

**Application for Locally Adopted Energy Standards  
by the City of Cupertino  
In Accordance With Section 10-106  
of the California Code of Regulations, Title 24, Part 1**

November 19, 2012

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## Green Building Ordinance Summary

Public Resources Code Section 25402.1(h)2 and Section 10-106 of the Building Energy Efficiency Standards (Standards) establish a process that allows local adoption of energy standards that are more stringent than the statewide Standards. This process allows local governments to: adopt and enforce energy standards before the statewide Standards effective date; require additional energy conservation measures; and/or, set more stringent energy budgets. Because these energy standards “reach” beyond the minimum requirements of Title 24, Part 6 of the California Building Code, they are commonly referred to as Reach Codes.

The process for adopting a Reach Code requires that local governments apply to the California Energy Commission (CEC) for approval. As part of the application, the applicant jurisdiction must prepare a Cost-Effectiveness Study that provides the basis of the local government’s determination that the proposed Reach Code Standards are cost-effective. Once the CEC staff has verified that the local Reach Code Standards will require buildings to use no more energy than the current statewide Standards and that the documentation requirements in Section 10-106 are met, the application is brought before the full California Energy Commission for approval.

The Cupertino City Council approved a Green Building Ordinance, with a first reading on September 4, 2012. The ordinance requires that new residential projects of nine or more units obtain LEED for Homes or Green Point Rated certification and that non-residential projects larger than 25,000 square feet obtain LEED Building Design and Construction Certification. Major renovations of residential development of 35,000 square feet or greater are required to earn Green Point Rated or LEED certification and non-residential development of 35,000 square feet or greater are required to earn LEED certification. As both of LEED and Green Point Rated include prerequisites that include an energy efficiency improvement better than the code minimum, the City is effectively establishing a local energy ordinance or reach code.

<b>Table 1: Overall Scope of the Ordinance</b>	
New ordinance or revision to previous ordinance?	New Ordinance
Projected effective date:	July 1, 2013
Green building or stand-alone energy ordinance?	Green Building Ordinance that references third-party standards that include energy prerequisites
Do minimum energy requirements increase after initial effective date?	No
Occupancies covered include:	Single-family Residential Multifamily Residential Nonresidential
Energy requirements apply to new construction, additions, alterations?	New Construction and some Major Renovations (as defined by the local agency)
Special or unusual energy requirements?	No
Third party verification?	Yes, through GBCI or Built it Green
Implementation details in the ordinance or in a separate document?	No special implementation guidelines. See Implementation section

The required level energy performance that exceeds the Title 24, Part 6 minimum is the result of prerequisites in the LEED for Building Design and Construction, LEED for Homes, and Green Point Rated green building rating systems. LEED uses international reference standards, ASHRAE 90.1 2007 and the 2004 International Energy Conservation Code. Equivalencies have been established for the application of the LEED standards in California as follows: LEED for Homes requires 15% improvement over 2008 Title 24, Part 6 Low-Rise Residential standard and 14.5% improvement over the High-Rise Residential standard. Green Point Rated requires a 15% improvement over both the Low-Rise and High-Rise standards. LEED for Building and Design and Construction (commonly referred to as the LEED ND) requires 10% improvement over the 2008 Title 24, Part 6 Non-Residential standards for new construction and a 5% improvement for major renovations.

The LEED rating system offers four levels of certification, Certified, Silver, Gold, and Platinum, each of which requires that a project earn an increasing number of points. However, the energy prerequisites described above do not increase with the level of certification. Projects required to achieve LEED certification above the minimum Certified level would not inherently be required to achieve levels of energy efficiency that exceed what is addressed in the Climate Zone 3 cost-effectiveness study.

<b><i>Building Type</i></b>	<b><i>Percentage Better than 2008 Title 24, Part 6</i></b>
Low-Rise Residential (3 stories and below)	15%
High-Rise Residential (4 stories and greater)	15%
Non-Residential	10%
Major Renovation Residential	15%
Major Renovation Non-Residential	5%

### **Cost-Effectiveness Determination**

The energy requirements in Green Building Ordinance were informed by the cost-effectiveness study for Climate Zone 3 prepared by Pacific Gas and Electric Company in support of local reach codes. The cost-effectiveness analysis is based on exceeding the 2008 code by 15%, which is consistent with or exceeds the levels that are required by the Cupertino Green Building Ordinance.

The six building types addressed in the Climate Zone study are:

Small Single Family House  
2-story, 2,025 sf

Large Single Family House  
2-story, 4,500 sf

Low-rise Multi-family Apartments  
8 dwelling units/2-story, 8,442 sf

High-rise Multi-family Apartments  
40 dwelling units/4-story, 36,800 sf

Low-rise Office Building  
*1-story, 10,580 sf*

High-rise Office Building  
*5-story, 52,900 sf*

Buildings of the above types are typical of the type of development in Cupertino. Future development is most likely to be consistent with the Large Single-Family House, High-Rise Apartments, and High-Rise Office Building typologies. The typical paybacks for these building types were discussed as part of the stakeholder outreach and public meetings related to the development and adoption of the Green Building Ordinance.

The Climate Study 3 study determined that a 15% improvement over the 2008 code is cost effective for all of the project types. As these project types are consistent with the type of development in Cupertino and the green building programs used as reference standards for the Cupertino Ordinance require a similar or lesser level of energy efficiency that that addressed in the cost-effective study, the requirements of the Cupertino Green Building Ordinance are consist with the Climate Zone 3 cost-effectiveness determination.

The Climate Zone 3 study is included as part of this application.

### **Implementation Approach**

To implement the Green Building Ordinance, specifically the energy reach code related portions, the City of Cupertino Building Official will review the Title 24, Part 6 CF-1R form to determine that the proposed building exceeds 2008 Standards by amount required by the applicable green building rating system, as described above. Projects will also be required to show proof of registration with the applicable green building program. The energy performance will also be reviewed by the LEED/GBDI reviews at the time of certification.

Field inspection of the energy features by the City will be identical to the process currently in place by the City for the 2008 Standards, or subsequently adopted state energy standards, whichever is applicable at the time of the building permit application. Depending on the type of certification pursued (LEED or Green Point Rated) additional field verification of the energy features by a HERS Rater or commissioning agent will be conducted. To further ensure successful implementation of the Green Building Ordinance, the City will provide special training as needed to City staff on enforcement of the energy standards and the special requirements of the Green Building Ordinance.

**ORDINANCE NO. 12-2099**

**AN ORDINANCE OF THE CITY COUNCIL OF THE CITY OF CUPERTINO  
AMENDING CHAPTER 16.58 OF THE CUPERTINO MUNICIPAL CODE TO  
AMEND THE GREEN BUILDING STANDARDS CODE TO INCLUDE LOCAL  
GREEN BUILDING REQUIREMENTS**

**WHEREAS**, the City Council authorized staff on January 19, 2010 to proceed with the development of a green building ordinance incorporating green building measures; and

**WHEREAS**, green building is a “whole systems” approach to the design, construction, location, and operation of buildings and structures to help mitigate the environmental, economic and social impacts of construction, demolition and renovation of buildings and structures; and

**WHEREAS**, the Environmental Resources and Sustainability Element of the City of Cupertino’s General Plan 2000-2020 recognizes that the community’s environmental resources are fragile, invaluable and interrelated, and protecting and sustaining the City’s viable ecological communities and environmental resources will result in the protection of both the human and natural environments; and

**WHEREAS**, the City of Cupertino’s General Plan 2000-2020 sets forth policies recognizing that the essential components of green building design and planning include consideration of location, site planning, energy efficiency, material efficiency and water efficiency; and

**WHEREAS**, the California Green Building Standards Code Section 101.7 provides that a local government may establish more stringent building standards if they are reasonably necessary due to local climactic, geologic, topographical or environmental conditions; and

**WHEREAS**, the City of Cupertino has already adopted ordinances to further green building measures, including the California Green Building Standards Code, the Landscaping Ordinance to reduce water waste, Recycling and Diversion of Construction and Demolition Waste Ordinance, and Stormwater Pollution and Prevention and Watershed Protection; and

**WHEREAS**, the City of Cupertino intends to adopt local amendments to the California Green Building Standards Code by establishing green building requirements exceeding the Mandatory Requirements of the 2010 California Green Building Standards Code; and

**WHEREAS**, the Planning Commission adopted Resolution No. 6615 to recommend adoption of green building measures in a green building ordinance as a result of conducting public hearings; and

**WHEREAS**, the City Council has determined that amending Chapter 16.58, Green Building Standards Code, is necessary to incorporate local green building requirements; and

**WHEREAS**, the City Council of the City of Cupertino conducted properly noticed public hearings; and

**WHEREAS**, adoption of the ordinance will improve the environment and is in the public interest.

**NOW, THEREFORE, THE CITY COUNCIL OF THE CITY OF CUPERTINO HEREBY ORDAINS AS FOLLOWS:**

**Section 1.** Title 16 of the Cupertino Municipal Code is hereby amended by the adoption of amendments to Chapter 16.58 as set forth in Exhibit A.

**Section 2.** The City Council adopts the findings for local amendments to the California Green Building Standards Code, 2010 Edition, attached hereto as Exhibit B and incorporated herein by reference.

**Section 3.** Because this project will assure the maintenance, restoration, enhancement, or protection of the environment and does not relax the regulation of construction activities or standards allowing environmental degradation, this project is exempt from CEQA pursuant to CEQA Guidelines section 15308.

**Section 4.** Should any provision of this Ordinance, or its application to any person or circumstance, be determined by a court of competent jurisdiction to be unlawful, unenforceable or otherwise void, that determination shall have no effect on any other provision of this Ordinance or the application of this Ordinance to any other person or circumstance and, to that end, the provisions hereof are severable.

**Section 5.** This Ordinance shall take effect and be in force on July 1, 2013 as provided by Government Code Section 36937.

**Section 6.** The City Clerk shall certify to the passage and adoption of this Ordinance and shall give notice of its adoption as required by law. Pursuant to Government Code Section 36933, a summary of this Ordinance may be published and posted in lieu of publication and posting of the entire text.

**INTRODUCED** at a regular meeting of the Cupertino City Council the 4th day of September 2012 and **ENACTED** at a regular meeting of the Cupertino City Council on this 18<sup>th</sup> of September 2012 by the following vote:

AYES: Santoro, Mahoney, Sinks, Wong  
NOES: Chang  
ABSENT: None  
ABSTAIN: None

ATTEST:

/s/Grace Schmidt

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Grace Schmidt, City Clerk

APPROVED:

/s/Mark Santoro

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Mark Santoro, Mayor, City of Cupertino

**Exhibit A**

**City of Cupertino**

**CHAPTER 16.58: GREEN BUILDING STANDARDS CODE ADOPTED**

**16.58.010 Code Adoption.**

The provisions of the 2010 California Green Building Standards Code and each and all of the regulations, provisions, conditions and terms of the code is referred to as if fully set forth in this chapter, and is by such reference adopted.

One (1) copy of the code therefore is on file in the office of the Building Official pursuant to Health and Safety Code Section 18942(d)(1) and is made available for public inspection.

**16.58.015 Adoption of Appendix Chapters**

No Appendix Chapters from the 2010 California Green Building Standards Code have been adopted.

**16.58.040 Local Amendments**

The following provisions of this Chapter shall constitute local amendments to the cross-referenced provisions of the California Green Building Standards Code, 2010 Edition, and shall be deemed to amend the cross-referenced sections of said Code with the respective provisions set forth in this Chapter.

**16.58.050 Section 101.1 – Amended**

Amend Section 101.1 to read as follows:

**101.1 Title.** These regulations shall be known as the California Green Building Standards Code as amended by the City of Cupertino and may be cited as such and will be referred to herein as “this code.” The California Green Building Standards Code as amended by the City of Cupertino is an amendment to Part 11 of 12 parts of the official compilation and publication of the adoption, amendment and repeal of building regulations to the California Code of Regulations, Title 24, also referred to as the California Building Standards Code.

**16.58.070 Section 101.3 – Amended**

Amend Section 101.3 to read as follows:

**101.3 Scope.** The provisions of this code shall apply to the planning, design, operation, construction, use and occupancy of every newly constructed building or structure, unless otherwise indicated in this code for the City of Cupertino.

The California Green Building Standards Code also is hereby amended to apply to additions, renovations and tenant improvements of privately-owned buildings and structures in accordance

with the provisions of this Chapter.

It is not the intent that this code substitute or be identified as meeting the certification requirements of any private, third party green building program.

**16.58.100 Section 101.10 – Amended.**

Amend Section 101.10 to read as follows:

**101.10 Mandatory requirements.** This code contains mandatory green building measures. In addition, this Chapter contains required minimum green building measures as amended by the City of Cupertino. All new buildings and structures, additions, renovations and tenant improvements subject to requirements in Table 101.10 shall comply with the mandatory measures of the 2010 California Green Building Standards Code as adopted by the state in addition to local amendments included in this code, regardless of height or number of stories, unless specifically exempted by this code.

**16.58.110 Section 101.10.1 – Added**

Add Section 101.10.1 to read as follows:

**101.10.1 Project Types** – as set forth in Table 101.10.

**16.58.120 Section 101.10.1.1 – Added.**

Add Section 101.10.1.1 to read as follows:

**101.10.1.1 Residential projects** – as set for in Table 101.10.

**16.58.130 Section 101.10.1.1.1 – Added**

Add Section 101.10.1.1.1 to read as follows:

**101.10.1.1.1 Residential new construction – Equal to or less than nine (9) homes** – as set forth in Table 101.10.

**16.58.140 Section 101.10.1.1.2 -- Added:**

Add Section 101.10.1.1.2 to read as follows:

**101.10.1.1.2 Residential new construction – Greater than nine (9) homes or more** – as set forth in Table 101.10.

**16.58.150 Section 101.10.1.1.3 -- Added**

Add Section 101.10.1.1.3 to read as follows:

**101.10.1.1.3 Major multi-family residential renovations/additions** – as set forth in Table 101.10. Requirements shall only apply to the area of renovation/addition.

**16.58.160 Section 101.10.1.1.4 - Added**

Add Section 101.10.1.1.4 to read as follows:

**101.10.1.1.4 Non-residential new construction, small** – as set forth in Table 101.10.

**16.58.170 Section 101.10.1.1.5 – Added**

Add Section 101.10.1.1.5 to read as follows:

**101.10.1.1.5 Non-residential new construction, medium** -- as set forth in Table 101.10.

**16.58.180 Section 101.10.1.1.6 – Added**

Add Section 101.10.1.1.6 to read as follows:

**101.10.1.1.6 Non-residential new construction, large** -- as set forth in Table 101.10.

**16.58.190 Section 101.10.1.1.7 – Added**

Add Section 101.10.1.1.7 to read as follows:

**101.10.1.1.7 Non-residential renovations/additions, minor** -- as set forth in Table 101.10. Requirements shall only apply to the scope of work of renovation/addition.

**16.58.200 Section 101.10.1.1.8 – Added**

Add Section 101.10.1.1.8 to read as follows:

**101.10.1.1.8 Non-residential renovations/additions, major** -- as set forth in Table 101.10. Requirements shall only apply to the area of renovation/addition.

**16.58.210 Section 101.10.1.1.9 – Added**

Add Section 101.10.1.1.9 to read as follows:

**101.10.1.1.9 Mixed-Use** -- as set forth in Table 101.10.

**16.58.220 Table 101.10 – Added**

Add Table 101.10 to read as follows:

<i>Project Type</i>	<i>Minimum Green Building Requirement</i>	<i>Required Verification</i>
<b>A. NEW CONSTRUCTION</b>		
<b>Residential</b>		
<b>Single Family and Multi-Family homes equal to or less than 9 homes:</b>	<ul style="list-style-type: none"> <li>CALGreen Building Code in accordance with CALGreen’s minimum thresholds.</li> </ul>	City Review
<b>Single Family and Multi-Family homes greater than 9 homes:</b>	<ul style="list-style-type: none"> <li>GPR certified at minimum 50 points or</li> <li>LEED Silver or</li> <li>Alternate Reference Standard per Section 101.10.2</li> </ul>	Third Party GPR or LEED certification as applicable  Alternate Reference Standard: See Section 101.10.2
<b>Non-Residential</b>		
<b>Small, less than 25,000 SF:</b>	<ul style="list-style-type: none"> <li>CALGreen Building Code * per Chapter 5 of the California Green Building Standards Code</li> </ul>	City Review
<b>Mid-size, from 25,000 to 50,000 SF:</b>	<ul style="list-style-type: none"> <li>LEED Certified or</li> <li>Alternate Reference Standard per Section 101.10.2</li> </ul>	Third Party LEED Certification Alternate Reference Standard: See Section 101.10.2
<b>Large, greater than 50,000 SF:</b>	<ul style="list-style-type: none"> <li>LEED Silver or</li> <li>Alternate Reference Standard per Section 101.10.2</li> </ul>	Third Party LEED Certification  Alternate Reference Standard: See Section 101.10.2

<i>Project Type</i>	<i>Minimum Green Building Requirement</i>	<i>Required Verification</i>
<b>B. RENOVATIONS AND ADDITIONS</b>		
<b>a. Residential</b>		
<b>i. Single-family</b>	<ul style="list-style-type: none"> <li>CALGreen Building Code in accordance with CALGreen’s minimum thresholds.</li> </ul>	City Review
<b>ii. Multi-family (minor):</b>	<ul style="list-style-type: none"> <li>CALGreen Building Code in accordance with CALGreen’s minimum thresholds.</li> </ul>	City Review
<b>iii. Multi-family (major):</b> Renovations and/or additions with a Floor Area Ratio (FAR) increase $\geq 50\%$ and at least 35,000 square feet, and that replace or substantially alter the HVAC system and at least two of the following: building envelope, hot water system and lighting system.	<ul style="list-style-type: none"> <li>GPR minimum 50 pts or</li> <li>LEED Certified or</li> <li>LEED EBOM Certified or</li> <li>Alternate Reference Standard per Section 101.10.2</li> </ul>	Third Party GPR or LEED Certification as applicable  Alternate Reference Standard: See Section 101.10.2
<b>b. Non-Residential</b>		
<b>i. Minor:</b> Renovations and/or additions that do not meet the higher thresholds for “major renovations and additions” outlined as defined in (ii) below.	<ul style="list-style-type: none"> <li>CALGreen Building Code in accordance with CALGreen’s minimum thresholds.</li> </ul>	City Review
<b>ii. Major:</b> Renovations and/or additions that comprise at least 35,000 square feet, and replace or substantially alter the HVAC system and two of the following: building envelope, hot water system, and lighting system.	<ul style="list-style-type: none"> <li>LEED Certified (applicable only to the area of renovation/addition) or</li> <li>LEED EBOM Certified or</li> <li>Alternate Reference Standard per Section</li> </ul>	Third Party LEED Certification  Alternate Reference Standard: See Section 101.10.2

<i>Project Type</i>	<i>Minimum Green Building Requirement</i>	<i>Required Verification</i>
	101.10.2	
<p><b>Mixed-Use</b>                      For new and renovation/addition projects with residential and non-residential components, the use shall comply by either:</p> <ol style="list-style-type: none"> <li>1. Meeting the applicable requirements for each use; or</li> <li>2. Meeting the applicable requirements for the use that comprises the majority of the project's square footage/where uses are attached and/or combined in a building.</li> </ol>		
<p><b>Notes:</b>  <i>"Major" renovations and/or additions" apply only to the area of the renovation/addition unless the LEED EBOM Certified option is selected.</i>  <i>*Chapter 5 of the California Green Building Standards Code (Cal Green Mandatory) requirements shall only be applied to elements included in the scope of a project, unless otherwise required by the California Green Building Standards Code.</i></p>		

**16.58.230 Section 101.10.2 – Added**

Add Section 101.10.2 to read as follows:

**101.10.2 Alternate green building standards.** The applicant may request to apply an alternate green building standard for a project in lieu of the minimum standards per Table 101.10. In making a determination in response to an application under this section, the Building Official may allow an alternate standard if he/she finds that the proposed alternative standard complies with all of the following:

- A. Addresses a comprehensive scope of green building issues including energy efficiency, water efficiency, resource efficient materials, and healthy building practices;
- B. Applies standards that are, when taken as a whole, as stringent as the GPR and LEED standards;
- C. Includes a formalized certification process that incorporates third party verification; and
- D. The project will advance the purposes of this Chapter.

**16.58.240 Section 102.3 – Amended**

Amend Section 102.3 to read as follows:

**102.3 Verification.** Documentation of conformance for applicable green building measures shall be provided to the City of Cupertino. Verification that the project meets the applicable environmental standards occurs through either the Third Party process or City Review

per the requirements in Table 101.10. The following lists the verification requirements for Third Party verification, and alternative methods:

- A. **Third Party Certification.** A project will be required to meet the Third Party certification process if the City determines that the project meets or exceeds the applicable thresholds listed in Table 101.10. The applicant shall submit all of the following to the City, in addition to other application requirements, to assist the City in determination compliance with the green building requirements:
  - a. Planning Application. A green building checklist that includes cross-references to appropriate locations in the construction documents for all prerequisites and selected points or credits that demonstrates that the proposed project meets the applicable minimum requirements.
  - b. Building Permit.
    - i. Proof of project registration with administrating body of the applicable reference standard, and
    - ii. A green building checklist that includes cross-references to appropriate locations in the construction documents for all prerequisites and selected points or credits; that demonstrate that the proposed project meets the applicable minimum requirements, and
  - c. Green Building Deposit. The green building deposit in an amount that may be set from time to time by resolution of the City Council. The applicant may provide the deposit in the form of cash or in any other form that the City finds acceptable to meet the purposes of this Section. The full amount of the deposit shall be returned upon the certification document being provided per 102.3 (A)(c). If however, the project does not meet the requirements of this Chapter, as applied to the project, then the City shall retain the full amount of the deposit, and shall use the deposit solely to advance the purposes of this Chapter.
  - d. Time Limit. Within 18 months of Final Occupancy – Provide certification document for LEED, GPR or alternate rating standard in a form accepted by the City per Table 101.10. The Building Official may grant a one-time 6-month extension.

**16.58.260 Section 102.3.1 – Added**

Added Section 102.3.1 to read as follows:

**102.3.1 Exemptions.** The Building Official shall determine the maximum feasible threshold of compliance reasonably achievable for the project. Projects that are exempted from the requirements of the California Green Building Standards Code as amended by the City of Cupertino shall meet the requirement in section A and at least one of the requirements in sections B-D:

- A. Projects that demonstrate that it is not feasible for the project to fully meet the green building requirements and that the purposes of this chapter will have been achieved to

- the maximum extent possible shall be exempted only for the specific rating system prerequisite that has been determined to be infeasible.
- B. Projects that demonstrate compliance with this code but which will conflict with the Cupertino General Plan and/or Municipal Code Ordinance, such as those requiring historic preservation as determined by the Director of Community Development; or
  - C. Projects that demonstrate compliance with this code but which will conflict with the California Building Standards Code; or
  - D. Projects with atypical energy-related design requirements and/or patterns of use that make compliance with the thresholds of this code infeasible.

**16.58.280 Section 202 – Amended**

Amend Section 202 to add or amend the following definitions:

- A. “Building Envelope” means the separation between the interior and the exterior environments of a building in order to provide structural integrity, moisture control, temperature control, and air pressure control. The principal physical components of the building envelope include the foundation, roof, walls, and windows.
- B. “Decision maker” means the person or entity with final approval authority over the underlying project.
- C. “Green Building Checklist” means a checklist, typically with prerequisites and credits and/or points that is developed by the administrators of green building certification systems and used to determine whether a development project can achieve certification.
- D. “Green Point Rated (GPR)” means a residential green building rating system developed by Build It Green. Projects can use any of the adopted GPR checklists that most appropriately apply to the project type proposed.
- E. “Leadership in Energy and Environmental Design (LEED)” means a green building rating system developed by the U.S. Green Building Council for residential and non-residential projects. Projects can use any of the adopted LEED checklists that most appropriately apply to the project type proposed.
- F. “Minimum Green Building Requirement” means the minimum green building requirement that applies to a particular project, as listed in column 2 of Table 101.10.
- G. “Required Verification” means the standards that correspond to the requirements of a particular green building rating system and project type, as listed in column 3 of Table 101.10, for which verification procedures are fully set forth in Section 102.3.
- H. "Feasible" means capable of being accomplished in a successful manner within a reasonable period of time, taking into account economic, environmental, social, and technological factors.

**16.58.290 Section 303.1.1 -- Amended**

Amend Section 103.1.1 to read as follows:

**303.1.1 Tenant improvements.** The provisions of this code shall apply to the applicable tenant or occupant improvements to a project.

**16.58.300 Section 4.304.1.1 – Added**

Add Section 4.304.1.1 to read as follows:

**4.304.1.1 Compliance with local water-efficient landscape ordinance.** Residential projects must comply with the City of Cupertino’s Landscape Ordinance, pursuant to Chapter 14.15 of the Cupertino Municipal Code.

**16.58.310 Section 5.304.1.1 – Added**

Add Section 5.304.1.1 to read as follows:

**5.304.1.1 Compliance with local water-efficient landscape ordinance.** Non-residential projects must comply with the City of Cupertino’s Landscape Ordinance, pursuant to Chapter 14.15 of the Cupertino Municipal Code.

**Exhibit B**

**Findings for Amendments to the California Green Building Standards Code**

In accordance with the Health and Safety Code Sections 17958, 17958.5, and 17958.7, the City Council must make findings for each proposed local change to the provisions of the California Building Standards Code, including green building standards, to support its determination that each such local amendment is reasonably necessary based on climatic, topographical or geological conditions.

In adopting the amendments to Chapter 16.58 of the Cupertino Municipal Code pertaining to the California Green Building Standards Code, the City Council of the City of Cupertino finds as follows:

A. General Findings Related to Green Building Requirements in Cupertino

1. Green building is a “whole systems” approach to the design, construction, location, and operation of buildings and structures to help mitigate the environmental, economic and social impacts of construction, demolition and renovation of buildings and structures.
2. The Environmental Resources and Sustainability Element of the City of Cupertino’s General Plan 2000-2020 recognizes that the community’s environmental resources are fragile, invaluable and interrelated, and protecting and sustaining the City’s viable ecological communities and environmental resources will result in the protection of both the human and natural environments.
3. City of Cupertino’s General Plan 2000-2020 sets forth policies recognizing that the essential components of green building design and planning include consideration of:
  - a. Location
  - b. Site planning
  - c. Energy efficiency
  - d. Material efficiency
  - e. Water efficiency
4. The City of Cupertino previously adopted ordinances to further green building measures, including the California Green Building Standards Code, the Landscaping Ordinance to reduce water waste, Recycling and Diversion of Construction and Demolition Waste Ordinance, and Stormwater Pollution and Prevention and Watershed Protection.

B. Findings for Local Amendments to the 2010 California Green Building Standards Code (16.58 of the Cupertino Municipal Code)

1. The City Council authorized staff on January 19, 2010 to proceed with the development of a green building ordinance incorporating green building measures.
2. Green building is a “whole systems” approach to the design, construction, location, and operation of buildings and structures to help mitigate the environmental, economic and social impacts of construction, demolition and renovation of buildings and structures.
3. The Environmental Resources and Sustainability Element of the City of Cupertino’s General Plan 2000-2020 recognizes that the community’s environmental resources are fragile, invaluable and interrelated, and protecting and sustaining the City’s viable ecological communities and environmental resources will result in the protection of both the human and natural environments.
4. City of Cupertino’s General Plan 2000-2020 sets forth policies recognizing that the essential components of green building design and planning include consideration of:
  - a. Location
  - b. Site planning
  - c. Energy efficiency
  - d. Material efficiency
  - e. Water efficiency
5. California Assembly Bill 32 (Global Warming Solutions Act of 2006, Health and Safety Code §38500 et seq.) requires actions on the part of the State and local governments to significantly reduce greenhouse gas (GHG) emissions such that statewide GHG emissions in 2020 are lowered to 1990 levels.
6. Green building regulations further the Sustainability Principles of the General Plan involving building and land development, disposal of construction and demolition debris, storm water quality and floor protection, tree protection, water conservation, landscaping and resource conservation.
7. Built It Green is acknowledged in promoting and defining residential green building by development of its Green Point Rated Rating System.
8. The Green Building Certification Institute (GBCI) administers the U.S. Green Building Council’s LEED (Leadership in Energy and Environmental Design) Rating System.

9. Green building techniques are widespread in residential and non-residential building construction, and such techniques can impact the City's environment, greenhouse gas emissions, resource usage, energy efficiency, water usage, waste management, and the health and productivity of residents, workers and visitors over the life of the building.
10. Requiring green building measures is necessary to achieve public health and welfare benefits to the community.

# Codes and Standards Title 24 Energy-Efficient Local Ordinances

## **Title:** Climate Zone 3 Energy Cost-Effectiveness Study

### **Prepared for:**

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Last Modified: July 19, 2010



## Climate Zone 3 Energy Cost-Effectiveness Study

July 19, 2010

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## **LEGAL NOTICE**

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## **1.0 Executive Summary**

This report presents the results of Gabel Associates' research and review of the feasibility and energy cost-effectiveness of building permit applicants exceeding the 2008 Building Energy Efficiency Standards to meet the minimum energy-efficiency requirements of local energy efficiency standards covering Climate Zone 3. A local government may use this report as a basis for demonstrating energy cost-effectiveness of a proposed green building or energy ordinance. The study assumes that such an ordinance requires, for the building categories covered, that building energy performance exceeds the 2008 TDV energy standard budget by at least 15%.

The study is also contained in the local government's application to the California Energy Commission (CEC) which must meet all requirements specified in Section 10-106 of the California Code of Regulations, Title 24, Part 1, Article 1: Locally Adopted Energy Standards. An ordinance shall be legally enforceable (a) after the CEC has reviewed and approved the local energy standards as meeting all requirements of Section 10-106; and (b) the ordinance has been adopted by the local government and filed with the Building Standards Commission.

The 2008 Building Energy Efficiency Standards, which took effect on January 1, 2010, are the baseline used to calculate the cost-effectiveness data.

## **2.0 Methodology and Assumptions**

The energy performance impacts of exceeding the performance requirements of the 2008 Title 24 Building Energy Efficiency Standards (2008 Standards) have been evaluated in Climate Zone 3 using the following residential and nonresidential prototypical building types:

<b>Small Single Family House</b> 2-story 2,025 sf	<b>Large Single Family House</b> 2-story 4,500 sf
<b>Low-rise Multi-family Apartments</b> 8 dwelling units/2-story 8,442 sf	<b>High-rise Multi-family Apartments</b> 40 dwelling units/4-story 36,800 sf
<b>Low-rise Office Building</b> 1-story 10,580 sf	<b>High-rise Office Building</b> 5-story 52,900 sf

### **Methodology**

The methodology used in the case studies is based on a design process for each of the proposed prototypical building types that first meets the minimum requirements and then exceeds the 2008 Standards by 15%. The process includes the following major stages:

#### ***Stage 1: Minimum Compliance with 2008 Standards:***

Each prototype building design is tested for minimum compliance with the 2008 Standards, and the mix of energy measures are adjusted using common construction options so the building first just meets the Standards. The set of energy measures chosen represent a reasonable combination which reflects how designers, builders and developers are likely to achieve a specified level of performance using a relatively low first incremental (additional) cost.

#### ***Stage 2: Incremental Cost for Exceeding 2008 Standards by 15%:***

Starting with that set of measures which is minimally compliant with the 2008 Standards, various energy measures are upgraded so that the building just exceeds the 2008 Standards by 15%. The design choices by the consultant authoring this study are based on many years of experience with architects, builders, mechanical engineers; and general knowledge of the relative acceptance and preferences of many measures, as well as their incremental costs. This approach tends to reflect how building energy performance is typically evaluated for code compliance and how it's used to select design energy efficiency measures. Note that lowest simple payback with respect to building site energy is not the primary focus of selecting measures; but rather the requisite reduction of Title 24 Time Dependent Valuation(TDV) energy at a reasonable incremental cost consistent with other non-monetary but important design considerations. A minimum and

maximum range of incremental costs of added energy efficiency measures is established by a variety of research means. A construction cost estimator, Building Advisory LLC, was contracted to conduct research to obtain current measure cost information for many energy measures; and Gabel Associates performed its own additional research to establish first cost data.

### ***Stage 3: Cost Effectiveness Determination:***

Energy savings in kWh and therms is calculated from the Title 24 simulation results to establish the annual energy cost savings and CO<sub>2</sub>-equivalent reductions in greenhouse gases. A simple payback analysis in years is calculated by dividing the incremental cost for exceeding the 2008 Standards by the estimated annual energy cost savings.

### **Assumptions**

#### ***Annual Energy Cost Savings***

1. Annual site electricity (kWh) and natural gas (therms) saved are calculated using Micropas 8, state-approved energy compliance software for the 2008 Building Energy Efficiency Standards.
2. Average residential utility rates of \$0.18/kWh for electricity and \$1.15/therm for natural gas in current constant dollars; nonresidential rates are time-of-use rate schedules modeled explicitly in the DOE-2.1E computer simulation: PG&E A-6 schedule for electricity and PG&E G-NR1 schedule for natural gas.
3. No change (i.e., no inflation or deflation) of utility rates in constant dollars
4. No increase in summer temperatures from global climate change

#### ***Simple Payback Analysis***

1. No external cost of global climate change -- and corresponding value of additional investment in energy efficiency and CO<sub>2</sub> reduction -- is included
2. The cost of money (e.g., opportunity cost) invested in the incremental cost of energy efficiency measures is not included.

### **3.0 Minimum Compliance with 2008 Standards**

The following energy design descriptions of the following building prototypes just meet the 2008 Standards in Climate Zone 3.

#### **Small Single Family House**

- 2,025 square feet
- 2-story
- 20.2% glazing/floor area ratio

<b>Energy Efficiency Measures</b>
R-38 Roof w/ Radiant Barrier
R-13 Walls
R-30 Raised Floor over Garage/Open at 2nd Floor
R-0 Slab on Grade
Low E2 Vinyl Windows, U=0.36, SHGC=0.30
Furnace: 80% AFUE
Air Conditioner: None
R-8 Attic Ducts
Reduced Duct Leakage/Testing (HERS)
50 Gallon Gas Water Heater: EF=0.62

#### **Large Single Family House**

- 4,500 square feet
- 2-story
- 22.0% glazing/floor area ratio

<b>Energy Efficiency Measures</b>
R-30 Roof w/ Radiant Barrier
R-13 Walls
R-19 Raised Floor
Low E2 Vinyl Windows, U=0.36, SHGC=0.30
(2) Furnaces: 80% AFUE
Air Conditioner: None
R-6 Attic Ducts
Reduced Duct Leakage/Testing (HERS)
(2) 50 Gallon Gas Water Heaters: EF=0.61

### **Low-rise Multi-family Apartments**

- 8,442 square feet
- 8 units/2-story
- 12.5% glazing/floor area ratio

<b>Energy Efficiency Measures</b>
R-30 Roof w/ Radiant Barrier
R-13 Walls
R-0 Slab on Grade
Low E2 Vinyl Windows, U=0.36, SHGC=0.30
(8) Furnaces: 80% AFUE
Air Conditioner: None
R-6 Attic Ducts
(8) 40 Gallon Gas Water Heaters: EF=0.63
Pipe Insulation

### **High-rise Multifamily Apartments**

- 36,800 sf,
- 40 units
- 4-story
- Window to Wall Ratio = 35.2%

<b>Energy Efficiency Measures to Meet Title 24</b>
R-19 under Metal Deck and additional R-11 batt below (no framing); with Cool Roof Reflectance = 0.55, Emittance = 0.75
R-19 in Metal Frame Walls
R-4 (1.25" K-13 spray-on) Raised Slab over parking garage
Dual Metal Windows: default U-factor=0.79, SHGC COG = 0.38
1.5 ton 4-pipe fan coils, 80% AFUE boiler, 70-ton scroll air cooled chiller @ 0.72 KW/ton
Central DHW boiler: 80% AFUE and recirculating system w/ timer-temperature controls

## **Low-rise Office Building**

- Single Story
- 10,580 sf,
- Window to Wall Ratio = 37.1%

<b>Energy Efficiency Measures to Meet Title 24</b>
R-19 under Metal Deck, no cool roof
R-19 in Metal Frame Walls
R-0 (un-insulated) slab-on-grade 1st floor
Metal windows: Default glazing U=0.71, COG SHGC=0.54
Lighting = 0.858 w/sf: Open Office Areas: (60) 2-lamp T8 fixtures @58w each; (24) 18w recessed CFLs no lighting controls. Small Offices: (56) 2-lamp T8 fixtures; (40) 18w recessed CFLs, on/off lighting controls. Support Areas: (32) 18w recessed CFLs; (48) 13w CFL wall sconces; no controls.
(3) 10-ton DX units EER=11.0; 80% AFUE furnaces; standard efficiency fan motors; fixed temp. integrated air economizers
R-6 duct insulation w/ ducts on roof
(1) Tank Gas Water Heaters EF=0.58

**High-rise Office Building**

- 5-story
- 52,900 sf,
- Window to Wall Ratio = 34.5%

**Design "A" for Options 1 and 2**

<b>Energy Efficiency Measures to Meet Title 24</b>
R-19 under Metal Deck, no cool roof
R-19 in Metal Frame Walls
R-0 (un-insulated) slab-on-grade 1st floor
Metal windows: Default glazing U=0.71, SHGC = 0.73
Lighting = 0.858 w/sf: Open Office Areas: (300) 2-lamp T8 fixtures @58w each; no lighting controls; (120) 18w recessed CFLs no lighting controls. Small Offices: (280) 2-lamp T8 58w fixtures on/off lighting controls; (200) 18w recessed CFLs no lighting on/off lighting controls. Support Areas: (160) 18w recessed CFLs no lighting controls; (240) 13w CFL wall sconces; no lighting controls.
(3) 60 ton Packaged VAV system 10 EER/80% TE, standard efficiency variable speed fan motors; 20% VAV boxes, electric water reheat on perimeter zones
R-6 duct insulation w/ ducts in conditioned
(1) Tank Gas Water Heaters EF=0.58

**Design "B" for Options 3, 4 and 5**

<b>Energy Efficiency Measures to Meet Title 24</b>
R-19 under Metal Deck, no cool roof
R-19 in Metal Frame Walls
R-0 (un-insulated) slab-on-grade 1st floor
Metal windows: Default glazing U=0.71, SHGC = .73
Lighting = 0.858 w/sf: Open Office Areas: (300) 2-lamp T8 fixtures @58w each; no lighting controls; (120) 18w recessed CFLs no lighting controls. Small Offices: (280) 2-lamp T8 58w fixtures on/off lighting controls; (200) 18w recessed CFLs no lighting on/off lighting controls. Support Areas: (160) 18w recessed CFLs no lighting controls; (240) 13w CFL wall sconces; no lighting controls.
(3) 60 ton Packaged VAV system 10 EER/80% TE, standard efficiency variable speed fan motors; 25% VAV boxes, hot water reheat on perimeter zones with 80% AFUE boiler.
R-6 duct insulation w/ ducts in conditioned
DHW 80% AFUE boiler

## 4.0 Incremental Cost to Exceed 2008 Standards by 15%

The following tables list the energy features and/or equipment included in the 2008 Standards base design, the efficient measure options, and an estimate of the incremental cost for each measure included to improve the building performance to use 15% less TDV energy than the corresponding Title 24 base case design.

### Small Single Family House

- 2,025 square feet
- 2-story
- 20.2% glazing/floor area ratio

#### **Incremental Cost Estimate to Exceed Title 24 by 15%**

**Single Family Prototype: 2,025 SF, Option 1**

2025 sf

Climate Zone 3

Energy Efficiency Measures	Change Type	Incremental Cost Estimate		
		Min	Max	Avg
R-38 Roof w/ Radiant Barrier	-	\$ -	\$ -	\$ -
R-19 Walls (from R-13): 2,550 sf @\$0.31 to \$0.54/sf	Upgrade	\$ 791	\$ 1,377	\$ 1,084
R-30 Raised Floor over Garage/Open at 2nd Floor	-	\$ -	\$ -	\$ -
R-0 Slab on Grade	-	\$ -	\$ -	\$ -
Low E2 Vinyl Windows, U=0.36, SHGC=0.30	-	\$ -	\$ -	\$ -
Furnace: 92% AFUE (from 80% AFUE)	Upgrade	\$ 500	\$ 1,200	\$ 850
Air Conditioner: None	-	\$ -	\$ -	\$ -
R-6 Attic Ducts (from R-8)	Downgrade	\$ (325)	\$ (225)	\$ (275)
Reduced Duct Leakage/Testing (HERS)	-	\$ -	\$ -	\$ -
50 Gallon Gas Water Heater: EF=0.62	-	\$ -	\$ -	\$ -
<b>Total Incremental Cost of Energy Efficiency Measures:</b>		<b>\$ 966</b>	<b>\$ 2,352</b>	<b>\$ 1,659</b>
<b>Total Incremental Cost per Square Foot:</b>		<b>\$ 0.48</b>	<b>\$ 1.16</b>	<b>\$ 0.82</b>

#### **Incremental Cost Estimate to Exceed Title 24 by 15%**

**Single Family Prototype: 2,025 SF, Option 2**

2025 sf

Climate Zone 3

Energy Efficiency Measures	Change Type	Incremental Cost Estimate		
		Min	Max	Avg
R-38 Roof w/ Radiant Barrier	-	\$ -	\$ -	\$ -
R-19 Walls (from R-13): 2,550 sf @\$0.31 to \$0.54/sf	Upgrade	\$ 791	\$ 1,377	\$ 1,084
R-30 Raised Floor over Garage/Open at 2nd Floor	-	\$ -	\$ -	\$ -
R-0 Slab on Grade	-	\$ -	\$ -	\$ -
Low E2 Vinyl Windows, U=0.36, SHGC=0.30	-	\$ -	\$ -	\$ -
Furnace: 80% AFUE	-	\$ -	\$ -	\$ -
Air Conditioner: None	-	\$ -	\$ -	\$ -
R-4.2 Attic Ducts (from R-8)	Downgrade	\$ (650)	\$ (450)	\$ (550)
Reduced Duct Leakage/Testing (HERS)	-	\$ -	\$ -	\$ -
Instantaneous Gas Water Heater: RE=0.80 (from 50 Gal Gas: EF=0.62)	Upgrade	\$ 900	\$ 1,500	\$ 1,200
<b>Total Incremental Cost of Energy Efficiency Measures:</b>		<b>\$ 1,041</b>	<b>\$ 2,427</b>	<b>\$ 1,734</b>
<b>Total Incremental Cost per Square Foot:</b>		<b>\$ 0.51</b>	<b>\$ 1.20</b>	<b>\$ 0.86</b>

**Incremental Cost Estimate to Exceed Title 24 by 15%**  
**Single Family Prototype: 2,025 SF, Option 3**

2025 sf

Climate Zone 3

Energy Efficiency Measures	Change Type	Incremental Cost Estimate		
		Min	Max	Avg
R-38 Roof w/ Radiant Barrier	-	\$ -	\$ -	\$ -
R-21 Walls (from R-13): 2,550 sf @ \$0.45 to \$0.70/sf	Upgrade	\$ 1,148	\$ 1,785	\$ 1,466
R-30 Raised Floor over Garage/Open at 2nd Floor	-	\$ -	\$ -	\$ -
R-0 Slab on Grade	-	\$ -	\$ -	\$ -
Low E2 Vinyl Windows, U=0.36, SHGC=0.30	-	\$ -	\$ -	\$ -
Furnace: 90% AFUE (from 80% AFUE)	Upgrade	\$ 500	\$ 1,000	\$ 750
Air Conditioner: None	-	\$ -	\$ -	\$ -
R-4.2 Attic Ducts (from R-8)	Downgrade	\$ (650)	\$ (450)	\$ (550)
Reduced Duct Leakage/Testing (HERS)	-	\$ -	\$ -	\$ -
50 Gallon Gas Water Heater: EF=0.61 (from EF=0.62)	Downgrade	\$ (100)	\$ (50)	\$ (75)
<b>Total Incremental Cost of Energy Efficiency Measures:</b>		<b>\$ 898</b>	<b>\$ 2,285</b>	<b>\$ 1,591</b>
<b>Total Incremental Cost per Square Foot:</b>		<b>\$ 0.44</b>	<b>\$ 1.13</b>	<b>\$ 0.79</b>

**Large Single Family House**

- 4,500 square feet
- 2-story
- 22.0% glazing/floor area ratio

**Incremental Cost Estimate to Exceed Title 24 by 15%**  
**Single Family Prototype: 4,500 SF, Option 1**

4500 sf

Climate Zone 3

Energy Efficiency Measures	Change Type	Incremental Cost Estimate		
		Min	Max	Avg
R-38 Roof w/ Radiant Barrier (from R-30 w/ Radiant Barrier): 2,700 sf @ 0.15 to 0.20/sf	Upgrade	\$ 405	\$ 540	\$ 473
R-21 Walls (from R-13): 2,518 sf @ \$0.45 to \$0.70/sf	Upgrade	\$ 1,133	\$ 1,763	\$ 1,448
R-30 Raised Floor (from R-19): 2,700 sf @ \$0.25 to \$0.35	Upgrade	\$ 675	\$ 945	\$ 810
Low E2 Vinyl Windows, U=0.36, SHGC=0.30	-	\$ -	\$ -	\$ -
(2) Furnaces: 80% AFUE	-	\$ -	\$ -	\$ -
Air Conditioner: None	-	\$ -	\$ -	\$ -
R-8 Attic Ducts (from R-6)	Upgrade	\$ 450	\$ 650	\$ 550
Reduced Duct Leakage/Testing (HERS)	-	\$ -	\$ -	\$ -
(2) 50 Gallon Gas Water Heaters: EF=0.62 (from EF=0.61)	Upgrade	\$ 100	\$ 200	\$ 150
<b>Total Incremental Cost of Energy Efficiency Measures:</b>		<b>\$ 2,763</b>	<b>\$ 4,098</b>	<b>\$ 3,430</b>
<b>Total Incremental Cost per Square Foot:</b>		<b>\$ 0.61</b>	<b>\$ 0.91</b>	<b>\$ 0.76</b>

**Incremental Cost Estimate to Exceed Title 24 by 15%**  
**Single Family Prototype: 4,500 SF, Option 2**

4500 sf

Climate Zone 3

Energy Efficiency Measures	Change Type	Incremental Cost Estimate		
		Min	Max	Avg
R-38 Roof w/ Radiant Barrier (from R-30 w/ Radiant Barrier): 2,700 sf @ 0.15 to 0.20/sf	Upgrade	\$ 405	\$ 540	\$ 473
R-15 Walls (from R-13): 2,518 sf @ \$0.14 to \$0.18/sf	Upgrade	\$ 353	\$ 453	\$ 403
R-30 Raised Floor (from R-19): 2,700 sf @ \$0.25 to \$0.35	Upgrade	\$ 675	\$ 945	\$ 810
Low E2 Vinyl Windows, U=0.36, SHGC=0.30	-	\$ -	\$ -	\$ -
(2) Furnaces: 92% AFUE (from 80% AFUE)	Upgrade	\$ 1,000	\$ 2,400	\$ 1,700
Air Conditioner: None	-	\$ -	\$ -	\$ -
R-8 Attic Ducts (from R-6)	Upgrade	\$ 450	\$ 650	\$ 550
Reduced Duct Leakage/Testing (HERS)	-	\$ -	\$ -	\$ -
(2) 50 Gallon Gas Water Heaters: EF=0.63 (from EF=0.61)	Upgrade	\$ 100	\$ 300	\$ 200
<b>Total Incremental Cost of Energy Efficiency Measures:</b>		<b>\$ 2,983</b>	<b>\$ 5,288</b>	<b>\$ 4,135</b>
<b>Total Incremental Cost per Square Foot:</b>		<b>\$ 0.66</b>	<b>\$ 1.18</b>	<b>\$ 0.92</b>

**Incremental Cost Estimate to Exceed Title 24 by 15%**  
**Single Family Prototype: 4,500 SF, Option 3**

4500 sf

Climate Zone 3

Energy Efficiency Measures	Change	Incremental Cost Estimate		
		Min	Max	Avg
R-38 Roof w/ Radiant Barrier (from R-30 w/ Radiant Barrier): 2,700 sf @ 0.15 to 0.20/sf	Upgrade	\$ 405	\$ 540	\$ 473
R-19 Walls (from R-13): 2,518 sf @ \$0.31 to \$0.54/sf	Upgrade	\$ 781	\$ 1,360	\$ 1,070
R-19 Raised Floor	-	\$ -	\$ -	\$ -
Quality Insulation Installation (HERS)	Upgrade	\$ 900	\$ 1,200	\$ 1,050
Low E2 Vinyl Windows, U=0.36, SHGC=0.30	-	\$ -	\$ -	\$ -
(2) Furnaces: 80% AFUE	-	\$ -	\$ -	\$ -
Air Conditioner: None	-	\$ -	\$ -	\$ -
R-6 Attic Ducts	-	\$ -	\$ -	\$ -
Reduced Duct Leakage/Testing (HERS)	-	\$ -	\$ -	\$ -
(2) 50 Gallon Gas Water Heaters: EF=0.63 (from EF=0.61)	Upgrade	\$ 100	\$ 300	\$ 200
<b>Total Incremental Cost of Energy Efficiency Measures:</b>		<b>\$ 2,186</b>	<b>\$ 3,400</b>	<b>\$ 2,793</b>
<b>Total Incremental Cost per Square Foot:</b>		<b>\$ 0.49</b>	<b>\$ 0.76</b>	<b>\$ 0.62</b>

### Low-rise Multi-family Apartments

- 8,442 square feet
- 8 units/2-story
- 12.5% glazing/floor area ratio

#### **Incremental Cost Estimate to Exceed Title 24 by 15%**

**Multi-Family Prototype: 8,442 SF, Option 1**

**8442 sf**

**Climate Zone 3**

Energy Efficiency Measures	Change Type	Incremental Cost Estimate		
		Min	Max	Avg
R-30 Roof w/ Radiant Barrier	-	\$ -	\$ -	\$ -
R-21 Walls (from R-13 ): 10,146 sf @ \$0.45 to \$0.70/sf	Upgrade	\$ 4,566	\$ 7,102	\$ 5,834
R-0 Slab on Grade	-	\$ -	\$ -	\$ -
Low E2 Vinyl, U=0.36, SHGC=0.30	-	\$ -	\$ -	\$ -
(8) Furnaces: 80% AFUE	-	\$ -	\$ -	\$ -
Air Conditioner: None	-	\$ -	\$ -	\$ -
R-4.2 Attic Ducts (from R-6)	Downgrade	\$ (1,600)	\$ (1,000)	\$ (1,300)
Reduced Duct Leakage/Testing (HERS)	Upgrade	\$ 2,400	\$ 4,800	\$ 3,600
(8) 40 Gallon Gas Water Heaters: EF=0.63	-	\$ -	\$ -	\$ -
Remove Pipe Insulation	Downgrade	\$ (1,600)	\$ (1,200)	\$ (1,400)
<b>Total Incremental Cost of Energy Efficiency Measures:</b>		<b>\$ 3,766</b>	<b>\$ 9,702</b>	<b>\$ 6,734</b>
<b>Total Incremental Cost per Square Foot:</b>		<b>\$ 0.45</b>	<b>\$ 1.15</b>	<b>\$ 0.80</b>

#### **Incremental Cost Estimate to Exceed Title 24 by 15%**

**Multi-Family Prototype: 8,442 SF, Option 2**

**8442 sf**

**Climate Zone 3**

Energy Efficiency Measures	Change Type	Incremental Cost Estimate		
		Min	Max	Avg
R-38 Roof w/ Radiant Barrier (from R-30 w/Radiant Barrier): 4,221 sf @ 0.15 to 0.20/sf	Upgrade	\$ 633	\$ 844	\$ 739
R-19 Walls (from R-13 ): 10,146 sf @ \$0.31 to \$0.54/sf	Upgrade	\$ 3,145	\$ 5,479	\$ 4,312
R-0 Slab on Grade	-	\$ -	\$ -	\$ -
Low E2 Vinyl, U=0.36, SHGC=0.30	-	\$ -	\$ -	\$ -
(8) Furnaces: 80% AFUE	-	\$ -	\$ -	\$ -
Air Conditioner: None	-	\$ -	\$ -	\$ -
R-6 Attic Ducts	-	\$ -	\$ -	\$ -
Reduced Duct Leakage/Testing (HERS)	Upgrade	\$ 2,400	\$ 4,800	\$ 3,600
(8) 40 Gallon Gas Water Heaters: EF=0.63	-	\$ -	\$ -	\$ -
Remove Pipe Insulation	Downgrade	\$ (1,600)	\$ (1,200)	\$ (1,400)
<b>Total Incremental Cost of Energy Efficiency Measures:</b>		<b>\$ 4,578</b>	<b>\$ 9,923</b>	<b>\$ 7,251</b>
<b>Total Incremental Cost per Square Foot:</b>		<b>\$ 0.54</b>	<b>\$ 1.18</b>	<b>\$ 0.86</b>

**Incremental Cost Estimate to Exceed Title 24 by 15%**  
**Multi-Family Prototype: 8,442 SF, Option 3**

8442 sf

Climate Zone 3

Energy Efficiency Measures	Change Type	Incremental Cost Estimate		
		Min	Max	Avg
R-19 Roof w/ Radiant Barrier (from R-30 w/Radiant Barrier): 4,221 sf @ 0.25 to 0.35/sf	Downgrade	\$ (1,477)	\$ (1,055)	\$ (1,266)
R-19 Walls (from R-13 ): 10,146 sf @ \$0.31 to \$0.54/sf	Upgrade	\$ 3,145	\$ 5,479	\$ 4,312
R-0 Slab on Grade	-	\$ -	\$ -	\$ -
Low E2 Vinyl, U=0.36, SHGC=0.30	-	\$ -	\$ -	\$ -
(8) Furnaces: 90% AFUE (from 80% AFUE)	Upgrade	\$ 4,000	\$ 8,000	\$ 6,000
Air Conditioner: None	-	\$ -	\$ -	\$ -
R-4.2 Attic Ducts (from R-6)	Downgrade	\$ (1,600)	\$ (1,000)	\$ (1,300)
Reduced Duct Leakage/Testing (HERS)	Upgrade	\$ 2,400	\$ 4,800	\$ 3,600
(8) 40 Gallon Gas Water Heaters: EF=0.62 (from EF=0.63)	Downgrade	\$ (400)	\$ -	\$ (200)
Remove Pipe Insulation	Downgrade	\$ (1,600)	\$ (1,200)	\$ (1,400)
<b>Total Incremental Cost of Energy Efficiency Measures:</b>		<b>\$ 4,468</b>	<b>\$ 15,024</b>	<b>\$ 9,746</b>
<b>Total Incremental Cost per Square Foot:</b>		<b>\$ 0.53</b>	<b>\$ 1.78</b>	<b>\$ 1.15</b>

**High-rise Multifamily Apartments**

- 36,800 sf,
- 40 units/4-story
- Window to Wall Ratio = 31.6%

**Incremental Cost Estimate to Exceed Title 24 by 15%**  
**High-rise Residential Prototype: 36,800 SF, Option 1**

Climate Zone 3

Energy Efficiency Measures to Exceed Title 24 by 15%	Change Type	Incremental Cost Estimate		
		Min	Max	Avg
R-19 under Metal Deck <b>and additional R-30 batt below</b> (no framing); with Cool Roof Reflectance = 0.55, Emittance = 0.75; 9,200 sf @ \$0.30 to \$0.40/sf	Upgrade	\$ 2,760	\$ 3,680	\$ 3,220
R-19 in Metal Frame Walls	-	\$ -	\$ -	\$ -
R-4 (1.25" K-13 spray-on) Raised Slab over parking garage	-	\$ -	\$ -	\$ -
Dual Metal Windows: <b>COG U-factor=0.3, COG SHGC=0.27</b> 6,240 sf @ \$2.00 to \$3.00/sf	Upgrade	\$ 12,480	\$ 18,720	\$ 15,600
1.5 ton 4-pipe fan coil, <b>98% AFUE</b> boiler, 60-ton scroll air cooled chiller 0.72 KW/ton (cost of boiler below under DHW)	Upgrade	\$ -	\$ -	\$ -
Central DHW boiler: <b>98% AFUE</b> and recirculating system w/ timer-temperature controls	Upgrade	\$ 4,000	\$ 8,000	\$ 6,000
<b>Total Incremental Cost of Energy Efficiency Measures:</b>		<b>\$ 19,240</b>	<b>\$ 30,400</b>	<b>\$ 24,820</b>
<b>Total Incremental Cost per Square Foot:</b>		<b>\$ 0.52</b>	<b>\$ 0.83</b>	<b>\$ 0.67</b>

**Incremental Cost Estimate to Exceed Title 24 by 15%  
High-rise Residential Prototype: 36,800 SF, Option 2**

**Climate Zone 3**

Energy Efficiency Measures to Exceed Title 24 by 15%	Change Type	Incremental Cost Estimate		
		Min	Max	Avg
R-19 under Metal Deck and additional R-11 batt below (no framing); with no cool roof; 9,200 sf @ \$0.35 to \$0.50/sf	Downgrade	\$ (3,220)	\$ (4,600)	\$ (3,910)
R-19 in Metal Frame Walls w/ 1" continuous outside (R-5); 12,112 sf @ \$4.00/sf to \$7.00/sf	Upgrade	\$ 48,448	\$ 84,784	\$ 66,616
R-4 (1.25" K-13 spray-on) Raised Slab over parking garage	-	\$ -	\$ -	\$ -
Dual Metal Windows: <b>COG U-factor=0.3, COG SHGC=0.31</b> 6,240 sf @ \$1.00 to \$2.00/sf	Upgrade	\$ 6,240	\$ 12,480	\$ 9,360
1.5 ton 4-pipe fan coil, <b>98% AFUE</b> boiler, 60-ton scroll air cooled chiller 0.72 KW/ton (cost of boiler below under DHW)	Upgrade	\$ -	\$ -	\$ -
Central DHW boiler: <b>98% AFUE</b> and recirculating system w/ timer-temperature controls	Upgrade	\$ 4,000	\$ 8,000	\$ 6,000
<b>Total Incremental Cost of Energy Efficiency Measures:</b>		<b>\$ 55,468</b>	<b>\$ 100,664</b>	<b>\$ 78,066</b>
<b>Total Incremental Cost per Square Foot:</b>		<b>\$ 1.51</b>	<b>\$ 2.74</b>	<b>\$ 2.12</b>

**Incremental Cost Estimate to Exceed Title 24 by 15%  
High-rise Residential Prototype: 36,800 SF, Option 3**

**Climate Zone 3**

Energy Efficiency Measures to Exceed Title 24 by 15%	Change Type	Incremental Cost Estimate		
		Min	Max	Avg
R-19 under Metal Deck and additional R-30 batt below (no framing); with Cool Roof Reflectance = 0.55, Emittance = 0.75; 9,200 sf @ \$0.30 to \$0.40/sf	Upgrade	\$ 2,760	\$ 3,680	\$ 3,220
R-19 in Metal Frame Walls	-	\$ -	\$ -	\$ -
R-4 (1.25" K-13 spray-on) Raised Slab over parking garage	-	\$ -	\$ -	\$ -
Dual Metal Windows: <b>COG U-factor=0.3, COG SHGC=0.38</b> 6,240 sf @ \$0.50 to \$1.00/sf	Upgrade	\$ 3,120	\$ 6,240	\$ 4,680
1.5 ton 4-pipe fan coil, <b>94% AFUE</b> boiler, 70-ton scroll air cooled chiller 0.72 KW/ton	Upgrade	\$ 3,000	\$ 6,000	\$ 4,500
Central DHW boiler: <b>94% AFUE</b> and recirculating system w/ timer-temperature controls and solar water heating, <b>25% Net Solar Fraction</b> (cost of boiler above under space heating boiler)	Upgrade	\$ 40,000	\$ 55,000	\$ 47,500
<b>Total Incremental Cost of Energy Efficiency Measures:</b>		<b>\$ 48,880</b>	<b>\$ 70,920</b>	<b>\$ 59,900</b>
<b>Total Incremental Cost per Square Foot:</b>		<b>\$ 1.33</b>	<b>\$ 1.93</b>	<b>\$ 1.63</b>

## Low-rise Office Building

- Single Story
- 10,580 sf,
- Window to Wall Ratio = 37.1%

**Incremental Cost Estimate to Exceed Title 24 by 15%**  
**Nonresidential Prototype: 10,580 SF, Option 1**

Climate Zone 3

Energy Efficiency Measures to Exceed Title 24 by 15%	Change Type	Incremental Cost Estimate		
		Min	Max	Avg
R-19 under Metal Deck <b>and additional R-13 batt below (no framing); with Cool Roof Reflectance = 0.55, Emittance = 0.75;</b> 10,580 sf @ \$0.60 to \$0.85/sf	Upgrade	\$ 6,348	\$ 8,993	\$ 7,671
R-19 in Metal Frame Walls	-	\$ -	\$ -	\$ -
R-0 (un-insulated) slab-on-grade 1st floor	-	\$ -	\$ -	\$ -
Metal windows: default U=0.71, <b>COG SHGC=0.38;</b> 3,200 sf @ \$1.50 to \$2.00/sf	Upgrade	\$ 4,800	\$ 6,400	\$ 5,600
Lighting = 0.783 w/sf: Open Office Areas: (60) 2-lamp T8 fixtures @58w each; (24) 18w recessed CFLs no lighting controls. Small Offices: (56) 2-lamp T8 fixtures, (40) 18w recessed CFLs: <b>(28) multi-level occupancy sensors on T8s and recessed CFLa @ \$75 to \$100 each.</b> Support Areas: (32) 18w recessed CFLs; (48) 13w CFL wall sconces; no controls.	Upgrade	\$ 2,100	\$ 2,800	\$ 2,450
(3) 10-ton DX units EER=11.0; 80% AFUE furnaces; standard efficiency fan motors; fixed temp. integrated air economizers	-	\$ -	\$ -	\$ -
R-6 duct insulation w/ducts on roof, <b>HERS verified duct leakage</b>	Upgrade	\$ 1,000	\$ 1,800	\$ 1,400
(1) Tank Gas Water Heaters EF=0.58	-	\$ -	\$ -	\$ -
<b>Total Incremental Cost of Energy Efficiency Measures:</b>		<b>\$ 14,248</b>	<b>\$ 19,993</b>	<b>\$ 17,121</b>
<b>Total Incremental Cost per Square Foot:</b>		<b>\$ 1.35</b>	<b>\$ 1.89</b>	<b>\$ 1.62</b>

**Incremental Cost Estimate to Exceed Title 24 by 15%**  
**Nonresidential Prototype: 10,580 SF, Option 2**

**Climate Zone 3**

Energy Efficiency Measures to Exceed Title 24 by 15%	Change Type	Incremental Cost Estimate		
		Min	Max	Avg
R-19 under Metal Deck <b>and additional R-25 batt below (no framing); with Cool Roof Reflectance = 0.55, Emittance = 0.75;</b> 10,580 sf @ \$0.75 to \$1.10/sf	Upgrade	\$ 7,935	\$ 11,638	\$ 9,787
R-19 in Metal Frame Walls	-	\$ -	\$ -	\$ -
R-0 (un-insulated) slab-on-grade 1st floor	-	\$ -	\$ -	\$ -
Metal windows: default U=0.71, <b>COG SHGC=0.27;</b> 3,200 sf @ \$2.00 to \$3.00/sf	Upgrade	\$ 6,400	\$ 9,600	\$ 8,000
Lighting = 0.858 w/sf: Open Office Areas: (60) 2-lamp T8 fixtures @58w each; (24) 18w recessed CFLs no lighting controls. Small Offices: (56) 2-lamp T8 fixtures; (40) 18w recessed CFLs, on/off lighting controls. Support Areas: (32) 18w recessed CFLs; (48) 13w CFL wall sconces; no controls.	-	\$ -	\$ -	\$ -
(3) 10-ton DX units EER=11.0; 80% AFUE furnaces; standard efficiency fan motors; fixed temp. integrated air economizers, <b>Controls to include "Cycle on at night"</b>	Upgrade	\$ 300	\$ 600	\$ 450
R-6 duct insulation w/ducts on roof, <b>HERS verified duct leakage</b>	Upgrade	\$ 1,000	\$ 1,800	\$ 1,400
(1) Tank Gas Water Heaters EF=0.58	-	\$ -	\$ -	\$ -
<b>Total Incremental Cost of Energy Efficiency Measures:</b>		<b>\$ 15,635</b>	<b>\$ 23,638</b>	<b>\$ 19,637</b>
<b>Total Incremental Cost per Square Foot:</b>		<b>\$ 1.48</b>	<b>\$ 2.23</b>	<b>\$ 1.86</b>

**Incremental Cost Estimate to Exceed Title 24 by 15%**

**Nonresidential Prototype: 10,580 SF, Option 3**

**Climate Zone 3**

Energy Efficiency Measures to Exceed Title 24 by 15%	Change Type	Incremental Cost Estimate		
		Min	Max	Avg
R-19 under Metal Deck <b>and additional R-13 batt below (no framing)</b> ; no cool roof; 10,580 sf @ \$0.25 to \$0.35/sf	Upgrade	\$ 2,645	\$ 3,703	\$ 3,174
R-19 in Metal Frame Walls	-	\$ -	\$ -	\$ -
R-0 (un-insulated) slab-on-grade 1st floor	-	\$ -	\$ -	\$ -
Metal windows: default U=0.71, <b>COG SHGC=0.38</b> ; 3,200 sf @ \$1.50 to \$2.00/sf	Upgrade	\$ 4,800	\$ 6,400	\$ 5,600
Lighting = 0.746 w/sf: Open Office Areas: <b>(32) HO 2-lamp T8 fixtures @74w each</b> ; (24) 18w recessed CFLs no lighting controls. Small Offices: (56) 2-lamp T8 fixtures, (40) 18w recessed CFLs: <b>(28) multi-level occupancy sensors on T8s and recessed CFLa @ \$75 to \$100 each</b> . Support Areas: (32) 18w recessed CFLs; (48) 13w CFL wall sconces; no controls.	Upgrade	\$ 820	\$ 1,648	\$ 1,234
(3) 10-ton DX units EER=11.0; 80% AFUE furnaces; standard efficiency fan motors; fixed temp. integrated air economizers; <b>Controls to include "Cycle on at night"</b>	Upgrade	\$ 300	\$ 600	\$ 450
R-6 duct insulation w/ ducts on roof	-			
(1) Tank Gas Water Heaters EF=0.58	-	\$ -	\$ -	\$ -
<b>Total Incremental Cost of Energy Efficiency Measures:</b>		<b>\$ 8,565</b>	<b>\$ 12,351</b>	<b>\$ 10,458</b>
<b>Total Incremental Cost per Square Foot:</b>		<b>\$ 0.81</b>	<b>\$ 1.17</b>	<b>\$ 0.99</b>

## High-rise Office Building

- 5-story
- 52,900 sf,
- Window to Wall Ratio = 34.5%

### Incremental Cost Estimate to Exceed Title 24 by 15% Nonresidential Prototype: 52,900 SF, Option 1

Climate Zone 3

Energy Efficiency Measures to Exceed Title 24 by 15%	Change Type	Incremental Cost Estimate		
		Min	Max	Avg
R-19 under Metal Deck with <b>Cool Roof Reflectance = 0.55, Emittance = 0.75</b> ; 10,580 sf @ \$0.35 to \$0.50/sf	Upgrade	\$ 3,703	\$ 5,290	\$ 4,497
R-19 in Metal Frame Walls	-	\$ -	\$ -	\$ -
R-0 (un-insulated) slab-on-grade 1st floor	-	\$ -	\$ -	\$ -
Metal windows: default U=0.71, <b>COG SHGC=0.38</b> ; 16,000 sf @ \$2.00 to \$2.50/sf	Upgrade	\$ 32,000	\$ 40,000	\$ 36,000
Lighting = 0.858 w/sf. Open Office Areas: (300) 2-lamp T8 fixtures @58w each; no lighting controls; (120) 18w recessed CFLs no lighting controls. Small Offices: (280) 2-lamp T8 58w fixtures on/off lighting controls; (200) 18w recessed CFLs no lighting on/off lighting controls. Support Areas: (160) 18w recessed CFLs no lighting controls; (240) 13w CFL wall sconces; no lighting controls.	-	\$ -	\$ -	\$ -
(3) 60 ton Packaged VAV system 10 EER/80% TE, standard efficiency variable speed fan motors; <b>15% VAV boxes</b> , electric water reheat on perimeter zones	Upgrade	\$ 26,450	\$ 39,675	\$ 33,063
R-6 duct insulation w/ ducts in conditioned	-	\$ -	\$ -	\$ -
(1) Tank Gas Water Heaters EF=0.58	-	\$ -	\$ -	\$ -
<b>Total Incremental Cost of Energy Efficiency Measures:</b>		<b>\$ 62,153</b>	<b>\$ 84,965</b>	<b>\$ 73,559</b>
<b>Total Incremental Cost per Square Foot:</b>		<b>\$ 1.17</b>	<b>\$ 1.61</b>	<b>\$ 1.39</b>

**Incremental Cost Estimate to Exceed Title 24 by 15%  
Nonresidential Prototype: 52,900 SF, Option 2**

**Climate Zone 3**

Energy Efficiency Measures to Exceed Title 24 by 15%	Change Type	Incremental Cost Estimate		
		Min	Max	Avg
R-19 under Metal Deck <b>and additional R-13 batt below (no framing)</b> ; no cool roof; 10,580 sf @ \$0.25 to \$0.35/sf	Upgrade	\$ 2,645	\$ 3,703	\$ 3,174
R-19 in Metal Frame Walls	-	\$ -	\$ -	\$ -
R-0 (un-insulated) slab-on-grade 1st floor	-	\$ -	\$ -	\$ -
Metal windows: default U=0.71, <b>COG SHGC=0.54</b> ; 16,000 sf @ \$1.50 to \$2.00/sf	Upgrade	\$ 24,000	\$ 32,000	\$ 28,000
Lighting = 0.783 w/sf: Open Office Areas: (300) 2-lamp T8 fixtures @58w each; no lighting controls; (120) 18w recessed CFLs no lighting controls. Small Offices: (280) 2-lamp T8 58w fixtures on/off lighting controls; (200) 18w recessed CFLs <b>multi-level occupancy sensors on T8s and recessed CFLs @ \$75 to \$100 each</b> . Support Areas: (160) 18w recessed CFLs no lighting controls; (240) 13w CFL wall sconces; no lighting controls.	Upgrade	\$ 10,500	\$ 14,000	\$ 12,250
(3) 60 ton Packaged VAV system 10 EER/80% TE, standard efficiency variable speed fan motors; <b>15% VAV boxes</b> , electric water reheat on perimeter zones	Upgrade	\$ 26,450	\$ 52,900	\$ 39,675
R-6 duct insulation w/ ducts in conditioned	-	\$ -	\$ -	\$ -
(1) Tank Gas Water Heaters EF=0.58	-	\$ -	\$ -	\$ -
<b>Total Incremental Cost of Energy Efficiency Measures:</b>		<b>\$ 63,595</b>	<b>\$ 102,603</b>	<b>\$ 83,099</b>
<b>Total Incremental Cost per Square Foot:</b>		<b>\$ 1.20</b>	<b>\$ 1.94</b>	<b>\$ 1.57</b>

**Incremental Cost Estimate to Exceed Title 24 by 15%**  
**Nonresidential Prototype: 52,900 SF, Option 3**

**Climate Zone 3**

Energy Efficiency Measures to Exceed Title 24 by 15%	Change Type	Incremental Cost Estimate		
		Min	Max	Avg
R-19 under Metal Deck <b>and additional R-13 batt below (no framing)</b> ; no cool roof; 10,580 sf @ \$0.25 to \$0.35/sf	Upgrade	\$ 2,645	\$ 3,703	\$ 3,174
R-19 in Metal Frame Walls	-	\$ -	\$ -	\$ -
R-0 (un-insulated) slab-on-grade 1st floor	-	\$ -	\$ -	\$ -
Metal windows: default U=0.71, <b>COG SHGC=0.54</b> ; 16,000 sf @ \$1.50 to \$2.00/sf	Upgrade	\$ 24,000	\$ 32,000	\$ 28,000
Lighting = 0.858 w/sf. Open Office Areas: (300) 2-lamp T8 fixtures @58w each; no lighting controls; (120) 18w recessed CFLs no lighting controls. Small Offices: (280) 2-lamp T8 58w fixtures on/off lighting controls; (200) 18w recessed CFLs no lighting on/off lighting controls. Support Areas: (160) 18w recessed CFLs no lighting controls; (240) 13w CFL wall sconces; no lighting controls.	-	\$ -	\$ -	\$ -
(3) 60 ton Packaged VAV system 10 EER/80% TE, standard efficiency variable speed fan motors; <b>20% VAV boxes</b> , hot water reheat on perimeter zones with <b>92% AFUE boiler</b> (cost of boiler included below for DHW)	Upgrade	\$ 26,450	\$ 52,900	\$ 39,675
R-6 duct insulation w/ ducts in conditioned	-	\$ -	\$ -	\$ -
DHW <b>92% AFUE boiler</b>	Upgrade	\$ 2,000	\$ 4,000	\$ 3,000
<b>Total Incremental Cost of Energy Efficiency Measures:</b>		<b>\$ 55,095</b>	<b>\$ 92,603</b>	<b>\$ 73,849</b>
<b>Total Incremental Cost per Square Foot:</b>		<b>\$ 1.04</b>	<b>\$ 1.75</b>	<b>\$ 1.40</b>

**Incremental Cost Estimate to Exceed Title 24 by 15%**  
**Nonresidential Prototype: 52,900 SF, Option 4**

**Climate Zone 3**

Energy Efficiency Measures to Exceed Title 24 by 15%	Change Type	Incremental Cost Estimate		
		Min	Max	Avg
R-19 under Metal Deck and additional R-13 batt below (no framing); with Cool Roof Reflectance = 0.55, Emittance = 0.75; 10,580 sf @ \$0.60 to \$0.85/sf	Upgrade	\$ 6,348	\$ 8,993	\$ 7,671
R-19 in Metal Frame Walls	-	\$ -	\$ -	\$ -
R-0 (un-insulated) slab-on-grade 1st floor	-	\$ -	\$ -	\$ -
Metal windows: default U=0.71, COG SHGC=0.54; 16,000 sf @ \$1.50 to \$2.00/sf	Upgrade	\$ 24,000	\$ 32,000	\$ 28,000
Lighting = 0.783 w/sf: Open Office Areas: (300) 2-lamp T8 fixtures @58w each; no lighting controls; (120) 18w recessed CFLs no lighting controls. Small Offices: (280) 2-lamp T8 58w fixtures on/off lighting controls; (200) 18w recessed CFLs multi-level occupancy sensors on T8s and recessed CFLs @ \$75 to \$100 each. Support Areas: (160) 18w recessed CFLs no lighting controls; (240) 13w CFL wall sconces; no lighting controls.	Upgrade	\$ 10,500	\$ 14,000	\$ 12,250
(3) 60 ton Packaged VAV system 10 EER/80% TE, standard efficiency variable speed fan motors; 25% VAV boxes, hot water reheat on perimeter zones with 92% AFUE boiler (cost of boiler included below for DHW).	Upgrade	\$ -	\$ -	\$ -
R-6 duct insulation w/ ducts in conditioned	-	\$ -	\$ -	\$ -
DHW 92% AFUE boiler	Upgrade	\$ 2,000	\$ 4,000	\$ 3,000
<b>Total Incremental Cost of Energy Efficiency Measures:</b>		<b>\$ 42,848</b>	<b>\$ 58,993</b>	<b>\$ 50,921</b>
<b>Total Incremental Cost per Square Foot:</b>		<b>\$ 0.81</b>	<b>\$ 1.12</b>	<b>\$ 0.96</b>

**Incremental Cost Estimate to Exceed Title 24 by 15%**  
**Nonresidential Prototype: 52,900 SF, Option 5**

**Climate Zone 3**

Energy Efficiency Measures to Exceed Title 24 by 15%	Change Type	Incremental Cost Estimate		
		Min	Max	Avg
R-19 under Metal Deck and additional R-13 batt below (no framing); with Cool Roof Reflectance = 0.55, Emittance = 0.75; 10,580 sf @ \$0.60 to \$0.85/sf	Upgrade	\$ 6,348	\$ 8,993	\$ 7,671
R-19 in Metal Frame Walls	-	\$ -	\$ -	\$ -
R-0 (un-insulated) slab-on-grade 1st floor	-	\$ -	\$ -	\$ -
Metal windows: default U=0.71, <b>COG SHGC=0.54</b> ; 16,000 sf @ \$1.50 to \$2.00/sf	Upgrade	\$ 24,000	\$ 32,000	\$ 28,000
Lighting = 0.678 w/sf: Open Office Areas: <b>(160) 2-lamp T8 fixtures @74w each</b> ; no lighting controls; (120) 18w recessed CFLs no lighting controls. Small Offices: (280) 2-lamp T8 58w fixtures on/off lighting controls; (200) 18w recessed CFLs <b>multi-level occupancy sensors on T8s and recessed CFLs @ \$75 to \$100 each</b> . Support Areas: (160) 18w recessed CFLs no lighting controls; (240) 13w CFL wall sconces; no lighting controls.	Upgrade	\$ 10,500	\$ 14,000	\$ 12,250
(3) 60 ton Packaged VAV system 10 EER/80% TE, standard efficiency variable speed fan motors; 25% VAV boxes, hot water reheat on perimeter zones with <b>94% AFUE boiler</b> (cost of boiler included below for DHW).	Upgrade	\$ -	\$ -	\$ -
R-6 duct insulation w/ ducts in conditioned	-	\$ -	\$ -	\$ -
DHW <b>94% AFUE boiler</b>	Upgrade	\$ 4,000	\$ 8,000	\$ 6,000
<b>Total Incremental Cost of Energy Efficiency Measures:</b>		<b>\$ 44,848</b>	<b>\$ 62,993</b>	<b>\$ 53,921</b>
<b>Total Incremental Cost per Square Foot:</b>		<b>\$ 0.85</b>	<b>\$ 1.19</b>	<b>\$ 1.02</b>

## **5.0 Cost -Effectiveness Determination**

Regardless of the building design, occupancy profile and number of stories, the incremental improvement in overall annual energy performance of buildings in exceeding the 2008 Standards is determined to be cost-effective. However, each building's overall design, occupancy type and specific design choices may allow for a large range of incremental costs for exceeding 2008 Standards, estimated annual energy cost savings, and subsequent payback period.

### **Small Single Family**

Building Description	Total Annual KWh Saving	Total Annual Therms Saving	Incremental First Cost (\$)	Annual Energy Cost Savings (\$)	Simple Payback (Years)
2,025 sf (Option 1)	78	85	\$1,659	\$112	14.8
2,025 sf (Option 2)	72	87	\$1,734	\$113	15.3
2,025 sf (Option 3)	85	81	\$1,592	\$108	14.7
Averages:	78	84	\$1,662	\$111	15.0

*Annual Reduction in CO2-equivalent: 0.50 lb./sq.ft.-year, 1,017 lb./building-year  
Increased Cost / lb. CO2-e reduction: \$1.63*

### **Large Single Family**

Building Description	Total Annual KWh Saving	Total Annual Therms Saving	Incremental First Cost (\$)	Annual Energy Cost Savings (\$)	Simple Payback (Years)
4,500 sf (Option 1)	181	105	\$3,431	\$153	22.4
4,500 sf (Option 2)	88	117	\$4,136	\$150	27.5
4,500 sf (Option 3)	172	106	\$2,793	\$153	18.3
Averages:	147	109	\$3,453	\$152	22.7

*Annual Reduction in CO2-equivalent: 0.30 lb./sq.ft.-year, 1,339 lb./building-year  
Increased Cost / lb. CO2-e reduction: \$2.58*

### **Low-rise Multi-family Apartments**

Building Description	Total Annual KWh Saving	Total Annual Therms Saving	Incremental First Cost (\$)	Annual Energy Cost Savings (\$)	Simple Payback (Years)
8-Unit, 8,442 sf (Option 1)	569	345	\$6,734	\$499	13.5
8-Unit, 8,442 sf (Option 2)	552	342	\$7,251	\$493	14.7
8-Unit, 8,442 sf (Option 3)	453	337	\$9,746	\$469	20.8
8-Unit, 8,442 sf (Option 4)	57	396	\$8,323	\$466	17.9
Averages:	354	358	\$8,440	\$476	17.8

*Annual Reduction in CO2-equivalent: 0.51 lb./sq.ft.-year, 4,316 lb./building-year  
Increased Cost / lb. CO2-e reduction: \$1.86*

### High-rise Multi-family Apartments

Building Description	Total Annual KWh Saving	Total Annual Therms Saving	Incremental First Cost (\$)	Annual Energy Cost Savings (\$)	Simple Payback (Years)
36,800 sf (Option 1)	668	1766	\$24,820	\$2,151	11.5
36,800 sf (Option 2)	-2616	2314	\$78,066	\$2,190	35.6
36,800 sf (Option 3)	-2519	2811	\$51,940	\$2,779	18.7
Averages:	-1489	2297	\$51,609	\$2,374	22.0

*Annual Reduction in CO2-equivalent: 0.71 lb./sq.ft.-year, 26,067 lb./building-year  
Increased Cost / lb. CO2-e reduction: \$1.97*

### Low-rise Office Building

Building Description	Total Annual KWh Saving	Total Annual Therms Saving	Incremental First Cost (\$)	Annual Energy Cost Savings (\$)	Simple Payback (Years)
10,580 sf (Option 1)	10410	-79	\$17,121	\$2,765	6.2
10,580 sf (Option 2)	8612	-182	\$19,637	\$2,247	8.7
10,580 sf (Option 3)	10594	-223	\$10,458	\$2,475	4.2
Averages:	9872	-161	\$15,738	\$2,496	6.4

*Annual Reduction in CO2-equivalent: 0.24 lb./sq.ft.-year, 2,564 lb./building-year  
Increased Cost / lb. CO2-e reduction: \$7.17*

### High-rise Office Building

Building Description	Total Annual KWh Saving	Total Annual Therms Saving	Incremental First Cost (\$)	Annual Energy Cost Savings (\$)	Simple Payback (Years)
52,900 sf (Option 1)	76452	-16	\$73,559	\$17,629	4.2
52,900 sf (Option 2)	74762	-3	\$83,099	\$16,457	5.0
52,900 sf (Option 3)	40583	4523	\$73,849	\$16,248	4.5
52,900 sf (Option 4)	55173	2217	\$50,921	\$34,725	1.5
52,900 sf (Option 5)	40996	4871	\$53,921	\$31,964	1.7
Averages:	57593	2318	\$67,070	\$23,405	3.4

*Annual Reduction in CO2-equivalent: 1.34 lb./sq.ft.-year, 70,667 lb./building-year  
Increased Cost / lb. CO2-e reduction: \$0.95*

## **Conclusions**

Regardless of the building design, occupancy profile and number of stories, the incremental improvement in overall annual energy performance of buildings which exceed the 2008 Title 24 Building Energy Efficiency Standards by 15% appears cost-effective. However, each building's overall design, occupancy type and specific design choices may allow for a large range of incremental first cost and payback. As with simply meeting the requirements of the Title 24 energy standards, a permit applicant complying with the energy requirements of a green building ordinance should carefully analyze building energy performance to reduce incremental first cost and the payback for the required additional energy efficiency measures.