted]	**10%**	**15%**	**20%**	**35%**
Ave. $/s.f.	[redacted]	$1.07	$1.80	$2.37	$4.20
Ave. $/unit (8 units/building)	[redacted]	$1,129.12	$1,899.45	$2,500.94	$4,432.05

Average of Climate Zones 3 & 12					
Building Size (square feet)	8,442				
%> T-24 2008	[redacted]	**10%**	**15%**	**20%**	**35%**
Ave. $/s.f. both climate zones	[redacted]	$0.81	$1.61	$1.98	$3.03
Ave. $/unit (8 units/building)	[redacted]	**$849.48**	**$1,698.95**	**$2,084.12**	**$3,197.41**
	~$270	~$850	**~$1,700**	~$2,000	~$3,000

On Average, the incremental cost per multifamily unit to exceed T-24 2008 by 15% is $1,700.

The "Meet Code" columns show the incremental cost per multifamily building to go from minimally compliant T-24 2005 to minimally compliant T-24 2008. On average, the incremental cost per multifamily dwelling unit to meet the new code is $300.

Figure 2

High-rise Multifamily Cost Effectiveness Summary

One prototype High-rise Residential building at 10%, 15%, 20% & 35% above the T-24 2008 Standards in Climate Zones 3 & 12

5 story, 40 units, 26,800 s.f.

Climate Zone 3					
Building Size (square feet)	26,800				
% > T-24 2008		**10%**	**15%**	**20%**	**35%**
Ave. $/s.f.		$0.86	$1.18	$2.66	$5.40
Ave. $/unit (40 units/building)		$907.52	$1,245.20	$2,806.97	$5,698.35

Climate Zone 12					
Building Size (square feet)	26,800				
% > T-24 2008		**10%**	**15%**	**20%**	**35%**
Ave. $/s.f.		$0.58	$0.76	$2.66	$4.69
Ave. $/unit (40 units/building)		$612.05	$801.99	$2,806.97	$4,949.12

Average of Climate Zones 3 & 12					
Building Size (square feet)	26,800				
%> T-24 2008		**10%**	**15%**	**20%**	**35%**
Ave. $/s.f. both climate zones		$0.72	$0.97	$2.66	$5.05
Ave. $/unit (40 units/building)		**$759.78**	**$1,023.59**	**$2,806.97**	**$5,323.74**
	~$0*	~$760	**~$1,000**	~$2,800	~$5,300

On Average, the incremental cost per high-rise residential unit to exceed T-24 2008 by 15% is $1,000.

* The "Meet Code" columns show the incremental cost per multifamily building to go from minimally compliant T-24 2005 to minimally compliant T-24 2008. On average, the incremental cost per multifamily dwelling unit to meet the new code is $0. In the Beta version of EnergyPro available at the time this analysis was conducted, the 2005 code Highrise Multifamily project also complied with the 2008 code and therefore showed no incremental cost. In the final version of EnergyPro with the residential (waterheating) code changes incorporated, we anticipate that there will be some incremental cost to meet the new code.

Figure 3

Non-Residential Cost Effectiveness Summary

One prototype low-rise office building at 10%, 15%, 20% & 25% above the T-24 2008 Standards in Climate Zones 3 & 12

2 story, 21,160 s.f.

Climate Zone 3					
Building Size (square feet)	21,160				
% > T-24 2008	[redacted]	**10%**	**15%**	**20%**	**25%**
Ave. $/s.f.	[redacted]	$0.91	$2.35	$3.98	$4.34
Ave. $/building	$770.33	$960.28	$2,479.84	$4,199.90	$4,579.79

Climate Zone 12					
Building Size (square feet)	21,160				
% > T-24 2008	[redacted]	**10%**	**15%**	**20%**	**25%**
Ave. $/s.f.	[redacted]	$0.95	$2.11	$2.61	$3.89
Ave. $/building	[redacted]	$1,002.49	$2,226.58	$2,754.20	$4,104.92

Average of Climate Zones 3 & 12					
Building Size (square feet)	21,160				
%> T-24 2008	[redacted]	**10%**	**15%**	**20%**	**25%**
Ave. $/s.f. both climate zones	[redacted]	$0.93	$2.23	$3.30	$4.12
Ave. $/building both climate zones	[redacted]	**$981.38**	**$2,353.21**	**$3,477.05**	**$4,342.35**
	~$1,150	**~$1,000**	~$2,300	~$3,500	~$4,300

The "Meet Code" columns show the incremental cost per non-residential office building to go from minimally compliant T-24 2005 to minimally compliant T-24 2008.

Figure 4

Non-Residential Cost Effectiveness Summary

One prototype high-rise office building at 10%, 15% & 20% above the T-24 2008 Standards in Climate Zones 3 & 12

5 story, 52,900 s.f.

Climate Zone 3				
Building Size (square feet)				
% > T-24 2008		**10%**	**15%**	**20%**
Ave. $/s.f.		$0.79	$1.74	$2.25
Ave. $/building		$833.65	$1,836.14	$2,374.31

Climate Zone 12				
Home Size (square feet)				
% > T-24 2008		**10%**	**15%**	**20%**
Ave. $/s.f.		$0.95	$1.01	$1.89
Ave. $/building		$1,002.49	$1,065.80	$1,994.42

Average of Climate Zones 3 & 12				
%> T-24 2008		**10%**	**15%**	**20%**
Ave. $/s.f. both climate zones		**$0.87**	**$1.38**	**$2.07**
Ave. of Both Climate Zones		**$918.07**	**$1,450.97**	**$2,184.37**
	~$700	**~$900**	~$1,500	~$2,100

The "Meet Code" columns show the incremental cost per highrise non-residential office building to go from minimally compliant T-24 2005 to minimally compliant T-24 2008.

Figure 5

Policy Recommendations:

When developing and implementing an energy efficiency or green building ordinance, we recommend the following:

- Performance vs. Prescriptive Approach

The performance approach to energy compliance should be implemented in all local ordinances for residential and nonresidential. There are two approaches to meet the energy code: the performance approach and the prescriptive approach. In order to show a project exceeds the energy code, California State requires a performance approach to meet a threshold percentage better than T-24. While the prescriptive approach is essentially a list of measures and can appear to be easier to implement, it doesn't provide a mechanism to determine the most cost-effective set of energy efficiency measures for each unique project. For these reasons, the performance approach showing a percentage of performance better than T-24 is used in a large variety of applications such as:

- Utility incentive programs
- State tax credits for solar PV systems (NSHP program)
- GreenPoint Rated program
- LEED rating system
- Local energy ordinances
- Low Income Housing Tax Credits
- ENERGY STAR New Homes
- Federal energy efficiency tax credits
- HERS Phase 2 for Existing and New Homes (2010)

Conversely, we strongly recommend against a local ordinance requiring prescriptive measures that can be modeled in the performance method because it does not allow building designers flexibility in deciding which energy measures, in combination and for the lowest cost, meet the overall energy budget for the building. The prescriptive approach's limitation on project decisions, and perceived preference towards specific energy saving products, could cause legal disputes with constituents and product manufacturers.

- Title 24 Analysis, Metric and Forms

Use Title 24 methods, rules, software and reports wherever possible, augmented only when necessary to comply with or document a special energy credit.

- LEED Energy Performance

Any local ordinance which references LEED should provide an administrative mechanism whereby a permit applicant can meet the minimum energy LEED requirement with a designated Title 24 energy equivalent performance.

- Energy Efficiency before On-site Generation

Only award solar PV credit after a building has already achieved the minimum energy efficiency performance. Energy efficiency is a more cost-effective investment to achieve green house gas reductions than on-site generation as documented in numerous studies, including the California

Public Utility Commission's (CPUC) 2020 Strategic Plan and the California Air Resources Board's (CARB) AB32 draft scoping plan.

We also recommend that, to ensure consistency with State programs and maximum benefit to applicants seeking to apply for available incentives, a local energy ordinance that includes provisions for PV meet all installation criteria in the "Guidelines for California's Solar Electric Incentive Programs Pursuant to Senate Bill 1." The methodology used to calculate the energy equivalent to the solar PV credit shall be the CECPV Calculator using the most recent version prior to the permit application date, which may be found at: http://www.gosolarcalifornia.ca.gov/nshpcalculator/.

- Certified Energy Plans Examiners (CEPEs)

The California Association of Building Energy Consultants (CABEC) sponsors and administers the Certified Energy Plans Examiner (CEPE) program for the Residential and Nonresidential Standards. CEPE candidates must pass an examination to demonstrate knowledge of the applicable standards.

Local ordinances can include a requirement, or create a permit incentive, for the energy analysis and documentation to be prepared by an individual with the current applicable CEPE credential.

State Review of Local Adopted Energy Standards

This cost effectiveness study and findings can be submitted by Cities in Alameda County to the California Energy Commission (CEC) and filed with the California Building Standards Commission (BSC) in the process described below. The following summarizes the steps of creating and implementing a local energy ordinance, or a green building ordinance which includes energy requirements, that exceed the California Energy Efficiency Standards for Residential and Nonresidential Buildings (Title 24, Part6):

1. Establish Ordinance (city/county staff)
2. Conduct Cost Effectiveness Study (city/county staff or consultant)
3. First Reading of Ordinance (City Council or Board of Supervisors)
4. Application to the California Energy Commission (CEC)
5. Second Reading of Ordinance (City Council or Board of Supervisors)
6. File with the California Building Standards Commission (BSC)
7. Implementation and Enforcement (city/county staff)

1. Establish Ordinance

Include the following findings in the ordinance:

- A clear policy statement outlining the green building or energy goals for each building type covered
- A general understanding of the relative impact on increased construction costs of the proposed ordinance

- A plan including the adoption timeline and approach for enforcement by the local building department

Specify thresholds for the more stringent energy requirements as defined by the following building permit scenarios:

- New construction vs. Additions vs. Alterations
- Occupancy type
- Number of stories and/or building height
- Total conditioned floor area

Note that the cost effectiveness study in this report only applies to *new construction*, a separate analysis would be required for existing buildings.

2. Cost Effectiveness Study

The jurisdiction makes an independent judgment as to the levels of energy efficiency appropriate for their permit applicants, usually requiring projects to be between 10% to 20% more energy efficient than Title 24, Part 6 depending on occupancy type and costs. A jurisdiction may choose for the ordinance to refer to one or more green building rating systems, such as LEED and GreenPoint Rated, which have standard minimum energy efficiency requirements for new construction and those requirements then become the basis for the local ordinance.

The energy cost-effectiveness study is a consideration of the incremental first cost to achieve the required percentage above code as compared to the annual energy cost savings for the various building types. The cost-effectiveness study should inform the energy efficiency thresholds as part of the supporting documentation provided to members of the City Council or Board of Supervisors prior to the vote on the ordinance. The Energy Cost-effectiveness study satisfies this requirement.

3. First Reading of Ordinance

An ordinance must have preliminary local approval *before* the application to the CEC can be submitted for state review. In most cases, that means a "first reading" or "introduction" of an ordinance, and its initial approval by the City Council or Board of Supervisors prior to its final adoption at a later date.

4. Application to the California Energy Commission (CEC)

Public Resources Code section 25402.1(h)(2) and the California Code of Regulations, Title 24, Part 1, Article 1, Section 10-106 establish that no local energy ordinance can be legally enforced unless the CEC first reviews the ordinance and finds that it "will require the diminution of energy consumption levels permitted by [Title 24].". The following is the full text of section 10-106:

SECTION 10-106 – LOCALLY ADOPTED ENERGY STANDARDS

(a) Requirements. Local governmental agencies may adopt and enforce energy standards for newly constructed buildings, additions, alterations, and repairs provided the Commission finds that the standards will require buildings to be designed to consume no more energy than

permitted by Part 6. Such local standards include, but are not limited to, adopting the requirements of Part 6 before their effective date, requiring additional energy conservation measures, or setting more stringent energy budgets. Local adoption of the requirements of Part 6 before their effective date is a sufficient showing that the local standards meet the requirements of this section and Section 25402.1(f)(2) of the Public Resources Code; in such a case only the documentation listed in Section 10-106(b), and a statement that the standards are those in Part 6, need be submitted.
(b) Documentation Application. Local governmental agencies wishing to enforce locally adopted energy conservation standards shall submit four copies of an application with the following materials to the executive director:
1. The proposed local energy standards.
2. A study with supporting analysis showing how the local agency determined energy savings.
3. A statement that the local standards will require buildings to be designed to consume no more energy than permitted by Part 6.
4. The basis of the agency's determination that the standards are cost effective.
NOTE: Authority cited: Section 25402.1, Public Resources Code. Reference: Section 25402.1, Public Resources Code.

The findings in the ordinance and scope of the cost-effectiveness study are at the discretion of the local jurisdiction. See example approved ordinances at:
http://www.energy.ca.gov/title24/2005standards/ordinances_exceeding_2005_building_standards.html

CEC staff will review the ordinance, and may have comments or request clarification of language that they interpret as unclear or potentially in conflict with Title 24 Standards. From the date that the CEC receives an application expect a minimum of two to three months until formal review by the Commission. CEC's required findings generally do not require the presence of local jurisdiction staff to be present in Sacramento to respond to questions or comments by the Commissioners although they are welcome to be present if they wish. They may also listen in to Energy Commission Business Meetings via the weblink at:
http://www.energy.ca.gov/calendar/events/index.php?com=detail&eID=30

5. Second Reading by City Council or Board of Supervisors

Final adoption of the ordinance by the local jurisdiction can occur any time after the date of CEC review of findings.

6. File with the California Building Standards Commission (BSC)

After the local energy ordinance has been adopted, it must be filed with the California Building Standards Commission (BSC). The BSC is responsible for administering California's building codes, including adopting, approving, publishing, and implementing codes and standards. However, the BSC does not review the energy ordinance or formally vote on it. The BSC clerk simply receives it and files it and nothing further.

NOTE: S*eparate* local climatic, geological, or topographical findings have to be filed with BSC for mandatory green building polices and ordinances that are more restrictive than the California Green Building Standards Code. This process is different than the one outlined in this document.

StopWaste.Org is developing Model Findings for its member agencies that will be available in March 2009.

7. Implementation and Enforcement

The effective date of the ordinance is generally 30 days (or some other specified number of days) after final ordinance adoption. Implementation of the ordinance requires building department staff training and resources such as:

- A concise summary of the local energy ordinance requirements for the building department to provide to permit applicants
- Provision for a clear methodology to meet green building program (e.g. LEED, GreenPoint Rated) energy requirements based on Title 24 calculations and documentation
- Clarification of how to calculate the extent to which a building exceeds Title 24 for specific building types
- Additional forms to supplement the standard Title 24 energy compliance report
- A commitment to improve enforcement of the Title 24 Standards as well as the requirements of the local ordinance

Energy Cost-Effectiveness Case Studies Using the 2008 Title 24 Building Energy Efficiency Standards

January 21, 2009

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1.0 Purpose of Study

Gabel Associates, LLC conducted an energy cost-effectiveness analysis using case studies of several building designs that meet and exceed the 2008 Title 24 Building Energy Efficiency Standards in the two California climate zones within Alameda County: Zones 3 and 12. The goal was to answer the following questions for each building type in in each climate zone:

- What set of energy measures are needed to just meet the 2008 Standards? And what sets of additional measures are needed to reduce the standard Time Dependent Valuation (TDV) energy in KBtu/sf-yr by 10%, 15%, 20% and 35%?
- What is the incremental (added) construction cost of the various sets of energy measures? And what are those costs per square foot?
- What is the annual energy saving for each scenario? And using current utility rates, what is the annual energy cost saving for each scenario?
- What is the Simple Payback for the added energy measures?
- What is the CO2-equivalent reduction in emissions from each scenario (lb./sf-yr)? And what is the added cost of CO2-equivalent reduction ($/sf-lb.-yr)?
- What level or levels of energy efficiency that exceed the 2008 Standard appear cost-effective in these climate zones?

The following data has been developed and compiled to consider these and related questions for single family residential, multifamily low-rise and multifamily high-rise residential and non-reisdential office buildings. This report can be used by Alameda County jurisdictions wishing to adopt mandatory energy policy(ies) that exceed T-24 part 6. The goal of these case studies is to provide relatively real-world order-of-magnitude results for local jurisdictions attempting to understand and calibrate energy and cost impacts of local energy ordinances or local green building ordinances. In this limited study, no attempt has been made to gather statistically significant data that can be applied to all new construction projects and thereby determine the macro-effects of specific policy decisions.

2.0 Methodology

2.1 Performance Approach

One important basis of this study is that the performance approach is used almost exclusively as the method which permit applicants use to demonstrate compliance with the Title 24 Building Energy Efficiency Standards. California Energy Commission studies have shown that well over 95% of new low-rise residential buildings are submitted with a performance Title 24 report. In addition, utility incentive programs use the performance

approach metric to establish eligibility for energy incentives; and the state uses the performance approach (e.g., exceeding the 2005 standards by 15%) to establish eligibility for the New Solar Homes Partnership (NSHP) program.

Some important reasons for the pre-dominant use of the performance approach are:

1. It allows the building designers the greatest flexibility in deciding which energy measures, in combination, meet the overall energy budget for the building;

2. It provide the best way to find the lowest first cost or the most cost-effective ways to meet or exceed the standards; and,

3. It allows building designers and developers an excellent means to assess the energy performance of specific energy measures or combinations of measures.

2.2 Title 24 Time Dependent Valuation (TDV) Energy and Other Possible Energy Metrics

Building energy efficiency programs and the GreenPoint Rated system use the Title 24 metric of TDV energy (KBtuh/sq.ft.-year) in measuring building energy performance. This metric weights the value of mostly electricity according to the day of the year and time of year (similar to Time-of-Use utility rates). Because the Title 24 rules, calculations, compliance rules and forms are familiar to the building industry, energy consultants and building departments, it makes sense to use the same procedures and the same metric to require higher energy efficiency. However, this may change in the future as the California Energy Commission may, by 2011, require that several other metrics of building energy performance be listed on the Certificate of Compliance which must be on the drawings. Other metrics in the future may include:

- The Home Energy Rating System (HERS) Phase 2 score for existing and new buildings which is a much better indication of how well specific building is performing with respect to a Zero Net Energy version of that building.

- The site energy use of the building in total KWh and Therms, or KBtuh/sf.

- The overall or per square foot CO2-equivalent reduction in greenhouse gases.

Until one or more of the above metrics is an automatic part of the Title 24 analysis and documentation, building energy performance will generally focus on TDV energy as the basis of improved energy performance.

2.3 Case Study Method

The methodology used in the case studies is based on the way that real buildings are designed and evaluated to meet or exceed the energy standards.

(a) Each prototype building design is tested for compliance with the 2008 Standards, and all energy measures are adjusted with common construction options to just barely meet the 2005 and 2008 Standards. The energy measures chosen are not all the prescriptive measures, but are a combination of measures which reflects how designers, builders and developers are likely to achieve a specified level of performance. It is worth noting that almost no new construction ever uses the prescriptive approach to demonstrate compliance, but instead uses a mix of features which are evaluated by an energy analyst using the performance approach.

(b) Starting with a 2008 Standards minimally compliant set of measures, various items are changed to just reach the next increment of energy performance (e.g, 10% better than Title 24). In this study, the design choices are based on years of work experience with architects, mechanical engineers and builders and general knowledge of the relative incremental costs of most measures. The intent of this approach is for the study to reflect how building energy performance is actually studied and used to select final energy measures in real life situations.

(c) A minimum and maximum range of incremental costs of added energy measures is established by a variety of research means. A construction cost estimator, Building Advisory LLC, was contracted to conduct research and surveys to obtain accurate and current measure cost information. Site energy in KWh and Therms, is calculated for each run to establish the annual energy savings, energy cost savings and CO2-equivalent reductions in greenhouse gases.

(d) A variety of charts are generated to illustrate and consider different aspects of cost-effectiveness by building type and climate zone.

2.4 Cost Effectiveness

The tables in section 4.0 are based upon the following:

- Incremental site electricity (kWh) and natural gas (therms) saved per year as calculated using the state-approved energy compliance;
- Average utility rates of $0.16/kWh for electricity and $1.30/therm for natural gas in constant dollars
- The assumption of no change (i.e., no inflation or deflation) of utility rates in constant dollars over time

- The assumption of no increase in summer temperatures, even though recent scientific studies suggest that global climate change will increase temperatures in the Western U.S. which in turn will increase air conditioning energy use

The tables illustrating Simply Payback include a cost-effectiveness analysis assuming:

- No external cost of global climate change -- and the corresponding value of additional investment in energy efficiency and CO2 reduction -- is included

- The cost of money invested in the incremental cost of energy measures is not included.

3.0 Impacts of the 2008 Standards

This study focuses on incremental impacts of exceeding the 2008 energy standards by specific percentages in different climate zones for each building design. We have also included the incremental measures and costs associated with upgrading a building that just meets the 2005 standards to the same building which meets the 2008 standards. This data is included in Section 4 with the various charts which illustrate additional first cost per dwelling unit, and additional first cost per square foot.

3.1 Single Family House Case Studies

House Designs. A typical single family home design is modeled to just meet the overall TDV energy performance requirements of 2008 Title 24 standards using a 2008 Standards research version of Micropas. Incremental improvements to building energy efficiency measures then are made to reduce TDV energy to:

(a) from 2005 standards, meet the 2008 standards;
(b) 10% less than the 2008 standards;
(c) 15% less than the 2008 standards;
(d) 20% less than the 2008 standards; and,
(e) 35% less than the 2008 standards.

The following measures were first evaluated so that the house design just meets the 2008 standards in each climate zone as follows:

Climate Zone #3: 2,025 SF 2-story home 2008 Title 24 Base Case, **20.2% total glazing** area:

- R-38 roof w/ radiant barrier
- R-13 exterior walls
- R-19 raised floor
- Dual vinyl windows, U=0.40, SHGC=0.40 w/ no overhangs
- Furnace: 80% AFUE; No Cooling
- R-6 ducts in the attic
- DHW: 50 gallon gas water heater, EF=0.62; no extra pipe insulation

Climate Zone #12: 2,025 SF 2-story home 2008 Title 24 Base Case, **20.2% total glazing** area:

- R-38 roof w/ radiant barrier
- R-19 exterior walls
- Covered slab-on-grade floor
- Dual vinyl windows, U=0.37, SHGC=0.25 w/ no overhangs
- Furnace, 80% AFUE; Air Conditioner, 15.0 SEER/12.0 EER
- Reduced duct leakage/testing (HERS)
- R-6 ducts in the attic
- DHW: 50 gallon gas water heater, EF=0.62; no extra pipe insulation

Climate Zone #3: 1,582 SF 1-story home 2008 Title 24 Base Case, **14.3% total glazing** area:

- R-38 roof w/ radiant barrier
- R-13 exterior walls
- R-19 raised floor
- Dual vinyl windows, U=0.36, SHGC=0.30 w/ no overhangs
- Furnace: 80% AFUE; No Cooling
- R-6 ducts in the attic
- DHW: 50 gallon gas water heater, EF=0.58; no extra pipe insulation

Climate Zone #12: 1,582 SF 1-story home 2008 Title 24 Base Case, **14.3% total glazing** area:

- R-38 roof w/ radiant barrier
- R-13 exterior walls
- Covered slab-on-grade floor
- Dual vinyl windows, U=0.36, SHGC=0.30 w/ no overhangs
- Furnace, 80% AFUE; Air Conditioner, 15.0 SEER/12.0 EER (HERS)
- Reduced duct leakage/testing (HERS)
- R-6 ducts in the attic
- DHW: 50 gallon gas water heater, EF=0.62; no extra pipe insulation

Energy Measures Needed to Meet the 2008 Standards

The following energy features were modified from the 2005 Title 24 set of measures so that the building just meets the 2008 standards. The added first cost of that measure compared with the equivalent 2005 Title 24 design measure is listed to the right, and the sum of all incremental costs is listed.

CLIMATE ZONE #3

2,025 sq.ft. (from 2005 Stds to 2008 Stds)

• Low-E glazing: 409 sf @ $1.35 - $1.50/sf	$ 550 - 615
• Water heater EF=0.62 (from EF=0.58)	$ 100 - 200
Total incremental cost of Ordinance energy measure:	**$ 650 - 815**
Incremental cost in $/sq.ft.:	**$ 0.32 to 0.40 /sq.ft.**
	Avg = $0.69 /sf

1,582 sq.ft. (from 2005 Stds to 2008 Stds)

• Radiant Barrier: 1,582 sf @ $0.12 - $0.18/sf	$ 190 - 285
Total incremental cost of Ordinance energy measure:	**$ 190 - 285**
Incremental cost in $/sq.ft.:	**$ 0.12 to 0.18 /sq.ft.**
	Avg = $0.15 /sf

CLIMATE ZONE #12

2,025 sq.ft. (from 2005 Stds to 2008 Stds)

• 15 SEER/12 EER air conditioner	$ 300 - 1350
• Water heater EF=0.62 (from EF=0.58)	$ 100 - 200
Total incremental cost of Ordinance energy measure:	**$ 400 - 1550**
Incremental cost in $/sq.ft.:	**$ 0.20 to 0.77 /sq.ft.**
	Avg = $0.48 /sf

1,582 sq.ft. (from 2005 Stds to 2008 Stds)

• Walls: from R-13 + R4 to R-19, 1116 sf -$0.45 to -$0.60	$ -500 - -400
• 15 SEER/12 EER air conditioner	$ 300 - 1350
• Reduced duct leakage (installation testing & HERS inspection)	$ 300 - 600
Total incremental cost of Ordinance energy measure:	**$ 100 - 1550**
Incremental cost in $/sq.ft.:	**$ 0.06 to 0.98 /sq.ft.**
	Avg = $0.52 /sf

Energy Measures Needed to Exceed the 2008 Standards

The following energy features have been modified from the above Title 24 set of measures so that the proposed design uses less TDV energy than the 2008 standards. The added first cost of that measure compared with the equivalent 2008 Title 24 design measure is listed to the right, and the sum of all incremental costs is listed.

CLIMATE ZONE #3

(A-10%) 2,025 sq.ft. (Reduction in 2008 T24 TDV Energy by 10%)

• 92% AFUE furnace	$ 500 - 1,200
• R-49 roof insulation: 1,443 sf @$0.19 to $0.22/sf	$ 275 - 320
• House wrap: 2,550 sf @ $0.08 to $0.12/sf	$ 205 - 305
Total incremental cost of Ordinance energy measure:	**$ 980 - 1,825**
Incremental cost in $/sq.ft.:	**$ 0.48 to 0.90 /sq.ft.**
	Avg = $0.69 /sf

(A-15%) 2,025 sq.ft. (Reduction in 2008 T24 TDV Energy by 15%)

• 92% AFUE furnace	$ 500 - 1,200
• Reduced duct leakage (installation testing & HERS inspection)	$ 300 - 600
• House wrap: 2,550 sf @ $0.08 to $0.12/sf	$ 205 - 305
Total incremental cost of Ordinance energy measure:	**$ 1,005 - 2,105**
Incremental cost in $/sq.ft.:	**$ 0.50 to 1.04 /sq.ft.**
	Avg = $0.77 /sf

(A-20%) 2,025 sq.ft. (Reduction in 2008 T24 TDV Energy by 20%)

• 92% AFUE furnace	$ 500 - 1,200
• Reduced duct leakage (installation testing & HERS inspection)	$ 300 - 600
• Quality insulation installation (includes HERS inspection)	$ 175 - 250
• House wrap: 2,550 sf @ $0.08 to $0.12/sf	$ 205 - 305
Total incremental cost of Ordinance energy measure:	**$ 1,180 - 2,355**
Incremental cost in $/sq.ft.:	**$ 0.58 to 1.16 /sq.ft.**
	Avg = $0.87 /sf

(A-35%) 2,025 sq.ft. (Reduction in 2008 T24 TDV Energy by 35%)

• 92% AFUE furnace	$ 500 - 1,200
• Reduced duct leakage (installation testing & HERS inspection)	$ 300 - 600
• R-19 walls: 2,550 sf @$0.27 to $0.39/sf	$ 690 - 995
• R-49 roof insulation: 1,443 sf @$0.19 to $0.22/sf	$ 275 - 320
• Quality insulation installation (includes HERS inspection)	$ 175 - 250
• Tankless gas DHW, 0.80 EF (5 to 10 gpm)	$ 900 - 1,500
• House wrap: 2,550 sf @ $0.08 to $0.12/sf	$ 205 - 305
Total incremental cost of Ordinance energy measure:	**$ 3,045 - 5,170**
Incremental cost in $/sq.ft.:	**$ 1.50 to 2.55 /sq.ft.**
	Avg = $2.03 /sf

(A-10%) 1,582 sq.ft. (Reduction in 2008 T24 TDV Energy by 10%)

• Reduced duct leakage (installation testing & HERS inspection)	$ 300 - 600
• Water heater EF=0.62 (from EF=0.58)	$ 100 - 200
• R-49 roof insulation: 1,582 sf @$0.19 to $0.22/sf	$ 300 - 350
• House wrap: 1,116 sf @ $0.08 to $0.12/sf	$ 90 - 135
Total incremental cost of Ordinance energy measure:	**$ 790 - 1,225**
Incremental cost in $/sq.ft.:	**$ 0.50 to 0.77 /sq.ft.**
	Avg = $0.64 /sf

(A-15%) 1,582 sq.ft. (Reduction in 2008 T24 TDV Energy by 15%)

• 92% AFUE furnace	$ 500 - 1,200
• Reduced duct leakage (installation testing & HERS inspection)	$ 300 - 600
• Water heater EF=0.62 (from EF=0.58)	$ 100 - 200
• R-49 roof insulation: 1,582 sf @$0.19 to $0.22/sf	$ 300 - 350
• House wrap: 1,116 sf @ $0.08 to $0.12/sf	$ 90 - 135
Total incremental cost of Ordinance energy measure:	**$ 1,290 - 2,485**
Incremental cost in $/sq.ft.:	**$ 0.82 to 1.57 /sq.ft.**
	Avg = $1.19 /sf

(A-20%) 1,582 sq.ft. (Reduction in 2008 T24 TDV Energy by 20%)

• 92% AFUE furnace	$ 500 - 1,200
• Quality insulation installation (includes HERS inspection)	$ 175 - 250
• Reduced duct leakage (installation testing & HERS inspection)	$ 300 - 600
• Water heater EF=0.62 (from EF=0.58)	$ 100 - 200
• R-49 roof insulation: 1,582 sf @$0.19 to $0.22/sf	$ 300 - 350
• House wrap: 1,116 sf @ $0.08 to $0.12/sf	$ 90 - 135
Total incremental cost of Ordinance energy measure:	**$ 1,465 - 2,735**
Incremental cost in $/sq.ft.:	**$ 0.93 to 1.73 /sq.ft.**
	Avg = $1.33 /sf

(A-35%) 1,582 sq.ft. (Reduction in 2008 T24 TDV Energy by 35%)

• 92% AFUE furnace	$ 500 - 1,200
• Quality insulation installation (includes HERS inspection)	$ 175 - 250
• Tankless gas DHW, 0.80 EF (5 to 10 gpm)	$ 900 - 1,500
• R-15 wall insulation: 1,116 sf @ $0.06 to $0.08/sf	$ 70 - 90
• Reduced duct leakage (installation testing & HERS inspection)	$ 300 - 600
• Water heater EF=0.62 (from EF=0.58)	$ 100 - 200
• R-49 roof insulation: 1,582 sf @$0.19 to $0.22/sf	$ 300 - 350
• House wrap: 1,116 sf @ $0.08 to $0.12/sf	$ 90 - 135
Total incremental cost of Ordinance energy measure:	**$ 2,435 - 4,325**
Incremental cost in $/sq.ft.:	**$ 1.54 to 2.73 /sq.ft.**
	Avg = $2.14 /sf

CLIMATE ZONE #12

(A-10%) 2,025 sq.ft. (Reduction in 2008 T24 TDV Energy by 10%)

• R-19 walls: 2,550 sf @$0.27 to $0.39/sf	$ 690 - 995
• Quality insulation installation (includes HERS inspection)	$ 175 - 250
• TXV/EER (HERS inspection)	$ 25 - 50
• Verified air flow (HERS inspection)	$ 100 - 150
Total incremental cost of Ordinance energy measure:	**$ 990 - 1,445**
Incremental cost in $/sq.ft.:	**$ 0.49 to 0.71 /sq.ft.**
	Avg = $0.60 /sf

(A-15%) 2,025 sq.ft. (Reduction in 2008 T24 TDV Energy by 15%)

• 92% AFUE furnace	$ 500 - 1,200
• Reduced building leakage SLA=3.0 (testing & HERS inspection)	$ 250 - 400
• R-19 walls: 2,550 sf @$0.27 to $0.39/sf	$ 690 - 995
• Quality insulation installation (includes HERS inspection)	$ 175 - 250
• TXV/EER (HERS inspection)	$ 25 - 50
• Verified air flow (HERS inspection)	$ 100 - 150
Total incremental cost of Ordinance energy measure:	**$ 1,740 - 3,045**
Incremental cost in $/sq.ft.:	**$ 0.86 to 1.50 /sq.ft.**
	Avg = $1.18 /sf

(A-20%) 2,025 sq.ft. (Reduction in 2008 T24 TDV Energy by 20%)

• 92% AFUE furnace	$ 500 - 1,200
• Reduced building leakage SLA=3.0 (testing & HERS inspection)	$ 250 - 400
• R-19 walls: 2,550 sf @$0.27 to $0.39/sf	$ 690 - 995
• Quality insulation installation (includes HERS inspection)	$ 175 - 250
• TXV/EER (HERS inspection)	$ 25 - 50
• Super Low-E glazing: 409 sf @ $1.35 - $1.50/sf	$ 550 - 615
• R-49 roof insulation: 1,443 sf @$0.19 to $0.22/sf	$ 275 - 320
• Verified air flow (HERS inspection)	$ 100 - 150
Total incremental cost of Ordinance energy measure:	**$ 2,565 - 4,280**
Incremental cost in $/sq.ft.:	**$ 1.27 to 2.11 /sq.ft.**
	Avg = $1.69 /sf

(A-35%) 2,025 sq.ft. (Reduction in 2008 T24 TDV Energy by 35%)

• 92% AFUE furnace	$ 500 - 1,200
• Reduced building leakage SLA=3.0 (testing & HERS inspection)	$ 250 - 400
• R-19 walls: 2,550 sf @$0.27 to $0.39/sf	$ 690 - 995
• Quality insulation installation (includes HERS inspection)	$ 175 - 250
• TXV/EER (HERS inspection)	$ 25 - 50
• Super Low-E glazing: 409 sf @ $1.35 - $1.50/sf	$ 550 - 615
• R-49 roof insulation: 1,443 sf @$0.19 to $0.22/sf	$ 275 - 320
• 70% NSF solar hot water system	$ 5,000 - 6,000
• Tankless gas DHW, 0.80 EF (5 to 10 gpm)	$ 900 - 1,500
• Verified air flow (HERS inspection)	$ 100 - 150
Total incremental cost of Ordinance energy measure:	**$ 8,465- 11,480**
Incremental cost in $/sq.ft.:	**$ 4.18 to 5.67 /sq.ft.**
	Avg = $4.92 /sf

(A-10%) 1,582 sq.ft. (Reduction in 2008 T24 TDV Energy by 10%)

• Quality insulation installation (includes HERS inspection)	$ 175 - 250
• R-21 walls: 1,116 sf @$0.37 to $0.52/sf	$ 415 - 580
• Refrig. Charge & Adequate Airflow (HERS inspection)	$ 100 - 150
• House wrap: 1,116 sf @ $0.08 to $0.12/sf	$ 90 - 135
Total incremental cost of Ordinance energy measure:	**$ 780 - 1,115**
Incremental cost in $/sq.ft.:	**$ 0.49 to 0.70 /sq.ft.**
	Avg = $0.60 /sf

(A-15%) 1,582 sq.ft. (Reduction in 2008 T24 TDV Energy by 15%)

• 92% AFUE furnace	$ 500 - 1,200
• R-49 roof insulation: 1,582 sf @$0.19 to $0.22/sf	$ 300 - 350
• R-19 walls: 1,116 sf @$0.27 to $0.39/sf	$ 300 - 435
• Refrig. Charge (HERS inspection)	$ 75 - 125
• House wrap: 1,116 sf @ $0.08 to $0.12/sf	$ 90 - 135
Total incremental cost of Ordinance energy measure:	**$ 1,265 - 2,245**
Incremental cost in $/sq.ft.:	**$ 0.80 to 1.42 /sq.ft.**
	Avg = $1.11 /sf

(A-20%) 1,582 sq.ft. (Reduction in 2008 T24 TDV Energy by 20%)

• Low-E3 windows: U-factor=0.36, SHGC=0.23 226 sf @ $1.35 - $1.50/sf	$ 305 - 340
• Refrig. Charge & Adequate Airflow (HERS inspection)	$ 100 - 150
• Hot water pipe insulation (from minimum to all)	$ 250 - 300
• R-21 walls: 1,116 sf @$0.37 to $0.52/sf	$ 415 - 580
• 94% AFUE furnace	$ 800 - 1,300
• Quality insulation installation (includes HERS inspection)	$ 175 - 250
• Water heater EF=0.62 (from EF=0.58)	$ 100 - 200
• R-49 roof insulation: 1,582 sf @$0.19 to $0.22/sf	$ 300 - 350
• House wrap: 1,116 sf @ $0.08 to $0.12/sf	$ 90 - 135
Total incremental cost of Ordinance energy measure:	**$ 2,535 - 3,605**
Incremental cost in $/sq.ft.:	**$ 1.60 to 2.28 /sq.ft.**
	Avg = $1.94 /sf

(A-35%) 1,582 sq.ft. (Reduction in 2008 T24 TDV Energy by 35%)

• 92% AFUE furnace	$ 500 - 1,200
• Quality insulation installation (includes HERS inspection)	$ 175 - 250
• Tankless gas DHW, 0.80 EF (5 to 10 gpm)	$ 900 - 1,500
• Low-E3 windows: U-factor=0.36, SHGC=0.30 226 sf @ $1.35 - $1.50/sf	$ 305 - 340
• Hot water pipe insulation (from minimum to all)	$ 250 - 300
• R-21 walls: 1,116 sf @$0.37 to $0.52/sf	$ 415 - 580
• Quality insulation installation (includes HERS inspection)	$ 175 - 250
• R-49 roof insulation: 1,582 sf @$0.19 to $0.22/sf	$ 300 - 350
• House wrap: 1,116 sf @ $0.08 to $0.12/sf	$ 90 - 135
• 60% Net Solar Fraction solar hot water collector system	$ 4,000 - 5,000
Total incremental cost of Ordinance energy measure:	**$ 7,110 - 9,905**
Incremental cost in $/sq.ft.:	**$ 4.49 to 6.26 /sq.ft.**
	Avg = $5.38 /sf

3.2 *Low-rise Multi-family Building Case Study*

Building Design. A typical 8-unit, 2-story low-rise multi-family building is modeled to just meet the overall TDV energy performance requirements of 2008 Title 24 standards using a 2008 Standards research version of Micropas. Incremental improvements to building energy efficiency measures then are made to reduce TDV energy to:

(f) 10% less than the 2008 standards;
(g) 15% less than the 2008 standards;
(h) 20% less than the 2008 standards; and,
(i) 35% less than the 2008 standards.

The following measures were first evaluated so that the house design just meets the 2008 standards in each climate zone as follows:

Climate Zone #3: 8,442 SF 2-story building 2008 Title 24 Base Case, **12.5% total glazing** area:

- R-38 roof w/ radiant barrier, R-13 exterior walls, slab-on-grade 1st floor
- Dual vinyl windows, U=0.39, SHGC=0.33 w/ no overhangs
- Furnace: 80% AFUE; No Cooling
- R-6 ducts in the attic
- DHW: 50 gallon gas water heater, EF=0.575; no extra pipe insulation

Climate Zone #12: 8,442 SF 2-story building 2008 Title 24 Base Case, **12.5% total glazing** area:

- R-38 roof w/ radiant barrier, R-19 exterior walls, slab-on-grade 1st floor
- House wrap
- Dual vinyl windows, U=0.35, SHGC=0.31 w/ no overhangs
- Furnace: 80% AFUE
- Air conditioner: 13.0 SEER, 11.0 EER
- R-6 ducts in the attic
- DHW: 50 gallon gas water heater, EF=0.62; no extra pipe insulation

Energy Measures Needed to Meet the 2008 Standards

The following energy features were modified from the 2005 Title 24 set of measures so that the building just meets the 2008 standards. The added first cost of that measure compared with the equivalent 2005 Title 24 design measure is listed to the right.

CLIMATE ZONE #3

• (8) Water heaters EF=0.62 (from EF=0.58)	$ 800 - 1,600
Total incremental cost of Ordinance energy measure:	**$ 800 - 1,600**
Incremental cost in $/sq.ft.:	**$ 0.09 to 0.19 /sq.ft.**
	Avg = $0.14 /sf

CLIMATE ZONE #12

• R-19 from R-13 walls, 9,266 sf @$0.27 - $0.39/sf	$ 2,505 - 3,615
Total incremental cost of Ordinance energy measure:	**$ 2,505 - 3,615**
Incremental cost in $/sq.ft.:	**$ 0.30 to 0.43 /sq.ft.**
	Avg = $0.37 /sf

Energy Measures Needed to Exceed the 2008 Standards

The following energy features have been modified from the above Title 24 set of measures so that the proposed design uses less TDV energy than the 2008 standards. The added first cost of that measure compared with the equivalent 2008 Title 24 design measure is listed to the right, and the sum of all incremental costs is listed.

CLIMATE ZONE #3

(A-10%) 8,442 sq.ft. (Reduction in 2008 T24 TDV Energy by 10%)

• Reduced duct leakage (installation testing & HERS inspection)	$ 2000 - 4000
• R-15 wall insulation: 9,266 sf @ $0.06 to $0.08/ sf	$ 560 - 745
• House wrap: 9,266 sf @ $0.08 to $0.12/sf	$ 745 - 1,115
Total incremental cost of Ordinance energy measure:	**$ 3,305 - 5,860**
Incremental cost in $/sq.ft.:	**$ 0.39 to 0.69 /sq.ft.**
	Avg = $0.54 /sf

(A-15%) 8,442 sq.ft. (Reduction in 2008 T24 TDV Energy by 15%)

• Reduced duct leakage (installation testing & HERS inspection)	$ 2000 - 4000
• R-15 wall insulation: 9,266 sf @ $0.06 to $0.08/ sf	$ 560 - 745
• House wrap: 9,266 sf @ $0.08 to $0.12/sf	$ 745 - 1,115
• (8) 92% AFUE furnaces	$ 4,000 - 9,600
• R-49 roof/ceiling insulation, 2,880 sf @$0.19 - $0.22/sf	$ 550 - 635
Total incremental cost of Ordinance energy measure:	**$ 7,855- 16,095**
Incremental cost in $/sq.ft.:	**$ 0.93 to 1.91 /sq.ft.**
	Avg = $1.42 /sf

(A-20%) 8,442 sq.ft. (Reduction in 2008 T24 TDV Energy by 20%)

• Reduced duct leakage (installation testing & HERS inspection)	$ 2,000 - 4,000
• R-19 wall insulation: 9,266 sf @ $0.27 to $0.39/ sf	$ 2,505 - 3,615
• House wrap: 9,266 sf @ $0.08 to $0.12/sf	$ 745 - 1,115
• (8) 92% AFUE furnaces	$ 4,000 - 9,600
• No roof radiant barrier 2,880sf @-$0.12 to -$0.18/sf	$ -520 - -345
Total incremental cost of Ordinance energy measure:	**$ 8,730 - 17,985**
Incremental cost in $/sq.ft.:	**$ 1.03 to 2.13 /sq.ft.**
	Avg = $1.58 /sf

(A-35%) 8,442 sq.ft. (Reduction in 2008 T24 TDV Energy by 35%)

• Reduced duct leakage (installation testing & HERS inspection)	$ 2,000 - 4,000
• R-19 wall insulation: 9,266_sf @ $0.27 to $0.39/ sf	$ 2,505 - 3,615
• (8) Tankless water heaters EF=0.805 @$900 - $1,500 each	$ 7,200 - 12,000
Total Incremental cost of Ordinance energy measure:	**$ 11,705 - 19,615**
Incremental cost in $/sq.ft.:	**$ 1.39 to 2.32 /sq.ft.**
	Avg = $1.86 /sf

CLIMATE ZONE #12

(A-10%) 8,442 sq.ft. (Reduction in 2008 T24 TDV Energy by 10%)

• Quality insulation installation (includes HERS inspection)	$ 1,100 - 1,600
• R-21 walls: 9,266_sf @$0.10 to $0.13/sf	$ 930 - 1,205
• (8) 15 SEER/12 EER air conditioner	$ 2,400 -10,800
Total incremental cost of Ordinance energy measure:	**$ 4,430 -13,605**
Incremental cost in $/sq.ft.:	**$ 0.52 to 1.61 /sq.ft.**
	Avg = $1.07 /sf

(A-15%) 8,442 sq.ft. (Reduction in 2008 T24 TDV Energy by 15%)

• Quality insulation installation (includes HERS inspection)	$ 1,100 - 1,600
• R-21 walls: 9,266_sf @$0.10 to $0.13/sf	$ 930 - 1,205
• (8) 15 SEER/12 EER air conditioners	$ 2,400 -10,800
• (8) 92% AFUE furnaces	$ 4,000 - 9,600
• Refrigerant charge tests	$ 300 - 1,600
Total incremental cost of Ordinance energy measure:	**$ 8,730 -21,605**
Incremental cost in $/sq.ft.:	**$ 1.03 to 2.56 /sq.ft.**
	Avg = $1.80 /sf

(A-20%) 8,442 sq.ft. (Reduction in 2008 T24 TDV Energy by 20%)

• Quality insulation installation (includes HERS inspection)	$ 1,100 - 1,600
• R-21 walls: 9,266_sf @$0.10 to $0.13/sf	$ 930 - 1,205
• (8) 15 SEER/12 EER air conditioners @$300 - $1,350 each	$ 2,400 -10,800
• (8) 92% AFUE furnaces @$500 - $800 each	$ 4,000 - 6,400
• Refrigerant charge tests	$ 300 - 1,600
• Low-E3 windows: U-factor=0.36, SHGC=0.23 1,055 sf @ $1.35 - $1.50/sf	$ 1,425 - 1,585
• Verified Air Flow	$ 300 - 1,600
• R-49 roof/ceiling insulation, 2,880 sf @$0.19 - $0.22/sf	$ 550 - 635
• Pipe insulation @$150 - $300/unit	$ 1,200 - 2,400
Total incremental cost of Ordinance energy measure:	**$12,205- 27,825**
Incremental cost in $/sq.ft.:	**$ 1.45 to 3.30 /sq.ft.**
	Avg = $2.37/sf

(A-35%) 8,442 sq.ft. (Reduction in 2008 T24 TDV Energy by 35%)

• Quality insulation installation (includes HERS inspection)	$ 1,100 - 1,600
• R-21 walls: 9,266 sf @$0.10 to $0.13/sf	$ 930 - 1,205
• (8) 15 SEER/12 EER air conditioners @$300 - $1,350 each	$ 2,400 -10,800
• (8) 92% AFUE furnaces @$800 - $1200 each	$ 6,400 - 9,600
• Refrigerant charge tests	$ 300 - 1,600
• Low-E3 windows: U-factor=0.36, SHGC=0.23 w/ argon gas 1,055 sf @ $2.35 - $2.50/sf	$ 2,480 - 2,640
• Verified Air Flow	$ 300 - 1.600
• R-49 roof/ceiling insulation, 2,880 sf @$0.19 - $0.22/sf	$ 550 - 635
• Pipe insulation @$150 - $300/unit	$ 1,200 - 2,400
• (8) Tankless water heaters EF=0.80 @$900 - $1,500 each	$ 7,200- 12,000
• R-8 ducts	$ 1,600 - 2,400
•	
Total incremental cost of Ordinance energy measure:	**$24,460- 46,480**
Incremental cost in $/sq.ft.:	**$ 2.90 to 5.51 /sq.ft.**
	Avg = $4.20 /sf

3.3 High-rise Residential Building Case Study

High-rise Residential Building Design. A typical high-rise residential buildings has been modeled according to the same criteria as in Section 2.1, except that a research version of EnergyPro has been used to evaluate compliance with the 2008 Nonresidential, Hotel/Motel and High-rise Residential standards.

The following measures were first evaluated so that the building just meets the 2008 standards in each climate zone as follows:

Climate Zone #3: 36,800 SF 5-story building 2008 Title 24 Base Case, **35.2% Window Wall Ratio glazing** area, 40 dwelling units:

(A) 36,800 SF 5-story apartment building which just meet Title 24:

- R-30 attic insulation w/ cool roof Reflectance=0.30, Emittance=0.75
- R-19 in metal frame exterior walls
- Un-insulated (R-0) raised slab floor over parking garage;
- Dual vinyl NFRC-rated Low-E windows: U-factor=0.33, SHGC=0.30, (SHGC includes minimal exterior shading)
- Split heat pump for each dwelling unit: HSPF=7.2, EER=10.2
- Central domestic hot water boiler, 82.7% AFUE; re-circulating system w/ timer and temperature controls; variable speed drive hot water pump

Energy Measures Needed to Meet the 2008 Standards

The same building designs that just meet the 2005 standards also must meet the 2008 standards, for both climate zones. Therefore, in this case study, there was no additional cost associated with meeting the 2008 standards.

Energy Measures Needed to Exceed the 2008 Standards

The following energy features have been modified from the above Title 24 set of measures so that the proposed design uses less TDV energy than the 2008 standards. The added first cost of that measure compared with the equivalent 2008 Title 24 design measure is listed to the right, and the sum of all incremental costs is listed.

CLIMATE ZONE #3

(A-10%) 36,800 sq.ft. (Reduction in 2008 T24 TDV Energy by 10%)

• R-3.5 (1") K-13 spray-on insulation under raised floor 9,200 sf @ $1.20 - $1.50/sf	$ 11,040 - 13,800
• (2) Munchkin boilers @ $1200 - $2,000 additional each	$ 2,400 - 4,000
• Heat pumps: HSPF=7.84 / EER=11.2 80 units @$150 - $250 each	$ 12,000 - 20,000
Total incremental cost of Ordinance energy measure:	**$ 25,440 - 37,800**
Incremental cost in $/sq.ft.:	**$ 0.69 to 1.03 /sq.ft.** **Avg = $0.86 /sf**

(A-15%) 36,800 sq.ft. (Reduction in 2008 T24 TDV Energy by 15%)

• Super Low-E glazing: U=0.33, SHGC=0.23, 6,240 sf @ $1.35 - $1.50/sf	$ 8,425 - 9,360
• R-3.5 (1") K-13 spray-on insulation under raised floor 9,200 sf @ $1.20 - $1.50/sf	$ 11,040 - 13,800
• (2) Munchkin boilers @ $1200 - $2,000 additional each	$ 2,400 - 4,000
• Heat pumps: HSPF=7.84 / EER=11.2 80 units @$150 - $250 each	$ 12,000 - 20,000
Total incremental cost of Ordinance energy measure:	**$ 33,865 - 47,160**
Incremental cost in $/sq.ft.:	**$ 0.92 to 1.28 /sq.ft.** **Avg = $1.18 /sf**

(A-20%) 36,800 sq.ft. (Reduction in 2008 T24 TDV Energy by 20%)

• Super Low-E glazing: U=0.33, SHGC=0.23, 6,240 sf @ $1.35 - $1.50/sf	$ 8,425 - 9,360
• R-3.5 (1") K-13 spray-on insulation under raised floor 9,200 sf @ $1.20 - $1.50/sf	$ 11,040 - 13,800
• (2) Munchkin boilers @ $1200 - $2,000 additional each	$ 2,400 - 4,000
• 30% Net Solar Fraction solar DHW system	$ 48,000 - 60,000
• Heat pumps: HSPF=8.8 / EER=11.3 80 units @$180 - $300 each	$ 14,400 - 24,000
Total incremental cost of Ordinance energy measure:	**$ 84,265 - 111,160**
Incremental cost in $/sq.ft.:	**$ 2.29 to 3.02 /sq.ft.** **Avg = $2.66 /sf**

(A-35%) 36,800 sq.ft. (Reduction in 2008 T24 TDV Energy by 36%)

• Super Low-E glazing: U=0.33, SHGC=0.23, 6,240 sf @ $1.35 - $1.50/sf	$ 8,425 - 9,360
• R-3.5 (1") K-13 spray-on insulation under raised floor 9,200 sf @ $1.20 - $1.50/sf	$ 11,040 - 13,800
• (2) Munchkin boilers @ $1200 - $2,000 additional each	$ 2,400 - 4,000
• 72% Net Solar Fraction solar DHW system	$140,000 - 168,000
• R-38 Roof: 9,200 sf @ $0.10 - $0.15/sf	$ 920 - 1,380
• Heat pumps: HSPF=8.8 / EER=11.3 80 units @$180 - $300 each	$ 14,400 - 24,000
Total incremental cost of Ordinance energy measure:	**$177,185 - 220,540**
Incremental cost in $/sq.ft.:	**$ 4.81 to 5.99 /sq.ft.**
	Avg = $5.40 /sf

CLIMATE ZONE #12

(A-10%) 36,800 sq.ft. (Reduction in 2008 T24 TDV Energy by 10%)

• Super Low-E glazing: U=0.33, SHGC=0.23, 6,240 sf @ $1.35 - $1.50/sf	$ 8,425 - 9,360
• R-3.5 (1") K-13 spray-on insulation under raised floor 9,200 sf @ $1.20 - $1.50/sf	$ 11,040 - 13,800
Total incremental cost of Ordinance energy measure:	**$ 19,465 - 23,160**
Incremental cost in $/sq.ft.:	**$ 0.53 to 0.63 /sq.ft.**
	Avg = $0.58 /sf

(A-15%) 36,800 sq.ft. (Reduction in 2008 T24 TDV Energy by 15%)

• Super Low-E glazing: U=0.33, SHGC=0.23, 6,240 sf @ $1.35 - $1.50/sf	$ 8,425 - 9,360
• (2) Munchkin boilers @ $1200 - $2,000 additional each	$ 2,400 - 4,000
• Heat pumps: HSPF=7.84 / EER=11.2 80 units @$150 - $250 each	$ 12,000 - 20,000
Total incremental cost of Ordinance energy measure:	**$ 22,825 - 33,360**
Incremental cost in $/sq.ft.:	**$ 0.62 to 0.91 /sq.ft.**
	Avg = $0.76 /sf

(A-20%) 36,800 sq.ft. (Reduction in 2008 T24 TDV Energy by 20%)

• Super Low-E glazing: U=0.33, SHGC=0.23, 6,240 sf @ $1.35 - $1.50/sf	$ 8,425 - 9,360
• R-7.0 (2") K-13 spray-on insulation under raised floor 9,200 sf @ $1.80 - $2.00/sf	$ 16,560 - 18,400
• (2) Munchkin boilers @ $1200 - $2,000 additional each	$ 2,400 - 4,000
• Heat pumps: HSPF=8.8 / EER=11.3 80 units @$180 - $300 each	$ 14,400 - 24,000
Total incremental cost of Ordinance energy measure:	**$ 41,785 - 55,760**
Incremental cost in $/sq.ft.:	**$ 1.14 to 1.52 /sq.ft.**
	Avg = $2.66 /sf

(A-35%) 36,800 sq.ft. (Reduction in 2008 T24 TDV Energy by 35%)

• Super Low-E glazing: U=0.33, SHGC=0.23, 6,240 sf @ $1.35 - $1.50/sf	$ 8,425 - 9,360
• R-8.75 (2.5") K-13 spray-on insulation under raised floor 9,200 sf @ $2.10 - $2.35/sf	$ 19,320 - 21,620
• (2) Munchkin boilers @ $1200 - $2,000 additional each	$ 2,400 - 4,000
• 55% Net Solar Fraction solar DHW system	$110,000 - 132,000
• Heat pumps: HSPF=8.8 / EER=11.3 80 units @$180 - $300 each	$ 14,400 - 24,000
Total incremental cost of Ordinance energy measure:	**$154,545 - 190,980**
Incremental cost in $/sq.ft.:	**$ 4.20 to 5.19 /sq.ft.**
	Avg = $4.69 /sf

3.4 Nonresidential Building Case Studies

Nonresidential 5-Story Office Building Design. A typical 5-story office building has been modeled according to the same criteria as in Section 2.1, except that a research version of EnergyPro has been used to evaluate compliance with the 2008 Nonresidential, Hotel/Motel and High-rise Residential standards.

CLIMATE ZONE #3 CASE STUDY

The following measures were first evaluated so that the building just meets the 2008 standards in climate zone #3 as follows:

Climate Zone #3: 52,900 SF 5-story building 2008 Title 24 Base Case, **32.5% Window Wall Ratio glazing** area:

(A) 52,900 SF 5-story office building which just meet Title 24:

- R-30 attic insulation, R-19 in metal frame exterior walls, slab-on-grade 1st floor
- NFRC-rated Low-E windows: U-factor=0.50, SHGCc=0.38 (e.g., Viracon VE 1-2M) w/ no exterior shading
- Lighting = 0.887 w/sf: 720 2-lamp 4' T8 fixtures @ 62w each and 260 26w CFLs @ 26 w each; no lighting controls
- 4 identical Packaged VAV units: Aaron 25 ton, EER=10.4, 10,000 CFM, standard efficiency fan motors, 30% VAV boxes w/ reheat
- Ducts in conditioned space, R-4.2 duct insulation
- Hot water assumed to be standard gas water heater

Energy Measures Needed to Meet the 2008 Standards

The same building with the 2005 standards measures fails to meet the 2008 standards by a margin of 6%. To bring the building up to the 2008 standards, the following measures were added.

52,900 sq.ft. (from 2005 Stds to 2008 Stds)

- U=0.50, SHGCc=0.38 (e.g., Viracon VE 1-2M)

9,496 sf @$1.50 - 2.50/sq.ft.	$ 14,250 - 23,750
Total incremental cost of Ordinance energy measure:	**$ 14,250 - 23,750**
	Avg = $19,000
Incremental cost in $/sq.ft.:	**$ 0.27 to 0.45 /sq.ft.**
	Avg = $0.36 /sf

Energy Measures Needed to Exceed the 2008 Standards

The following energy features have been modified from the above Title 24 set of measures so that the proposed design uses less TDV energy than the 2008 standards. The added first cost of that measure compared with the equivalent 2008 Title 24 design measure is listed to the right, and the sum of all incremental costs is listed.

(A-10%) 52,900 sq.ft. (Reduction in 2008 T24 TDV Energy by 10%)

• R-38 w/ Cool Roof 10,580 sf @ $0.30 - $0.40/sf	$ 3,175 - 4,230
• 10 NEMA Premium fan motors on supply & return fans	$ 750 - 1,250
• 720 2-lamp 4' T8 fixtures with high efficiency instant start ballasts and premium T8 lamps, 50 input watts @$25.00 - $30.00/fixture; Installed LPD=0.803	$ 18,000 - 21,600
• 120 occupant sensors controlling (2) 2-lamp T8 fixtures @$65.00 - $85.00 each	$ 7,800 - 10,200
• 40 more recessed CFL fixtures, all CFL fixtures w/ 18w lamps @$175 - $250 each	$ 7,000 - 10,000
Total incremental cost of Ordinance energy measure:	**$ 36,725 - 47,280**
	Avg = $42,003
Incremental cost in $/sq.ft.:	**$ 0.69 to $0.89/sq.ft.**
	Avg = $0.79 /sf

(A-15%) 52,900 sq.ft. (Reduction in 2008 T24 TDV Energy by 15%)

• 720 2-lamp 4' T8 fixtures with high efficiency instant start ballasts and premium T8 lamps, 50 input watts @$25.00 - $30.00/fixture; Installed LPD=0.803	$ 18,000 - 21,600
• 120 occupant sensors controlling (2) 2-lamp T8 fixtures @$65.00 - $85.00 each	$ 7,800 - 10,200
• 40 more recessed CFL fixtures, all CFL fixtures w/ 18w lamps @$175 - $250 each	$ 7,000 - 10,000
• (5) Trane 25 ton units, EER=11.0 @ $9,000 to $13,000 each w/ premium fan motors	$ 45,000 - 65,000
Total incremental cost of Ordinance energy measure:	**$ 77,800 - 106,800**
	Avg = $92,300
Incremental cost in $/sq.ft.:	**$ 1.47 to $2.02/sq.ft.**
	Avg = $1.74 /sf

(A-20%) 52,900 sq.ft. (Reduction in 2008 T24 TDV Energy by 20%)

• 720 2-lamp 4' T8 fixtures with high efficiency instant start ballasts and premium T8 lamps, 50 input watts @$25.00 - $30.00/fixture; Installed LPD=0.803	$ 18,000 - 21,600
• R-38 w/ Cool Roof 10,580 sf @ $0.25 - $0.35/sf	$ 2,645 - 3,700
• U=0.50, SHGCc=0.31 (e.g., Viracon VE 2-2M) 9,496 sf @$2.00 - 3.00/sq.ft.	$ 18,990 - 28,490
• 120 occupant sensors controlling (2) 2-lamp T8 fixtures; @$65.00 - $85.00 each	$ 7,800 - 10,200
• 40 more recessed CFL fixtures, all CFL fixtures w/ 18w lamps @$175 - $250 each	$ 7,000 - 10,000
• (5) Trane 25 ton units, EER=11.0 @ $9,000 to $13,000 each w/ premium fan motors	$ 45,000 - 65,000
Total incremental cost of Ordinance energy measure:	**$ 99,435 - 138,990**
	Avg = $119,213
Incremental cost in $/sq.ft.:	**$ 1.88 to $2.63/sq.ft.**
	Avg = $2.25 /sf

CLIMATE ZONE #12 CASE STUDY

The following measures were first evaluated so that the building just meets the 2008 standards in climate zone #12 as follows:

Climate Zone #12: 52,900 SF 5-story building 2008 Title 24 Base Case, **29.1% Window Wall Ratio glazing** area:

(A) 52,900 SF 5-story office building which just meet Title 24:

- R-30 attic insulation, w/ cool roof solar reflectance=0.55 and emttance=0.75, R-19 in metal frame exterior walls, slab-on-grade 1st floor;
- NFRC-rated Low-E windows: U-factor=0.50, SHGCc=0.31 (e.g., Viracon VE 2-2M) w/ exterior shading on front 1st floor glazing
- Lighting = 0.783 w/sf: 720 2-lamp 4' T8 fixtures (high efficiency lamps and ballasts) @ 50w each and 300 18w CFLs @ 18w each; no lighting controls
- 4 identical Packaged VAV units: Aaron 30 ton, EER=10.4, 12,000 CFM, standard efficiency fan motors, 30% VAV boxes w/ reheat
- Ducts in conditioned space, R-4.2 duct insulation
- Hot water assumed to be standard gas water heater

Energy Measures Needed to Meet the 2008 Standards

The same building with the 2005 standards measures fails to meet the 2008 standards by a margin of 23%. To bring the building up to the 2008 standards, the following measures were added.

52,900 sq.ft. (from 2005 Stds to 2008 Stds)

• U=0.50, SHGCc=0.31 (e.g., Viracon VE 1-2M) 8,500 sf @$2.50 - 3.50/sq.ft.	$ 21,250 - 29,750
• R-19 metal frame walls (from R-13 in 2x6 metal studs) 20,730 sf @ $0.08 – 0.10/sq.ft.	$ 1,660 - 2,075
• R-38 roof w/ cool roof, 10,580 sf @ $0.50 – 0.70/sq.ft.	$ 5,290 - 7,405
• 720 2-lamp 4' T8 fixtures with high efficiency instant start ballasts and premium T8 lamps, 50 input watts @$25.00 - $30.00/fixture; Installed LPD=0.803	$ 18,000 - 21,600
Total incremental cost of Ordinance energy measure:	**$ 46,200 - 60,830**
	Avg = $53,515
Incremental cost in $/sq.ft.:	**$ 0.87 to 1.15 /sq.ft.**
	Avg = $1.01 /sf

Energy Measures Needed to Exceed the 2008 Standards

The following energy features have been modified from the above Title 24 set of measures so that the proposed design uses less TDV energy than the 2008 standards. The added first cost of that measure compared with the equivalent 2008 Title 24 design measure is listed to the right, and the sum of all incremental costs is listed.

(A-10%) 52,900 sq.ft. (Reduction in 2008 T24 TDV Energy by 10%)

• R-38 w/ no cool roof, 10,580 sf @$0.35 – 0.50	($ 3,705 - 5,290)
• (5) Trane 30 ton units, EER=11.0 @ $9,000 to $13,000 each w/ premium fan motors	$ 45,000 - 65,000
Total incremental cost of Ordinance energy measure:	**$ 41,295 - 59,710**
	Avg = $50,503
Incremental cost in $/sq.ft.:	**$ 0.78 to $1.13/sq.ft.**
	Avg = $0.95 /sf

(A-15%) 52,900 sq.ft. (Reduction in 2008 T24 TDV Energy by 15%)

• R-38 w/ Cool Roof 10,580 sf @ $0.25 - $0.35/sf	$ 2,645 - 3,700
• 120 occupant sensors controlling (2) 2-lamp T8 fixtures; @$65.00 - $85.00 each	$ 7,800 - 10,200
• ¾" R-4.88 rigid insulation + R-19 metal frame walls 20,730 sf @ $1.75 – 2.25/sq.ft.	$ 36,280 - 46,645
Total incremental cost of Ordinance energy measure:	**$ 46,725 - 60,545**
	Avg = $53,635
Incremental cost in $/sq.ft.:	**$ 0.88 to $1.14/sq.ft.**
	Avg = $1.01 /sf

(A-20%) 52,900 sq.ft. (Reduction in 2008 T24 TDV Energy by 20%)

• R-30 w/ no cool roof, 10,580 sf @$0.43 – 0.60	($ 4,550 - 6,350)
• 120 occupant sensors controlling (2) 2-lamp T8 fixtures; @$65.00 - $85.00 each	$ 7,800 - 10,200
• ¾" R-4.88 rigid insulation + R-19 metal frame walls 20,730 sf @ $1.75 – 2.25/sq.ft.	$ 36,280 - 46,645
• (5) Trane 25 ton units, EER=11.0 @ $9,000 to $13,000 each w/ premium fan motors	$ 45,000 - 65,000
Total incremental cost of Ordinance energy measure:	**$ 84,530 - 115,495**
	Avg = $100,013
Incremental cost in $/sq.ft.:	**$ 1.60 to $2.18/sq.ft.**
	Avg = $1.89 /sf

CLIMATE ZONE #3 CASE STUDY

The following measures were first evaluated so that the building just meets the 2008 standards in climate zone #12 as follows:

Climate Zone #3: 21,160 SF 2-story building 2008 Title 24 Base Case, **37.1% Window Wall Ratio glazing** area:

(A) 21,160 SF 2-story office building which just meets Title 24:

- R-38 attic insulation, R-19 in metal frame exterior walls, slab-on-grade 1st floor;
- NFRC-rated Low-E windows: U-factor=0.50, SHGCc=0.38 (e.g., Viracon VE 1-2M) w/ no exterior shading
- Lighting = 0.867 w/sf: 248 2-lamp 4' T8 fixtures @ 62w each and 104 26w CFLs @ 26 w each; no lighting controls
- (4) 10-ton Packaged DX units: Carrier EER=11.0, 4,000 CFM; (4) 7.5-ton Packaged DX units: Carrier EER=11.0, 3,000 CFM; all standard efficiency fan motors
- Ducts in conditioned space, R-4.2 duct insulation
- Domestic hot water assumed to be standard gas water heater

Energy Measures Needed to Meet the 2008 Standards

The same building with the 2005 standards measures fails to meet the 2008 standards by a margin of 9%. To bring the building up to the 2008 standards, the following measures were changed.

21,160 sq.ft. (from 2005 Stds to 2008 Stds)

• U=0.50, SHGCc=0.38 (e.g., Viracon VE 1-2M) from SHGCc=0.54; 5,160 sf @$2.50 - 3.50/sq.ft.	$ 12,900 - 18,060
Total incremental cost of Ordinance energy measure:	**$ 12,900 - 18,060**
	Avg = $15,480
Incremental cost in $/sq.ft.:	**$ 0.61 to 0.85 /sq.ft.**
	Avg = $0.73 /sf

Energy Measures Needed to Exceed the 2008 Standards

The following energy features have been modified from the above Title 24 set of measures so that the proposed design uses less TDV energy than the 2008 standards. The added first cost of that measure compared with the equivalent 2008 Title 24 design measure is listed to the right, and the sum of all incremental costs is listed.

(A-10%) 21,160 sq.ft. (Reduction in 2008 T24 TDV Energy by 10%)

• U=0.50, SHGCc=0.31 (e.g., Viracon VE 2-2M) 5,160 sf @$2.00 - 3.00/sq.ft.	$ 10,320 - 15,480
• 248 2-lamp 4' T8 fixtures with high efficiency instant start ballasts and premium T8 lamps, 50 input watts @$25.00 - $30.00/fixture; Installed LPD=0.727	$ 5,800 - 6,960
Total incremental cost of Ordinance energy measure:	**$ 16,120 - 22,440**
	Avg = $19,280
Incremental cost in $/sq.ft.:	**$ 0.76 to $1.06/sq.ft.**
	Avg = $0.91 /sf

(A-15%) 21,160 sq.ft. (Reduction in 2008 T24 TDV Energy by 15%)

• U=0.50, SHGCc=0.31 (e.g., Viracon VE 2-2M) 5,160 sf @$2.00 - 3.00/sq.ft.	$ 10,320 - 15,480
• 248 2-lamp 4' T8 fixtures with high efficiency instant start ballasts and premium T8 lamps, 50 input watts @$25.00 - $30.00/fixture; Installed LPD=0.676	$ 5,800 - 6,960
• 64 (26% of) T8 fixtures on 32 occupant sensors, small offices: @$65.00 - $85.00 each	$ 2,080 - 2,720
• 24 more recessed CFL fixtures, all CFL fixtures w/ 18w lamps @$175 - $250 each	$ 4,200 - 6,000
• (8) Premium Efficiency supply fans, @$100 - $200 each	$ 800 - 1,600
• R-38 w/ Cool Roof 10,580 sf @ $1.75 - $2.35/sf includes R-10 (2") rigid insulation	$ 18,515 - 24,865
Total incremental cost of Ordinance energy measure:	**$ 41,715 - 57,625**
	Avg = $49,670
Incremental cost in $/sq.ft.:	**$ 1.97 to $2.72/sq.ft.**
	Avg = $2.35 /sf

(A-20%) 21,160 sq.ft. (Reduction in 2008 T24 TDV Energy by 20%)

• U=0.50, SHGCc=0.31 (e.g., Viracon VE 2-2M) 5,160 sf @$2.00 - 3.00/sq.ft.	$ 10,320 - 15,480
• 248 2-lamp 4' T8 fixtures with high efficiency instant start ballasts and premium T8 lamps, 50 input watts @$25.00 - $30.00/fixture; Installed LPD=0.676	$ 5,800 - 6,960
• 64 (26% of) T8 fixtures on 32 occupant sensors, small offices: @$65.00 - $85.00 each	$ 2,080 - 2,720
• 24 more recessed CFL fixtures, all CFL fixtures w/ 18w lamps @$175 - $250 each	$ 4,200 - 6,000
• (8) Premium Efficiency supply fans, @$100 - $200 each	$ 800 - 1,600
• (4) Global Energy Group 1400 Series 10-ton Packaged DX, EER = 13.4 @$2300 - $2900 each	$ 9,200 - 11,600
• (4) Global Energy Group 1400 Series 7.5-ton Packaged DX, EER = 13.0 @$1950 - $2450 each	$ 7,800 - 9,800
• R-6.5 rigid insulation + R-19 in metal stud walls, 8,752 sf @$1.50 - $2.00/sf	$ 13,130 - 17,505
• R-38 w/ Cool Roof 10,580 sf @ $1.75 - $2.35/sf includes R-10 (2") rigid insulation	$ 18,515 - 24,865
Total incremental cost of Ordinance energy measure:	**$ 71,845 - 96,530**
	Avg = $84,188
Incremental cost in $/sq.ft.:	**$ 3.40 to $4.56/sq.ft.**
	Avg = $3.98 /sf

(A-25%) 21,160 sq.ft. (Reduction in 2008 T24 TDV Energy by 25%)

• U=0.50, SHGCc=0.22 (e.g., Viracon VE 1-42M **) 5,160 sf @$3.50 - 4.50/sq.ft.	$ 18,060 - 23,220
• 248 2-lamp 4' T8 fixtures with high efficiency instant start ballasts and premium T8 lamps, 50 input watts @$25.00 - $30.00/fixture; Installed LPD=0.676	$ 5,800 - 6,960
• 64 (26% of) T8 fixtures on 32 occupant sensors, small offices: @$65.00 - $85.00 each	$ 2,080 - 2,720
• 24 more recessed CFL fixtures, all CFL fixtures w/ 18w lamps @$175 - $250 each	$ 4,200 - 6,000
• (8) Premium Efficiency supply fans, @$100 - $200 each	$ 800 - 1,600
• (4) Global Energy Group 1400 Series 10-ton Packaged DX, EER = 13.4 @$2300 - $2900 each	$ 9,200 - 11,600
• (4) Global Energy Group 1400 Series 7.5-ton Packaged DX, EER = 13.0 @$1950 - $2450 each	$ 7,800 - 9,800
• R-6.5 rigid insulation + R-19 in metal stud walls, 8,752 sf @$1.50 - $2.00/sf	$ 13,130 - 17,505
• R-38 w/ Cool Roof 10,580 sf @ $1.75 - $2.35/sf includes R-10 (2") rigid insulation	$ 18,515 - 24,865

Total incremental cost of Ordinance energy measure:	**$ 79,585 - 104,270** **Avg = $91,938**
Incremental cost in $/sq.ft.:	**$ 3.76 to $4.93/sq.ft.** **Avg = $4.34 /sf**

** *Note: This glass type has a low visible light transmittance (31%) which reduces the opportunity for manual control of lighting in response to daylight not accounted for in the Title 24 calculation.*

CLIMATE ZONE #12 CASE STUDY

The following measures were first evaluated so that the building just meets the 2008 standards in climate zone #12 as follows:

Climate Zone #12: 21,160 SF 2-story building 2008 Title 24 Base Case, **37.1% Window Wall Ratio glazing** area:

(A) 21,160 SF 2-story office building which just meets Title 24:

- R-38 roof w/ cool roof, R-19 in metal frame exterior walls, slab-on-grade 1st floor;
- NFRC-rated Low-E windows: U-factor=0.50, SHGCc=0.38 (e.g., Viracon VE 1-2M) w/ exterior shading on front 1st floor glazing
- Lighting = 0.839 w/sf: 240 2-lamp 4' T8 fixtures @ 62w each and 100 26w CFLs @ 26 w each; no lighting controls
- (4) 10-ton Packaged DX units: Carrier EER=11.0, 4,000 CFM; (4) 7.5-ton Packaged DX units: Carrier EER=11.0, 3,000 CFM; all standard efficiency fan motors
- Ducts in conditioned space, R-4.2 duct insulation
- Domestic hot water assumed to be standard gas water heater

Energy Measures Needed to Meet the 2008 Standards

The same building with the 2005 standards measures fails to meet the 2008 standards by a margin of 22%. To bring the building up to the 2008 standards, the following measures were changed.

21,160 sq.ft. (from 2005 Stds to 2008 Stds)

• U=0.50, SHGCc=0.38 (e.g., Viracon VE 1-2M) from generic dual Low-E glazing; 5,160 sf @$5.00 - 7.00/sq.ft.	$ 25,800 - 36,120
Total incremental cost of Ordinance energy measure:	**$ 25,800 - 36,120** **Avg = $30,960**
Incremental cost in $/sq.ft.:	**$ 1.22 to 1.71 /sq.ft.** **Avg = $1.46 /sf**

Energy Measures Needed to Exceed the 2008 Standards

The following energy features have been modified from the above Title 24 set of measures so that the proposed design uses less TDV energy than the 2008 standards. The added first cost of that measure compared with the equivalent 2008 Title 24 design measure is listed to the right, and the sum of all incremental costs is listed.

(A-10%) 21,160 sq.ft. (Reduction in 2008 T24 TDV Energy by 10%)

• U=0.50, SHGCc=0.31 (e.g., Viracon VE 2-2M) 5,160 sf @$2.00 - 3.00/sq.ft.	$ 10,320 - 15,480
• 8 NEMA Premium fan motors on supply fans	$ 600 - 1,000
• 240 2-lamp 4' T8 fixtures with high efficiency instant start ballasts and premium T8 lamps, 50 input watts @$25.00 - $30.00/fixture; Installed LPD=0.703	$ 6,000 - 7,200
Total incremental cost of Ordinance energy measure:	**$ 16,920 - 23,440**
	Avg = $20,180
Incremental cost in $/sq.ft.:	**$ 0.80 to $1.11/sq.ft.**
	Avg = $0.95 /sf

(A-15%) 21,160 sq.ft. (Reduction in 2008 T24 TDV Energy by 15%)

• U=0.50, SHGCc=0.31 (e.g., Viracon VE 2-2M) 5,160 sf @$2.00 - 3.00/sq.ft.	$ 10,320 - 15,480
• 240 2-lamp 4' T8 fixtures with high efficiency instant start ballasts and premium T8 lamps, 50 input watts @$25.00 - $30.00/fixture; Installed LPD=0.676	$ 6,000 - 7,200
• 72 (30% of) T8 fixtures on 36 occupant sensors, small offices: @$65.00 - $85.00 each	$ 2,340 - 3,060
• 20 more recessed CFL fixtures, all CFL fixtures w/ 18w lamps @$175 - $250 each	$ 3,500 - 5,000
• 8 NEMA Premium fan motors on supply fans	$ 600 - 1,000
• ¾" R-4.88 rigid insulation + R-19 in metal stud walls, 8,752 sf @$1.75 - $2.25/sf	$ 15,315 - 19,690
Total incremental cost of Ordinance energy measure:	**$ 38,075 - 51,430**
	Avg = $44,753
Incremental cost in $/sq.ft.:	**$ 1.80 to $2.43/sq.ft.**
	Avg = $2.11/sf

(A-20%) 21,160 sq.ft. (Reduction in 2008 T24 TDV Energy by 20%)

• R-30 w/ no cool roof, 10,580 sf @$0.43 – 0.60	($ 4,550 - 6,350)
• U=0.50, SHGCc=0.31 (e.g., Viracon VE 2-2M) 5,160 sf @$2.00 - 3.00/sq.ft.	$ 10,320 - 15,480
• 240 2-lamp 4' T8 fixtures with high efficiency instant start ballasts and premium T8 lamps, 50 input watts @$25.00 - $30.00/fixture; Installed LPD=0.676	$ 6,000 - 7,200
• 72 (30% of) T8 fixtures on 36 occupant sensors, small offices: @$65.00 - $85.00 each	$ 2,340 - 3,060

• 20 more recessed CFL fixtures, all CFL fixtures w/ 18w lamps @$175 - $250 each	$ 3,500 - 5,000
• (4) Global Energy Group 1400 Series 10-ton Packaged DX, EER = 13.4 @$2300 - $2900 each	$ 9,200 - 11,600
• (4) Global Energy Group 1400 Series 7.5-ton Packaged DX, EER = 13.0 @$1950 - $2450 each	$ 7,800 - 9,800
• ¾" R-4.88 rigid insulation + R-19 in metal stud walls, 8,752 sf @$1.75 - $2.25/sf	$ 15,315 - 19,690
Total incremental cost of Ordinance energy measure:	**$ 49,925 - 60,480** **Avg = $55,203**
Incremental cost in $/sq.ft.:	**$ 2.36 to $2.86/sq.ft.** **Avg = $2.61 /sf**

(A-25%) 21,160 sq.ft. (Reduction in 2008 T24 TDV Energy by 25%)

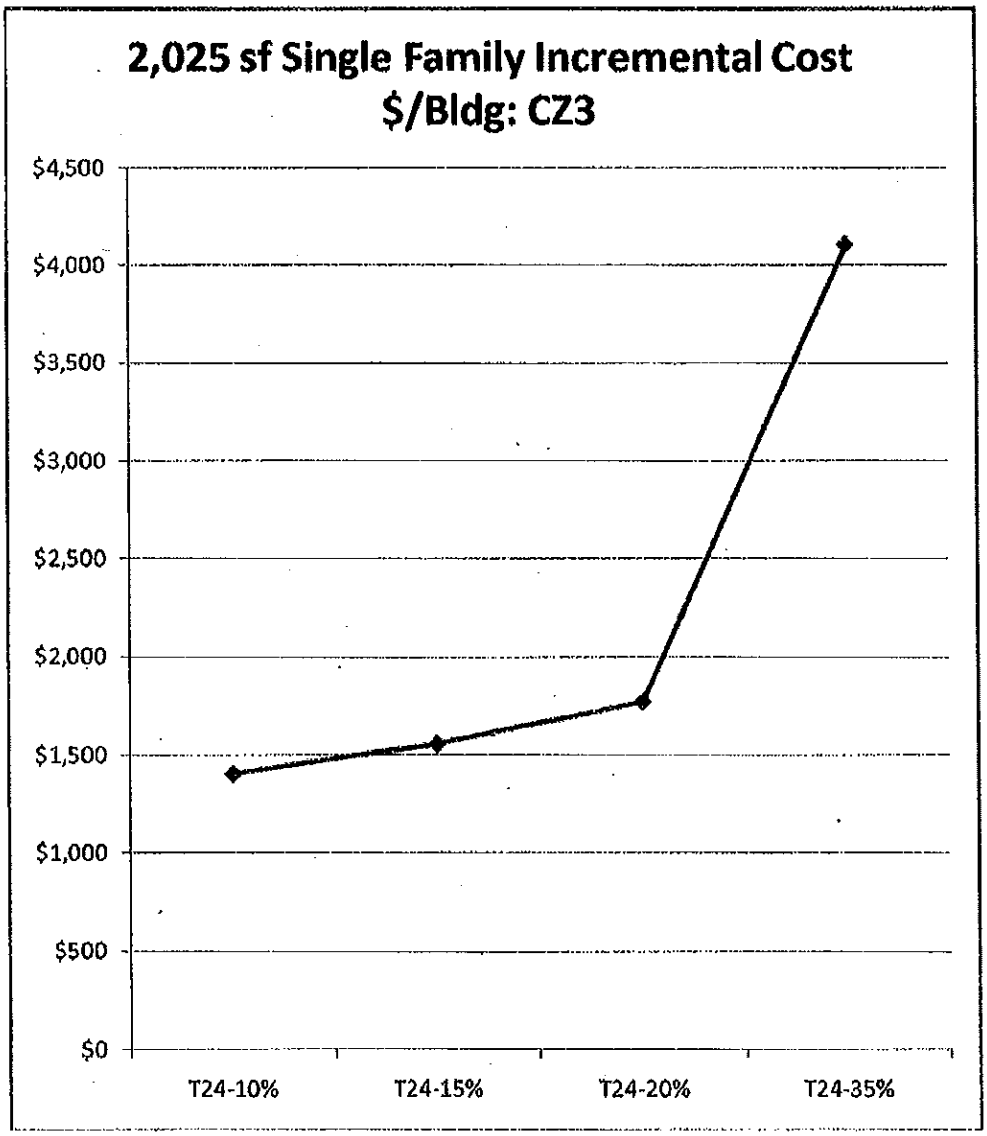
• U=0.50, SHGCc=0.22 (e.g., Viracon VE 1-42M **) 5,160 sf @$3.50 - 4.50/sq.ft.	$ 18,060 - 23,220
• 240 2-lamp 4' T8 fixtures with high efficiency instant start ballasts and premium T8 lamps, 50 input watts @$25.00 - $30.00/fixture; Installed LPD=0.676	$ 6,000 - 7,200
• 72 (30% of) T8 fixtures on 36 occupant sensors, small offices @$65.00 - $85.00 each	$ 2,340 - 3,060
• 20 more recessed CFL fixtures, all CFL fixtures w/ 18w lamps @$175 - $250 each	$ 3,500 - 5,000
• (4) Global Energy Group 1400 Series 10-ton Packaged DX, EER = 13.4 @$2300 - $2900 each	$ 9,200 - 11,600
• (4) Global Energy Group 1400 Series 7.5-ton Packaged DX, EER = 13.0 @$1950 - $2450 each	$ 7,800 - 9,800
• 1 ½" R-4.88 rigid insulation + R-19 in metal stud walls, 8,752 sf @$3.00 - $3.50/sf	$ 26,255 - 30,630
Total incremental cost of Ordinance energy measure:	**$ 73,155 - 90,510** **Avg = $82,333**
Incremental cost in $/sq.ft.:	**$ 3.46 to $4.28/sq.ft.** **Avg = $3.89 /sf**

** *Note: This glass type has a low visible light transmittance (31%) which reduces the opportunity for manual control of lighting in response to daylight not accounted for in the Title 24 calculation.*

4.0 Cost Effectiveness Graphs

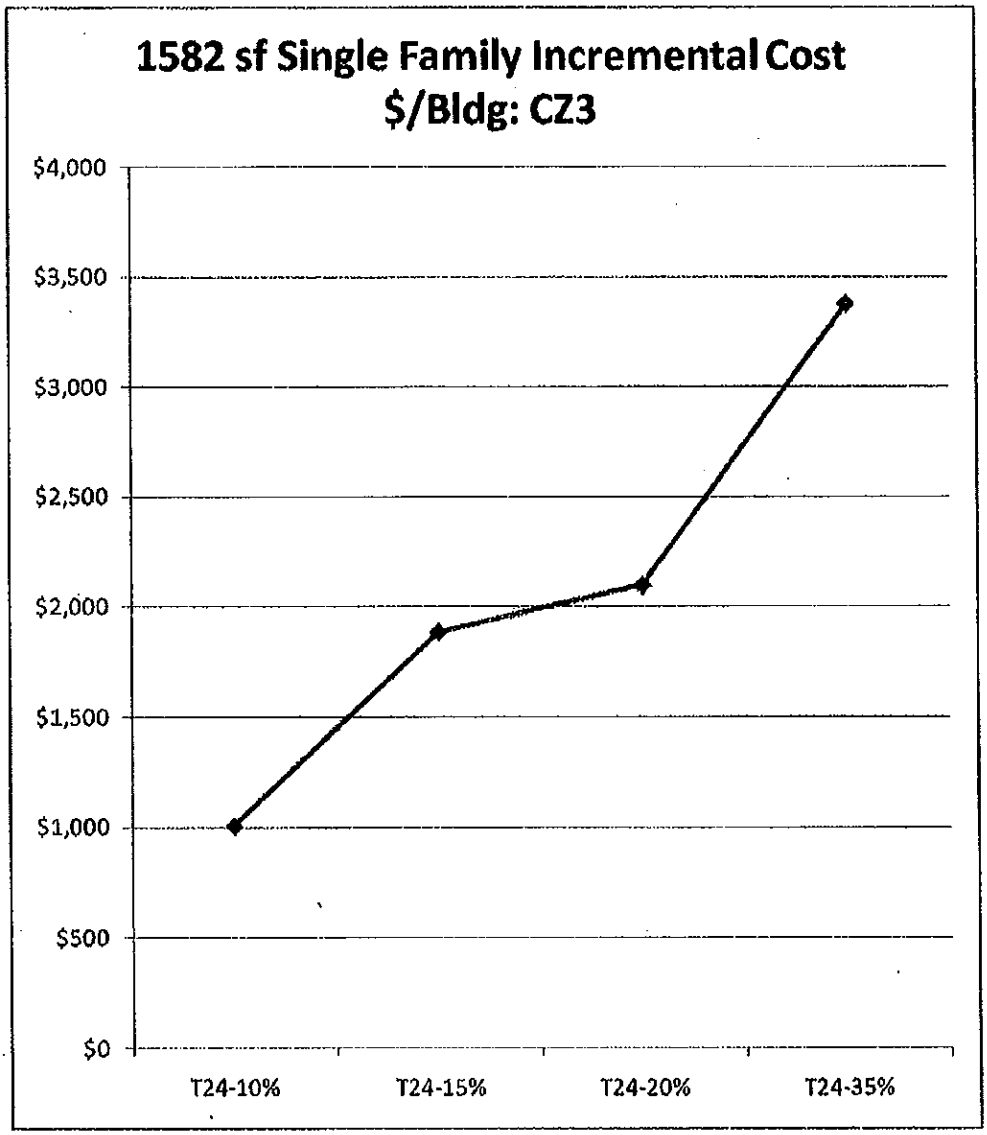
4.1 CLIMATE ZONE #3 CHARTS ILLUSTRATING RESULTS

Figure 4-CZ3a-1: Added First Cost – 2,025 sf 2-Story Single Family Home



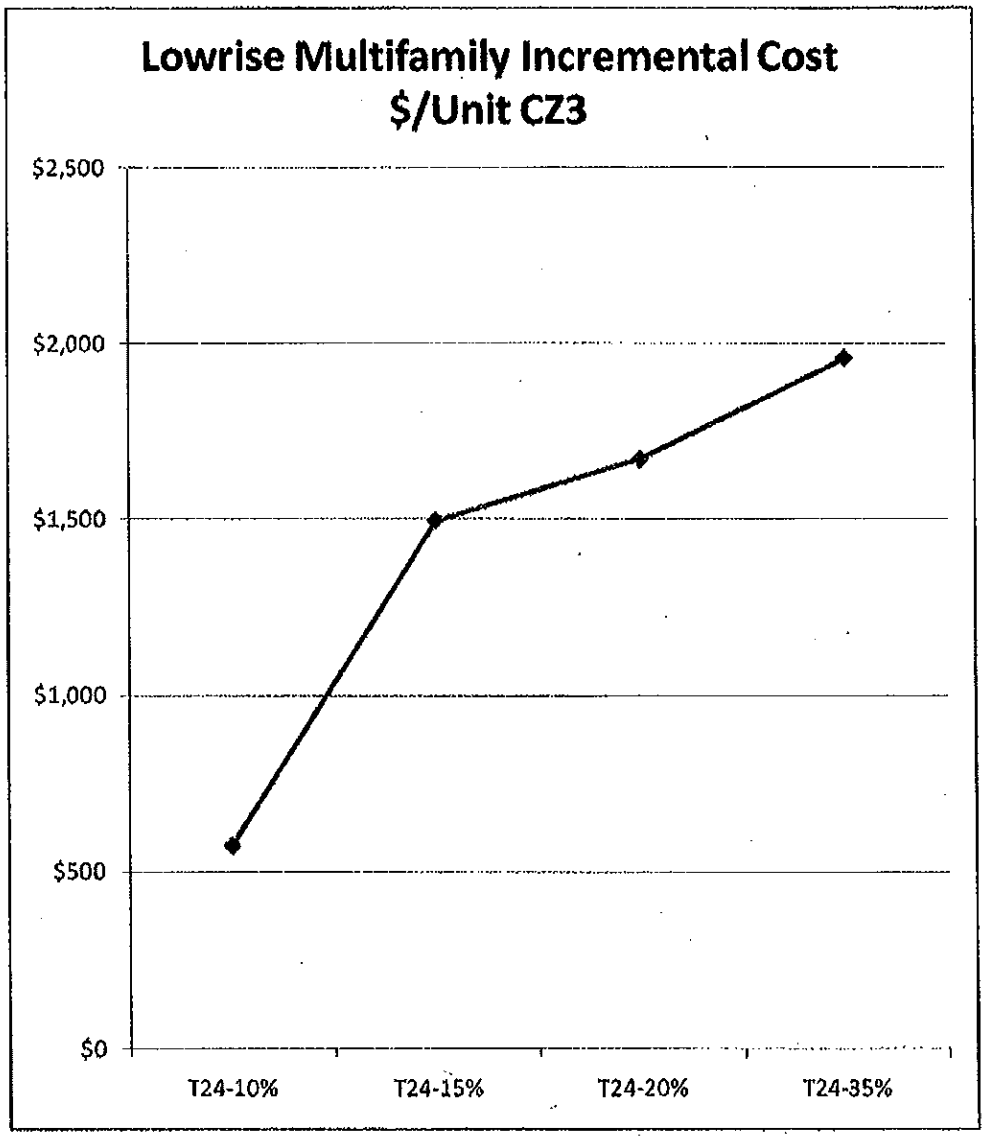
The average incremental energy measures to go from the 2005 standards to the 2008 standards cost $733 in this single family house design.

Figure 4-CZ3a-2: Added First Cost – 1,582 sf 1-Story Single Family Home



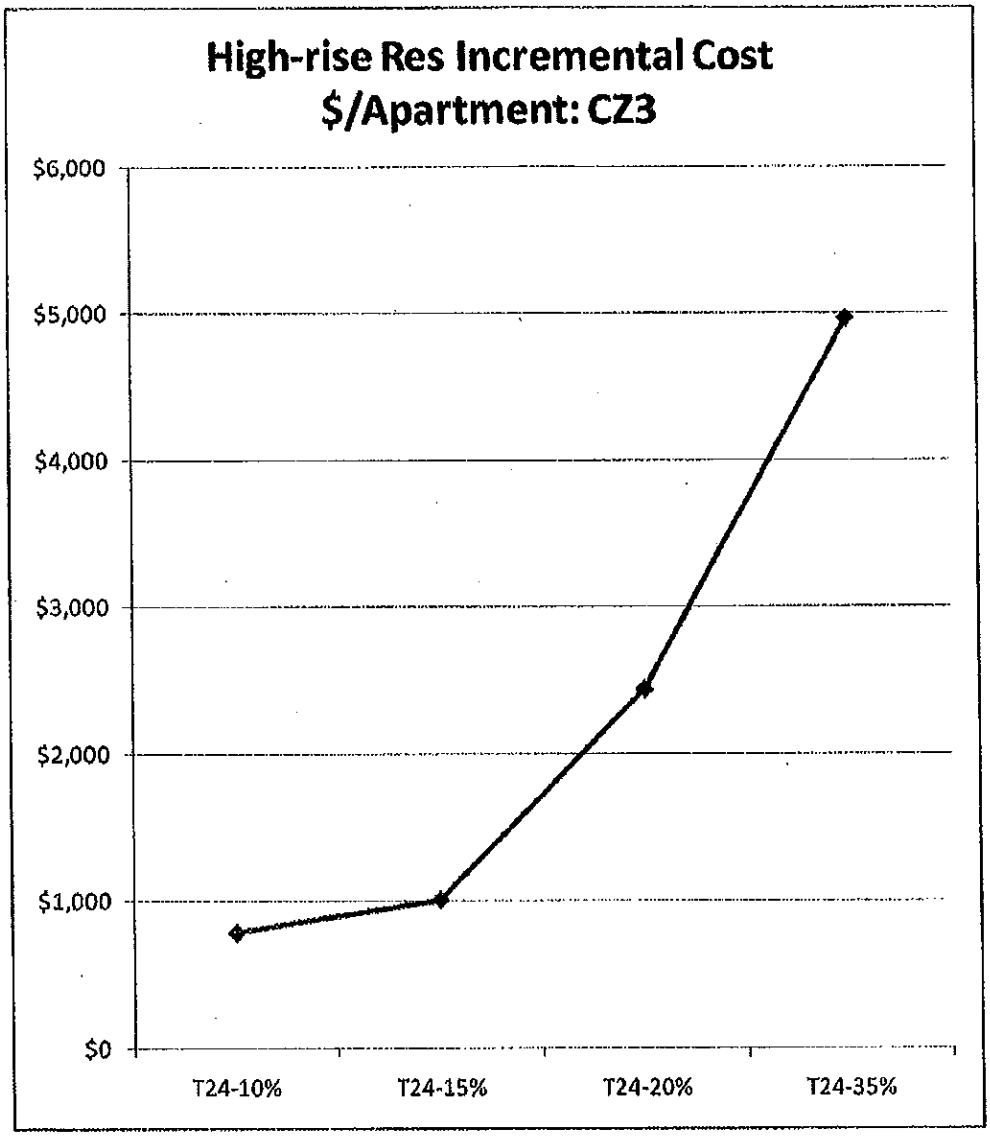
The average incremental energy measures to go from the 2005 standards to the 2008 standards cost $238 in this single family house design.

Figure 4-CZ3a-3: Added First Cost/Dwelling Unit, 2-Story Multifamily Building



The average incremental energy measures to go from the 2005 standards to the 2008 standards cost $150 per dwelling unit in this multifamily building design.

Figure 4-CZ3a-4: Added First Cost – 40 Unit, 5-Story High-rise Residential Building



The average incremental energy measures to go from the 2005 standards to the 2008 standards cost $0 per dwelling unit in this high-rise residential building design.
(No changes in the building design were required to meet the 2008 standards.)

Figure 4-CZ3a-5: Added First Cost – 21,160 sf 2-Story Nonresidential Building

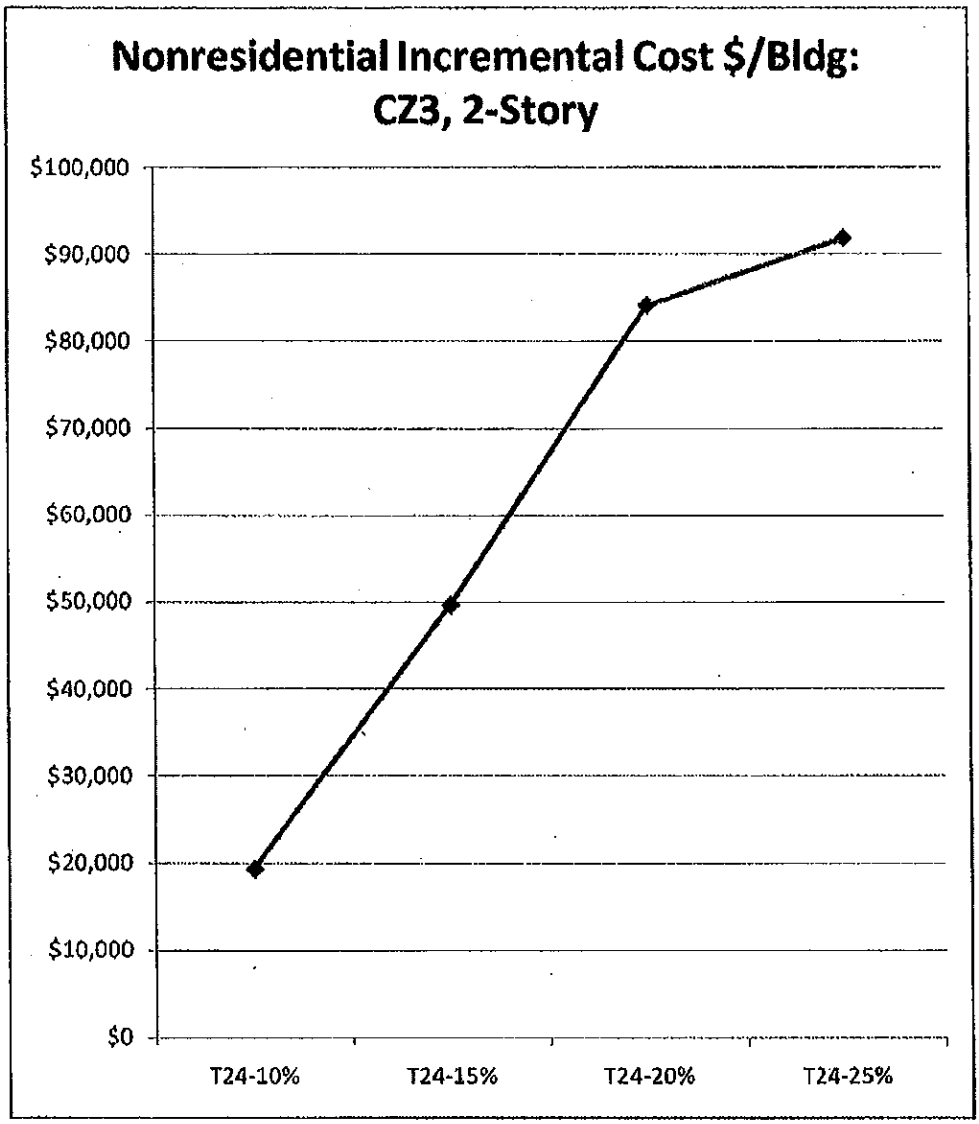


Figure 4-CZ3a-6: Added First Cost – 52,900 sf 5-Story Nonresidential Building

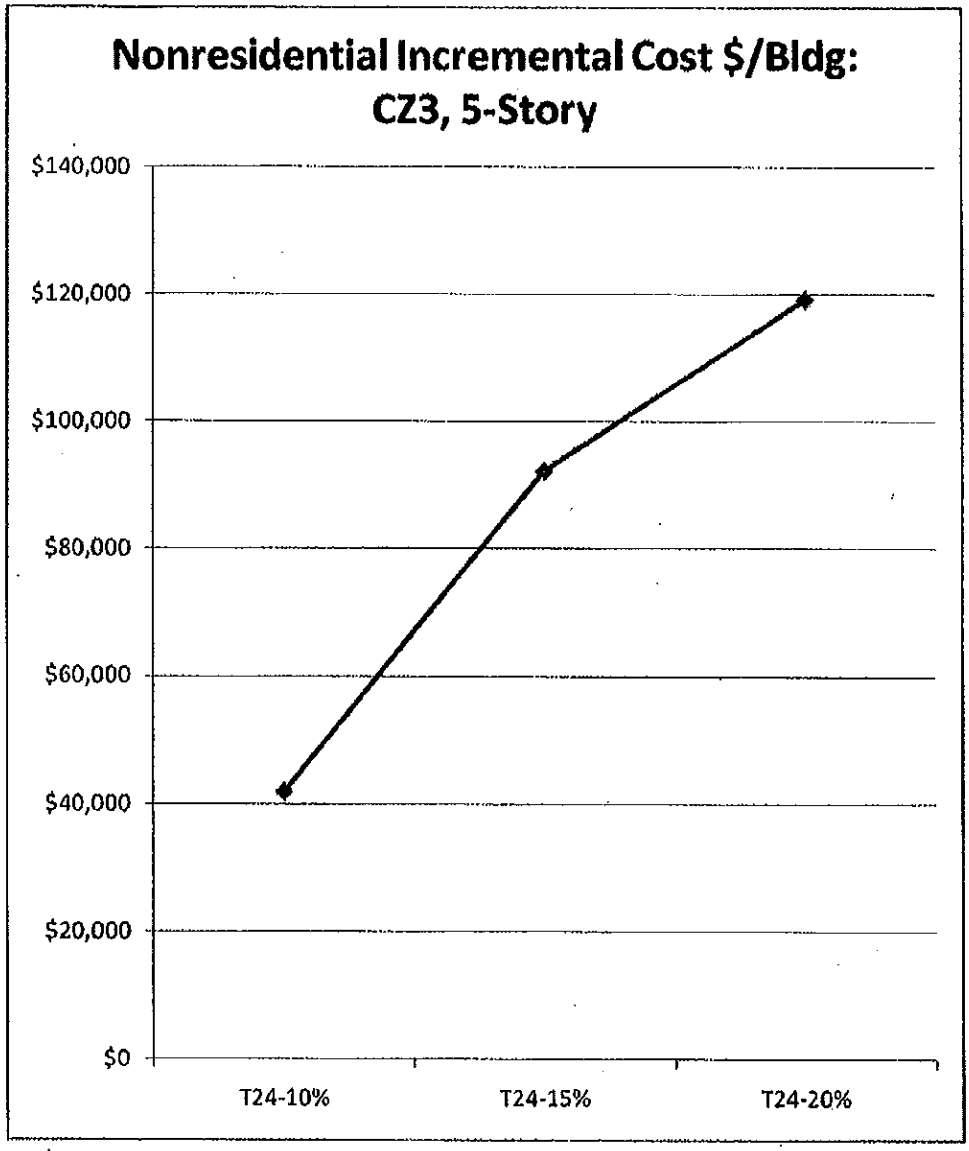


Figure 4-CZ3b-1: Added First Cost/Sq.Ft., – 2,025 sf 2-Story Single Family Home

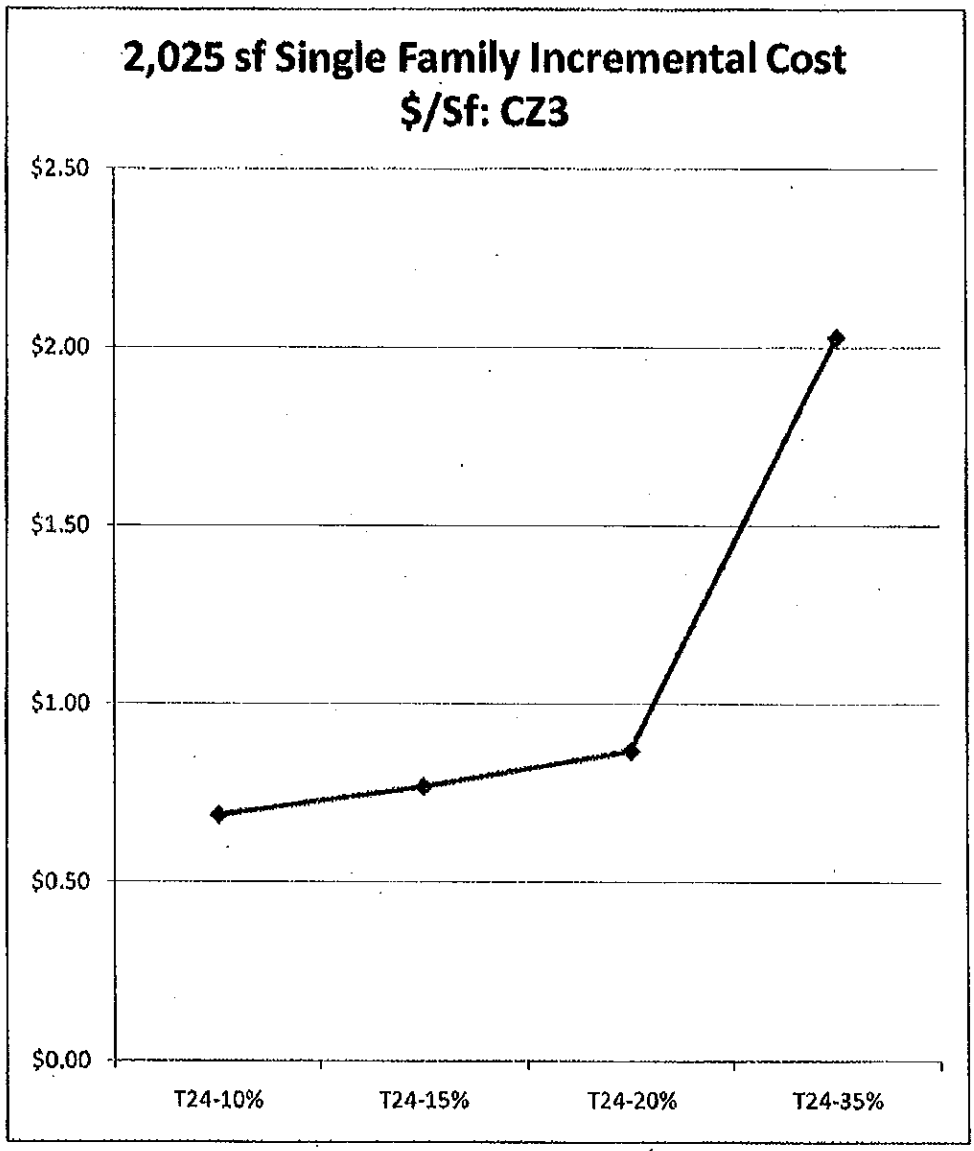


Figure 4-CZ3b-2: Added First Cost/Sq.Ft., – 1,582 sf 1-Story Single Family Home

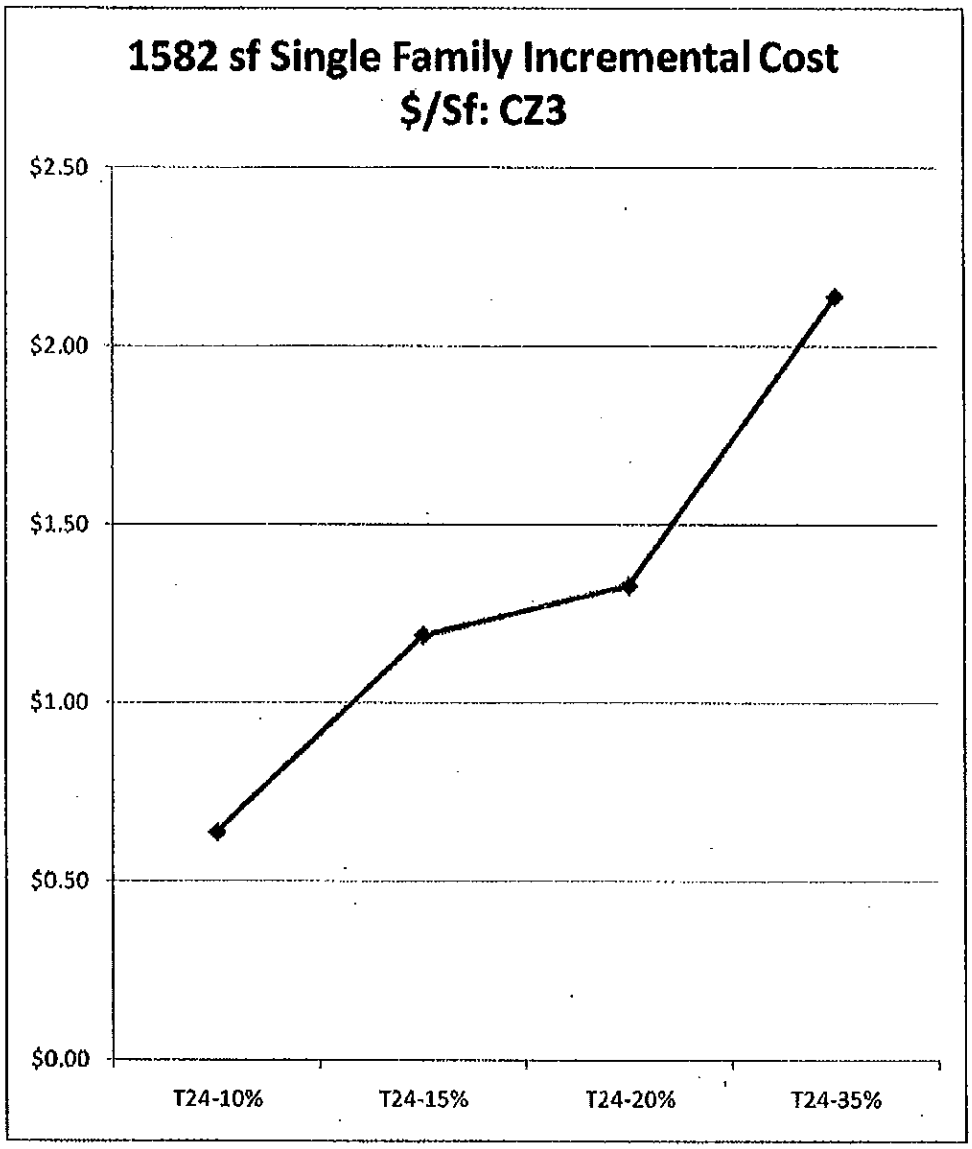


Figure 4-CZ3b-3: Added First Cost/Sq.Ft, 2-Story Multifamily Building

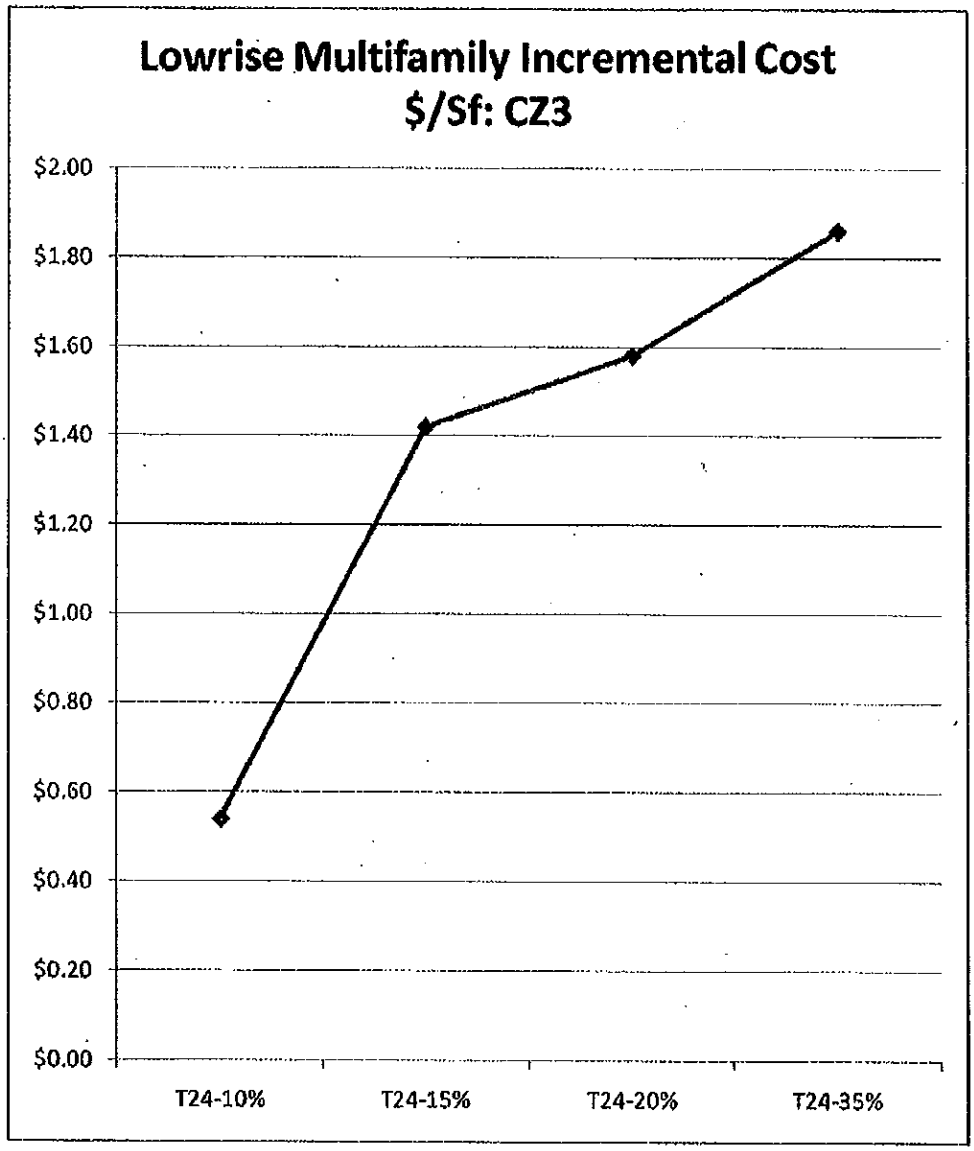
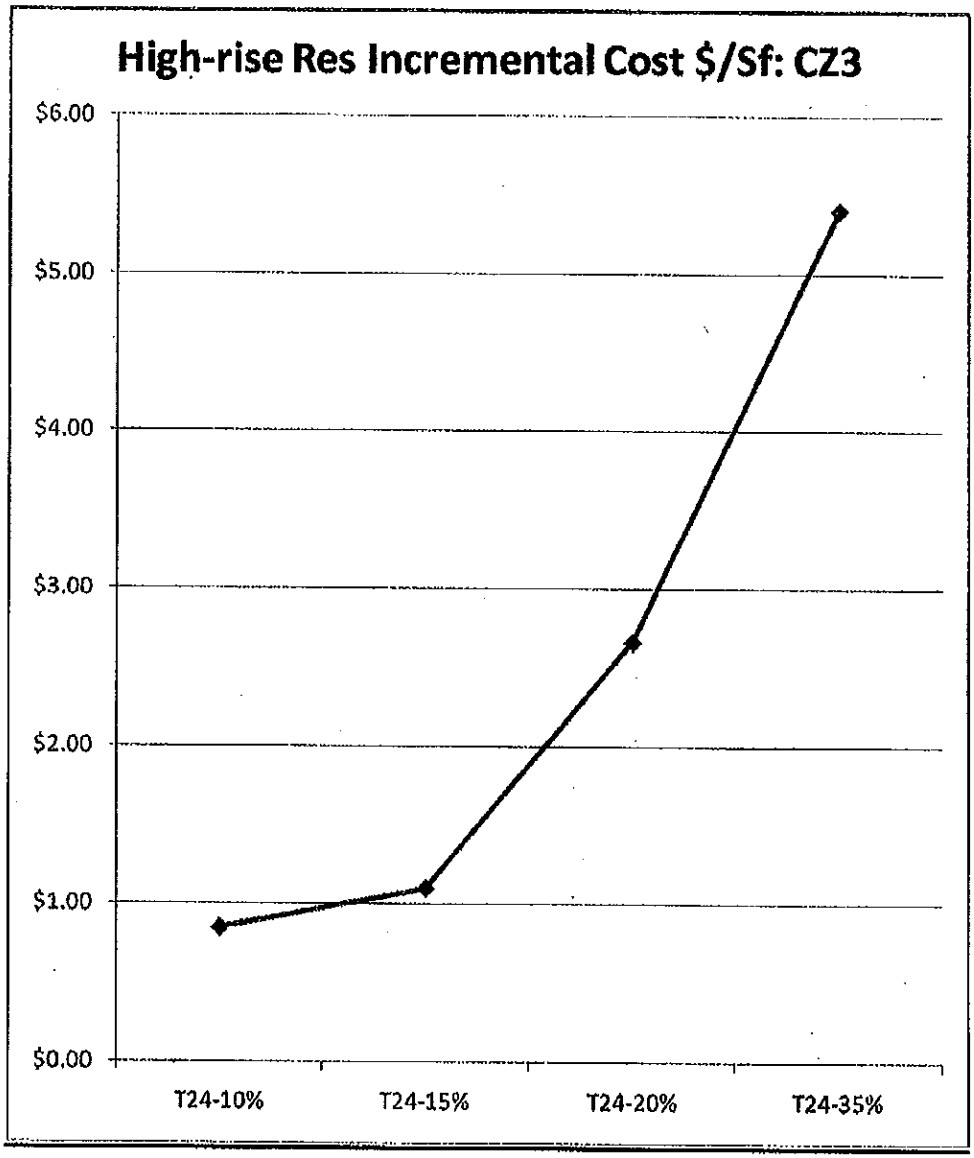


Figure 4-CZ3b-4: Added First Cost/Sq.Ft
– 40 Unit, 5-Story High-rise Residential Building



The average incremental energy measures to go from the 2005 standards to the 2008 standards cost $0 per square foot in this high-rise residential building design.
(No changes in the building design were required to meet the 2008 standards.)

Figure 4-CZ3b-5: Added First Cost/Sq.Ft., 21,160 sf 2-Story Nonresidential Building

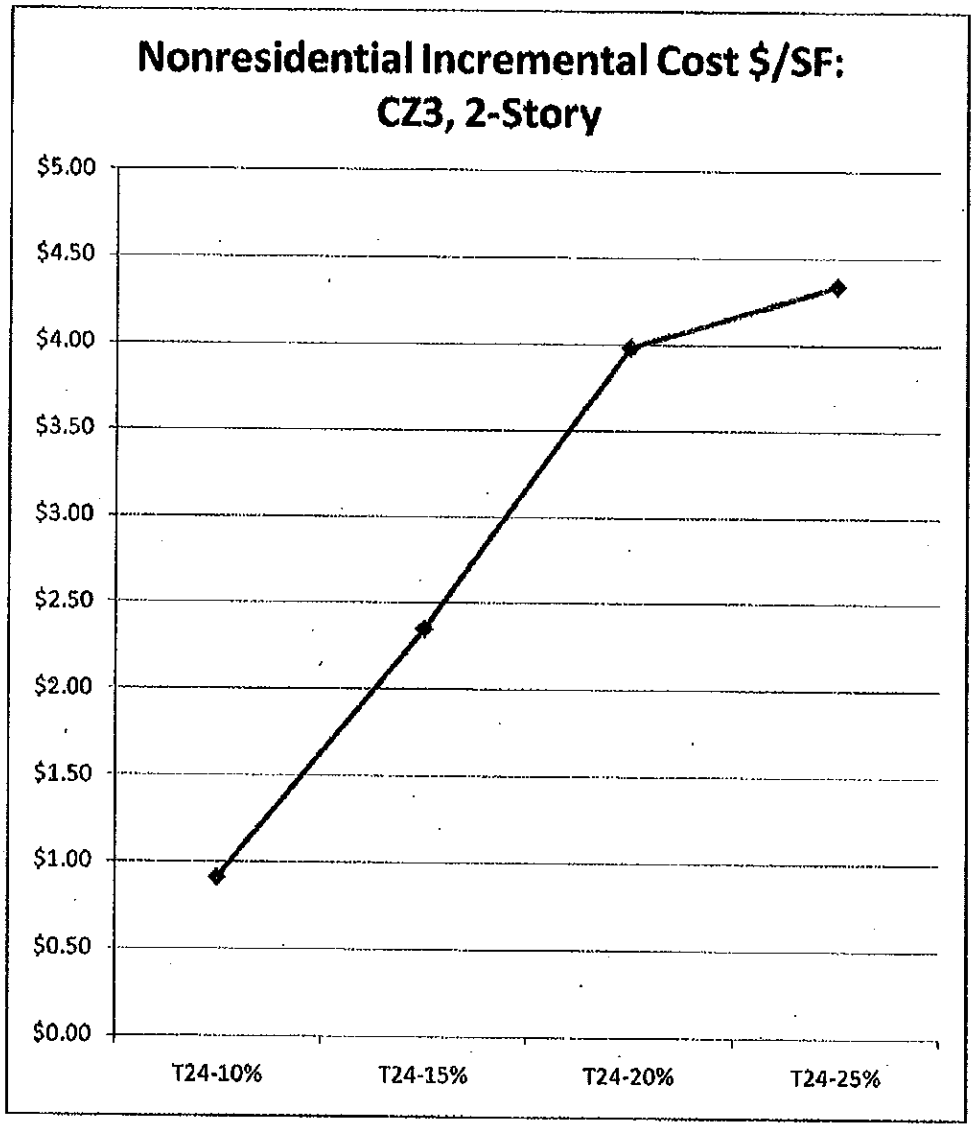


Figure 4-CZ3b-6: Added First Cost/Sq.Ft., 52,900 sf 5-Story Nonresidential Building

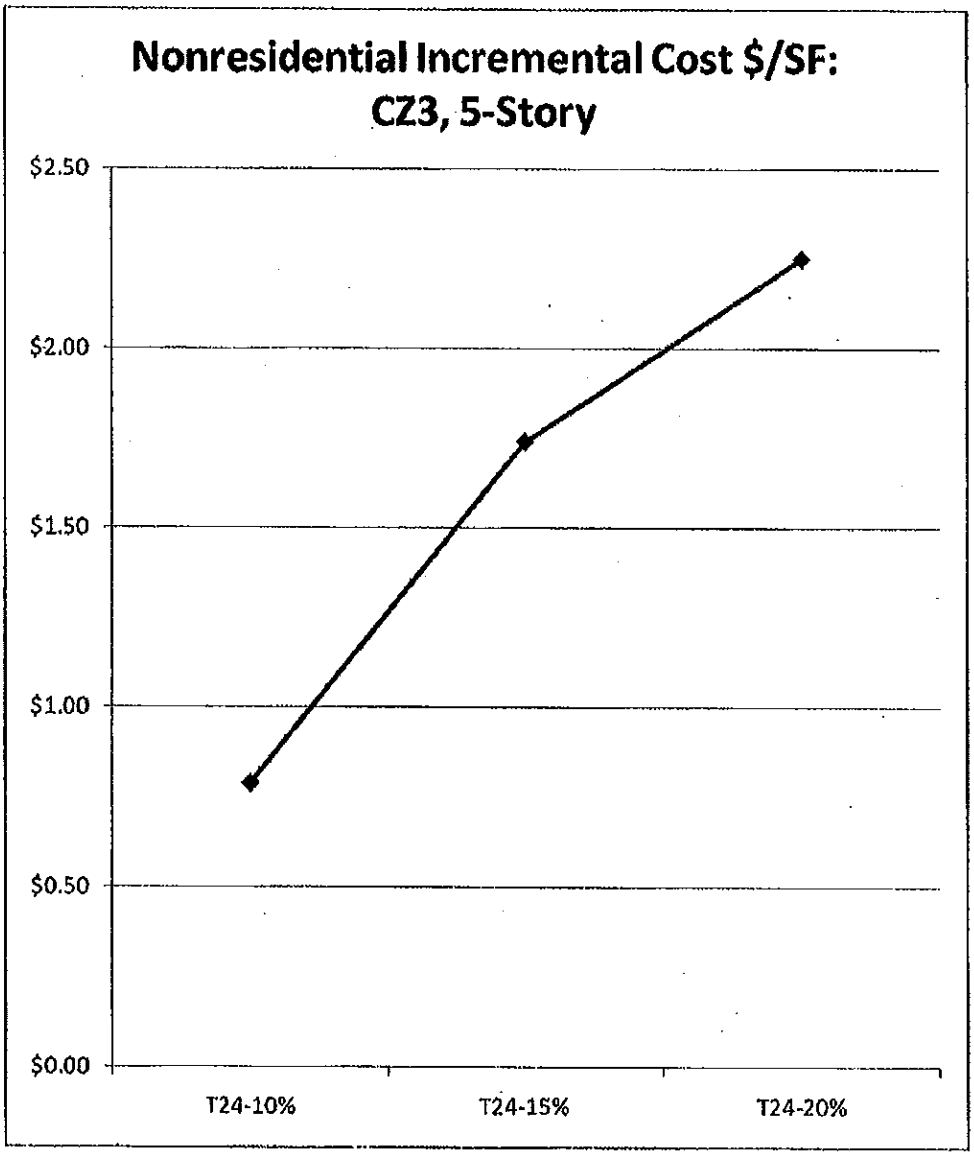


Figure 4-CZ3c-1: Simple Payback of Different Tiers of Energy Measures – 2,025 sf 2-Story Single Family Home

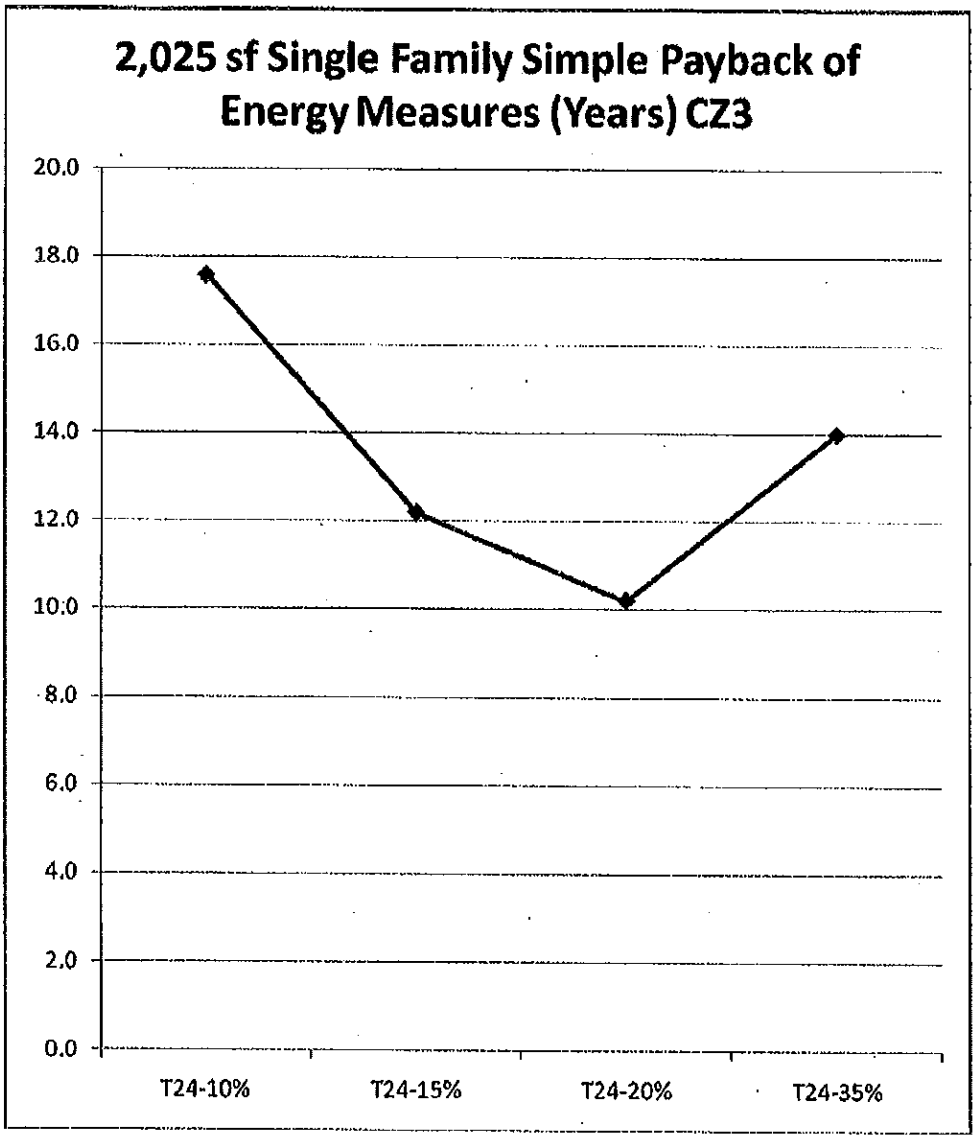


Figure 4-CZ3c-2: Simple Payback of Different Tiers of Energy Measures – 1,582 sf 1-Story Single Family Home

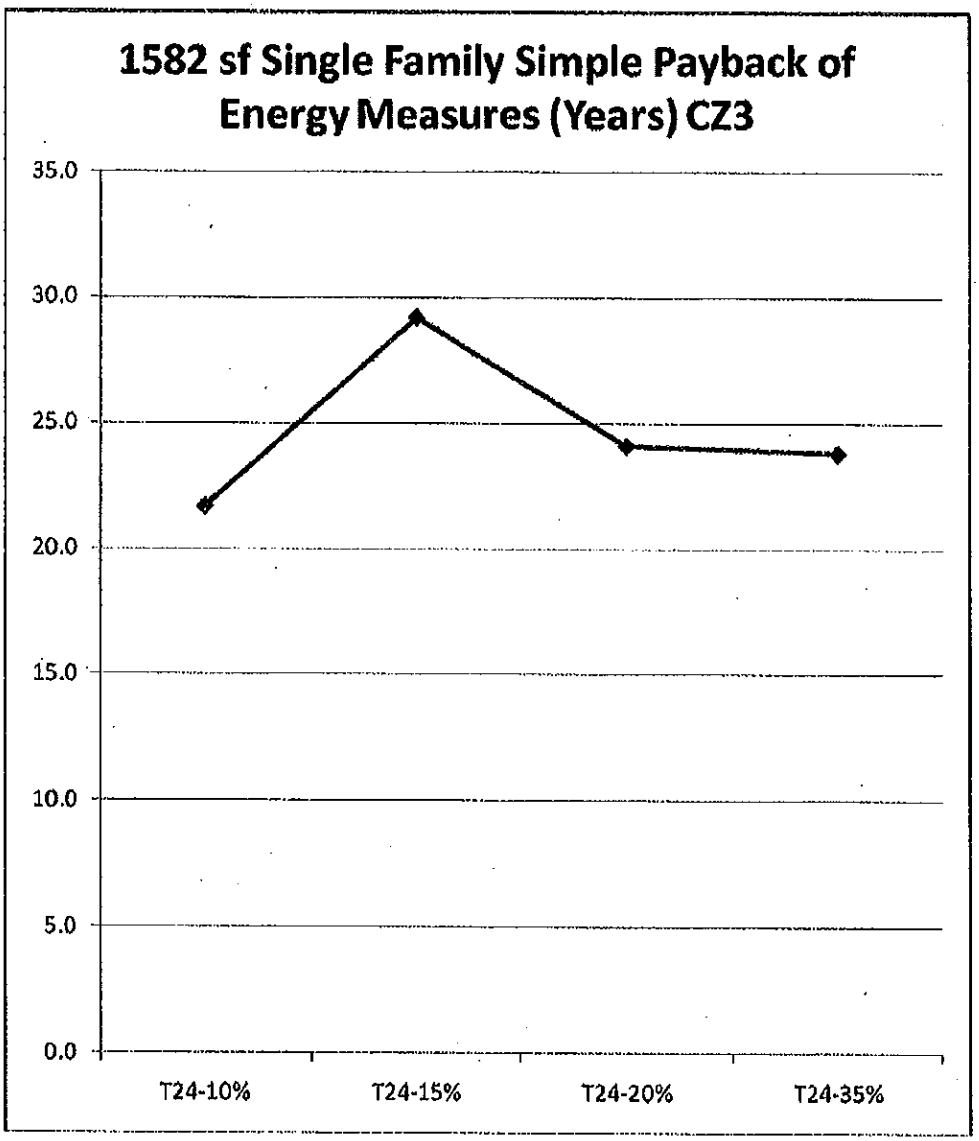


Figure 4-CZ3c-3: Simple Payback of Different Tiers of Energy Measures, 2-Story Multifamily Building

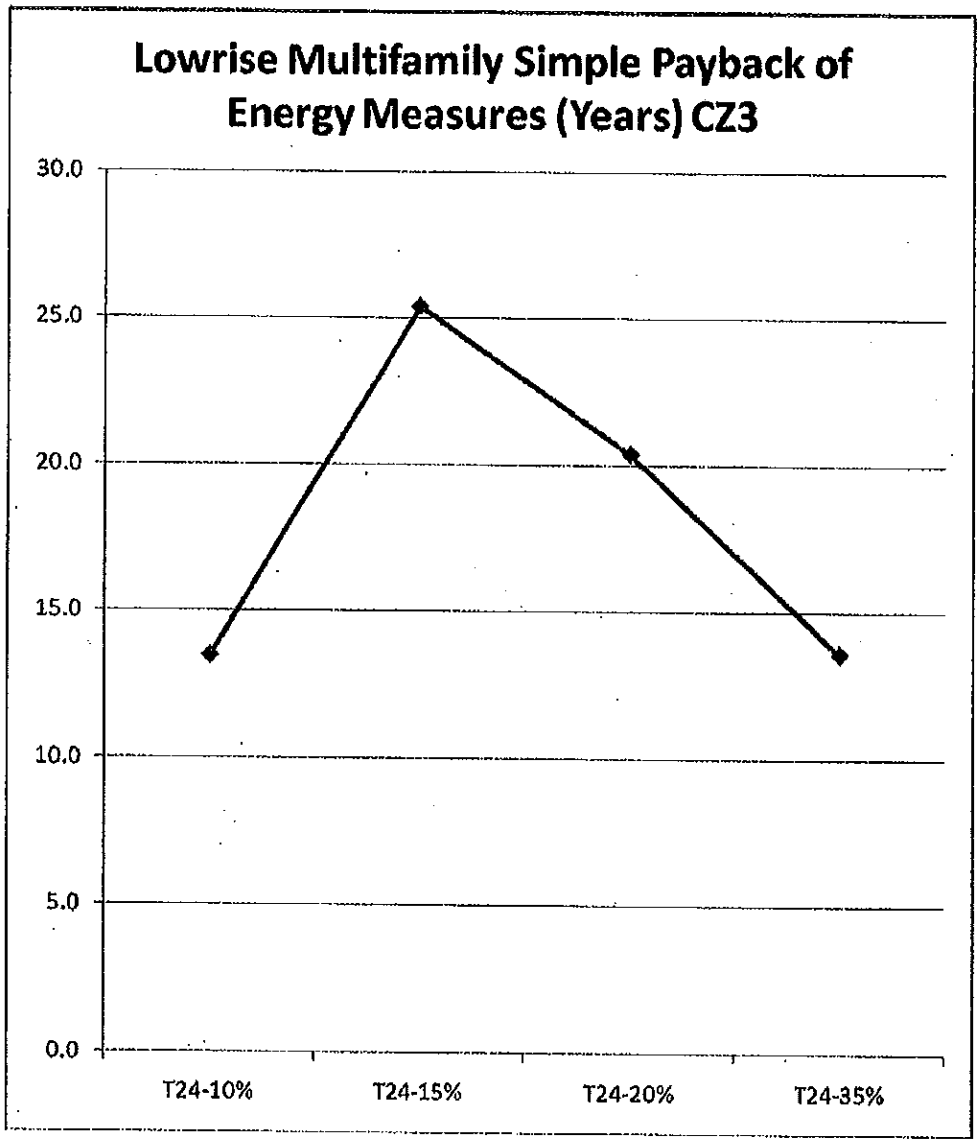


Figure 4-CZ3c-4: Simple Payback of Different Tiers of Energy Measures – 40 Unit, 5-Story High-rise Residential Building

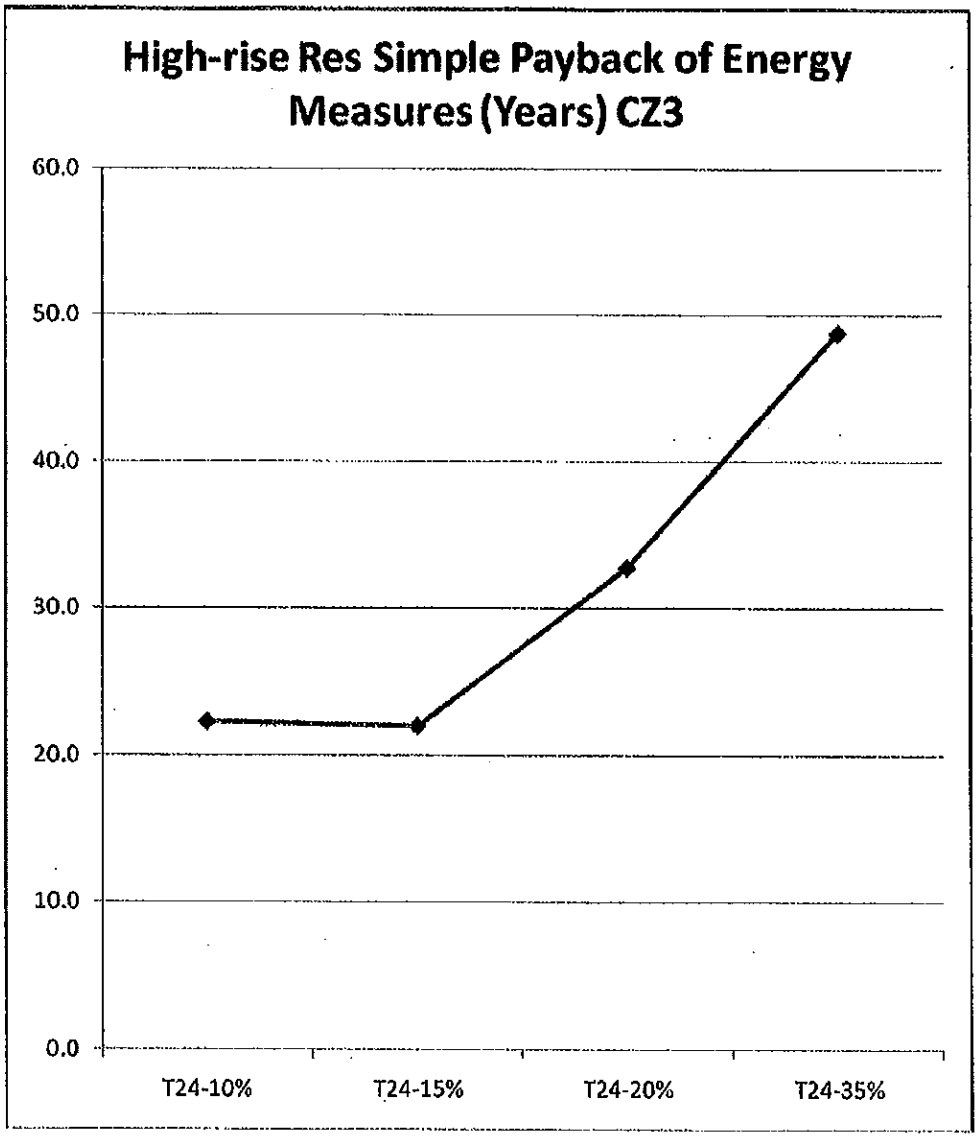


Figure 4-CZ3c-5: Simple Payback of Different Tiers of Energy Measures – 21,160 sf 2-Story Nonresidential Building

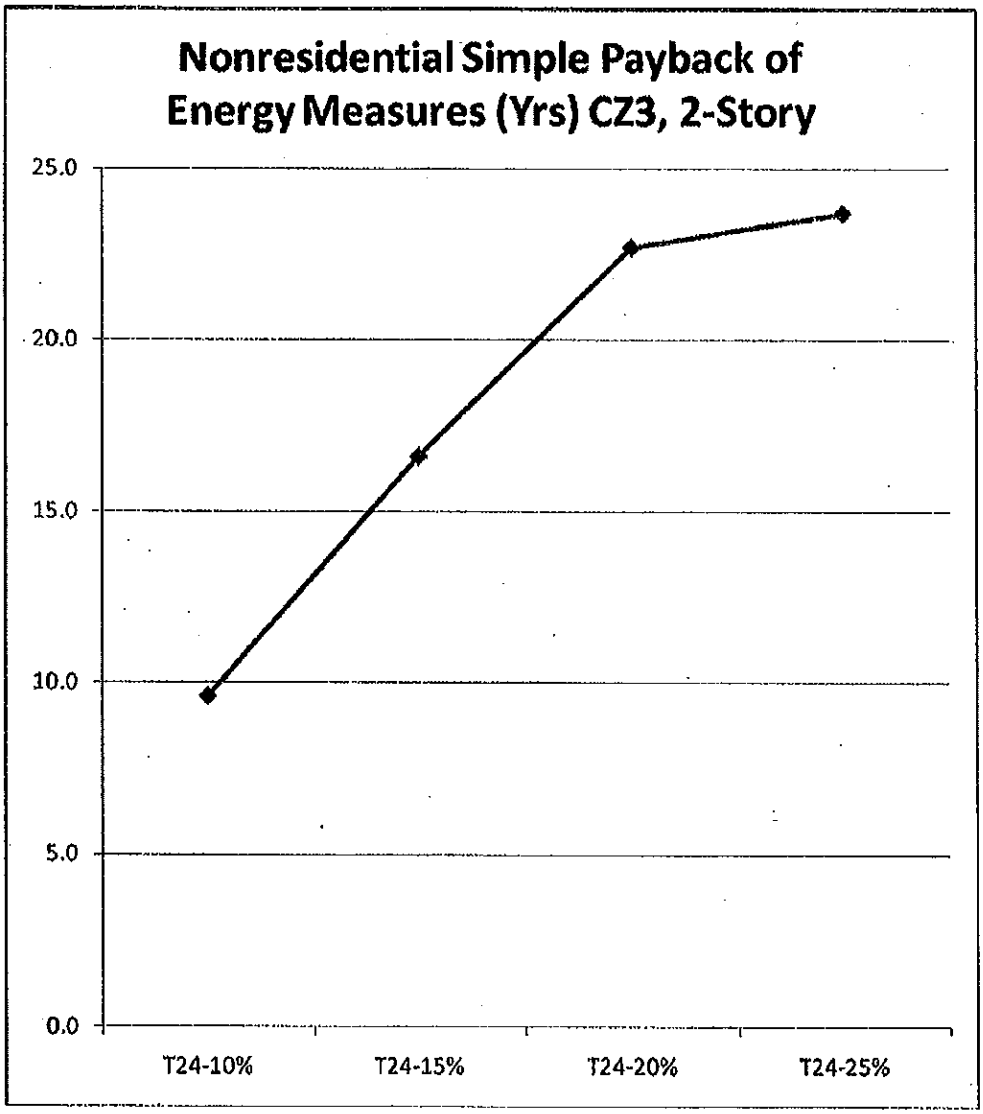


Figure 4-CZ3c-6: Simple Payback of Different Tiers of Energy Measures – 52,900 sf 5-Story Nonresidential Building

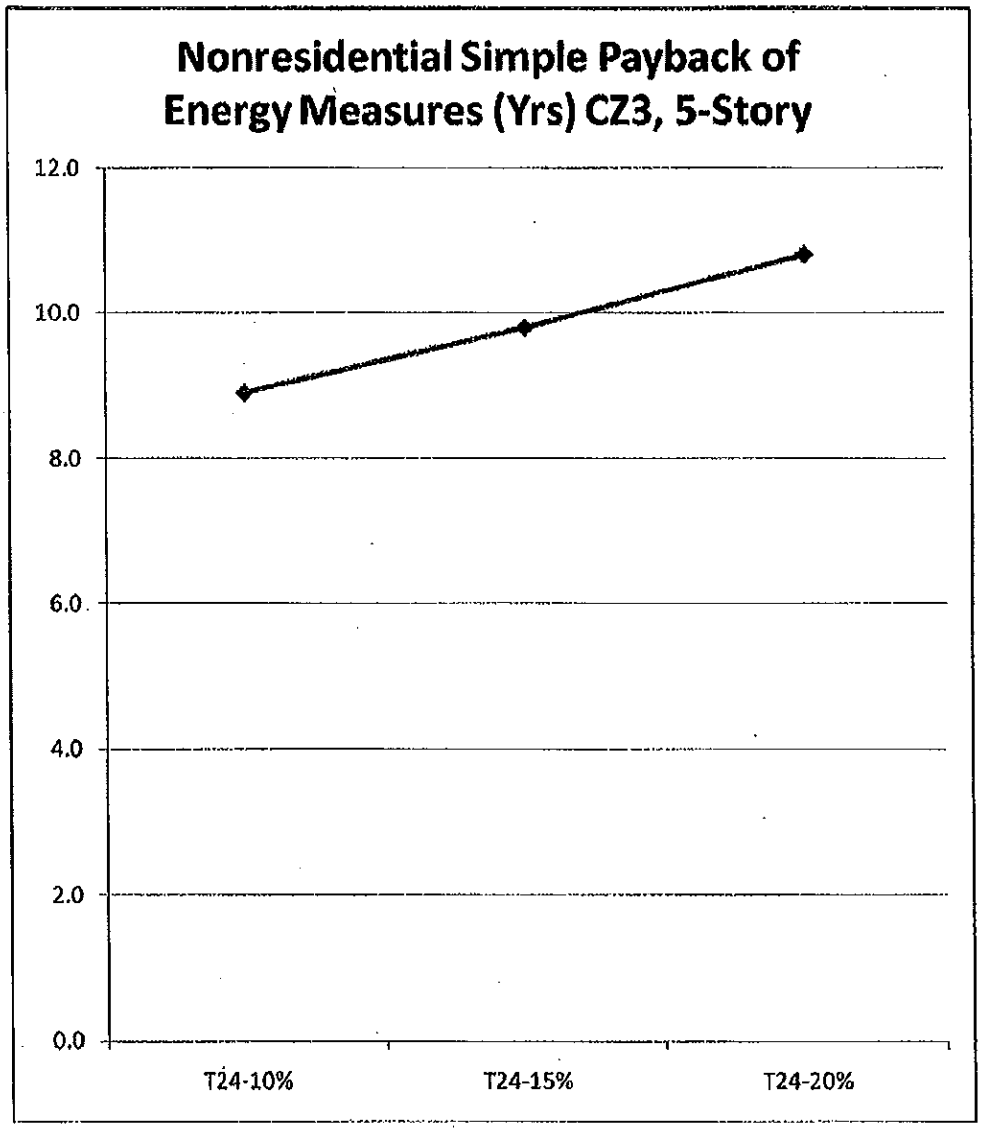


Figure 4-CZ3d-1: Added Cost/Sq.ft. per Lb. of CO2 Reduction – 2,025 sf 2-Story Single Family Home

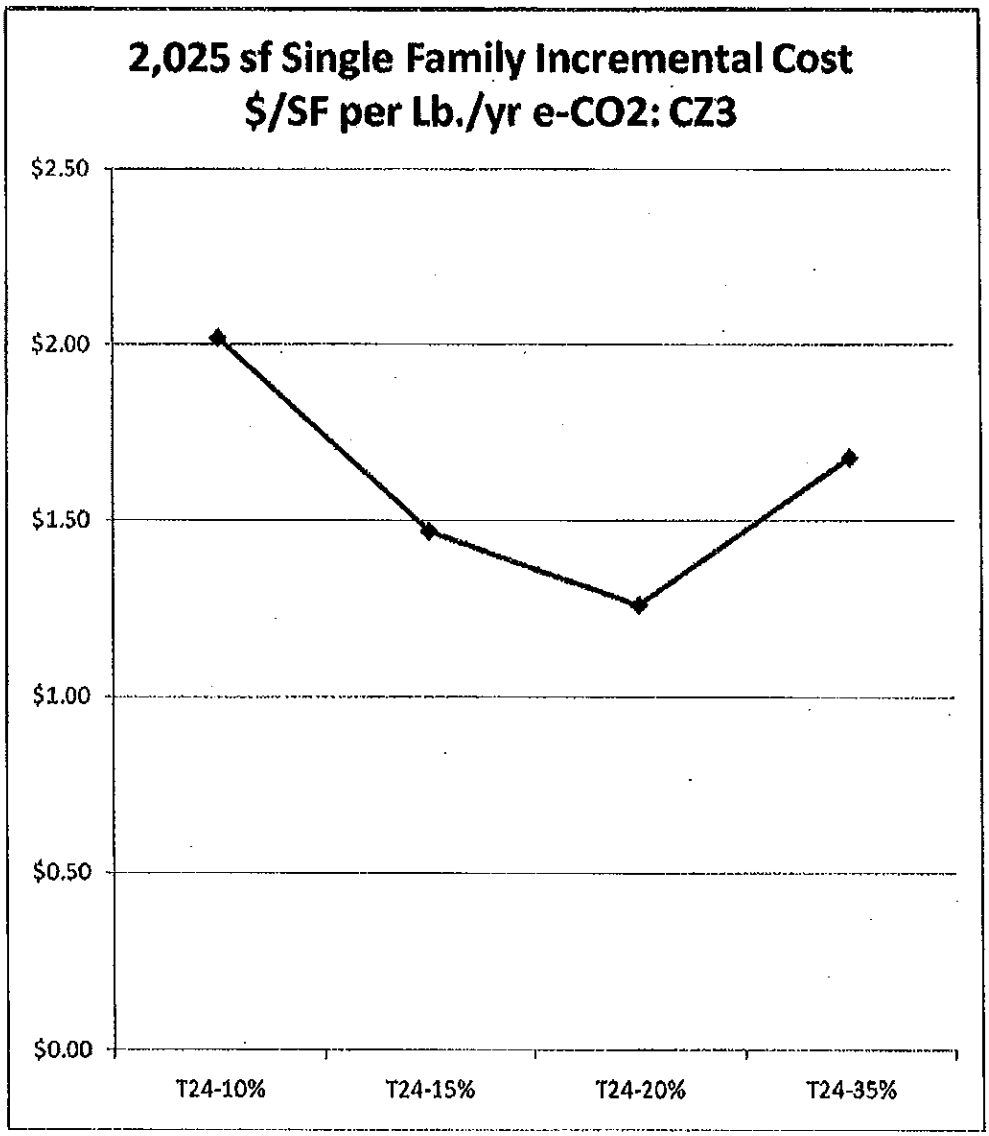


Figure 4-CZ3d-2: Added Cost/Sq.ft. per Lb. of CO2 Reduction – 1,582 sf 1-Story Single Family Home

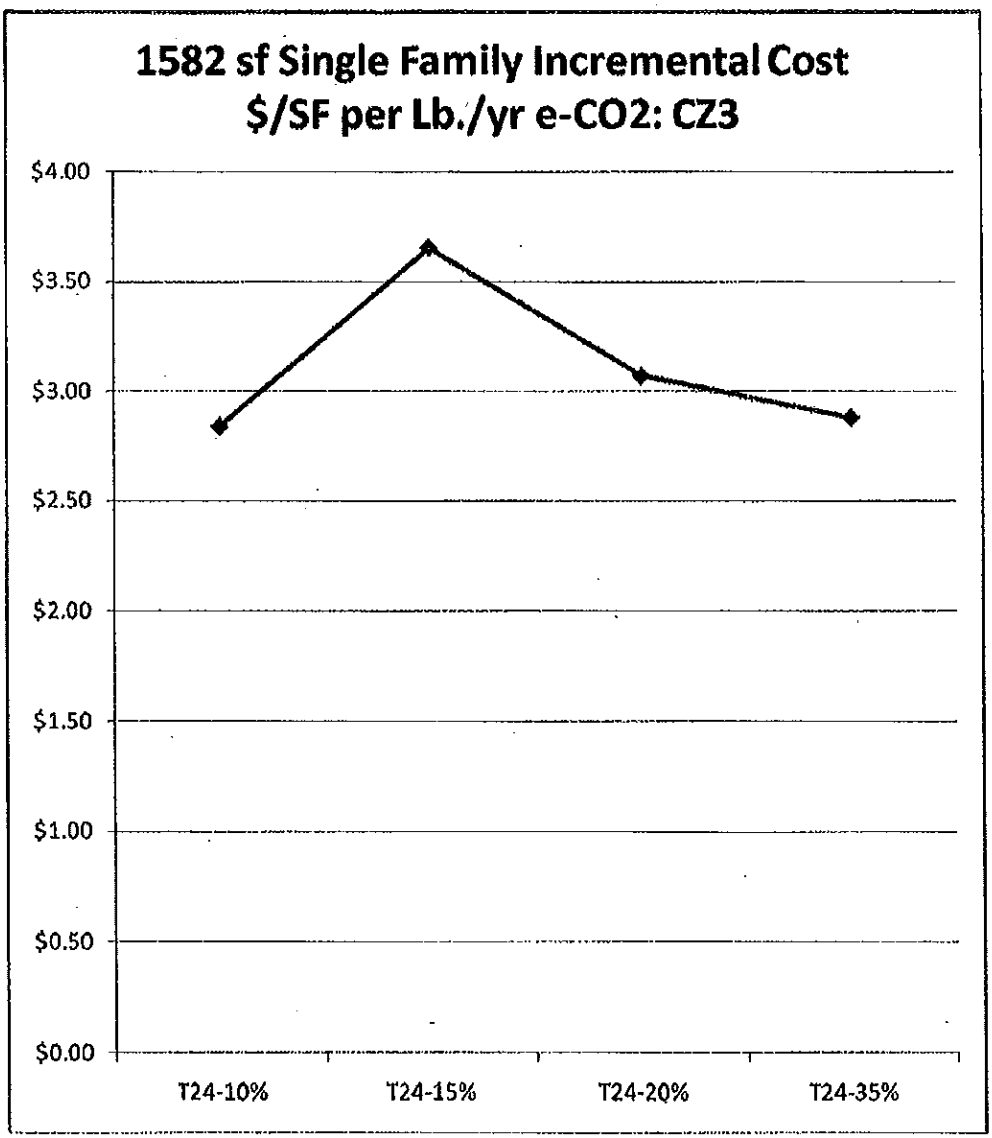


Figure 4-CZ3d-3: Added Cost/Sq.ft. per Lb. of CO2 Reduction, 2-Story Multifamily Building

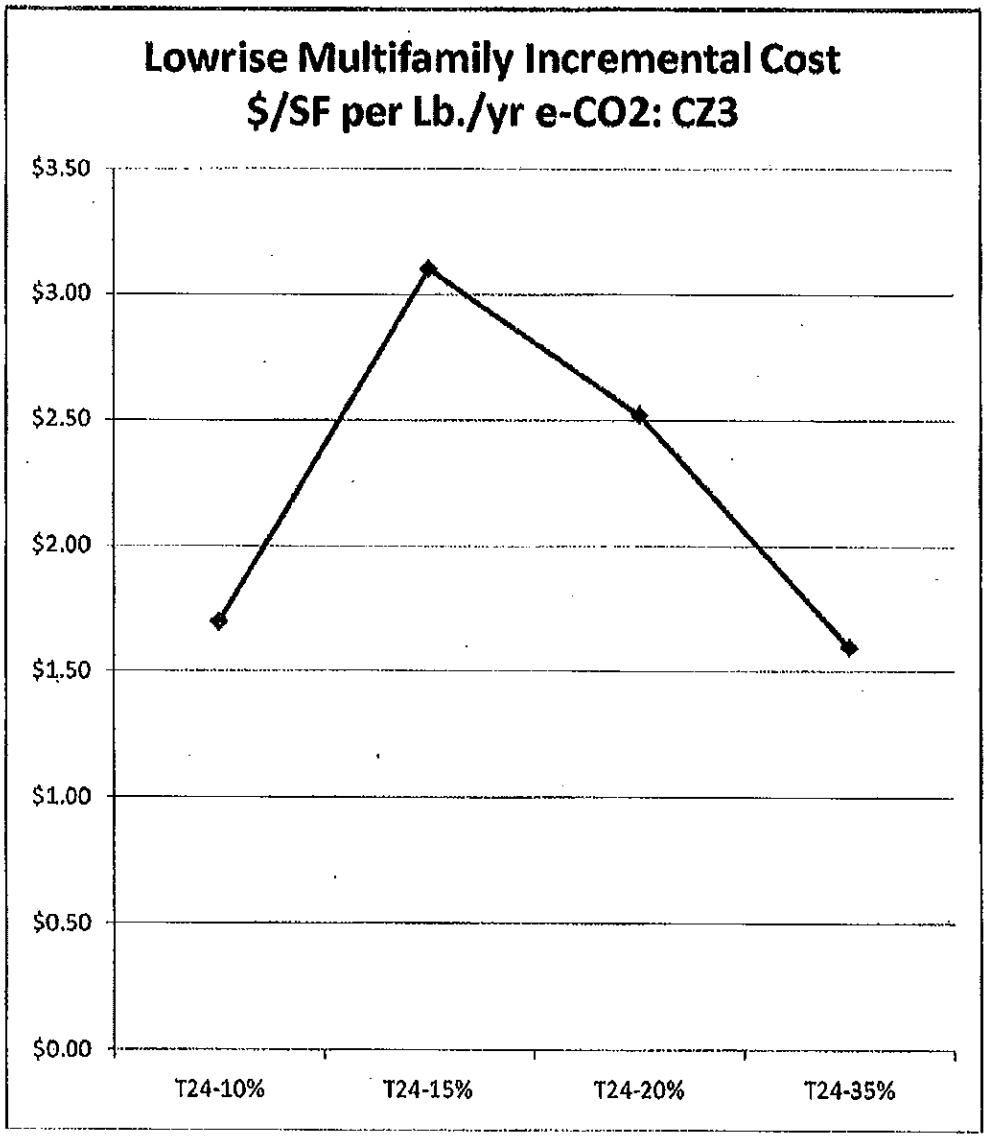


Figure 4-CZ3d-4: Added Cost/Sq.ft. per Lb. of CO2 Reduction – 40 Unit, 5-Story High-rise Residential Building

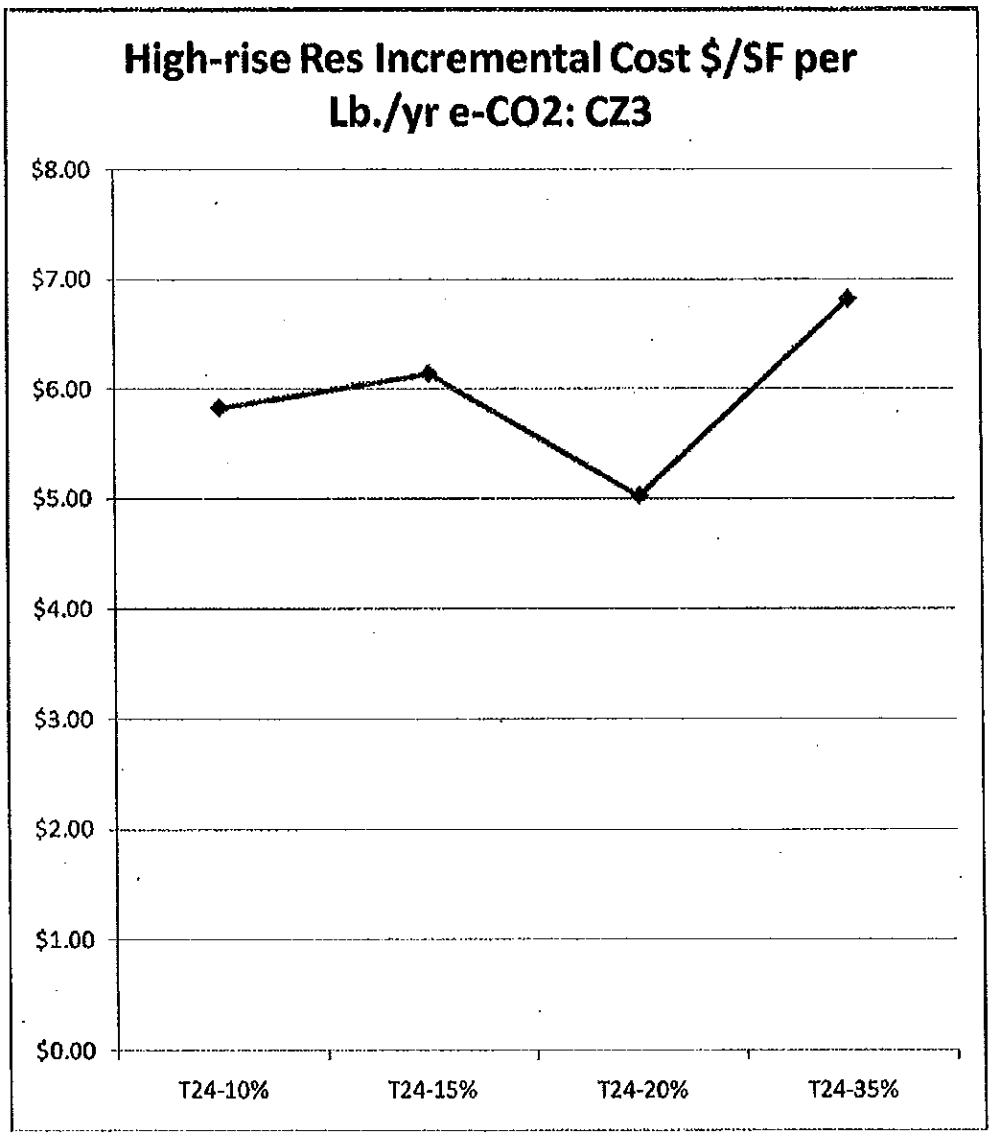


Figure 4-CZ3d-5: Added Cost/Sq.ft. per Lb. of CO2 Reduction – 21,160 sf 2-Story Nonresidential Building

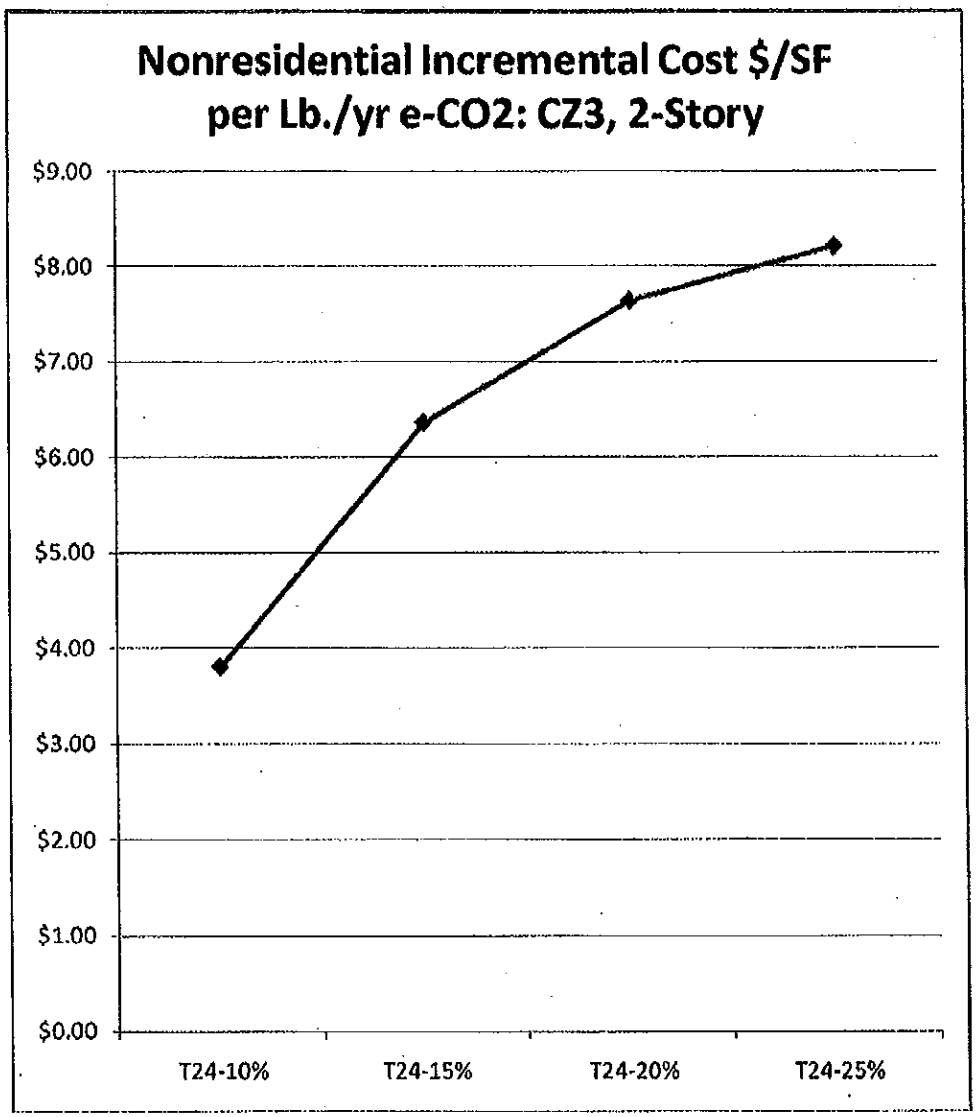


Figure 4-CZ3d-6: Added Cost/Sq.ft. per Lb. of CO2 Reduction – 52,900 sf 5-Story Nonresidential Building

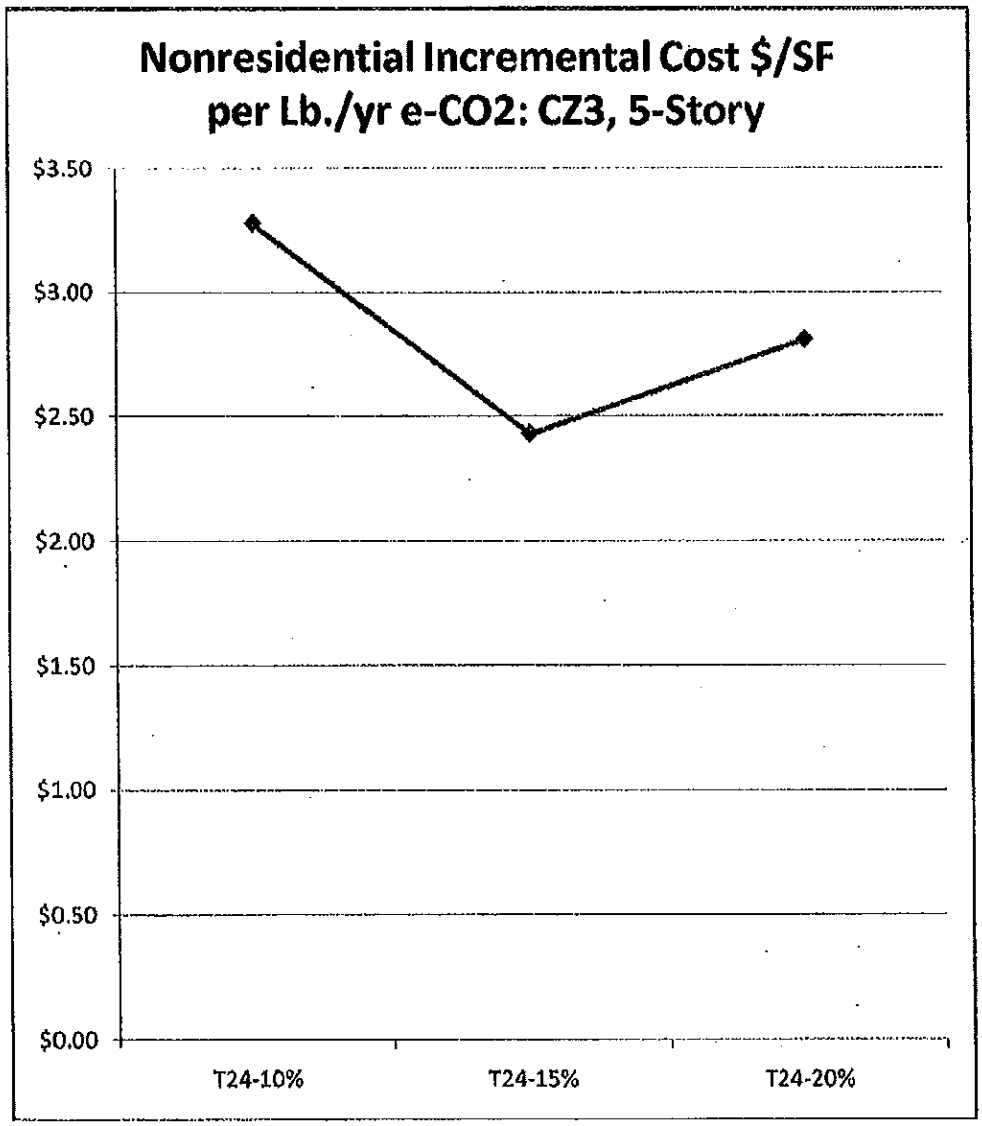


Figure 4-CZ3e-1: Annual Reduction in CO2 in Lbs./Sq.Ft. in Single Family – 2,025 sf 2-Story Single Family Home

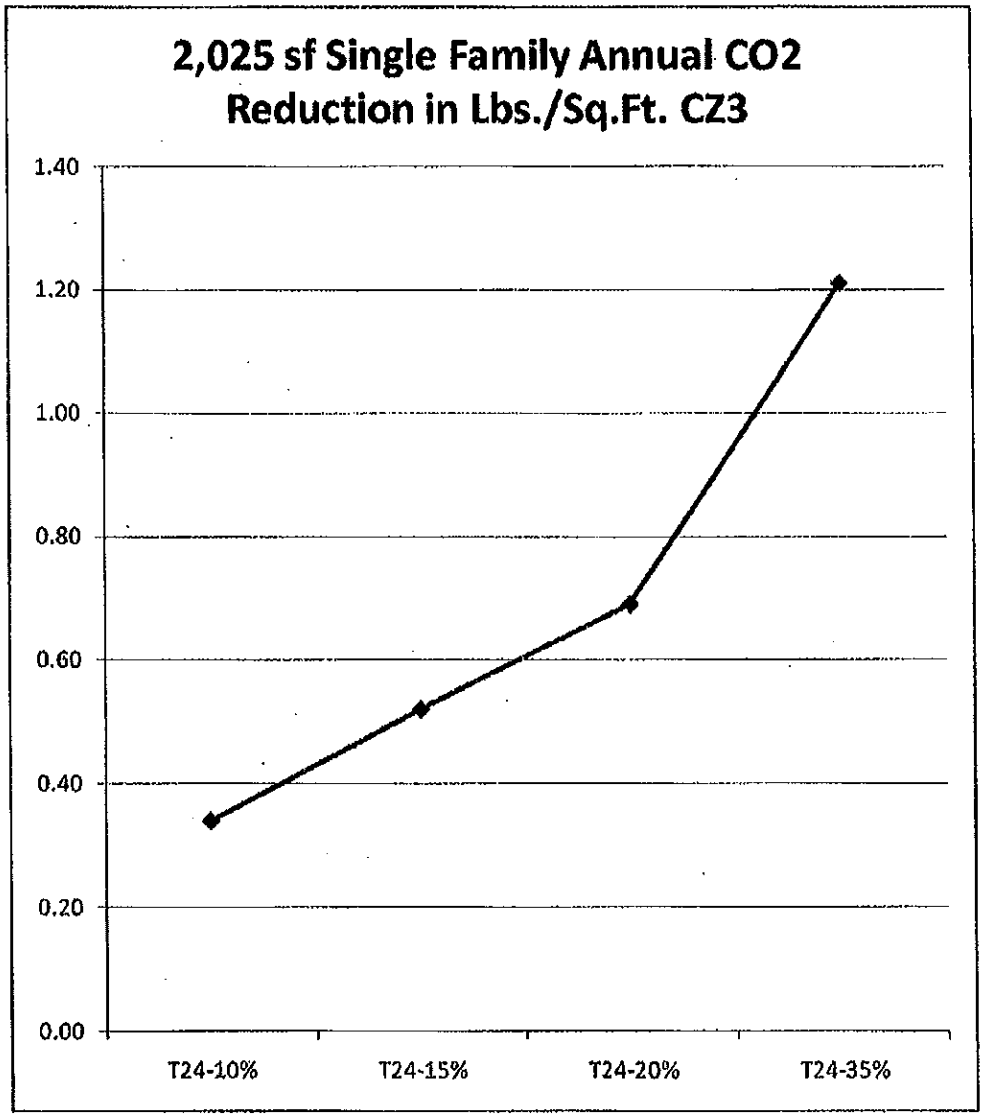


Figure 4-CZ3e-2: Annual Reduction in CO2 in Lbs./Sq.Ft. in Single Family – 1,582 sf 1-Story Single Family Home

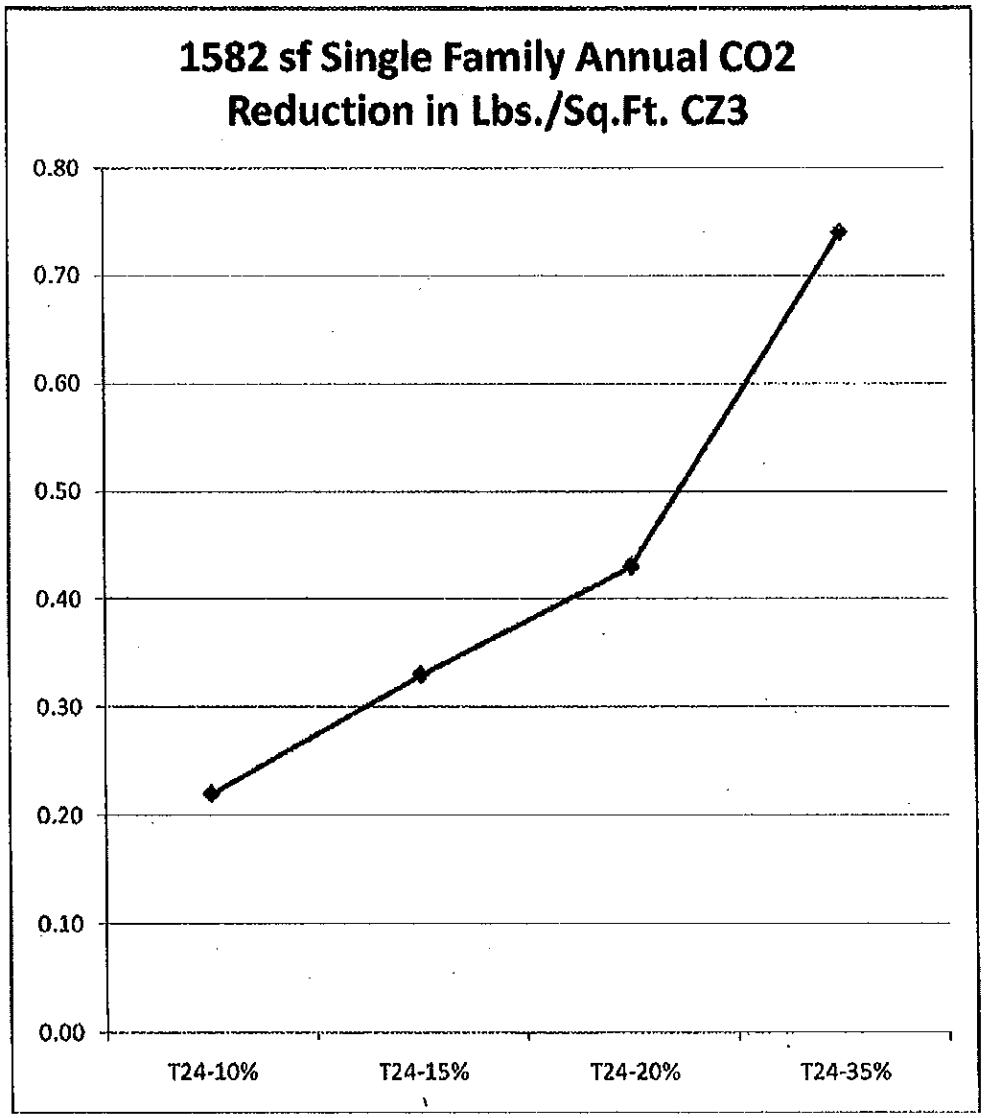


Figure 4-CZ3e-3: Annual Reduction in CO2 in Lbs./Sq.Ft., 2-Story Multifamily Building

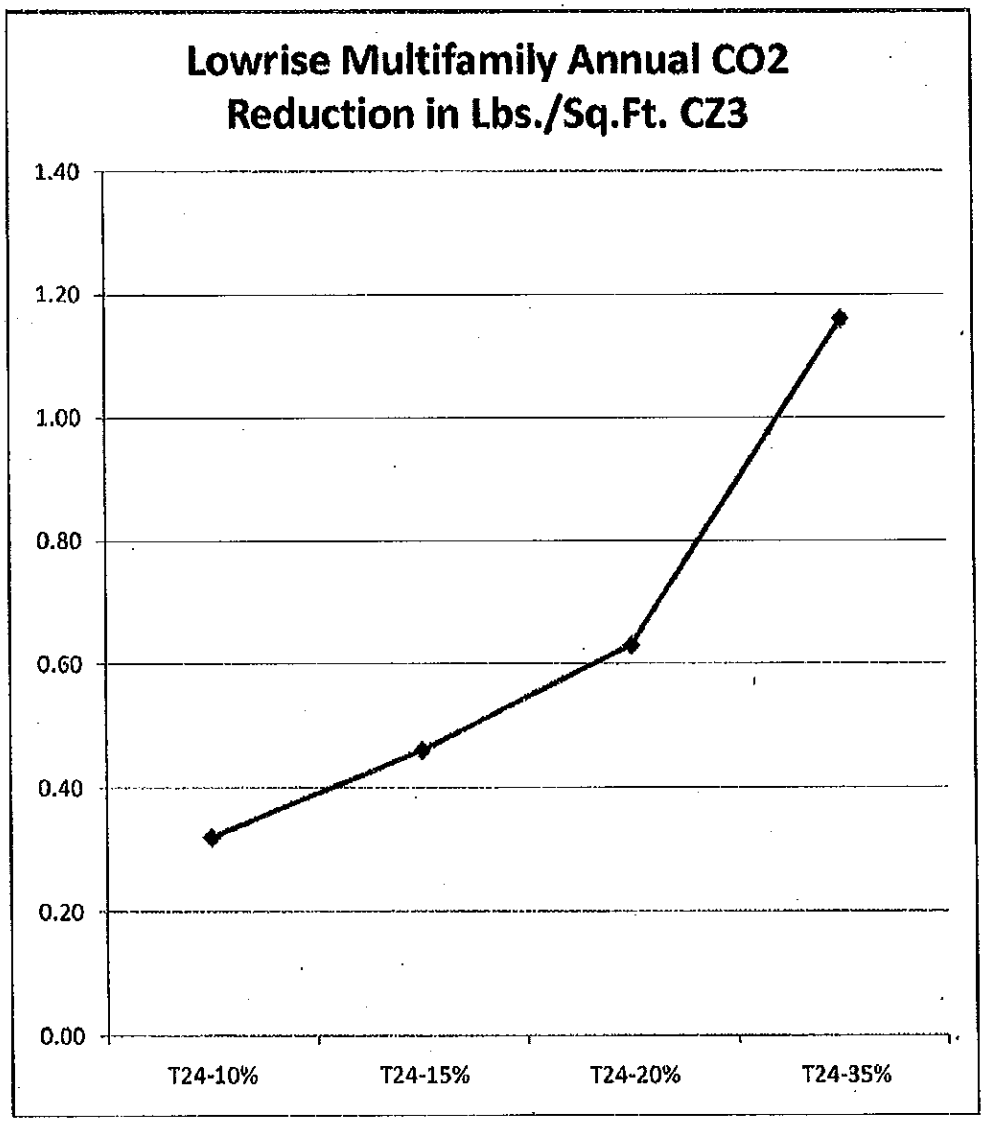


Figure 4-CZ3e-4: Annual Reduction in CO2 in Lbs./Sq.Ft., 40 Unit, 5-Story High-rise Residential Building

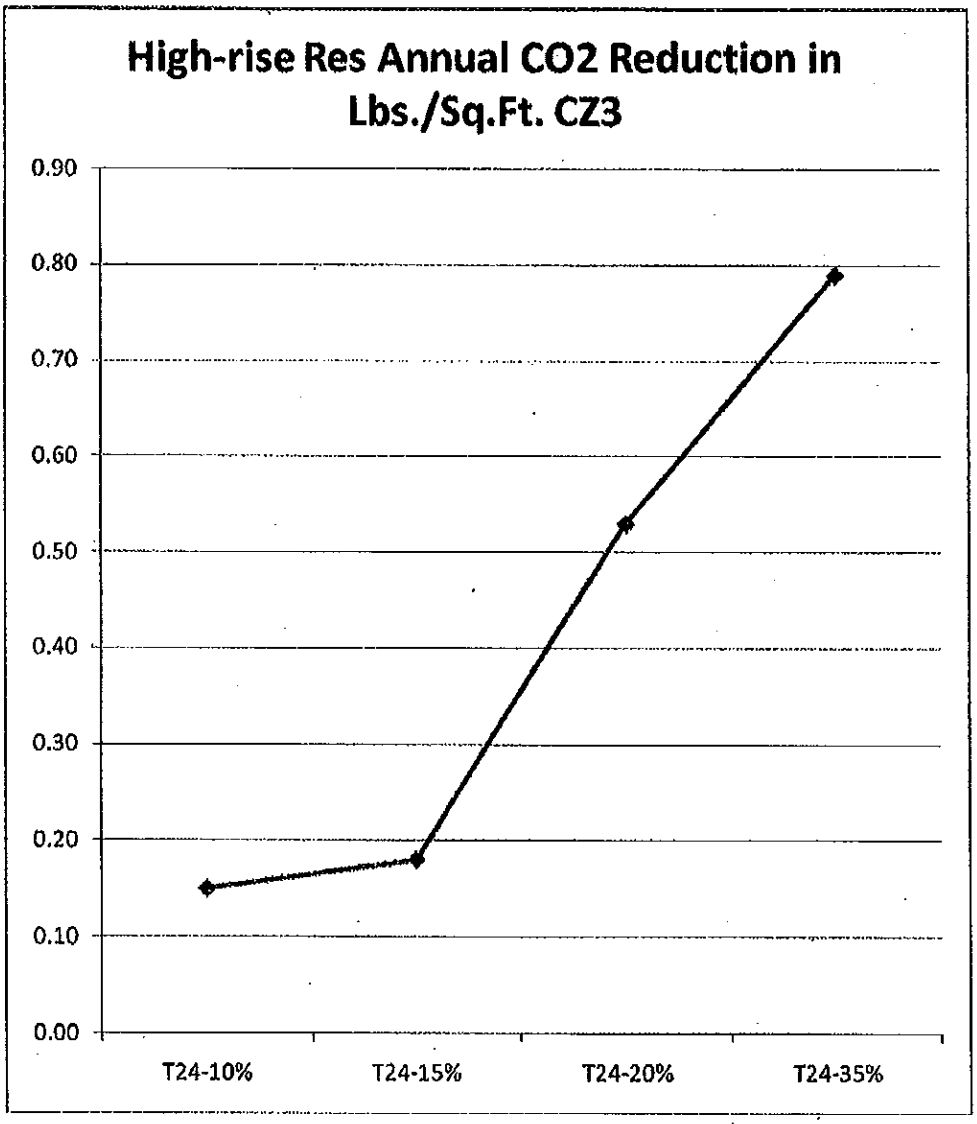


Figure 4-CZ3e-5: Annual Reduction in CO2 in Lbs./Sq.Ft., 21,160 sf 2-Story Nonresidential Building

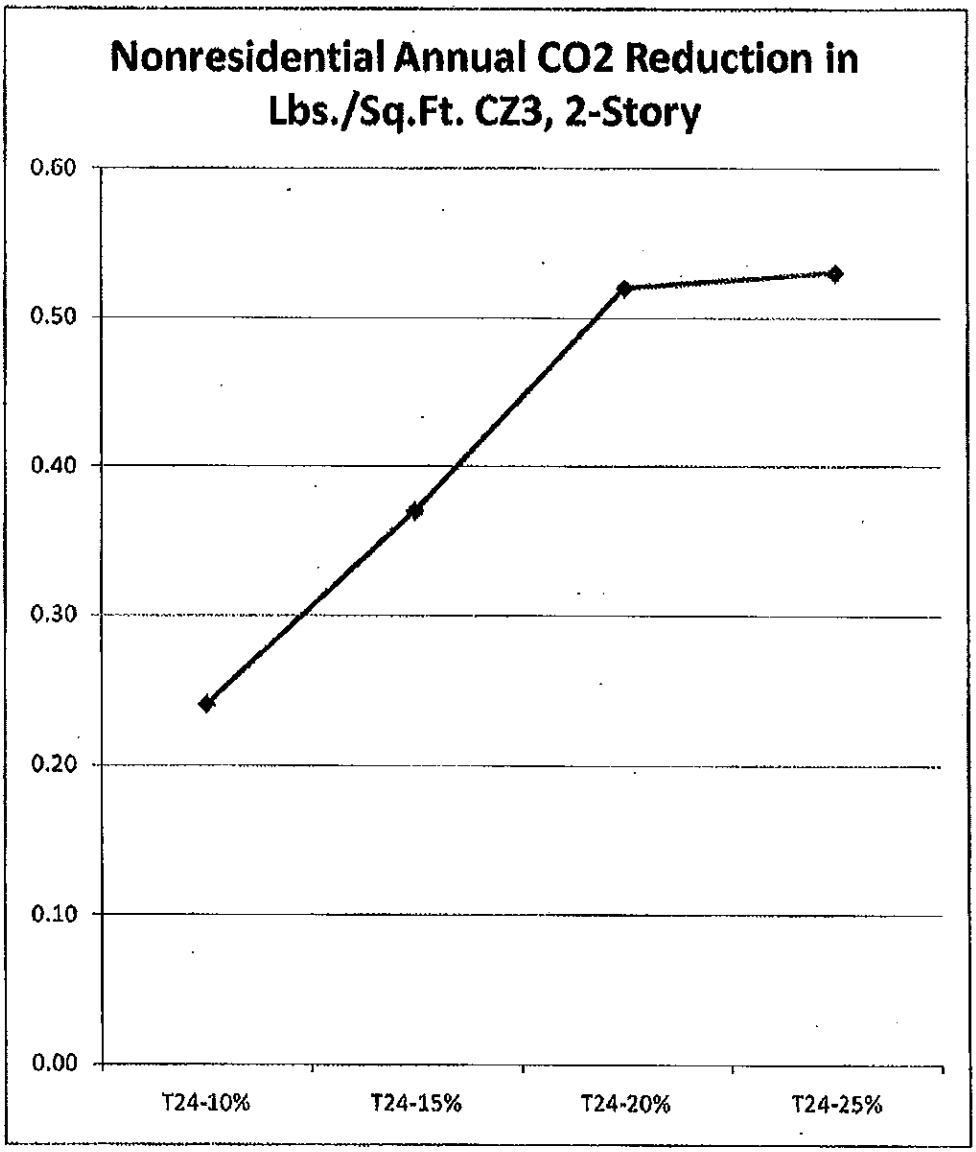
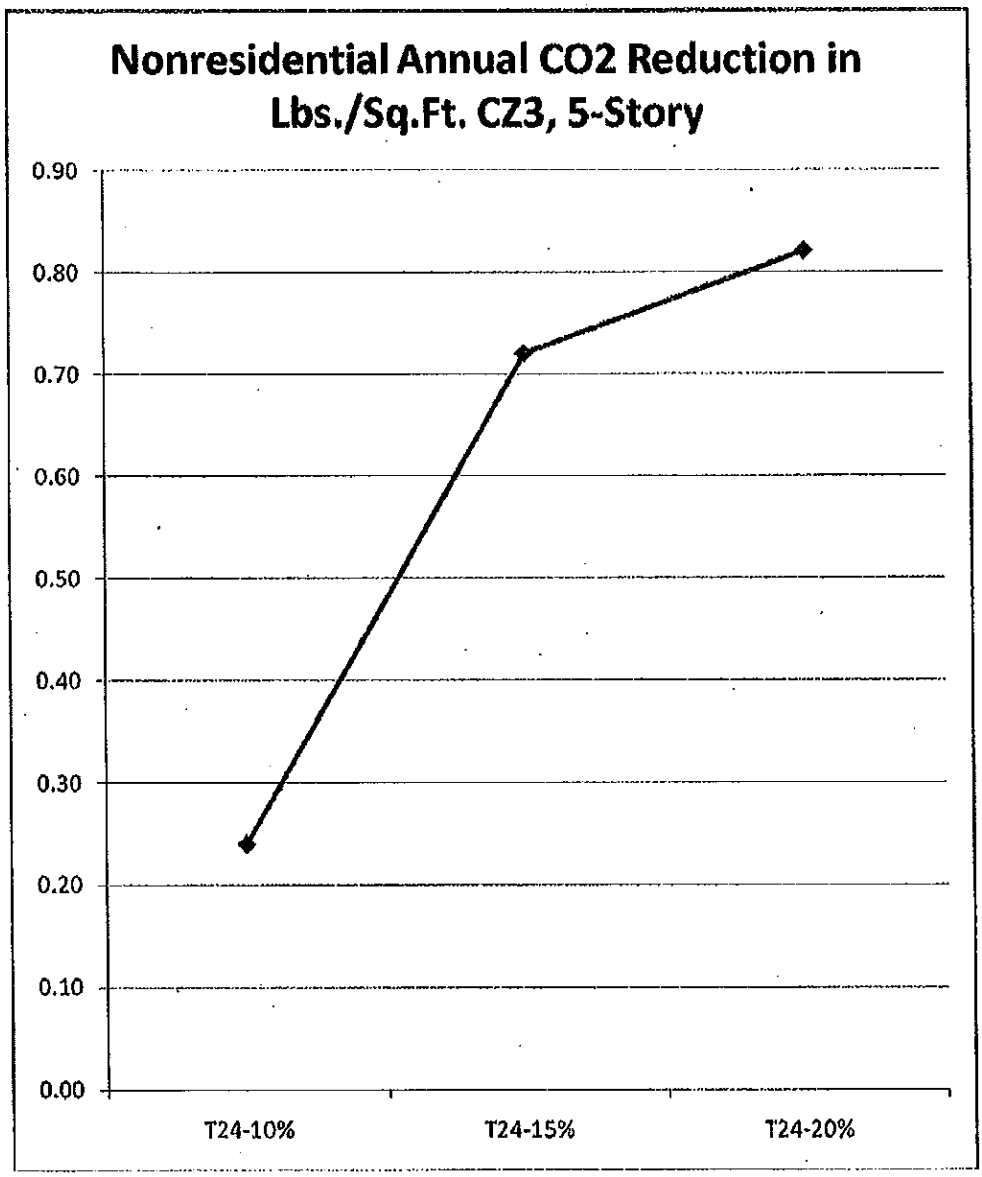
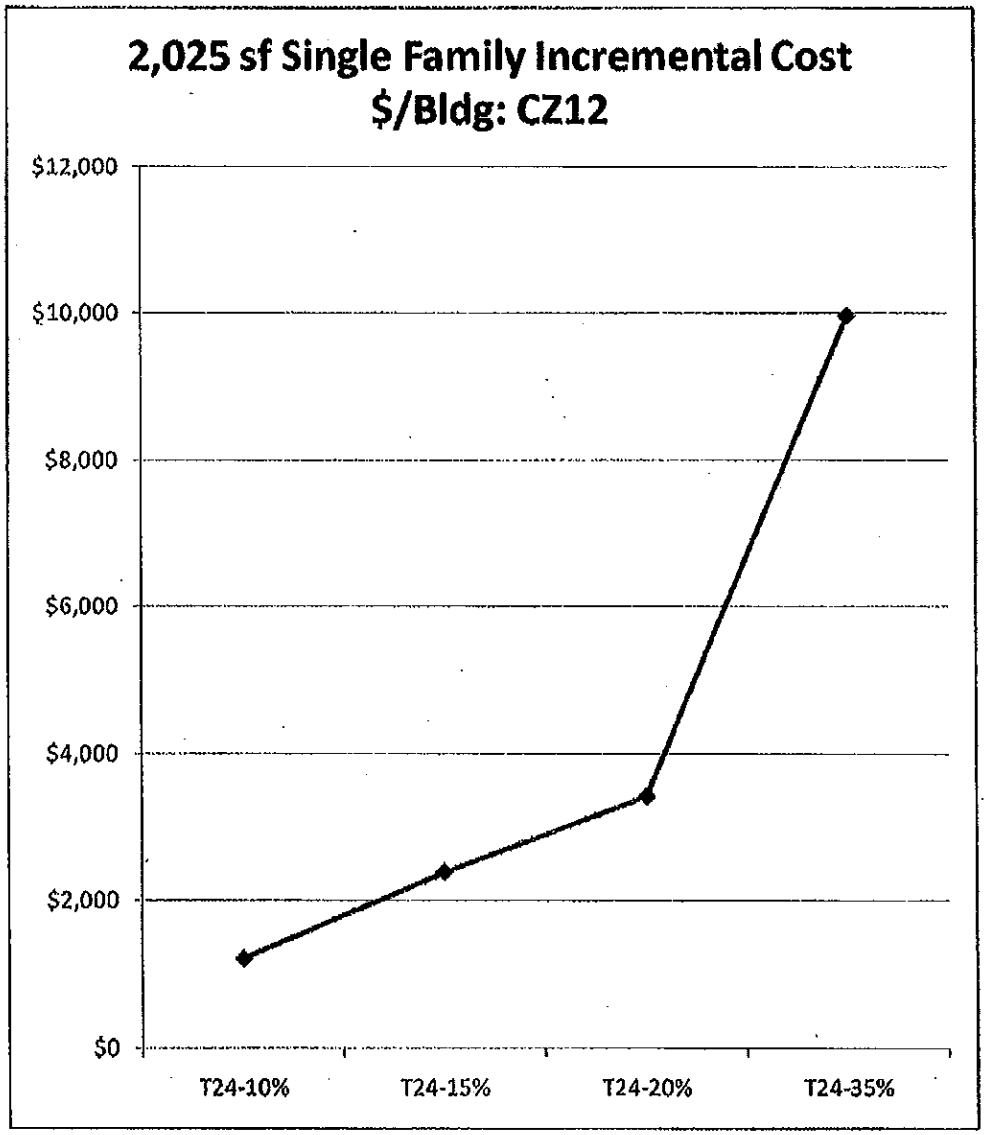


Figure 4-CZ3e-6: Annual Reduction in CO2 in Lbs./Sq.Ft., 52,900 sf 5-Story Nonresidential Building



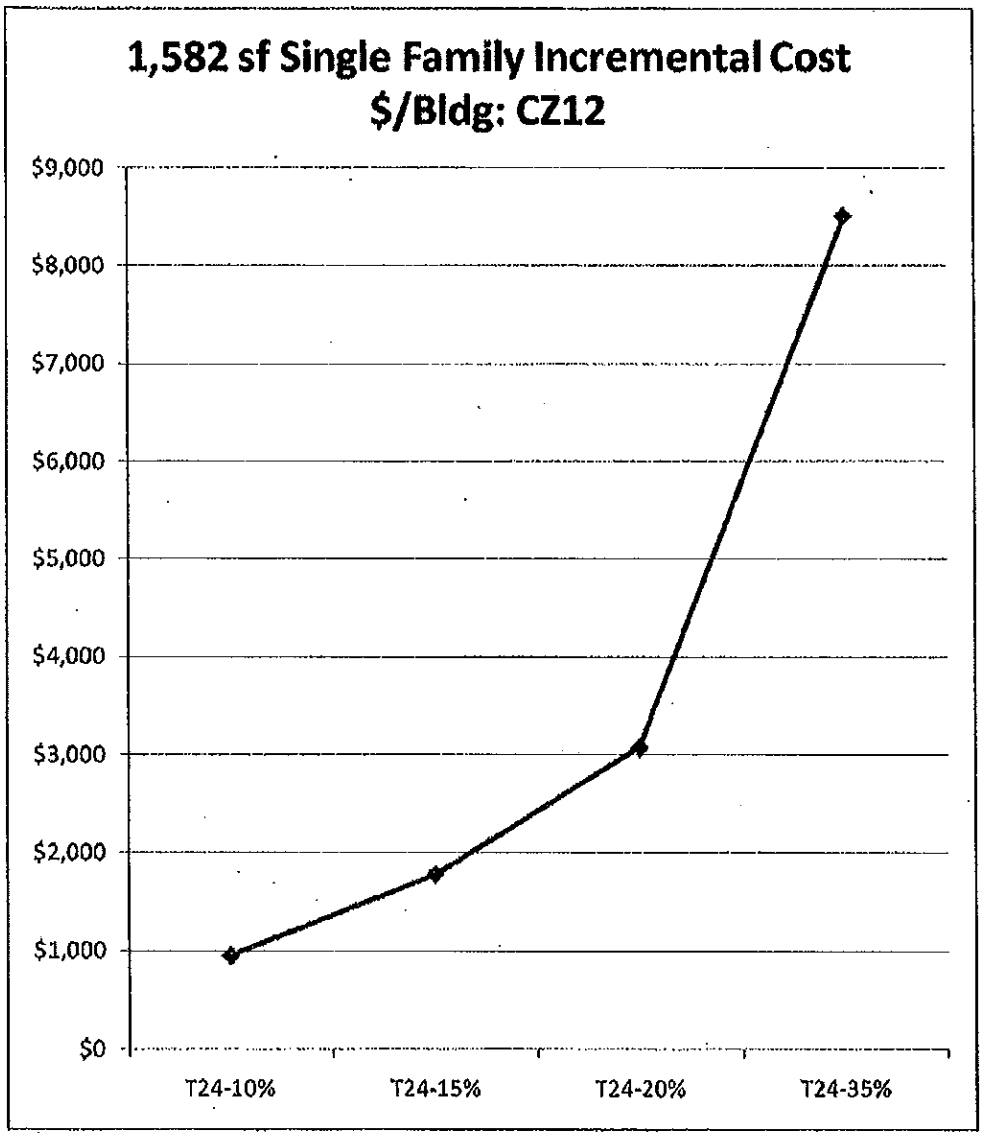
4.2 CLIMATE ZONE #12 CHARTS ILLUSTRATING RESULTS

Figure 4-CZ12a-1: Added First Cost – 2,025 sf 2-Story Single Family Home



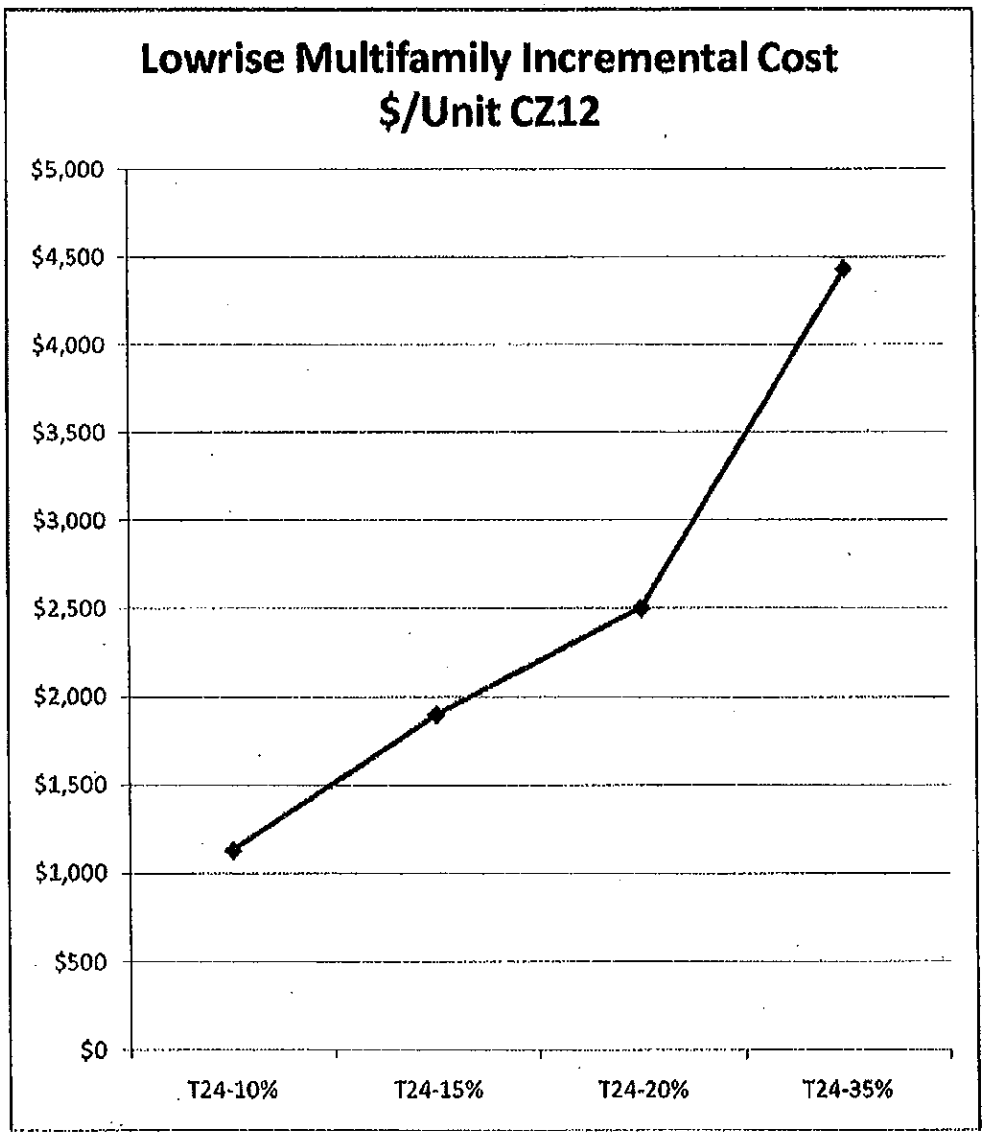
The average incremental energy measures to go from the 2005 standards to the 2008 standards cost $975 per square foot in this single family house design.

Figure 4-CZ12a-2: Added First Cost – 1,582 sf 1-Story Single Family Home



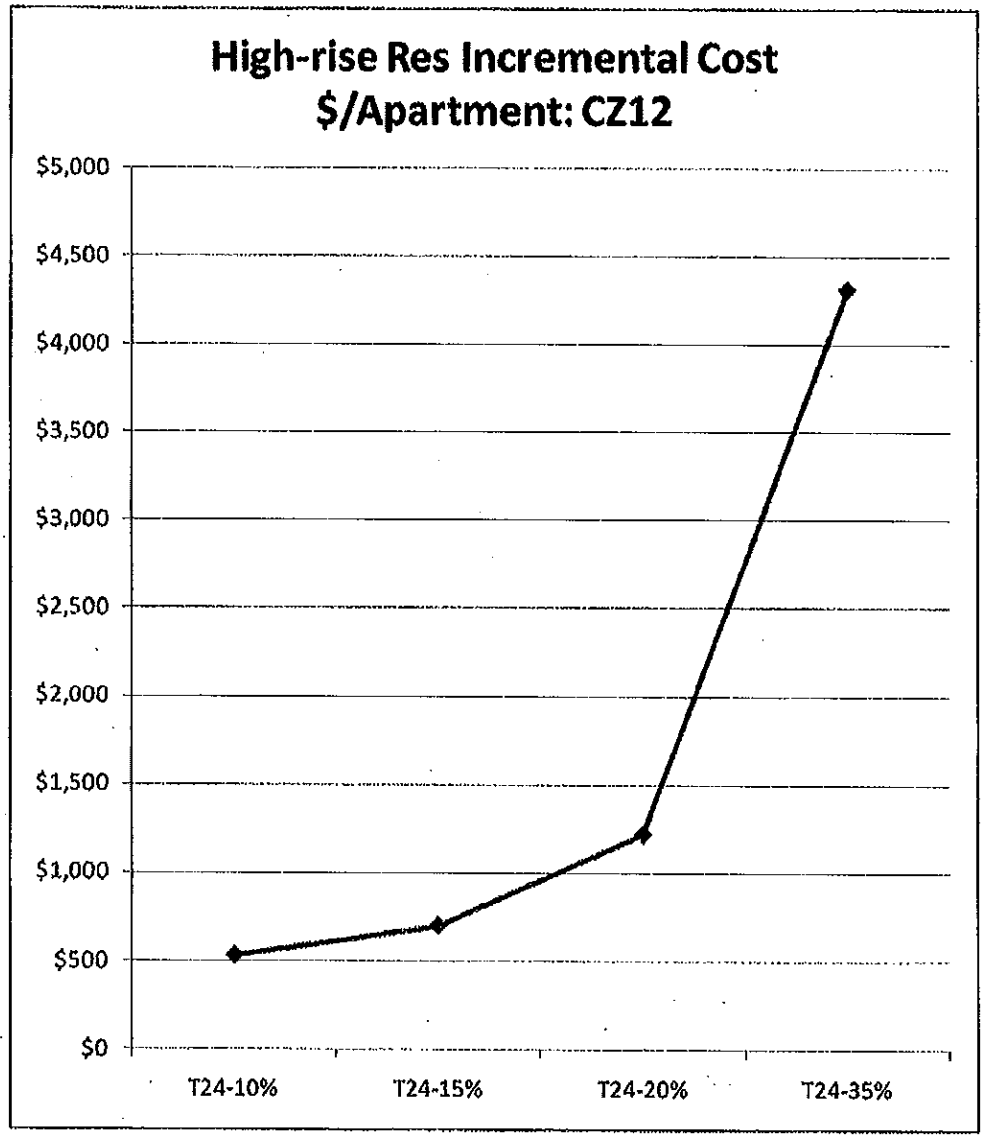
The average incremental energy measures to go from the 2005 standards to the 2008 standards cost $825 per square foot in this single family house design.

Figure 4-CZ12a-3: Added First Cost/Dwelling Unit, 2-Story Multifamily Building



The average incremental energy measures to go from the 2005 standards to the 2008 standards cost $383 per dwelling unit in this multifamily building design.

Figure 4-CZ12a-4: Added First Cost, 40 Unit, 5-Story High-rise Residential Building



The average incremental energy measures to go from the 2005 standards to the 2008 standards cost $0 per dwelling unit in this high-rise residential building design. (No changes in the building design were required to meet the 2008 standards.)

Figure 4-CZ12a-5: Added First Cost -- 21,160 sf 2-Story Nonresidential Building

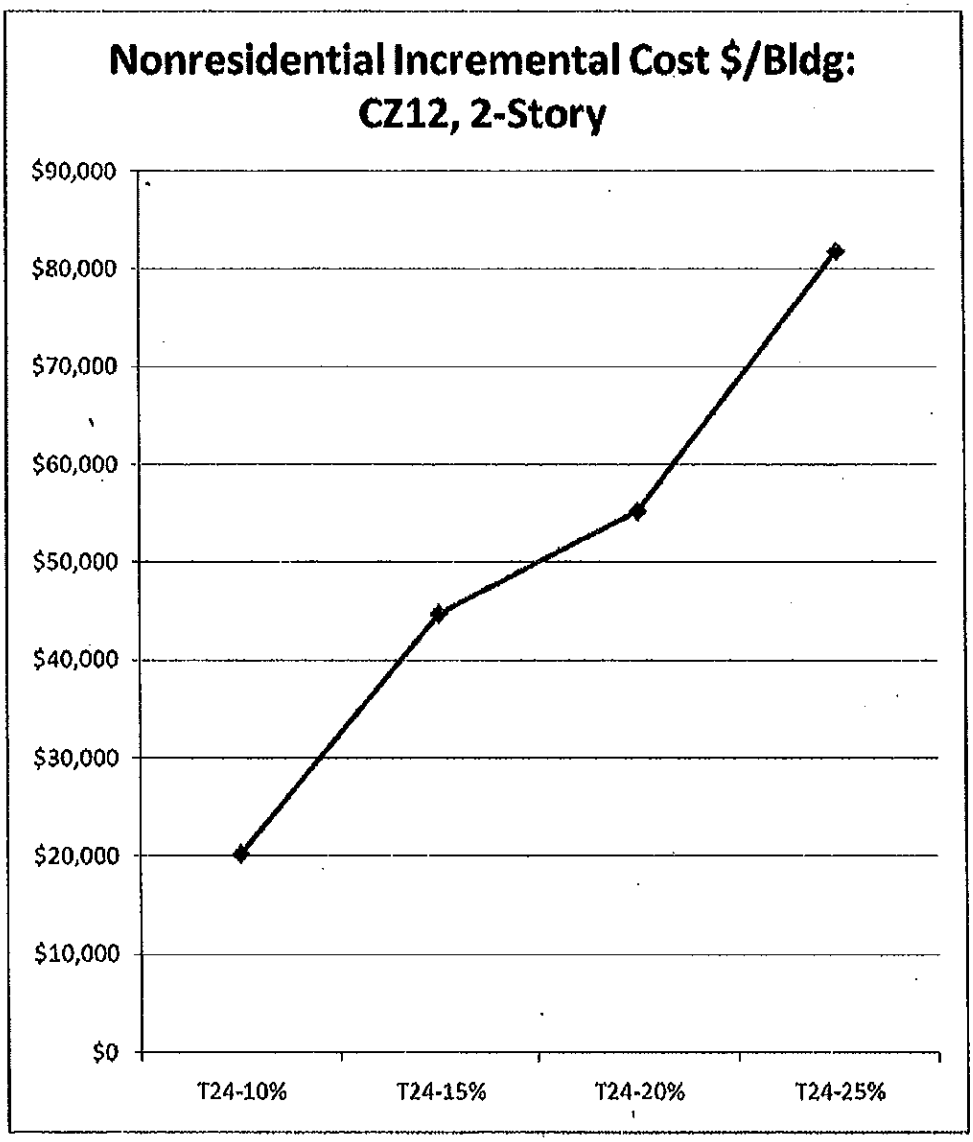


Figure 4-CZ12a-6: Added First Cost -- 52,900 sf 5-Story Nonresidential Building

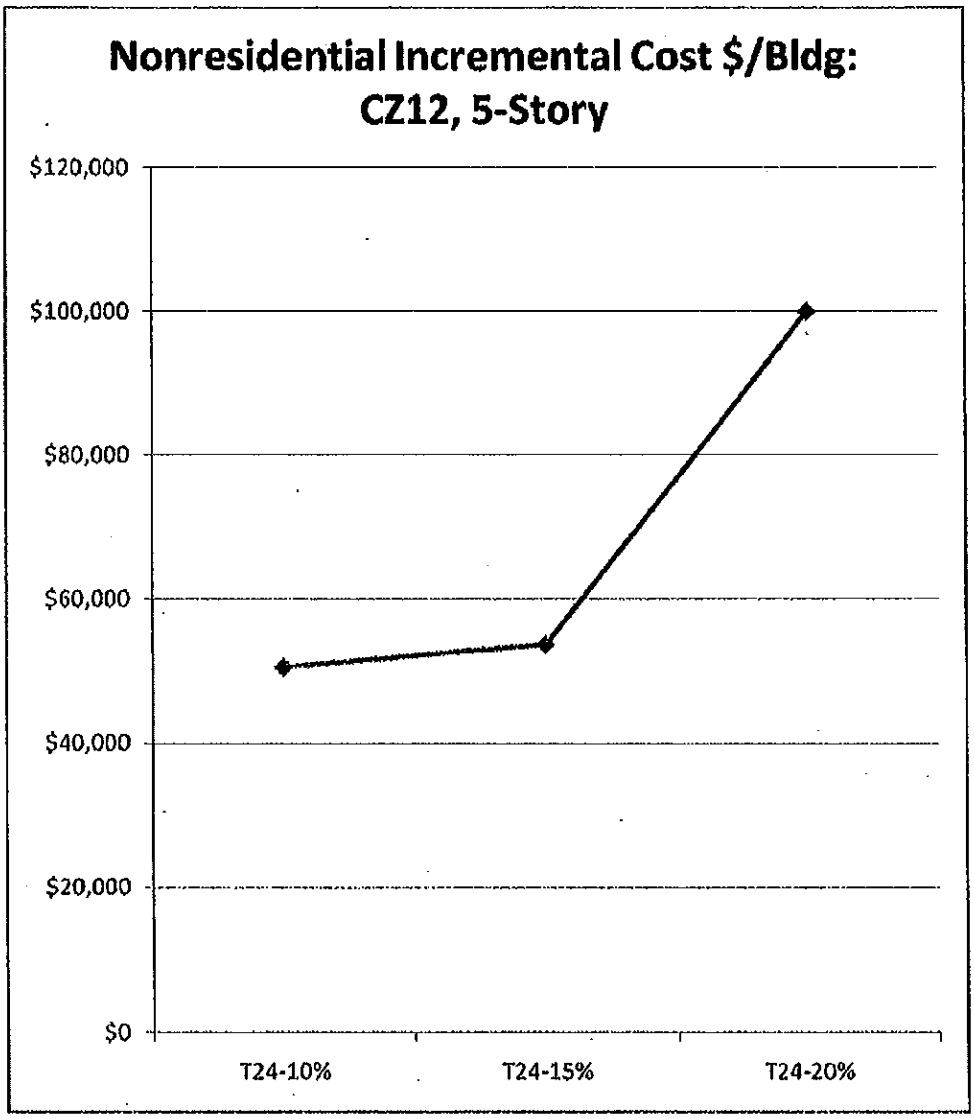


Figure 4-CZ12b-1: Added First Cost/Sq.Ft. – 2,025 sf 2-Story Single Family Home

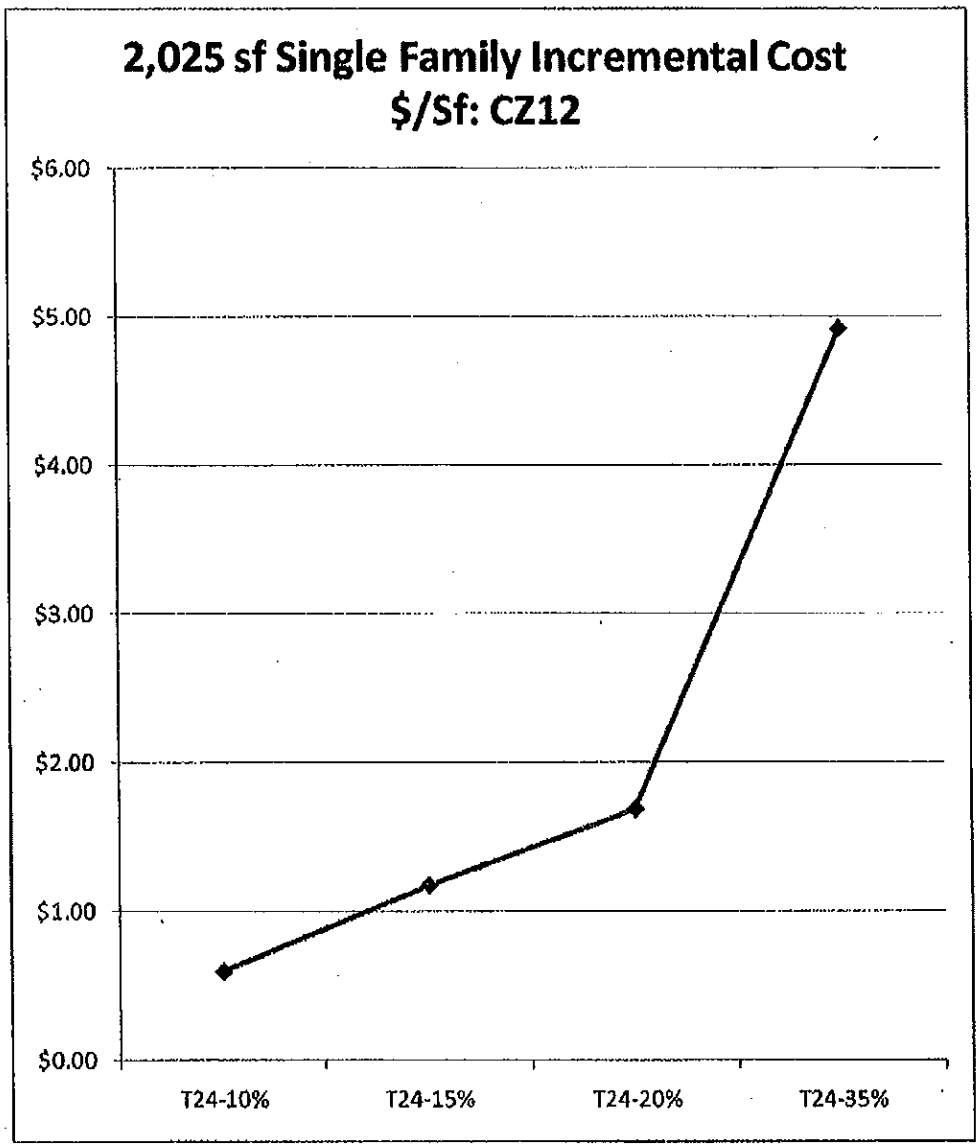


Figure 4-CZ12b-2: Added First Cost/Sq.Ft., – 1,582 sf 1-Story Single Family Home

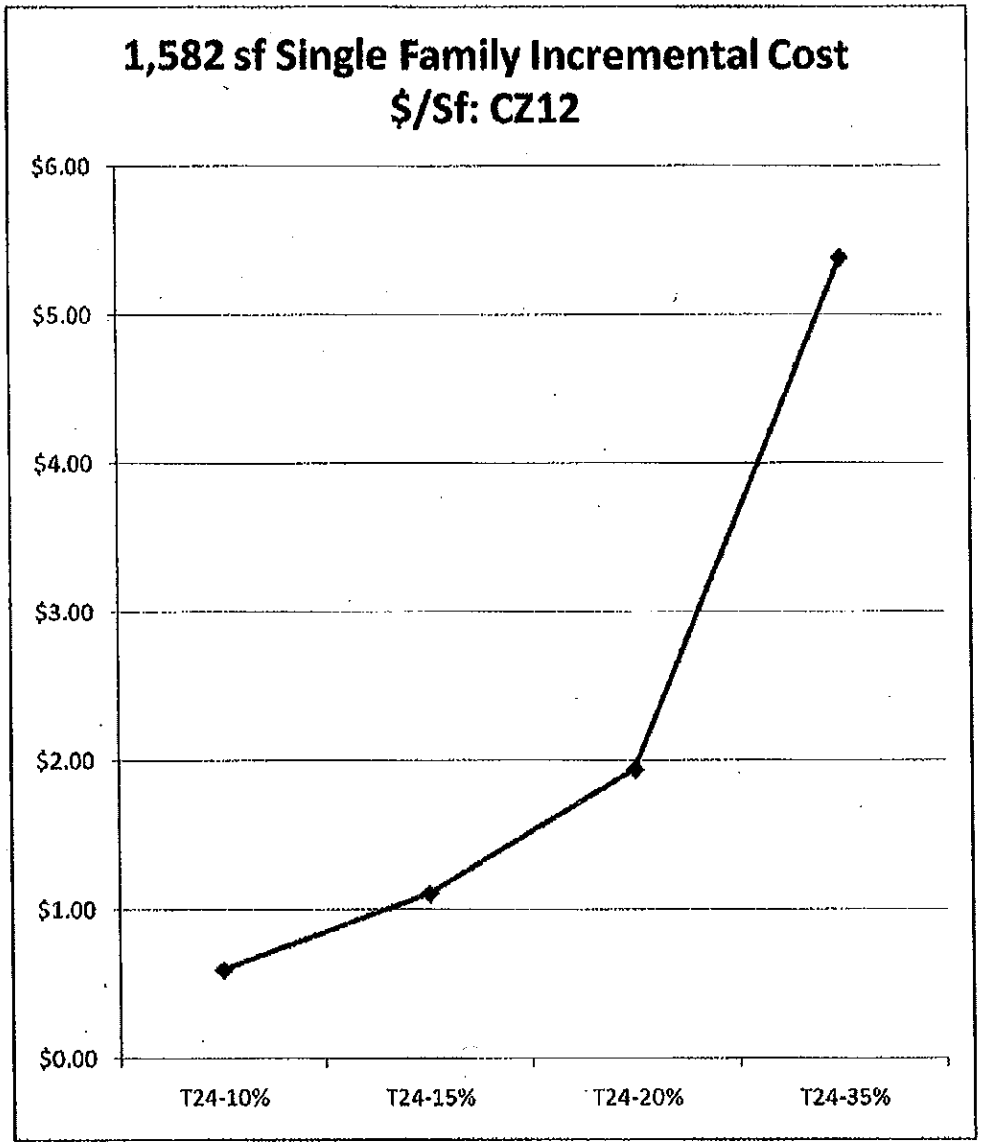


Figure 4-CZ12b-3: Added First Cost/Sq.Ft., 2-Story Multifamily Building

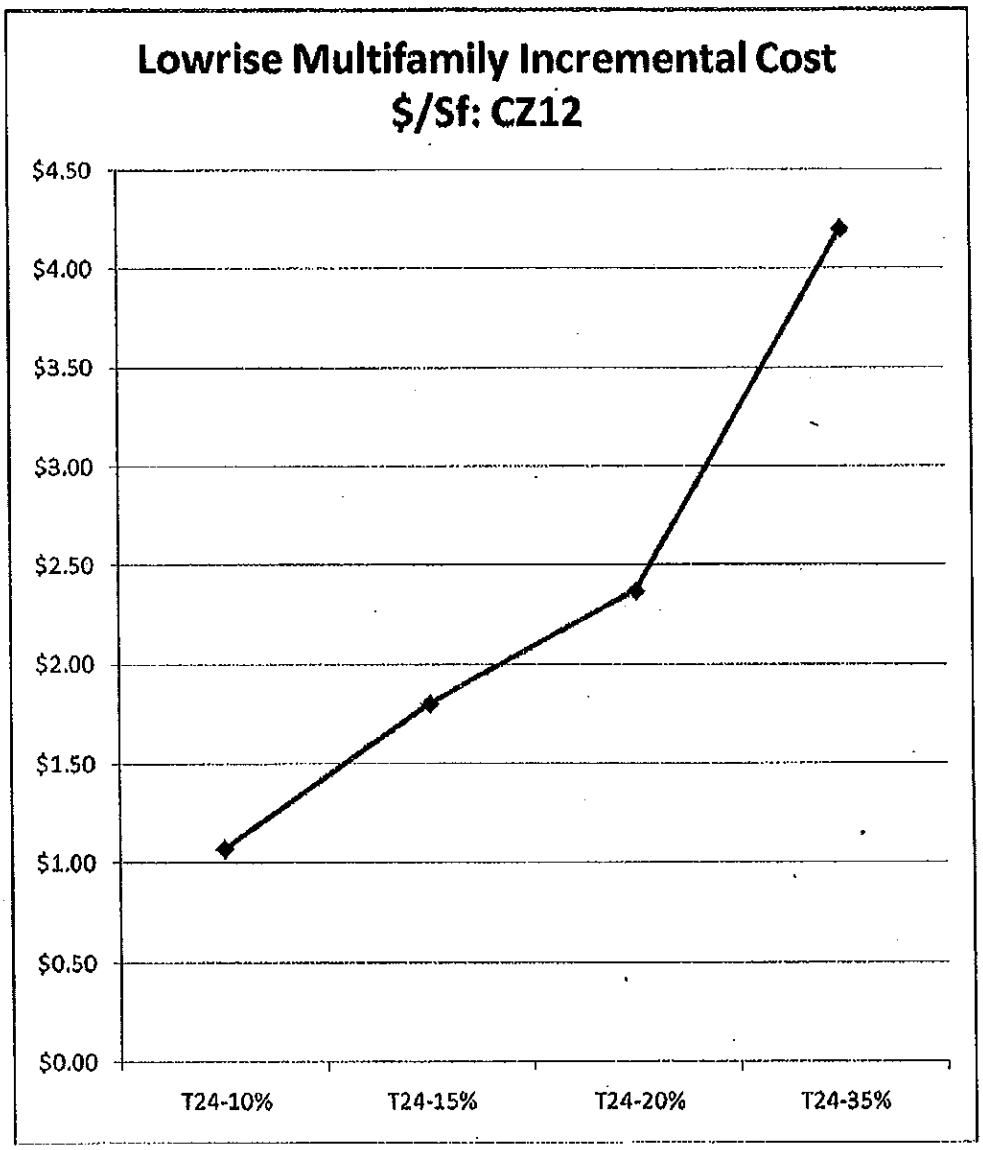


Figure 4-CZ12b-4: Added First Cost/Sq.Ft.
40 Unit, 5-Story High-rise Residential Building

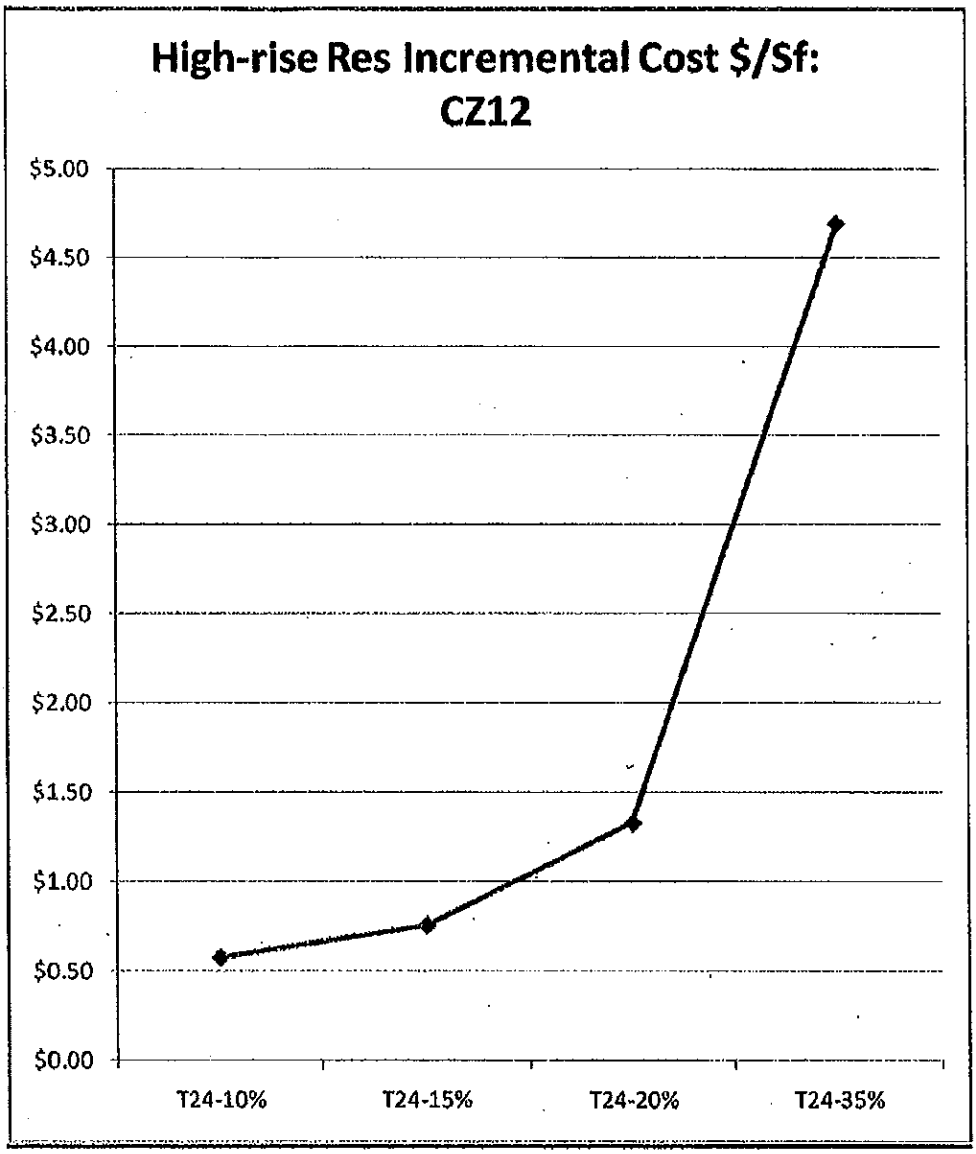


Figure 4-CZ12-b5: Added First Cost/Sq.Ft. -- 21,160 sf 2-Story Nonresidential Bldg

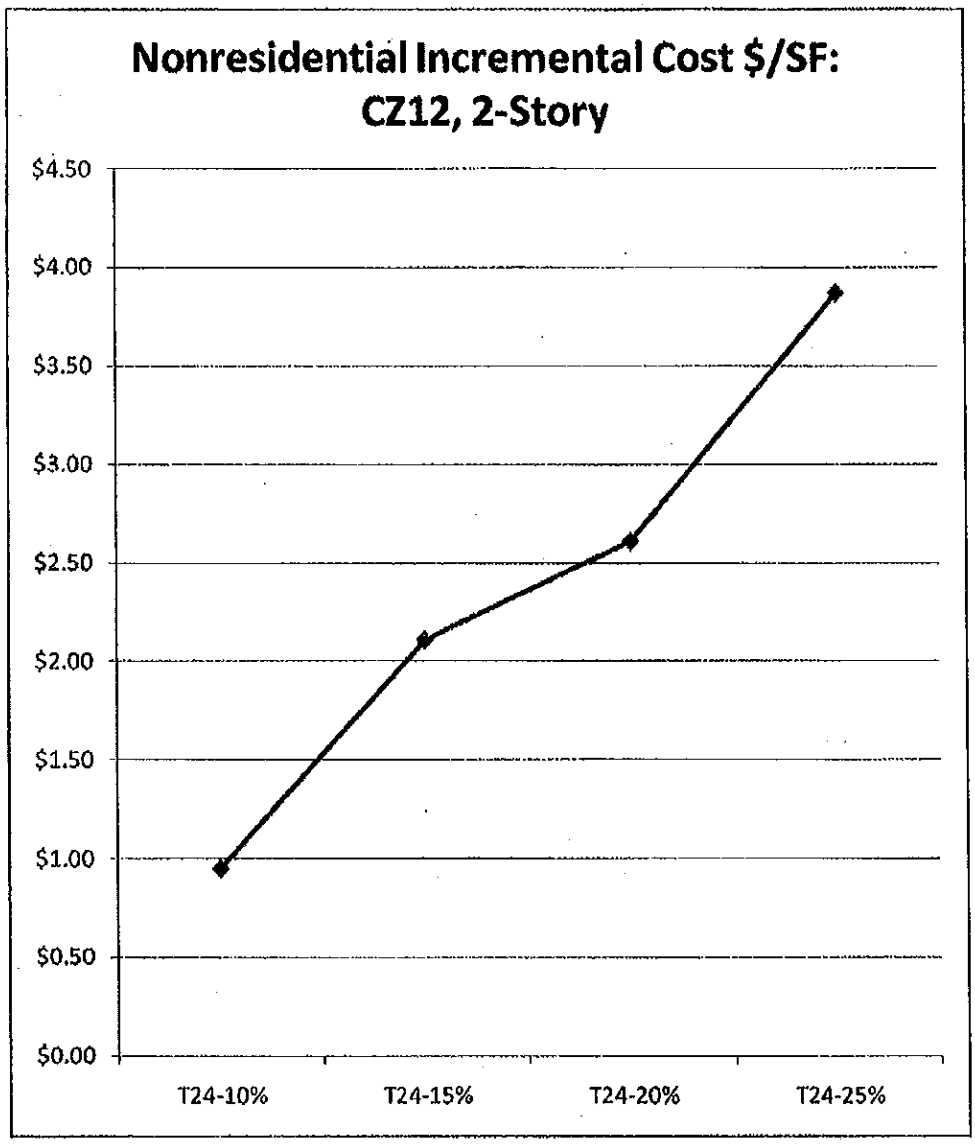


Figure 4-CZ12-b6: Added First Cost/Sq.Ft. -- 52,900 sf 5-Story Nonresidential Bldg

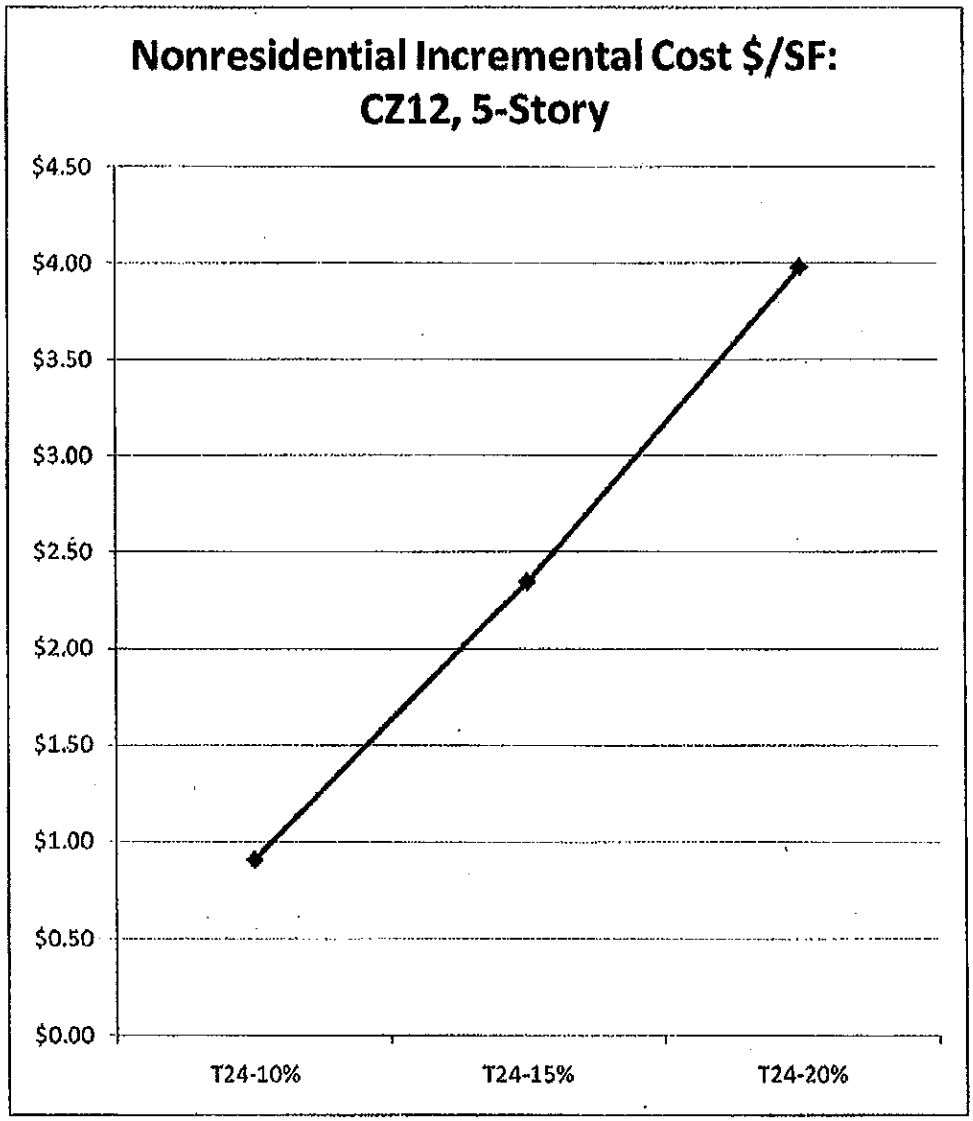


Figure 4-CZ12c-1: Simple Payback of Different Tiers of Energy Measures – 2,025 sf 2-Story Single Family Home

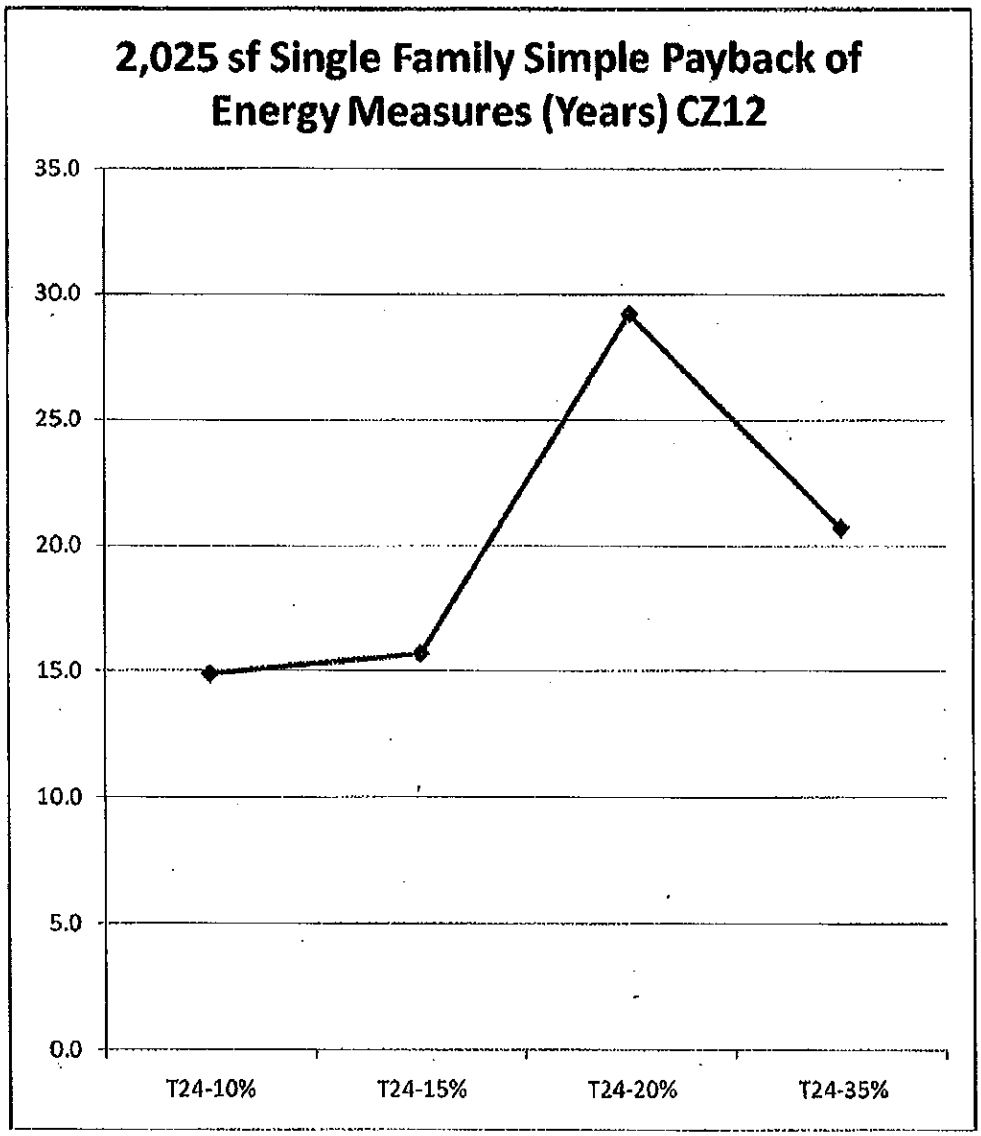


Figure 4-CZ12c-2: Simple Payback of Different Tiers of Energy Measures – 1,582 sf 1-Story Single Family Home

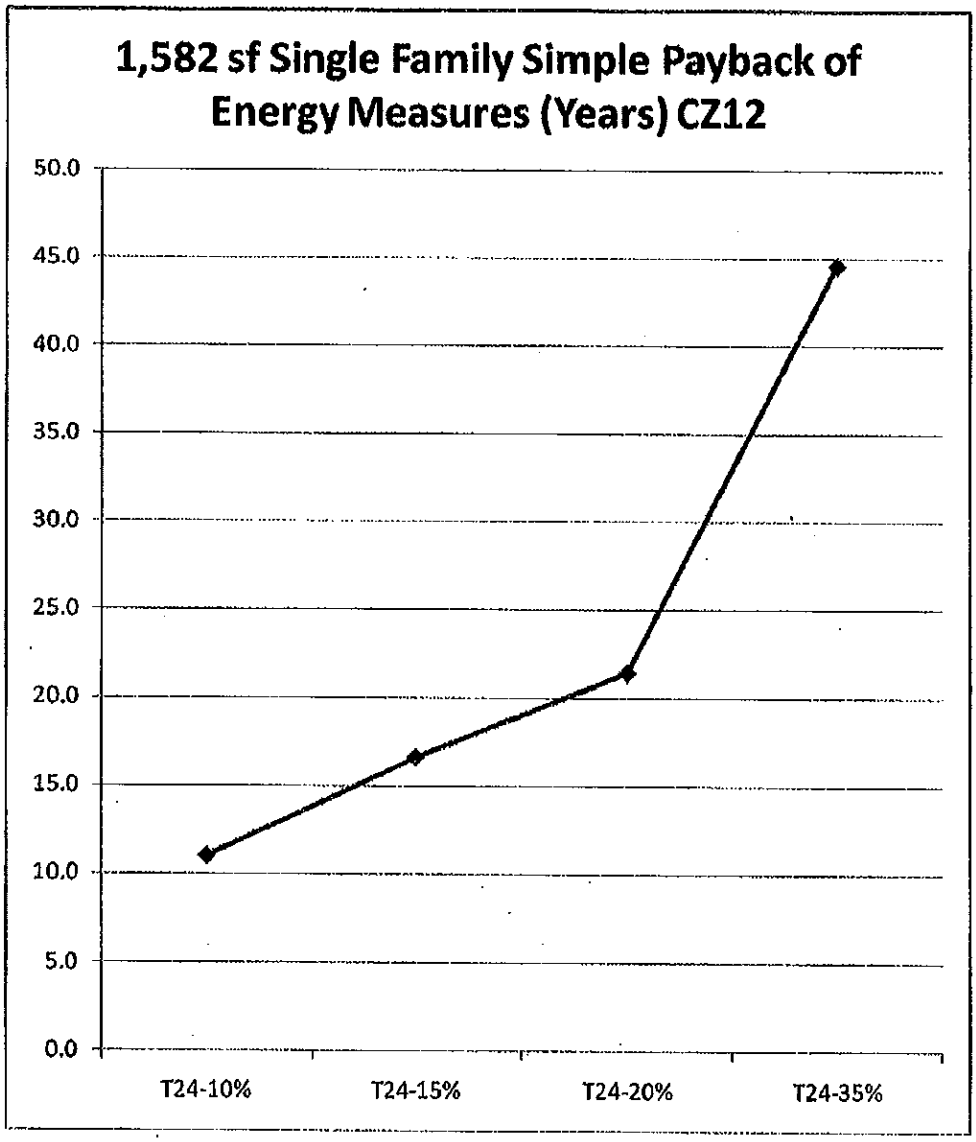


Figure 4-CZ12c-3: Simple Payback of Different Tiers of Energy Measures, 2-Story Multifamily Building

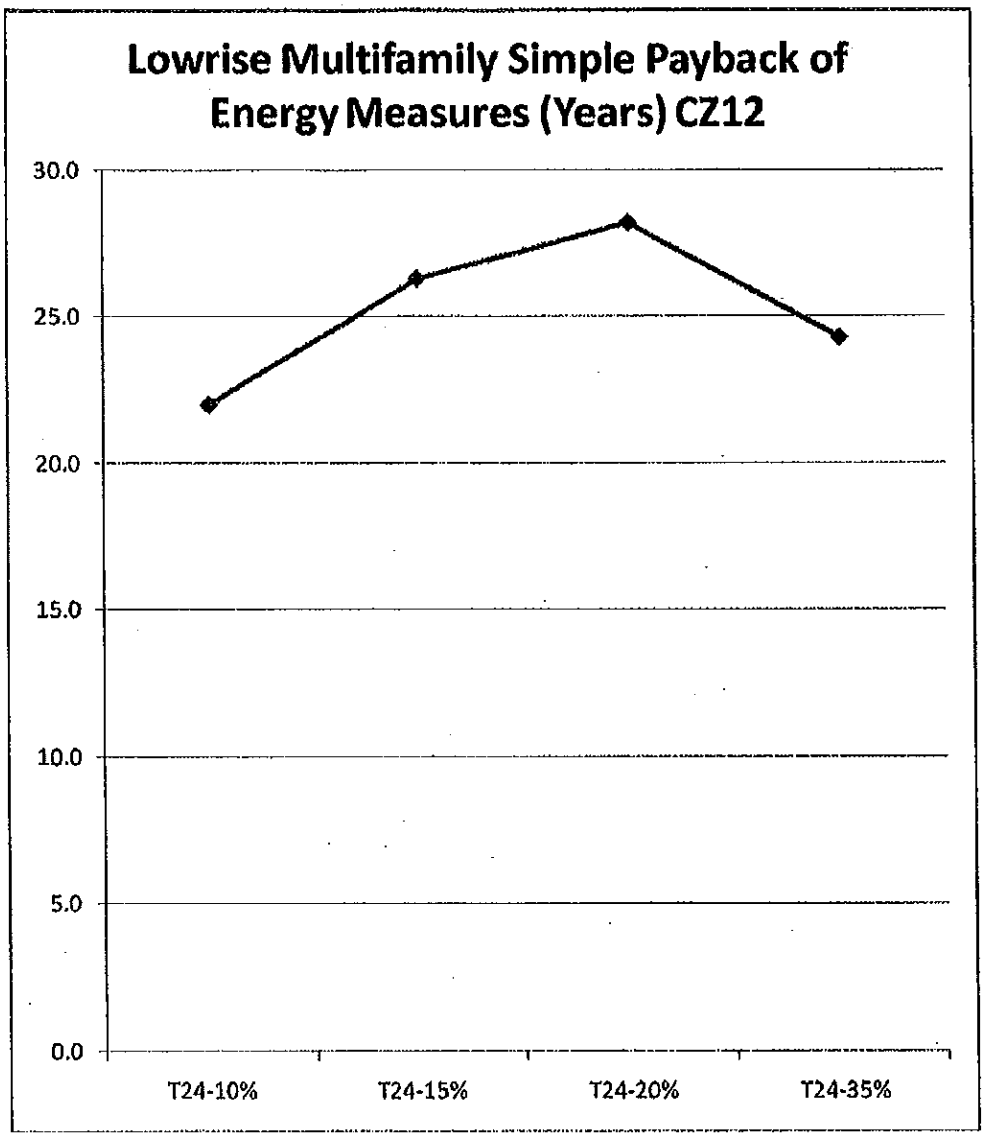


Figure 4-CZ12c-4: Simple Payback of Different Tiers of Energy Measures, 40 Unit, 5-Story High-rise Residential Building

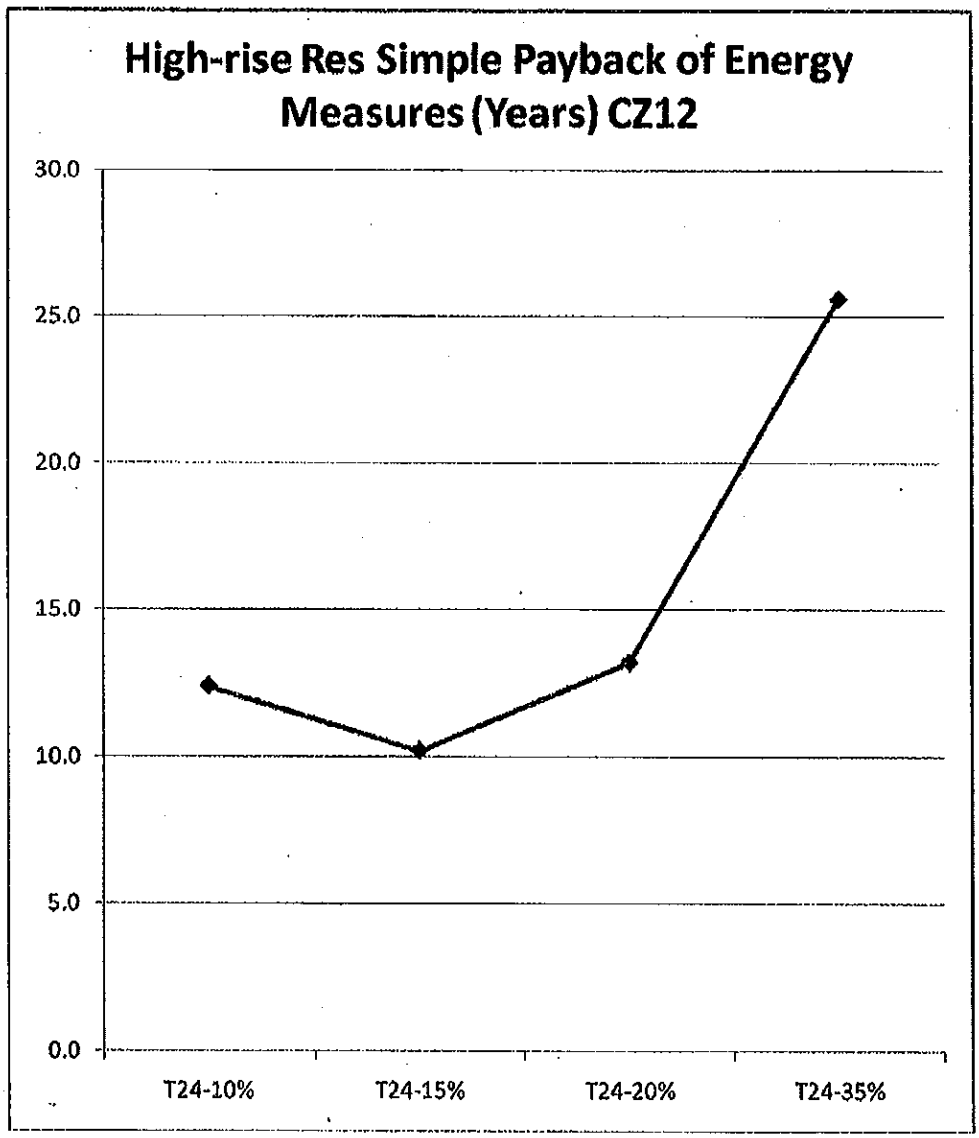


Figure 4-CZ12c-5: Simple Payback of Different Tiers of Energy Measures, 21,160 sf 2-Story Nonresidential Building

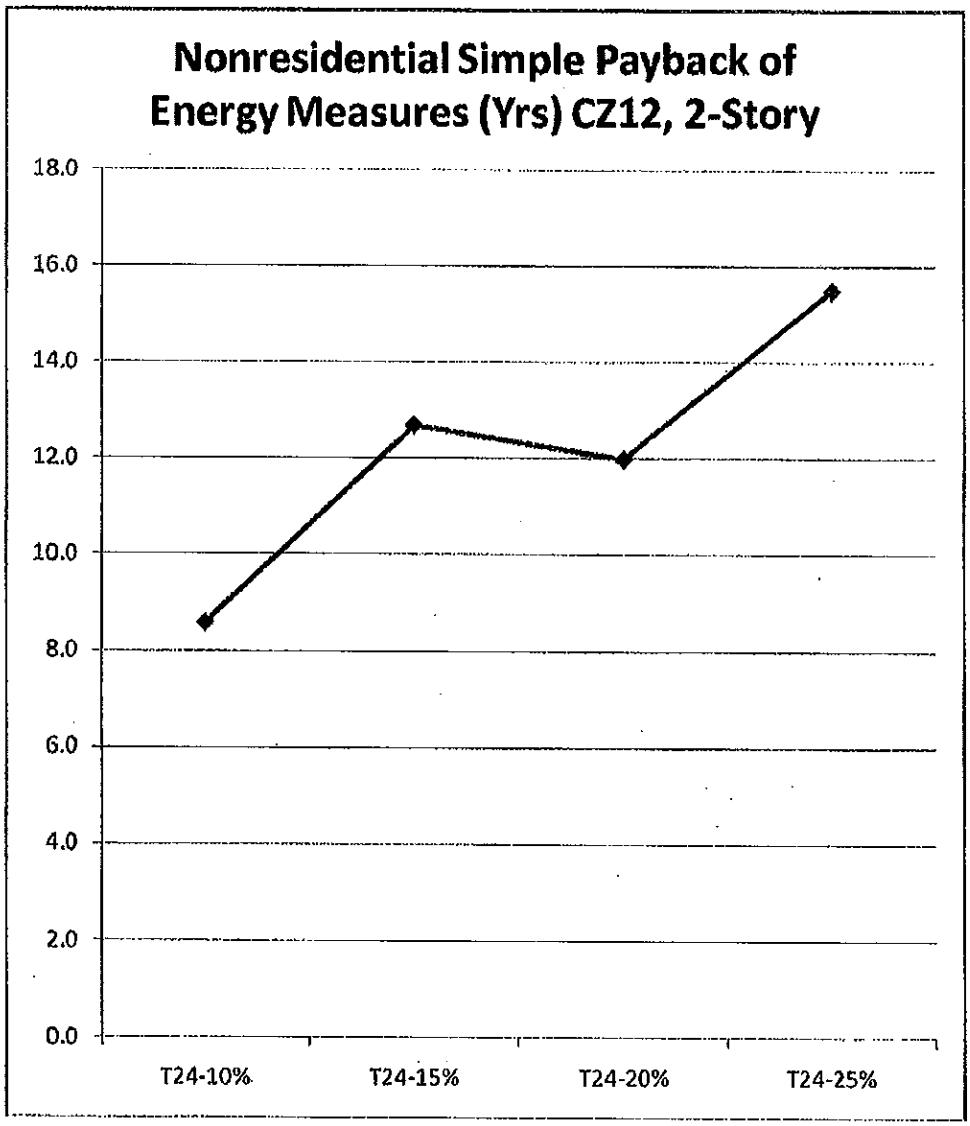


Figure 4-CZ12c-6: Simple Payback of Different Tiers of Energy Measures, 52,900 sf 5-Story Nonresidential Building

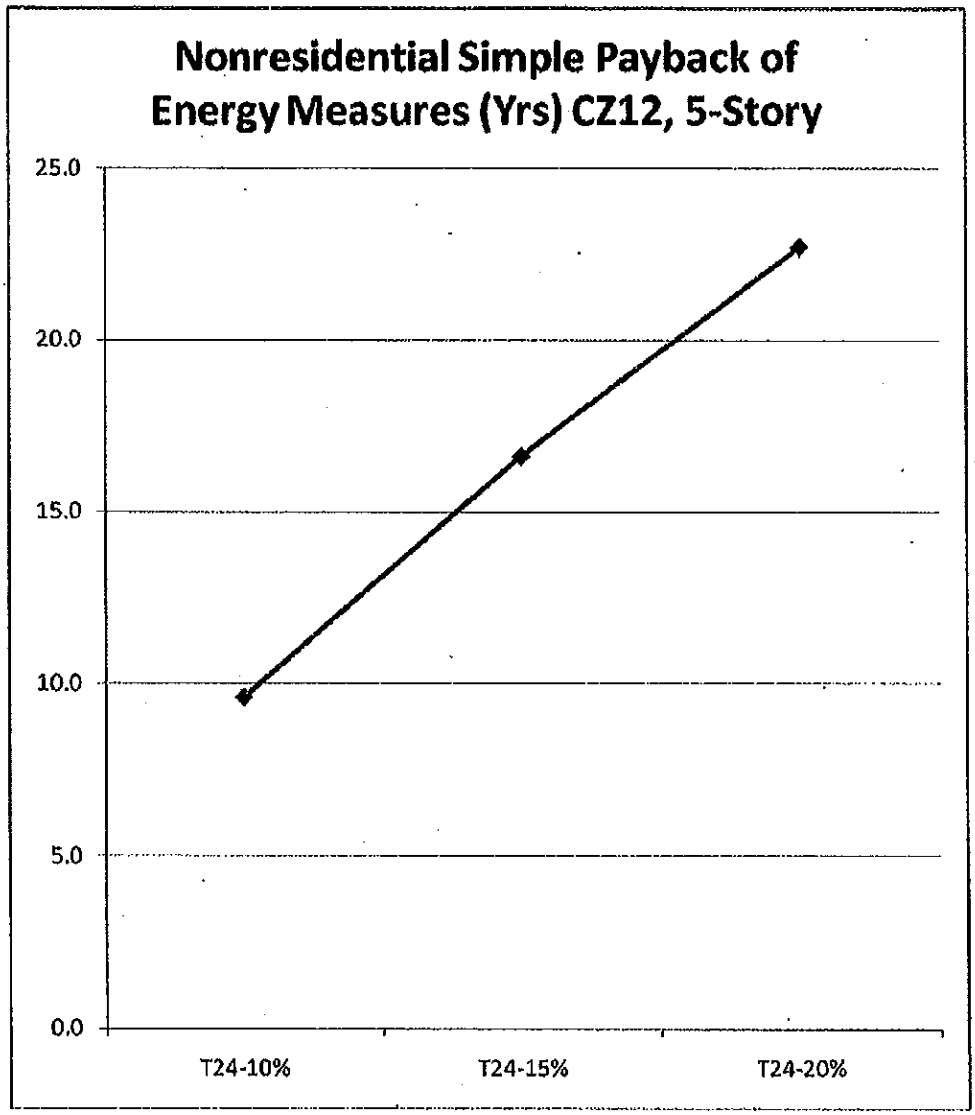


Figure 4-CZ12d-1: Added Cost/Sq.ft. per Lb. of CO2 Reduction, 2,025 sf 2-Story Single Family Home

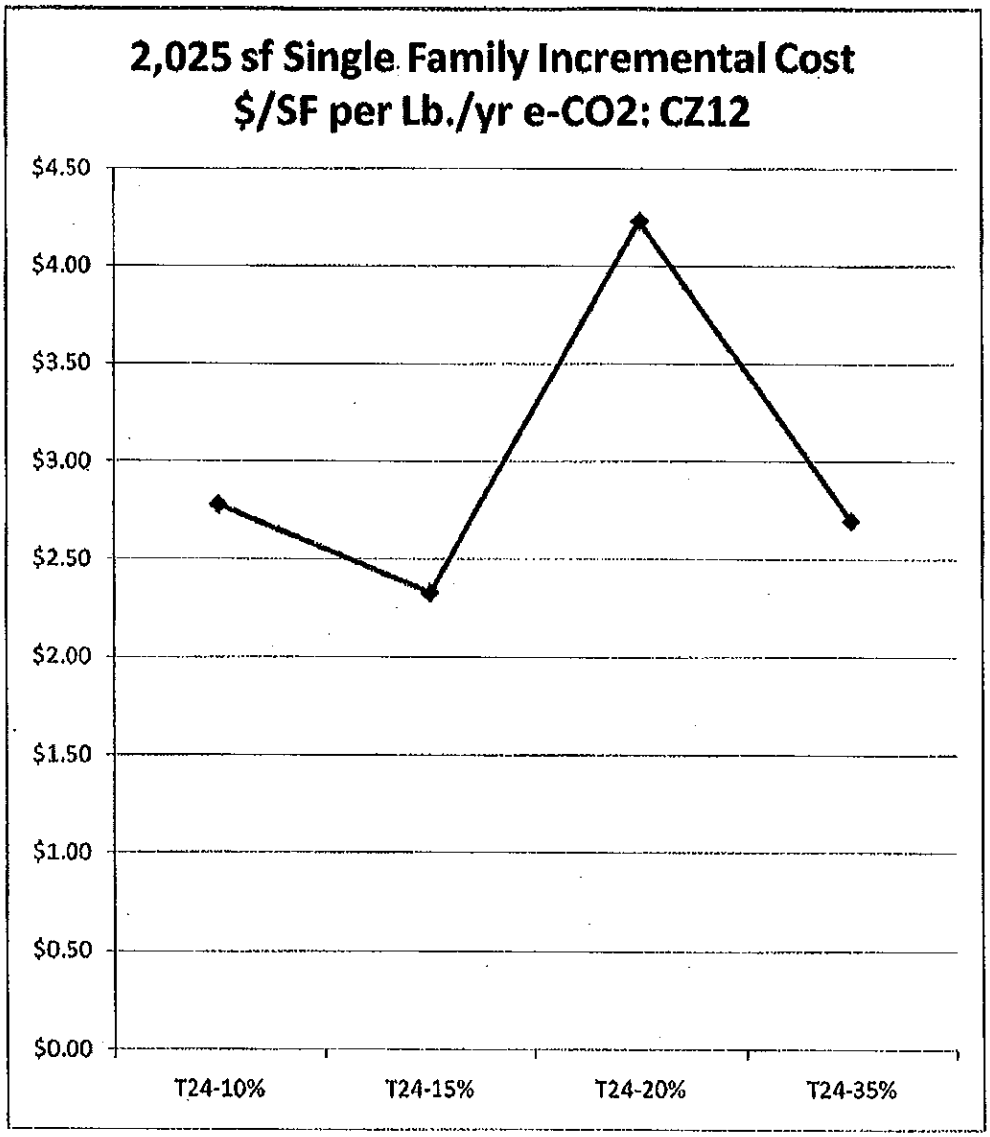


Figure 4-CZ12d-2: Added Cost/Sq.ft. per Lb. of CO2 Reduction, 1,582 sf 1-Story Single Family Home

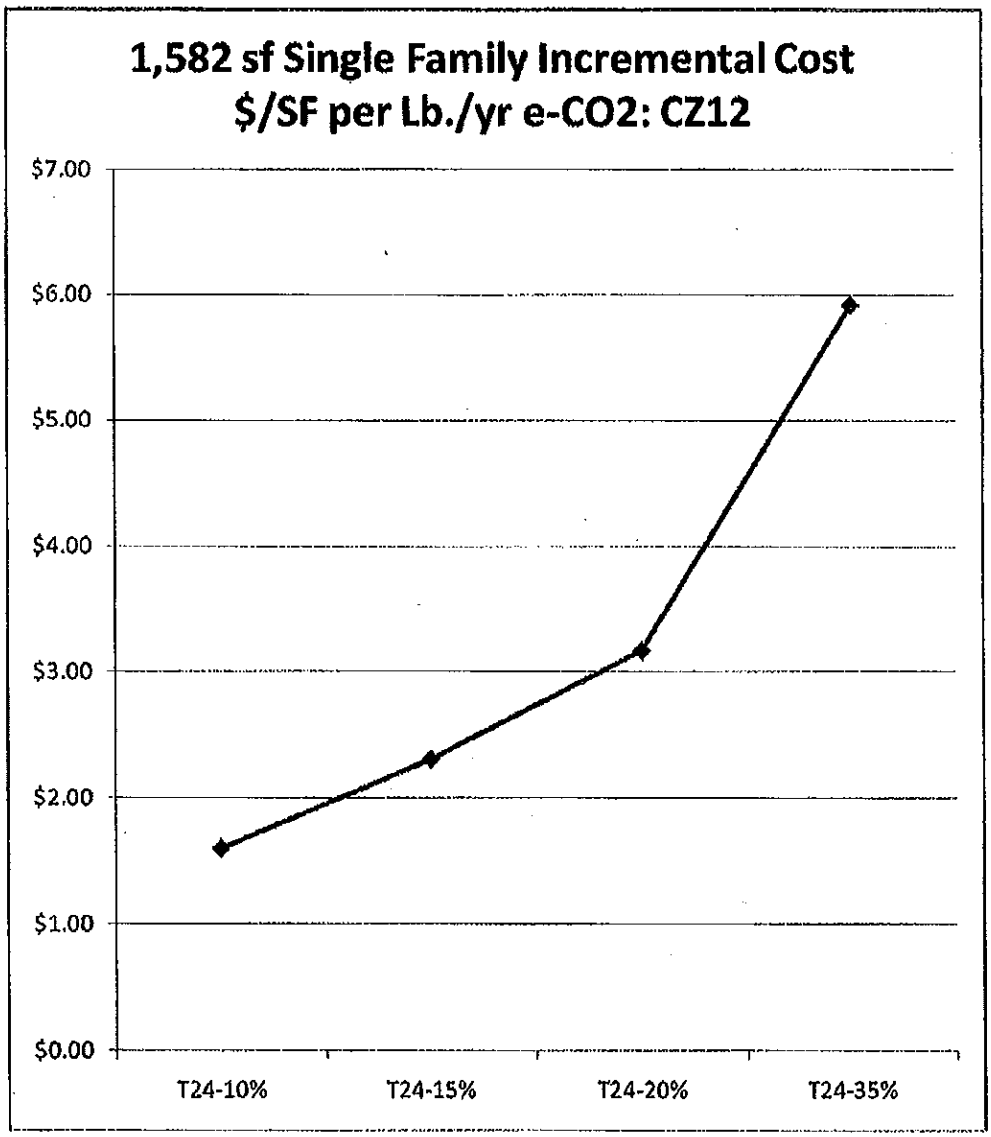


Figure 4-CZ12d-4: Added Cost/Sq.ft. per Lb. of CO2 Reduction, 2-Story Multifamily Building

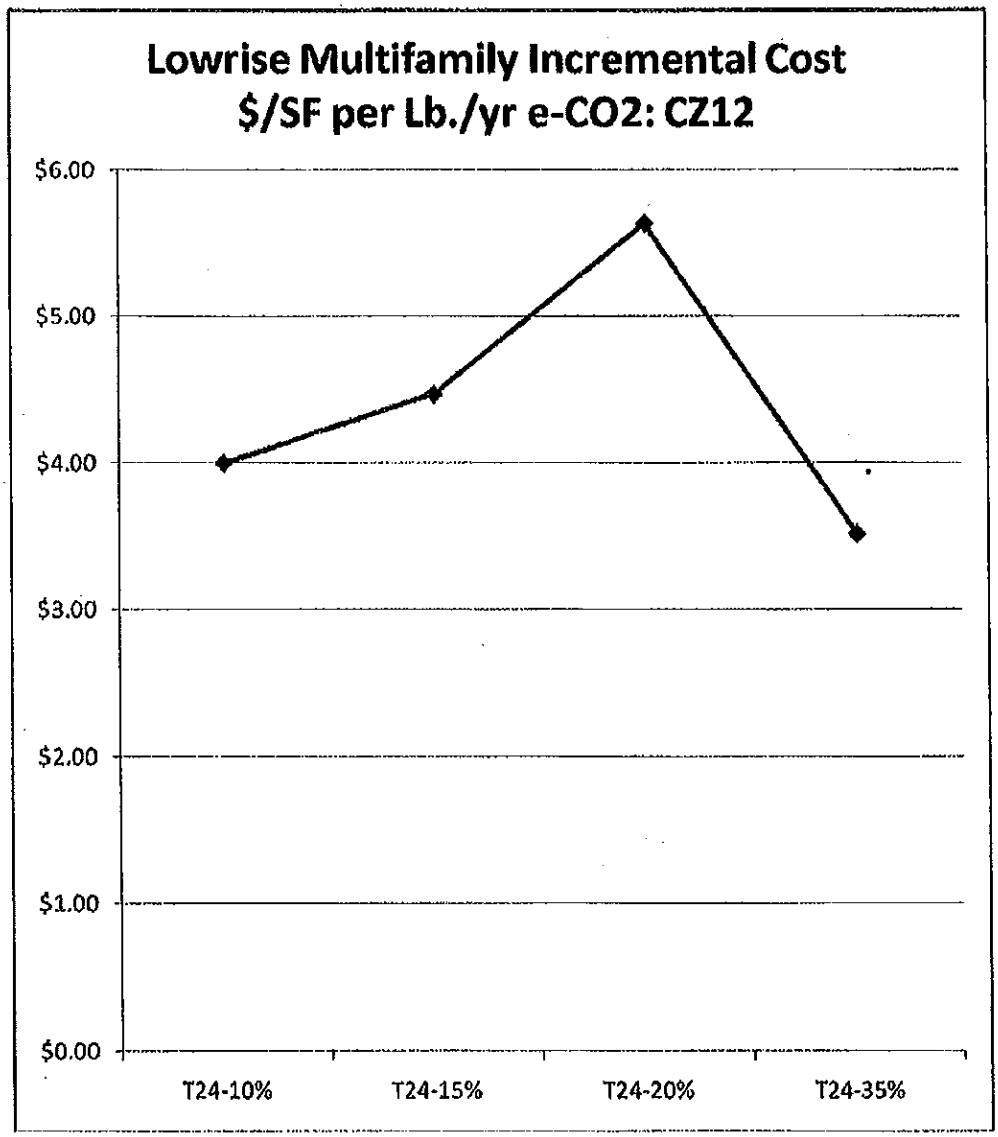


Figure 4-CZ12d-4: Added Cost/Sq.ft. per Lb. of CO2 Reduction, 40 Unit, 5-Story High-rise Residential Building

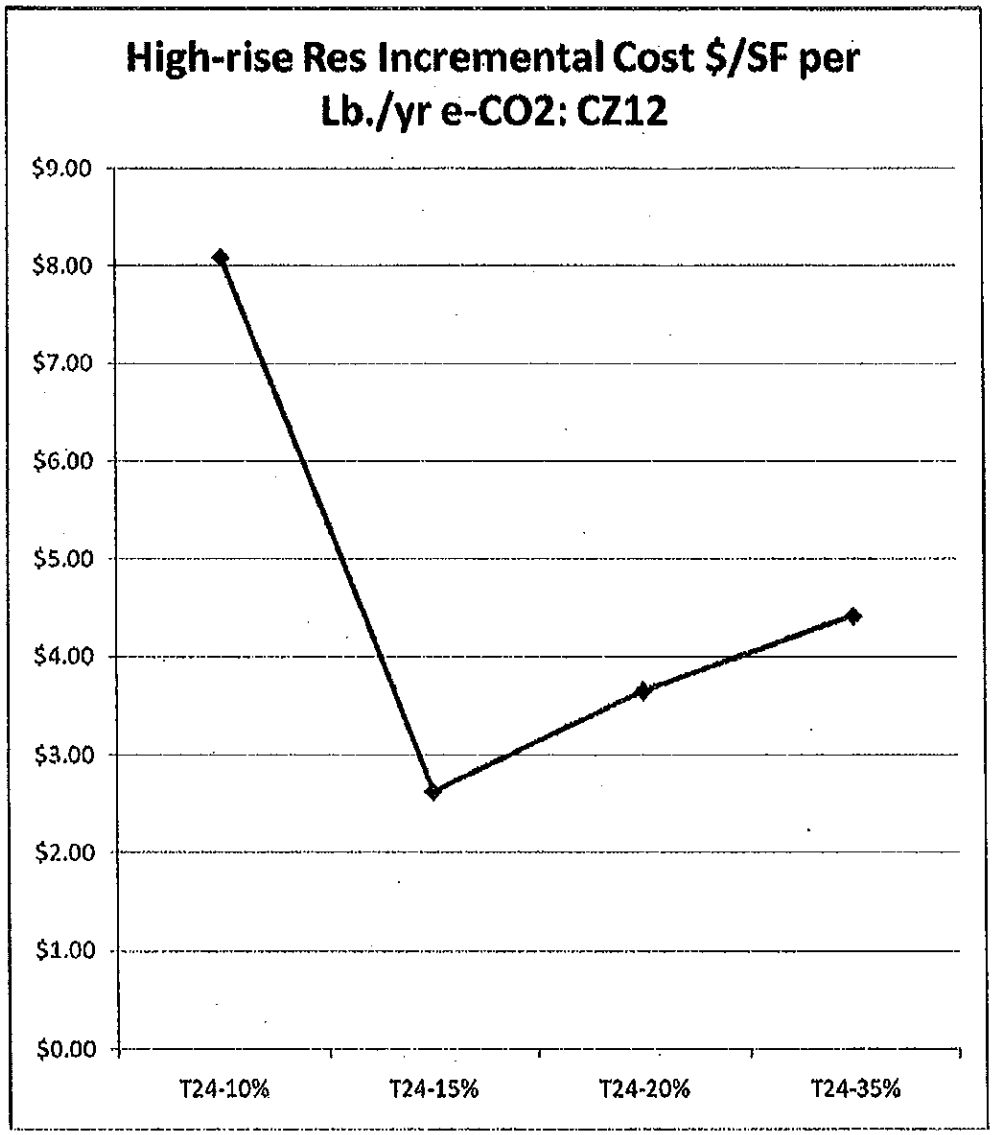


Figure 4-CZ12d-5: Added Cost/Sq.ft. per Lb. of CO2 Reduction, 21,160 sf 2-Story Nonresidential Building

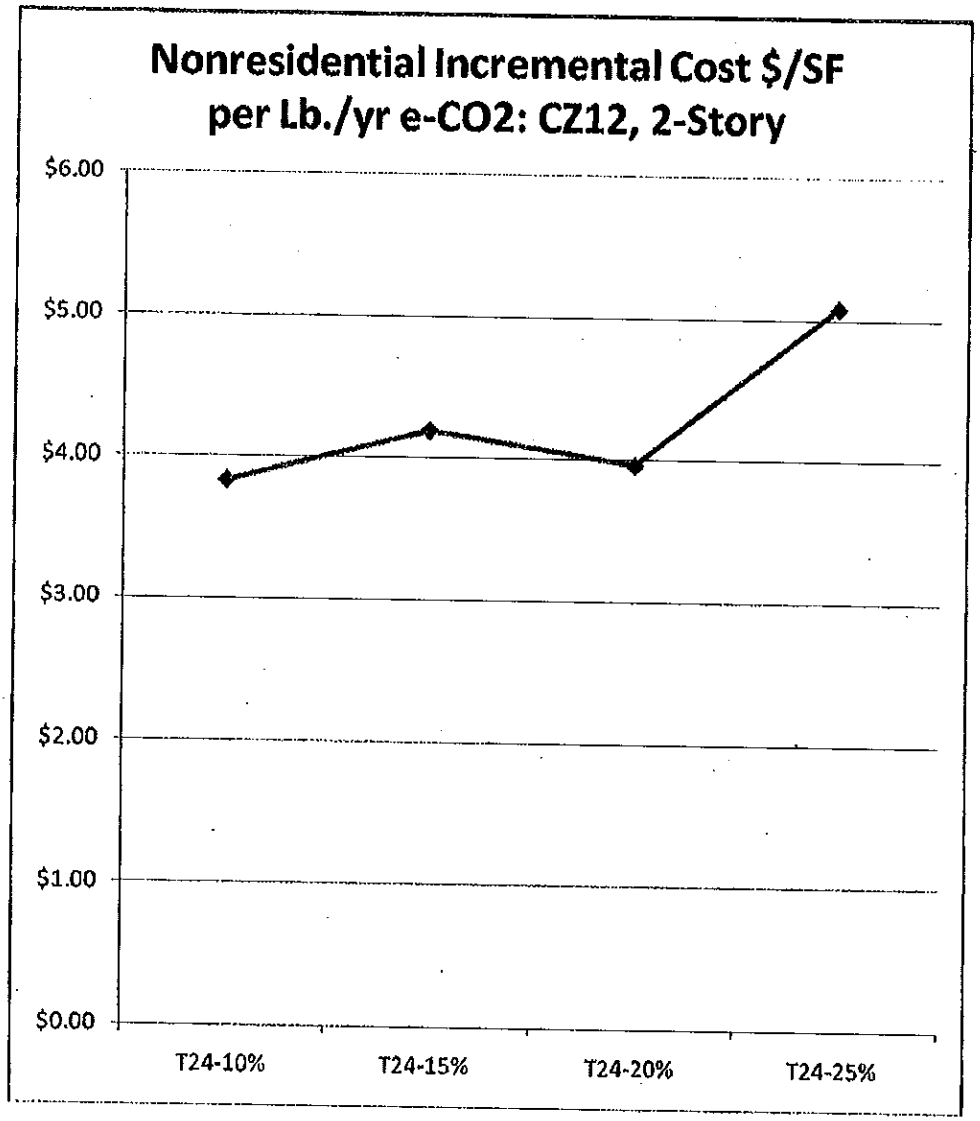


Figure 4-CZ12d-6: Added Cost/Sq.ft. per Lb. of CO2 Reduction, 52,900 sf 5-Story Nonresidential Building

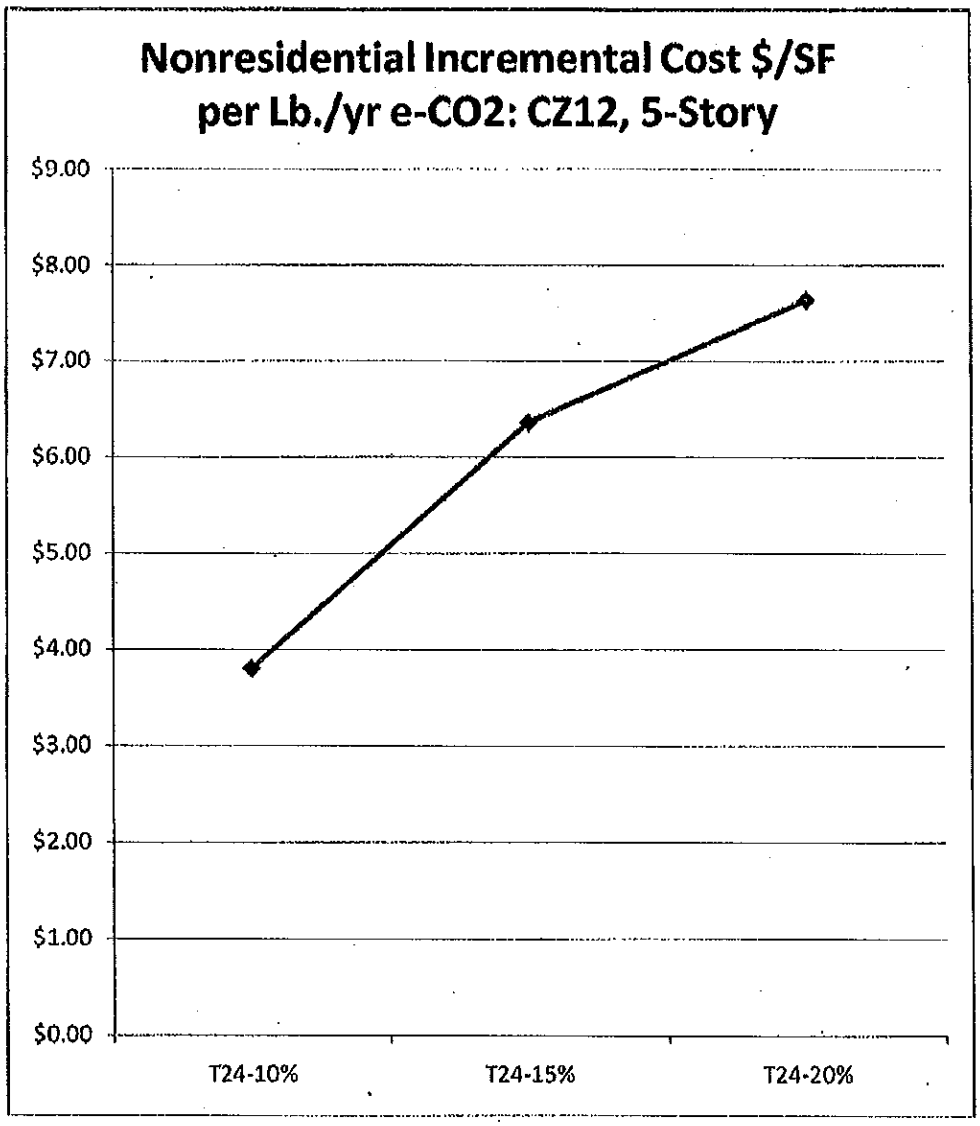


Figure 4-CZ12e-1: Annual Reduction in CO2 in Lbs./Sq.Ft. in Single Family, 2,025 sf 2-Story Single Family Home

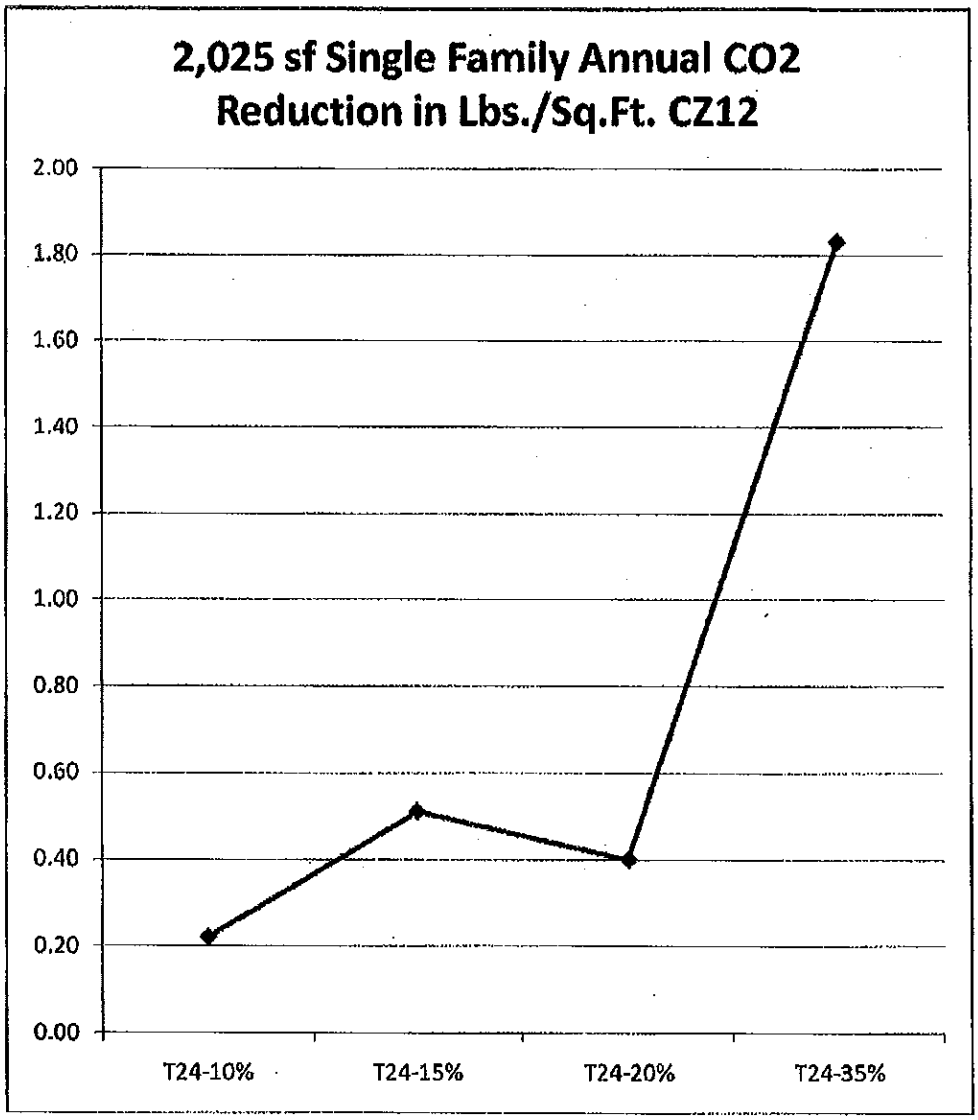


Figure 4-CZ12e-2: Annual Reduction in CO2 in Lbs./Sq.Ft. in Single Family, 1,582 sf 1-Story Single Family Home

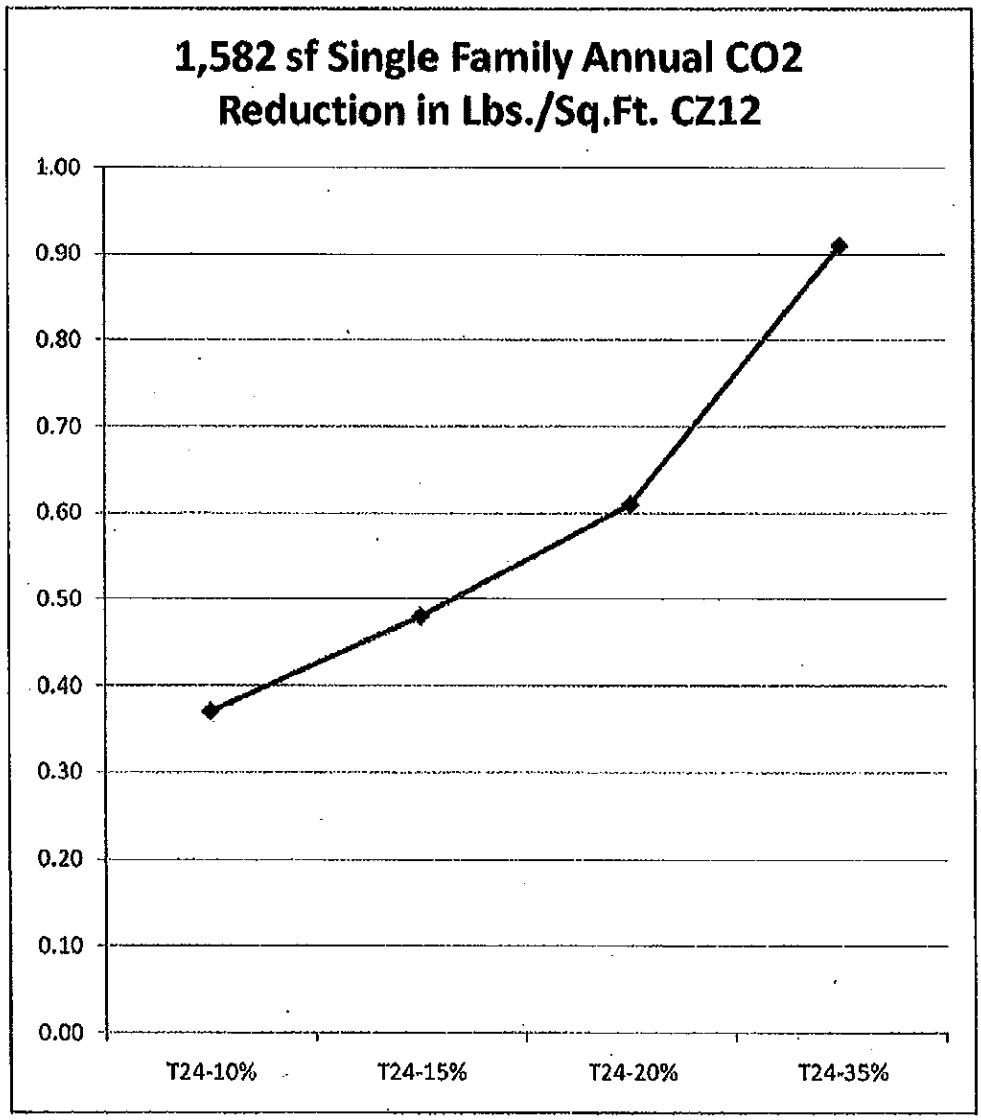


Figure 4-CZ12e-3: Annual Reduction in CO2 in Lbs./Sq.Ft., 2-Story Multifamily Building

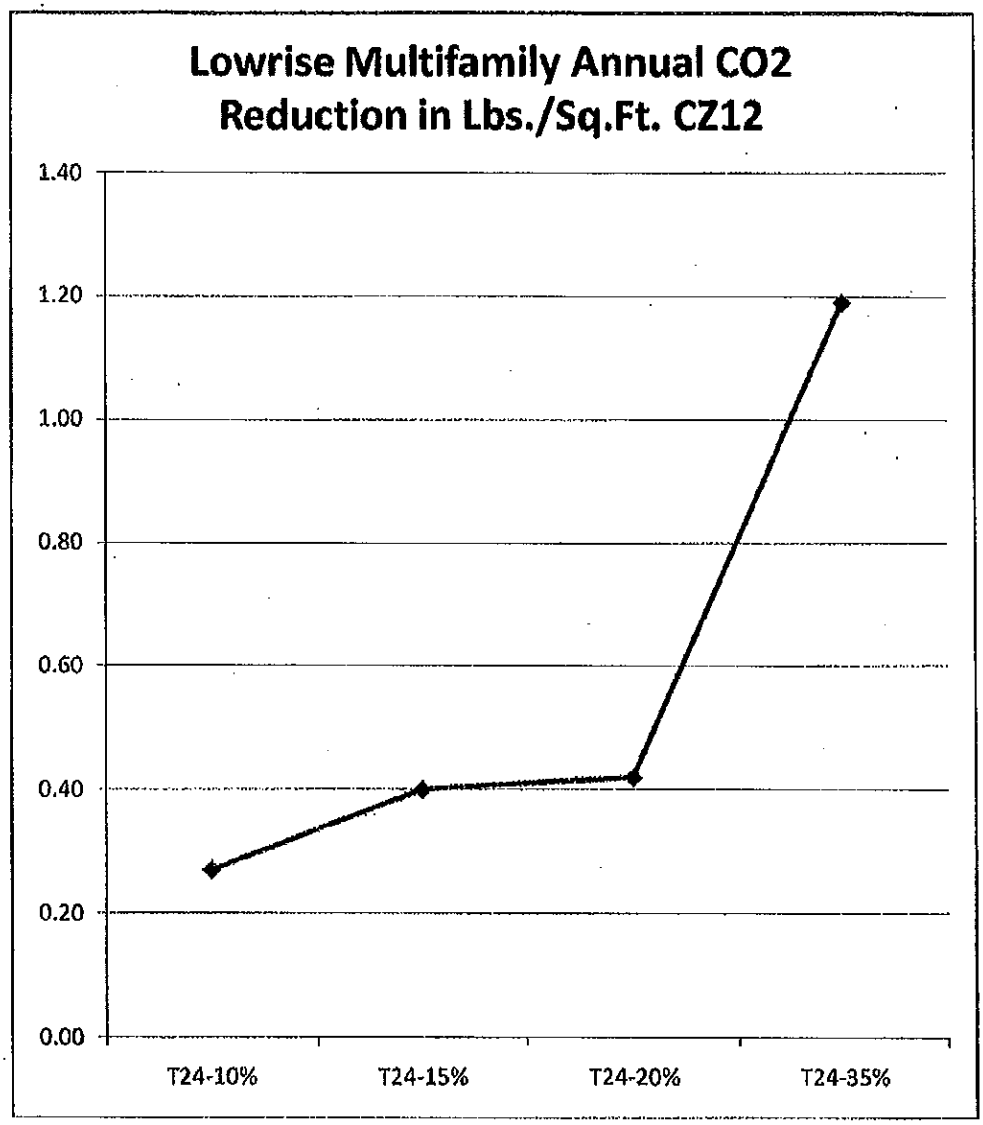


Figure 4-CZ12e-4: Annual Reduction in CO2 in Lbs./Sq.Ft., 40 Unit, 5-Story High-rise Residential Building

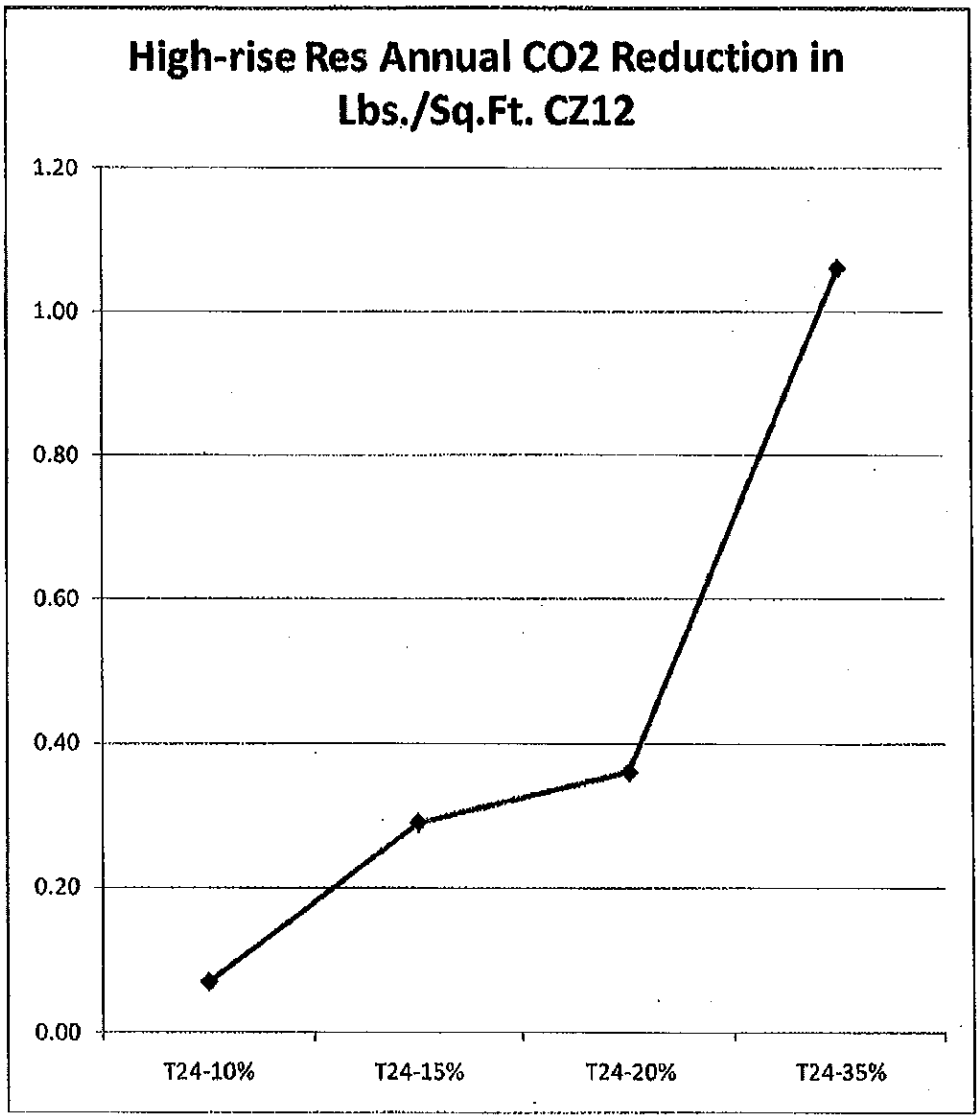


Figure 4-CZ12e-5: Annual Reduction in CO2 in Lbs./Sq.Ft., 21,160 sf 2-Story Nonresidential Building

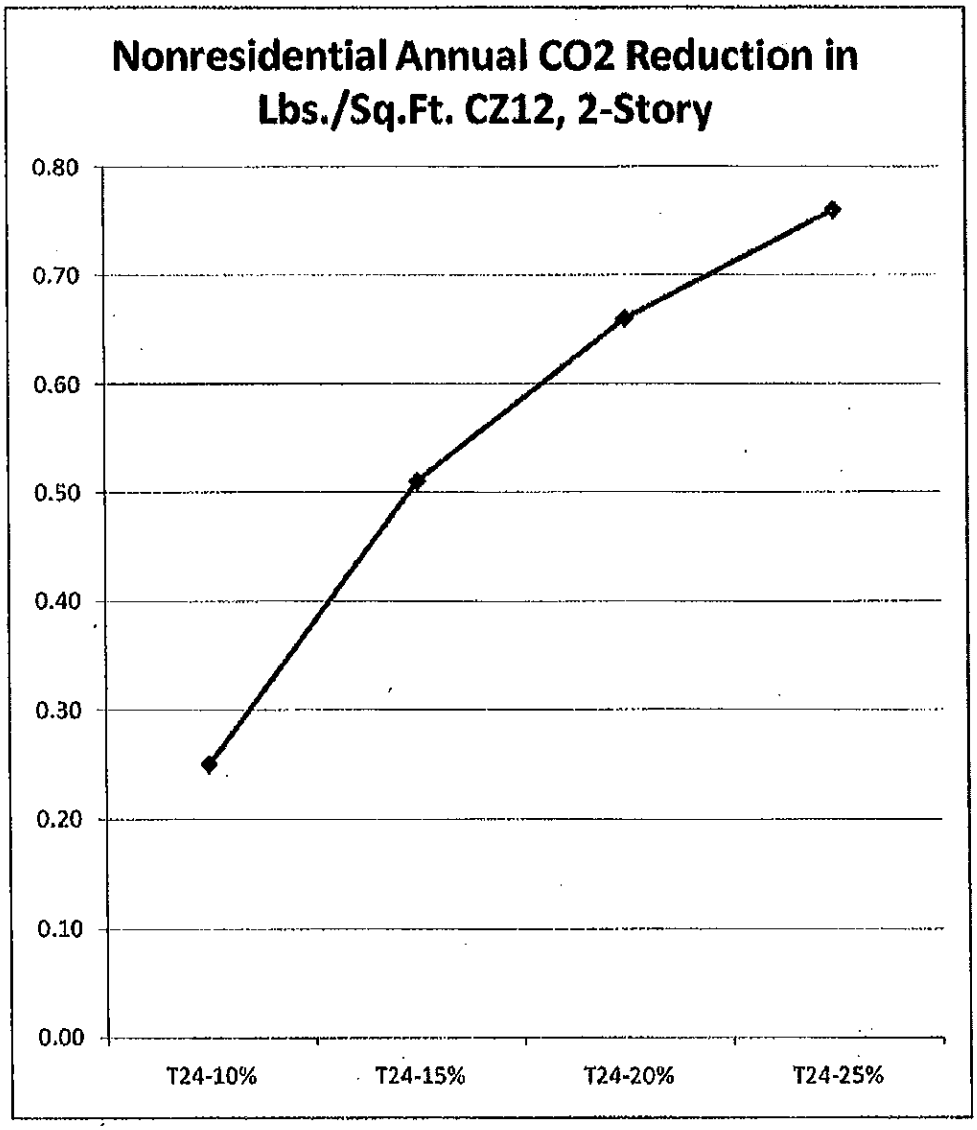
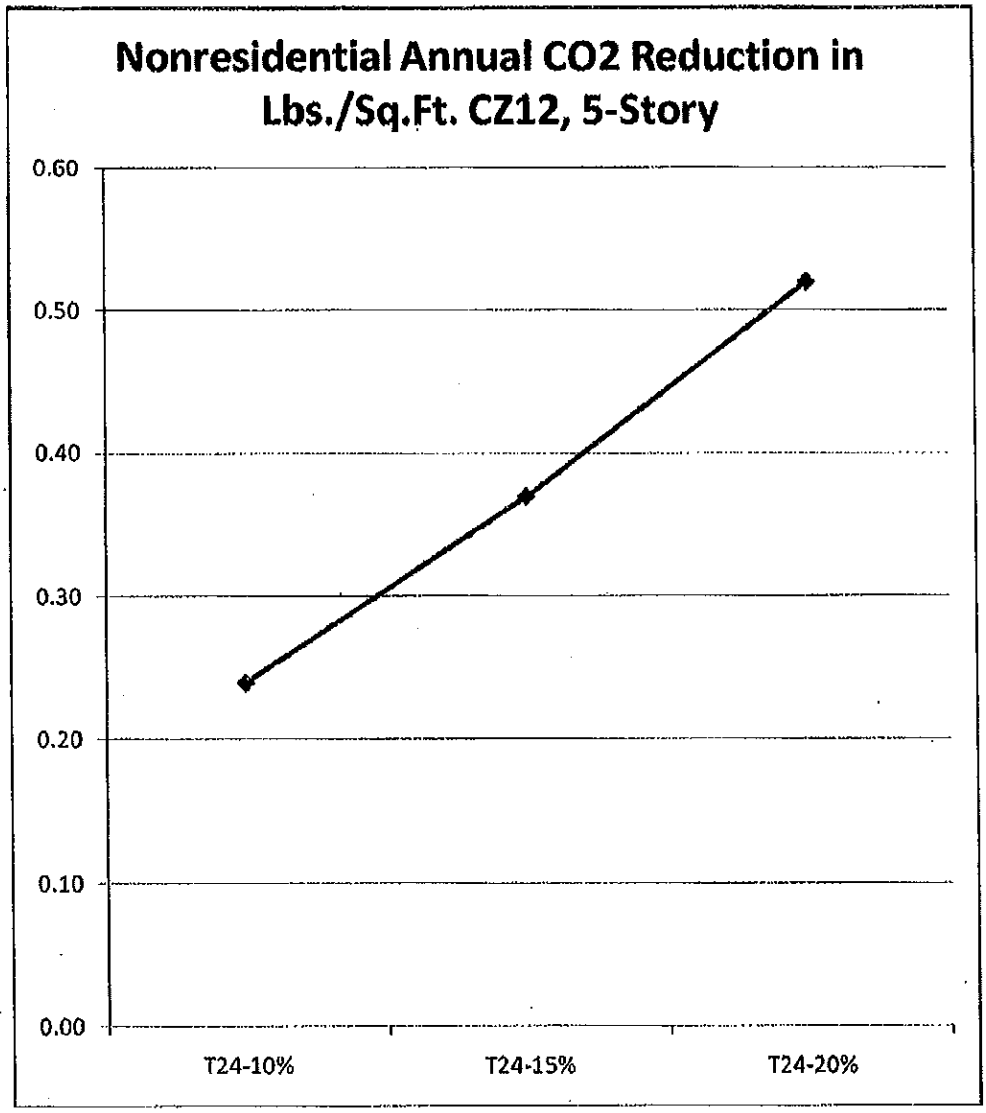


Figure 4-CZ12e-6: Annual Reduction in CO2 in Lbs./Sq.Ft., 52,900 sf 5-Story Nonresidential Building



5.0 Conclusions and Recommendations

5.1 Performance vs. Prescriptive Approach

While some local energy ordinances have in rare instances provided prescriptive options for local nonresidential envelope and lighting energy requirements, the performance approach has been implemented in all local ordinances for residential and nonresidential buildings as the most effective and cost-effective way to achieve higher levels of building energy efficiency. Rather than selecting specific energy measures as required, it is better to have the building industry determine how to reach energy-equivalence with the required efficiency level using the performance method. This is the approach used in a large variety of applications such as:

- Utility incentive programs
- State tax credits for solar PV systems (NSHP program)
- GreenPoint Rated green building system
- LEED green building system
- Local energy ordinances
- Low Income Housing Tax Credits
- ENERGY STAR New Homes
- Federal energy efficiency tax credits
- HERS Phase 2 for Existing and New Homes (2010)

Conversely, we strongly recommend against a local ordinance requiring prescriptive measures that can be modeled in the performance method. The reason is that, on a case-by-case basis, and because of many different variables, a specific energy measure (e.g., high performance Low-E windows with a U=0.33 and SHGC=0.23) may or may not be the most cost-effective solution in reducing energy use for a particular project.

5.2 Title 24 Analysis, Metric and Forms

Because of the familiarity of the building industry and building departments with Title 24 standards, it is best, as a minimum, to use the approved Title 24 software and modeling guidelines, the TDV energy in KBtu/sf-yr for Standard and Proposed designs, and the Title 24 compliance and installation/acceptance forms to document building energy performance measures. Special credits for solar PV systems and other options can be documented separately by the permit applicant, especially if a simple local compliance form is provided by the building department which augments the Title 24 report.

We recommend that all local ordinances use Title 24 methods, rules, software and reports wherever possible; and that those be augmented only when necessary to comply with or document a special energy credit.

5.3 LEED Energy Performance

Because there is a minimum energy requirement for LEED, and nonresidential buildings must meet LEED requirements in many local green building ordinances, it is worthwhile noting that:

(1) LEED 2009 (the next LEED program after v2 which is scheduled to be released sometime in 2009) is based on the ASHRAE 90.1-2007 energy performance standards, which uses the Energy Cost Budget (ECB) method to determine compliance. The minimum energy requirement for LEED 2009 is reducing annual energy cost by at least 10% below the 90.1-2007 baseline annual energy cost.

(2) The 90.1-2007 calculation and ECB metric is very different from the 2008 Title 24 calculation and TDV energy. The building industry in California does not generally understand how to meet and document the LEED requirement.

(3) Some local jurisdictions (e.g., San Francisco and Palo Alto) have adopted ordinances which give the chief building official or other designated City official the option to allow a Title 24 calculation and report to document LEED energy equivalence whether or not the project will be registered and reviewed by USGBC.

We recommend that any local ordinance which references LEED provide an administrative mechanism whereby a permit applicant can meet the minimum energy LEED requirement with a designated Title 24 energy equivalent performance.

5.4 Energy Efficiency before On-site Generation

To ensure consistency with State programs and maximum benefit to applicants seeking to apply for available incentives, a local energy ordinance that includes provisions for PV must meet all installation criteria in the "Guidelines for California's Solar Electric Incentive Programs Pursuant to Senate Bill 1." The methodology used to calculate the energy equivalent to the solar PV credit shall be the CECPV Calculator using the most recent version prior to the permit application date, which may be found at: http://www.gosolarcalifornia.ca.gov/nshpcalculator/. Because energy-efficiency is a more cost-effective investment than generation, programs such as State and Utility incentives, LEED and GreenPoint Rated award solar PV credit only after a building has already achieved the minimum energy efficiency performance.

5.5 Certified Energy Plans Examiners (CEPEs)

The California Association of Building Energy Consultants (CABEC) sponsors and administers the Certified Energy Plans Examiner (CEPE) program for the Residential and Nonresidential Standards. CEPE candidates must pass an examination to demonstrate knowledge of the applicable standards. We recommend that local ordinances include a requirement, or create a permit incentive, for the energy analysis and documentation to be prepared by an individual with the current applicable CEPE credential.