

# Codes and Standards Title 24 Energy-Efficient Local Ordinances

## **Title:** Marin County Green Building Ordinance Energy Cost-Effectiveness Study

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Marin County Green Building Ordinance  
Energy Cost-Effectiveness Study

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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 the proposed Marin County Ordinance for local energy efficiency standards. The proposed ordinance states that residential new construction projects must meet the overall requirements summarized in the Resolution printed on the following pages.

The study contained in this report shall be included in Marin County's application to the California Energy Commission (CEC) which must meet the requirements specified in Section 10-106 of the California Code of Regulations, Title 24, Part 1, **LOCALLY ADOPTED ENERGY STANDARDS**. The proposed Ordinance shall be enforceable after the CEC has reviewed and approved the local energy standards as meeting all requirements of Section 10-106; and the Ordinance has been adopted by the County and filed with the Building Standards Commission.

The 2008 Building Energy Efficiency Standards, scheduled to take effect on January 1, 2010, are the baseline used to calculate the cost-effectiveness of the proposed Ordinance.

**MARIN COUNTY MODEL GREEN BUILDING ORDINANCE (Draft)**

**TABLE A: GREEN BUILDING STANDARDS FOR COMPLIANCE FOR RESIDENTIAL CONSTRUCTION AND RENOVATION**

Covered Project	Green Building Rating System	Minimum Compliance Threshold	Energy Budget Below CA Title 24 Part 6	Verification
<b>Single-Family or Two-Family Residential: New construction</b>				
500-2,499 sq. ft.	GPR New Home	75 points	15%	Green Point Rated <sup>1</sup>
2,500-3,999 sq. ft.	GPR New Home	100 points	15%	Green Point Rated <sup>1</sup>
4,000-5,499 sq. ft.	GPR New Home	125 points	20%	Green Point Rated <sup>1</sup>
5,500-6,999 sq. ft.	GPR New Home	150 points	30%	Green Point Rated <sup>1</sup>
7,000+ sq. ft.	GPR New Home	200 points	Net zero energy	Green Point Rated <sup>1</sup>
<b>Single-Family or Two-Family Residential: Renovations (including additions to existing buildings)</b>				
Less than \$50,000 valuation	n/a	Insulate exposed hot water pipes; Install radiant barrier when reroofing and removing sheathing		City building inspector
Less than 500 sq. ft. or \$50,000-\$99,999 valuation <sup>3</sup>	GPR Existing Home	Checklist submittal and completion of a HERSII or BPI home performance audit		City plan check
500-749 sq. ft. or \$100,000-\$149,999 valuation <sup>3</sup>	GPR Existing Home – Elements	25 points		GreenPoint Rater <sup>2</sup>
750-999 sq. ft. or \$150,000-\$299,999 valuation <sup>3</sup>	GPR Existing Home – Elements	35 points		GreenPoint Rater <sup>2</sup>
1,000+ sq. ft. or \$300,000+ valuation <sup>3</sup>	GPR Existing Home – Whole House	50 points + 20% improvement in HERSII or BPI home performance audit results or a HERSII score 100 or better		GreenPoint Rated <sup>2</sup>
<b>Multi-Family Residential: New Construction</b>				
Less than 1,000 sq. ft. average unit size	GPR Multi-Family	60 points	15%	GreenPoint Rated <sup>1</sup>
1,000+ sq. ft. average unit size	GPR Multi-Family	75 points	15%	GreenPoint Rated <sup>1</sup>

<sup>1</sup> Project verification by GreenPoint Rater and certification by Build It Green

<sup>2</sup> Project verification by GreenPoint Rater

<sup>3</sup> Project valuation will be the primary determinate in establishing the Minimum Compliance Threshold for the project, with use of project size range when valuation is uncertain or in the opinion of the building official does not accurately reflect the project scope.

**MARIN COUNTY MODEL GREEN BUILDING ORDINANCE (Draft)**

**TABLE B: GREEN BUILDING STANDARDS FOR COMPLIANCE FOR NONRESIDENTIAL CONSTRUCTION AND RENOVATION**

Covered Project	Green Building Rating System	Minimum Compliance Threshold	Energy Budget Below CA Title 24 Part 6	Verification
<b>New construction (including additions to existing buildings)</b>				
2,000-4,999 sq. ft.	LEED® New Construction or Core & Shell	Checklist submittal + compliance with Prerequisites		LEED® AP with additional GreenPoint Rater or BPI Certification
5,000-49,999 sq. ft.	LEED® New Construction or Core & Shell	LEED® Silver	15%	LEED® AP with additional GreenPoint Rater or BPI Certification
50,000+ sq. ft.	LEED® New Construction or Core & Shell	LEED® Gold	15%	GBCI Certified
<b>Renovations</b>				
500-4,999 sq. ft. or less than \$500,000 valuation <sup>3</sup>	LEED® Commercial Interiors or Operations & Maintenance	<b>Voluntary</b> compliance with the following Prerequisites: WE P1 (Water Efficiency – Baseline Requirements only) EA P3 (Fundamental Refrigerant Management) for renovations of ≥50% of the building interior area <b>Voluntary</b> compliance with the following Credits: EA C1.3 (Optimize Energy Performance – HVAC) for renovations of ≥50% of the building interior area		None
5,000-24,999 sq. ft. or \$500,000 - \$5 million valuation <sup>3</sup>	LEED® Commercial Interiors or Operations & Maintenance	Same as above, but Required.		City building inspector
25,000+ sq. ft. or greater than \$5 million valuation <sup>3</sup>	LEED® Commercial Interiors or Operations & Maintenance	LEED® Silver		LEED® AP with additional GreenPoint Rater or BPI Certification

<sup>3</sup> Project valuation will be the primary determinate in establishing the Minimum Compliance Threshold for the project, with use of project size range when valuation is uncertain or in the opinion of the building official does not accurately reflect the project scope.

## **SOLAR ELECTRIC SYSTEMS**

A solar photovoltaic (PV) energy system may be used to meet the Energy Budget Below CA Title 24 Part 6 requirements of this resolution which exceed 15%. To qualify for energy credits, the PV energy system must be capable of generating electricity from sunlight, supply the electricity directly to the building, and the system is connected, through a reversible meter, to the utility grid. The installation of any qualifying PV energy system must meet all installation criteria contained in the California Energy Commission's Guidebook "Eligibility Criteria and Conditions for Incentives for Solar Energy Systems." The methodology used to calculate the energy equivalent to the PV credit shall be the CECPV Calculator, using the most recent version, provided by the California Energy Commission.

## **INCENTIVES [optional]**

A City Green Building emblem for construction signage shall be provided for all residential and non-residential projects that obtain a GreenPoint or LEED rating.

The following incentives shall be provided for residential projects that achieve at least 100 GreenPoints or non-residential projects that achieve at least a LEED® Gold rating:

1. Expedited building permit plan check (typically 2-week turnaround)
2. Reimbursement for the cost of the GreenPoint Rater services (residential projects only, up to a maximum of \$1,000)
3. Provision of a bronze plaque for building mounting, identifying the project as a green building

## **EXCEPTIONS [optional]**

The following shall not be included as Covered Projects:

1. Second dwelling units,
2. Buildings which are temporary,
3. Building area which is not or is not intended to be conditioned space, and
4. Any requirement which would impair the historic integrity of any building listed on a local, state or federal register of historic structures.

The following shall not be included in project valuation:

1. Improvements primarily intended for seismic upgrades or required disabled access,
2. Building replacement due to catastrophic loss due to flood or earthquake damage, and
3. Installation of renewable energy systems.

## **2.0 Impacts of the New Ordinance**

The energy performance impacts of the Ordinance have been evaluated using several prototypical designs which collectively reflect a broad range of building types, including:

- Single family house: 2-story 1,582 sf (CZ3)
- Single family house: 2-story 2,025 sf (CZ2, CZ3)
- Single family house: 2-story 2,682 sf (CZ2)
- Single family house: 2-story 5,000 sf (CZ2, CZ3): Exceeding Title 24 by 20%
- Single family house: 2-story 6,500 sf (CZ2, CZ3): Exceeding Title 24 by 30%
- Single family house: 2-story 7,500 sf (CZ2, CZ3): Net Energy Zero TDV
- Low-rise Multi-family building, 8 dwelling units: 2-story 8,442 sf (CZ2, CZ3)
- High-rise Multi-family building, 40 dwelling units: 4-story 36,800 sf (CZ2, CZ3)
- Nonresidential office building: 2-story, 21,160 sf (CZ2, CZ3)
- Nonresidential office building: 5-story, 52,900 sf (CZ2, CZ3)

The methodology used in the case studies is based on a design process for buildings that meet or exceed the energy standards, and includes the following:

- (a) Each prototype building design is tested for 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
- (b) Starting with that set of measures which is minimally compliant with the 2008 Standards, various energy measures are upgraded so that the building just meets the minimum energy performance required by the proposed Ordinance (e.g., 15% better than 2008 Title 24). 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 always the primary focus of selecting measures; but rather the requisite reduction of Title 24 Time Dependent Valuation(TDV) energy at a reasonably low incremental cost consistent with other non-monetary but important design considerations.

- (c) 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. Site energy in kWh and therms, is calculated from the Title 24 simulation results to establish the annual energy savings, energy cost savings and CO2-equivalent reductions in greenhouse gases.

## 2.1 Single Family Homes

### **CLIMATE ZONE 2**

The following energy design descriptions of single family building prototypes just meet the 2008 Title 24 Building Energy Efficiency Standards in **Climate Zone 2**:

#### **CZ2: 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-0 Slab on Grade
R-19 Raised Floor over Garage/Open at 2nd Floor
Low E2 Vinyl Windows, U=0.36, SHGC=0.30
Furnace: 80% AFUE
Air Conditioner: 13 SEER
R-6 Attic Ducts
Reduced Duct Leakage/Testing (HERS)
50 Gallon Gas Water Heater: EF=0.60

#### **CZ2: Single Family House 2,682 square feet, 2-story, 21.1% 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
Furnace: 80% AFUE
Air Conditioner: 13 SEER
R-6 Attic Ducts
Reduced Duct Leakage/Testing (HERS)
50 Gallon Gas Water Heaters: EF=0.60

**CZ2: Single Family House 5,000 square feet, 2-story, 22.0% glazing/floor area ratio**

<b>Energy Efficiency Measures</b>
R-38 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
(2) Air Conditioners: 13 SEER, 11 EER (HERS)
(2) Air Conditioners: Refrig. Charge (HERS)
R-8 Attic Ducts
Reduced Duct Leakage/Testing (HERS)
(2) 50 Gallon Gas Water Heaters: EF=0.60

**CZ2: Single Family House 6,500 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
Quality Insulation Installation (HERS)
Low E2 Vinyl Windows, U=0.36, SHGC=0.30
(3) Furnaces: 80% AFUE
(3) Air Conditioners: 13 SEER, 11 EER (HERS)
(3) Air Conditioners: Refrig. Charge (HERS)
R-8 Attic Ducts
Reduced Duct Leakage/Testing (HERS)
(3) 50 Gallon Gas Water Heaters: EF=0.60

**CZ2: Single Family House 7,500 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
Quality Insulation Installation (HERS)
Low E2 Vinyl Windows, U=0.36, SHGC=0.30
(3) Furnaces: 80% AFUE
(3) Air Conditioners: 13 SEER, 11 EER (HERS)
(3) Air Conditioners: Refrig. Charge (HERS)
R-8 Attic Ducts
Reduced Duct Leakage/Testing (HERS)
(3) 50 Gallon Gas Water Heaters: EF=0.60

## Climate Zone 2 Energy Efficiency Measures Needed to Meet the Ordinance

The following tables list the energy features and/or equipment included in the Title 24 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** (except homes equal or greater than 4,000 square feet as indicated).

In any actual project, the designer, builder or owner selects which measures will be included to meet the proposed Ordinance requirements. There are a number of factors in choosing the final mix of energy measures including first cost, aesthetics, maintenance and replacement considerations. The analysis includes at least two different options to meet the proposed Ordinance requirements for each prototypical design.

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

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

2025 sf

Climate Zone 2

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 @ \$0.55 to \$0.85/sf	Upgrade	\$ 1,403	\$ 2,168	\$ 1,786
R-0 Slab on Grade	-	\$ -	\$ -	\$ -
R-19 Raised Floor over Garage/Open at 2nd Floor	-	\$ -	\$ -	\$ -
Low E2 Vinyl Windows, U=0.36, SHGC=0.30	-	\$ -	\$ -	\$ -
Furnace: 80% AFUE	-	\$ -	\$ -	\$ -
Air Conditioner: 13 SEER, 11 EER (HERS)	Upgrade	\$ 25	\$ 75	\$ 50
Air Conditioner: Refrig. Charge (HERS)	Upgrade	\$ 150	\$ 200	\$ 175
R-6 Attic Ducts	-	\$ -	\$ -	\$ -
Reduced Duct Leakage/Testing (HERS)	-	\$ -	\$ -	\$ -
50 Gallon Gas Water Heater: EF=0.60	-	\$ -	\$ -	\$ -
<b>Total Incremental Cost of Energy Efficiency Measures:</b>		<b>\$ 1,578</b>	<b>\$ 2,443</b>	<b>\$ 2,011</b>
<b>Total Incremental Cost per Square Foot:</b>		<b>\$ 0.78</b>	<b>\$ 1.21</b>	<b>\$ 0.99</b>

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

2025 sf

Climate Zone 2

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 @ \$0.70 to \$0.95/sf	Upgrade	\$ 1,785	\$ 2,423	\$ 2,104
R-0 Slab on Grade	-	\$ -	\$ -	\$ -
R-19 Raised Floor over Garage/Open at 2nd Floor	-	\$ -	\$ -	\$ -
Low E2 Vinyl Windows, U=0.36, SHGC=0.30	-	\$ -	\$ -	\$ -
Furnace: 80% AFUE	-	\$ -	\$ -	\$ -
Air Conditioning: 13 SEER	-	\$ -	\$ -	\$ -
R-6 Attic Ducts	-	\$ -	\$ -	\$ -
Reduced Duct Leakage/Testing (HERS)	-	\$ -	\$ -	\$ -
50 Gallon Gas Water Heater: EF=0.60	-	\$ -	\$ -	\$ -
<b>Total Incremental Cost of Energy Efficiency Measures:</b>		<b>\$ 1,785</b>	<b>\$ 2,423</b>	<b>\$ 2,104</b>
<b>Total Incremental Cost per Square Foot:</b>		<b>\$ 0.88</b>	<b>\$ 1.20</b>	<b>\$ 1.04</b>

**Incremental Cost Estimate to Exceed Title 24 by 15%**  
**Single Family Prototype: 2,682 SF, Option 1**

2682 sf

Climate Zone 2

Energy Efficiency Measures	Change Type	Incremental Cost Estimate		
		Min	Max	Avg
R-30 Roof w/ Radiant Barrier	-	\$ -	\$ -	\$ -
R-19 Walls (from R-13): 2,638 sf @ \$0.55 to \$0.85/sf	Upgrade	\$ 1,451	\$ 2,242	\$ 1,847
R-19 Floor	-	\$ -	\$ -	\$ -
Low E2 Vinyl Windows, U=0.36, SHGC=0.30	-	\$ -	\$ -	\$ -
Furnace: 80% AFUE	-	\$ -	\$ -	\$ -
Air Conditioner: 13 SEER, 11 EER (HERS)	Upgrade	\$ 25	\$ 75	\$ 50
Air Conditioner: Refrig. Charge (HERS)	Upgrade	\$ 150	\$ 200	\$ 175
R-6 Attic Ducts	-	\$ -	\$ -	\$ -
Reduced Duct Leakage/Testing (HERS)	-	\$ -	\$ -	\$ -
50 Gallon Gas Water Heater: EF=0.60	-	\$ -	\$ -	\$ -
<b>Total Incremental Cost of Energy Efficiency Measures:</b>		<b>\$ 1,626</b>	<b>\$ 2,517</b>	<b>\$ 2,072</b>
<b>Total Incremental Cost per Square Foot:</b>		<b>\$ 0.61</b>	<b>\$ 0.94</b>	<b>\$ 0.77</b>

**Incremental Cost Estimate to Exceed Title 24 by 15%**  
**Single Family Prototype: 2,682 SF, Option 2**

2682 sf

Climate Zone 2

Energy Efficiency Measures	Change Type	Incremental Cost Estimate		
		Min	Max	Avg
R-38 Roof w/ Radiant Barrier (from R-30): 1,402sf @ 0.40 to 0.60/sf	Upgrade	\$ 561	\$ 841	\$ 701
R-15 Walls (from R-13): 2,638 sf @ \$0.12 to \$0.20/sf	Upgrade	\$ 317	\$ 528	\$ 422
R-19 Floor	-	\$ -	\$ -	\$ -
Quality Insulation Installation (HERS)	Upgrade	\$ 450	\$ 600	\$ 525
Low E2 Vinyl Windows, U=0.36, SHGC=0.30	-	\$ -	\$ -	\$ -
Furnace: 90% AFUE (from 80% AFUE)	Upgrade	\$ 500	\$ 1,000	\$ 750
Air Conditioner: 13 SEER	-	\$ -	\$ -	\$ -
R-6 Attic Ducts	-	\$ -	\$ -	\$ -
Reduced Duct Leakage/Testing (HERS)	-	\$ -	\$ -	\$ -
50 Gallon Gas Water Heater: EF=0.62 (from EF=0.60)	Upgrade	\$ 100	\$ 200	\$ 150
<b>Total Incremental Cost of Energy Efficiency Measures:</b>		<b>\$ 1,928</b>	<b>\$ 3,169</b>	<b>\$ 2,548</b>
<b>Total Incremental Cost per Square Foot:</b>		<b>\$ 0.72</b>	<b>\$ 1.18</b>	<b>\$ 0.95</b>

**Incremental Cost Estimate to Exceed Title 24 by 15%**  
**Single Family Prototype: 2,682 SF, Option 3**

2682 sf

Climate Zone 2

Energy Efficiency Measures	Change Type	Incremental Cost Estimate		
		Min	Max	Avg
R-30 Roof w/ Radiant Barrier	-	\$ -	\$ -	\$ -
R-21 Walls (from R-13): 2,638 sf @ \$0.70 to \$0.95/sf	Upgrade	\$ 1,847	\$ 2,506	\$ 2,177
R-19 Floor	-	\$ -	\$ -	\$ -
Low E2 Vinyl Windows, U=0.36, SHGC=0.30	-	\$ -	\$ -	\$ -
Furnace: 80% AFUE	-	\$ -	\$ -	\$ -
Air Conditioner: 13 SEER	-	\$ -	\$ -	\$ -
R-6 Attic Ducts	-	\$ -	\$ -	\$ -
Reduced Duct Leakage/Testing (HERS)	-	\$ -	\$ -	\$ -
50 Gallon Gas Water Heater: EF=0.62 (from EF=0.60)	Upgrade	\$ 100	\$ 200	\$ 150
<b>Total Incremental Cost of Energy Efficiency Measures:</b>		<b>\$ 1,947</b>	<b>\$ 2,706</b>	<b>\$ 2,327</b>
<b>Total Incremental Cost per Square Foot:</b>		<b>\$ 0.73</b>	<b>\$ 1.01</b>	<b>\$ 0.87</b>

For homes  $\geq 4,000$  square feet to 5,499 square feet, the following tables list the energy measures needed to improve a 5,000 square foot home so that it uses at least 20% less TDV energy than the corresponding Title 24 base case design.

**Incremental Cost Estimate to Exceed Title 24 by 20%**  
**Single Family Prototype: 5,000 SF, Option 1**

5000 sf

Climate Zone 2

Energy Efficiency Measures	Change Type	Incremental Cost Estimate		
		Min	Max	Avg
R-38 Roof w/ Radiant Barrier	-	\$ -	\$ -	\$ -
R-21 Walls (from R-13): 2,616 sf @ \$0.45 to \$0.70/sf	Upgrade	\$ 1,177	\$ 1,831	\$ 1,504
R-19 Raised Floor	-	\$ -	\$ -	\$ -
Super Low E Vinyl Windows, U=0.36, SHGC=0.23 (from Low E2, U=0.36, SHGC=0.23): 1,100 sf @ \$1.40 - \$1.75 / sf	Upgrade	\$ 1,540	\$ 1,925	\$ 1,733
(2) Furnace: 92% AFUE (from 80% AFUE)	Upgrade	\$ 1,000	\$ 2,400	\$ 1,700
(2) Air Conditioners: 13 SEER, 11 EER (HERS)	-	\$ -	\$ -	\$ -
(2) Air Conditioner: Refrig. Charge (HERS)	-	\$ -	\$ -	\$ -
R-8 Attic Ducts	-	\$ -	\$ -	\$ -
Reduced Duct Leakage/Testing (HERS)	-	\$ -	\$ -	\$ -
(2) 50 Gallon Gas Water Heaters: EF=0.62 (from EF=0.60)	Upgrade	\$ 200	\$ 400	\$ 300
<b>Total Incremental Cost of Energy Efficiency Measures:</b>		<b>\$ 3,917</b>	<b>\$ 6,556</b>	<b>\$ 5,237</b>
<b>Total Incremental Cost per Square Foot:</b>		<b>\$ 0.78</b>	<b>\$ 1.31</b>	<b>\$ 1.05</b>

**Incremental Cost Estimate to Exceed Title 24 by 20%**  
**Single Family Prototype: 5,000 SF, Option 2**

5000 sf

Climate Zone 2

Energy Efficiency Measures	Change Type	Incremental Cost Estimate		
		Min	Max	Avg
R-38 Roof w/ Radiant Barrier	-	\$ -	\$ -	\$ -
R-21 Walls (from R-13): 2,616 sf @ \$0.45 to \$0.70/sf	Upgrade	\$ 1,177	\$ 1,831	\$ 1,504
R-38 Raised Floor (from R-19): 3,000 sf @ \$0.30 to \$0.45	Upgrade	\$ 900	\$ 1,350	\$ 1,125
Quality Insulation Installation (HERS)	Upgrade	\$ 450	\$ 600	\$ 525
Super Low E Vinyl Windows, U=0.36, SHGC=0.23 (from Low E2, U=0.36, SHGC=0.23): 1,100 sf @ \$1.40 - \$1.75 / sf	Upgrade	\$ 1,540	\$ 1,925	\$ 1,733
(2) Furnaces: 80% AFUE	-	\$ -	\$ -	\$ -
(2) Air Conditioners: 13 SEER, 11 EER (HERS)	-	\$ -	\$ -	\$ -
(2) Air Conditioner: Refrig. Charge (HERS)	-	\$ -	\$ -	\$ -
R-6 Attic Ducts (from R-8)	Downgrade	\$ (650)	\$ (450)	\$ (550)
Reduced Duct Leakage/Testing (HERS)	-	\$ -	\$ -	\$ -
(2) 50 Gallon Gas Water Heaters: EF=0.62 (from EF=0.60)	Upgrade	\$ 200	\$ 400	\$ 300
<b>Total Incremental Cost of Energy Efficiency Measures:</b>		<b>\$ 3,617</b>	<b>\$ 5,656</b>	<b>\$ 4,637</b>
<b>Total Incremental Cost per Square Foot:</b>		<b>\$ 0.72</b>	<b>\$ 1.13</b>	<b>\$ 0.93</b>

**Incremental Cost Estimate to Exceed Title 24 by 20%**  
**Single Family Prototype: 5,000 SF, Option 3**

5000 sf

Climate Zone 2

Energy Efficiency Measures	Change Type	Incremental Cost Estimate		
		Min	Max	Avg
R-38 Roof w/ Radiant Barrier	-	\$ -	\$ -	\$ -
R-21 Walls (from R-13): 2,616 sf @ \$0.45 to \$0.70/sf	Upgrade	\$ 1,177	\$ 1,831	\$ 1,504
R-19 Raised Floor	-	\$ -	\$ -	\$ -
Super Low E Vinyl Windows, U=0.36, SHGC=0.23 (from Low E2, U=0.36, SHGC=0.23): 1,100 sf @ \$1.40 - \$1.75 / sf	Upgrade	\$ 1,540	\$ 1,925	\$ 1,733
(2) Furnace: 80% AFUE	-	\$ -	\$ -	\$ -
(2) Air Conditioners: 13 SEER, 11 EER (HERS)	-	\$ -	\$ -	\$ -
(2) Air Conditioner: Refrig. Charge (HERS)	-	\$ -	\$ -	\$ -
R-6 Attic Ducts (from R-8)	Downgrade	\$ (650)	\$ (450)	\$ (550)
Reduced Duct Leakage/Testing (HERS)	-	\$ -	\$ -	\$ -
(2) Instantaneous Gas Water Heater: RE=0.80 (from (2) 50 Gal Gas: EF=0.62)	Upgrade	\$ 1,800	\$ 3,000	\$ 2,400
<b>Total Incremental Cost of Energy Efficiency Measures:</b>		<b>\$ 3,867</b>	<b>\$ 6,306</b>	<b>\$ 5,087</b>
<b>Total Incremental Cost per Square Foot:</b>		<b>\$ 0.77</b>	<b>\$ 1.26</b>	<b>\$ 1.02</b>

For homes  $\geq$  5,500 square feet to 6,999 square feet, the following tables list the energy measures needed to improve a 6,500 square foot home so that it uses at least 30% less TDV energy than the corresponding Title 24 base case design.

**Incremental Cost Estimate to Exceed Title 24 by 30%**  
**Single Family Prototype: 6,500 SF, Option 1**

6500 sf

Climate Zone 2

Energy Efficiency Measures	Change Type	Incremental Cost Estimate		
		Min	Max	Avg
R-38 Roof w/ Radiant Barrier (from R-30 w/Radiant Barrier): 3,900 sf @ 0.15 to 0.20/sf	Upgrade	\$ 585	\$ 780	\$ 683
R-21 Walls (from R-13): 2,808 sf @ \$0.45 to \$0.70/sf	Upgrade	\$ 1,264	\$ 1,966	\$ 1,615
R-30 Raised Floor (from R-19): 3,900 sf @ \$0.25 to \$0.35	Upgrade	\$ 975	\$ 1,365	\$ 1,170
Quality Insulation Installation (HERS)	-	\$ -	\$ -	\$ -
Super Low E Vinyl Windows, U=0.36, SHGC=0.23 (from Low E2, U=0.36, SHGC=0.23): 1,430 sf @ \$1.40 - \$1.75 / sf	Upgrade	\$ 2,002	\$ 2,503	\$ 2,252
(3) Furnaces: 92% AFUE (from 80% AFUE)	Upgrade	\$ 1,500	\$ 3,600	\$ 2,550
(3) Air Conditioners: 13 SEER, 11 EER (HERS)	-	\$ -	\$ -	\$ -
(3) Air Conditioner: Refrig. Charge (HERS)	-	\$ -	\$ -	\$ -
R-6 Attic Ducts (from R-8)	Downgrade	\$ (975)	\$ (675)	\$ (825)
Reduced Duct Leakage/Testing (HERS)	-	\$ -	\$ -	\$ -
(3) Instantaneous Gas Water Heater: RE=0.80 (from (3) 50 Gal Gas: EF=0.60)	Upgrade	\$ 3,000	\$ 5,100	\$ 4,050
Pipe Insulation	Upgrade	\$ 450	\$ 600	\$ 525
<b>Total Incremental Cost of Energy Efficiency Measures:</b>		<b>\$ 8,801</b>	<b>\$ 15,238</b>	<b>\$ 12,019</b>
<b>Total Incremental Cost per Square Foot:</b>		<b>\$ 1.35</b>	<b>\$ 2.34</b>	<b>\$ 1.85</b>

**Incremental Cost Estimate to Exceed Title 24 by 30%**  
**Single Family Prototype: 6,500 SF, Option 2**

6500 sf

Climate Zone 2

Energy Efficiency Measures	Change Type	Incremental Cost Estimate		
		Min	Max	Avg
R-38 Roof w/ Radiant Barrier (from R-30 w/Radiant Barrier): 3,900 sf @ 0.15 to 0.20/sf	Upgrade	\$ 585	\$ 780	\$ 683
R-19 Walls (from R-13): 2,808 sf @ \$0.31 to \$0.54/sf	Upgrade	\$ 870	\$ 1,516	\$ 1,193
R-19 Raised Floor	-	\$ -	\$ -	\$ -
Quality Insulation Installation (HERS)	-	\$ -	\$ -	\$ -
Super Low E Vinyl Windows, U=0.36, SHGC=0.23 (from Low E2, U=0.36, SHGC=0.23): 1,430 sf @ \$1.40 - \$1.75 / sf	Upgrade	\$ 2,002	\$ 2,503	\$ 2,252
(3) Furnaces: 80% AFUE	-	\$ -	\$ -	\$ -
(3) Air Conditioners: 13 SEER, 11 EER (HERS)	-	\$ -	\$ -	\$ -
(3) Air Conditioner: Refrig. Charge (HERS)	-	\$ -	\$ -	\$ -
R-6 Attic Ducts (from R-8)	Downgrade	\$ (975)	\$ (675)	\$ (825)
Reduced Duct Leakage/Testing (HERS)	-	\$ -	\$ -	\$ -
(3) 50 Gallon Gas Water Heaters: EF=0.62 (from EF=0.60)	Upgrade	\$ 300	\$ 600	\$ 450
Solar Photovoltaic (PV) System: 1 KW	Upgrade	\$ 4,500	\$ 6,500	\$ 5,500
<b>Total Incremental Cost of Energy Efficiency Measures:</b>		<b>\$ 7,282</b>	<b>\$ 11,224</b>	<b>\$ 9,253</b>
<b>Total Incremental Cost per Square Foot:</b>		<b>\$ 1.12</b>	<b>\$ 1.73</b>	<b>\$ 1.42</b>

For homes  $\geq 7,000$  square feet the following tables list the energy measures needed to improve a 7,500 square foot home so that its net Title 24 TDV energy use is zero (i.e. Net Zero TDV Energy) as compared with the corresponding Title 24 base case design. To achieve this level of performance, a solar PV system is added to the home sized to just meet the Net Zero Energy threshold by rounding up to the next largest whole KW of nominal solar PV capacity.

**Incremental Cost Estimate of Net Zero TDV Energy**  
**Single Family Prototype: 7,500 SF, Option 1**

7500 sf

Climate Zone 2

Energy Efficiency Measures	Change Type	Incremental Cost Estimate		
		Min	Max	Avg
R-38 Roof w/ Radiant Barrier (from R-30 w/Radiant Barrier): 4,500 sf @ 0.15 to 0.20/sf	Upgrade	\$ 675	\$ 900	\$ 788
R-21 Walls (from R-13): 2,904 sf @ \$0.45 to \$0.70/sf	Upgrade	\$ 1,307	\$ 2,033	\$ 1,670
R-38 Raised Floor (from R-19): 4,500 sf @ \$0.30 to \$0.45	Upgrade	\$ 1,350	\$ 2,025	\$ 1,688
Quality Insulation Installation (HERS)	-	\$ -	\$ -	\$ -
Super Low E Vinyl Windows, U=0.36, SHGC=0.23 (from Low E2, U=0.36, SHGC=0.23): 1,650 sf @ \$1.40 - \$1.75 / sf	Upgrade	\$ 2,310	\$ 2,888	\$ 2,599
(3) Furnaces: 94% AFUE (from 80% AFUE)	Upgrade	\$ 2,700	\$ 5,400	\$ 4,050
(3) Air Conditioners: 15 SEER, 12 EER (HERS) (from 13 SEER, 11 EER)	Upgrade	\$ 1,500	\$ 4,500	\$ 3,000
(3) Air Conditioners: Refrig. Charge (HERS)	-	\$ -	\$ -	\$ -
R-8 Attic Ducts	-	\$ -	\$ -	\$ -
Reduced Duct Leakage/Testing (HERS)	-	\$ -	\$ -	\$ -
(3) Instantaneous Gas Water Heater: RE=0.82 (from (3) 50 Gal Gas: EF=0.60)	Upgrade	\$ 3,600	\$ 6,000	\$ 4,800
Pipe Insulation	Upgrade	\$ 450	\$ 600	\$ 525
Solar Photovoltaic (PV) System: 4 KW	Upgrade	\$ 18,000	\$ 26,000	\$ 22,000
<b>Total Incremental Cost of Energy Efficiency Measures:</b>		<b>\$ 31,892</b>	<b>\$ 50,345</b>	<b>\$ 41,119</b>
<b>Total Incremental Cost per Square Foot:</b>		<b>\$ 4.25</b>	<b>\$ 6.71</b>	<b>\$ 5.48</b>

**Incremental Cost Estimate of Net Zero TDV Energy  
Single Family Prototype: 7,500 SF, Option 1**

7500 sf

Climate Zone 2

Energy Efficiency Measures	Change Type	Incremental Cost Estimate		
		Min	Max	Avg
R-38 Roof w/ Radiant Barrier (from R-30 w/Radiant Barrier): 4,500 sf @ 0.15 to 0.20/sf	Upgrade	\$ 675	\$ 900	\$ 788
R-19 Walls (from R-13): 2,904 sf @ \$0.31 to \$0.54/sf	Upgrade	\$ 900	\$ 1,568	\$ 1,234
R-30 Raised Floor (from R-19): 4,500 sf @ \$0.25 to \$0.35	Upgrade	\$ 1,125	\$ 1,575	\$ 1,350
Quality Insulation Installation (HERS)	-	\$ -	\$ -	\$ -
Housewrap: 2,904 sf @ \$0.50 to \$0.75/sf	Upgrade	\$ 1,452	\$ 2,178	\$ 1,815
Super Low E Vinyl Windows, U=0.36, SHGC=0.23 (from Low E2, U=0.36, SHGC=0.23): 1,650 sf @ \$1.40 - \$1.75 / sf	Upgrade	\$ 2,310	\$ 2,888	\$ 2,599
(3) Furnaces: 92% AFUE (from 80% AFUE)	Upgrade	\$ 1,500	\$ 3,600	\$ 2,550
(3) Air Conditioners: 15 SEER, 12 EER (HERS) (from 13 SEER, 11 EER)	Upgrade	\$ 1,500	\$ 4,500	\$ 3,000
(3) Air Conditioners: Refrig. Charge (HERS)	-	\$ -	\$ -	\$ -
R-8 Attic Ducts	-	\$ -	\$ -	\$ -
Reduced Duct Leakage/Testing (HERS)	-	\$ -	\$ -	\$ -
(3) Instantaneous Gas Water Heater: RE=0.82 (from (3) 50 Gal Gas: EF=0.60)	Upgrade	\$ 3,600	\$ 6,000	\$ 4,800
Pipe Insulation	Upgrade	\$ 450	\$ 600	\$ 525
Solar Photovoltaic (PV) System: 4 KW	Upgrade	\$ 18,000	\$ 26,000	\$ 22,000
<b>Total Incremental Cost of Energy Efficiency Measures:</b>		<b>\$ 31,512</b>	<b>\$ 49,809</b>	<b>\$ 40,660</b>
<b>Total Incremental Cost per Square Foot:</b>		<b>\$ 4.20</b>	<b>\$ 6.64</b>	<b>\$ 5.42</b>

**CLIMATE ZONE 3**

The following energy design descriptions of single family building prototypes just meet the 2008 Title 24 Building Energy Efficiency Standards in **Climate Zone 3**:

**CZ3: Single Family House 1,582 square feet, 2-story, 14.3% glazing/floor area ratio**

Energy Efficiency Measures to Meet Title 24
R-38 Roof w/ Radiant Barrier
R-13 Walls
R-19 Raised Floor
Low E2 Vinyl Windows, U=0.36, SHGC=0.30; no overhangs
Furnace: 80% AFUE; No Cooling
R-6 Attic Ducts
50 gallon Gas DHW: EF=0.58; no extra pipe insulation

**CZ3: Single Family House 2,025 square feet, 2-story, 20.2% glazing/floor area ratio**

<b>Energy Efficiency Measures to Meet Title 24</b>
R-38 Roof w/ Radiant Barrier
R-13 Walls
R-19 Raised Floor
Low E2 Vinyl Windows, U=0.40, SHGC=0.40; no overhangs
Furnace: 80% AFUE; No Cooling
R-6 Attic Ducts
50 gallon Gas DHW: EF=0.62; no extra pipe insulation

**CZ3: Single Family House 5,000 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 Conditioners: None
R-8 Attic Ducts
Reduced Duct Leakage/Testing (HERS)
(2) 50 Gallon Gas Water Heaters: EF=0.60

**CZ3: Single Family House 6,500 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
Quality Insulation Installation (HERS)
Low E2 Vinyl Windows, U=0.36, SHGC=0.30
(3) Furnaces: 80% AFUE
Air Conditioners: None
R-8 Attic Ducts
Reduced Duct Leakage/Testing (HERS)
(3) 50 Gallon Gas Water Heaters: EF=0.60

**CZ3: Single Family House 7,500 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
Quality Insulation Installation (HERS)
Low E2 Vinyl Windows, U=0.36, SHGC=0.30
(3) Furnaces: 80% AFUE
Air Conditioners: None
R-6 Attic Ducts
Reduced Duct Leakage/Testing (HERS)
(3) 50 Gallon Gas Water Heaters: EF=0.60

**Climate Zone 3 Energy Efficiency Measures Needed to Meet the Ordinance**

The following tables list the energy features and/or equipment included in the Title 24 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** (except homes equal or greater than 4,000 square feet as indicated).

**Incremental Cost Estimate to Exceed Title 24 by 15%**  
**Single Family Prototype: 1,582 SF, Option 1**

**Climate Zone 3**

<b>Energy Efficiency Measures to Exceed Title 24 by 15%</b>	<b>Change Type</b>	<b>Incremental Cost Estimate</b>		
		<b>Min</b>	<b>Max</b>	<b>Avg</b>
Furnace: 92% AFUE	Upgrade	\$ 500	\$ 1,200	\$ 850
Reduced Duct Leakage/Testing (HERS)	Upgrade	\$ 300	\$ 600	\$ 450
House wrap: 1,116 sf @ \$0.08 to \$0.12/sf	Upgrade	\$ 90	\$ 135	\$ 113
R-49 roof insulation: 1,582 sf \$0.19 to \$0.22/sf	Upgrade	\$ 300	\$ 350	\$ 325
50 gallon DHW: EF=0.62 (from EF=0.58)	Upgrade	\$ 100	\$ 200	\$ 150
R-15 Wall Insulation: 1,116 sf @ \$0.06 to \$0.08/sf	-	\$ -	\$ -	\$ -
All DHW Pipe Insulation	-	\$ -	\$ -	\$ -
<b>Total Incremental Cost of Energy Efficiency Measures:</b>		<b>\$ 1,290</b>	<b>\$ 2,485</b>	<b>\$ 1,888</b>
<b>Total Incremental Cost per Square Foot:</b>		<b>\$ 0.82</b>	<b>\$ 1.57</b>	<b>\$ 1.19</b>

**Incremental Cost Estimate to Exceed Title 24 by 15%**  
**Single Family Prototype: 2,025 SF, Option 1**

Climate Zone 3

Energy Efficiency Measures to Exceed Title 24 by 15%	Change Type	Incremental Cost Estimate		
		Min	Max	Avg
Furnace: 92% AFUE	Upgrade	\$ 500	\$ 1,200	\$ 850
Reduced Duct Leakage/Testing (HERS)	Upgrade	\$ 300	\$ 600	\$ 450
House wrap: 1,116 sf @ \$0.08 to \$0.12/sf	Upgrade	\$ 205	\$ 305	\$ 255
R-49 roof insulation: 1,443 sf \$0.19 to \$0.22/sf	-	\$ -	\$ -	\$ -
50 gallon DHW: EF=0.62 (from EF=0.58)	-	\$ -	\$ -	\$ -
R-15 Wall Insulation: 2,550 sf @ \$0.06 to \$0.08/sf	-	\$ -	\$ -	\$ -
All DHW Pipe Insulation	-	\$ -	\$ -	\$ -
<b>Total Incremental Cost of Energy Efficiency Measures:</b>		<b>\$ 1,005</b>	<b>\$ 2,105</b>	<b>\$ 1,555</b>
<b>Total Incremental Cost per Square Foot:</b>		<b>\$ 0.50</b>	<b>\$ 1.04</b>	<b>\$ 0.77</b>

For homes  $\geq$  4,000 square feet to 5,499 square feet, the following tables list the energy measures needed to improve a 5,000 square foot home so that it uses at least 20% less TDV energy than the corresponding Title 24 base case design.

**Incremental Cost Estimate to Exceed Title 24 by 20%**  
**Single Family Prototype: 5,000 SF, Option 1**

5000 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): 2,616 sf @ \$0.45 to \$0.70/sf	Upgrade	\$ 1,177	\$ 1,831	\$ 1,504
R-19 Raised Floor	-	\$ -	\$ -	\$ -
Quality Insulation Installation (HERS)	Upgrade	\$ 450	\$ 600	\$ 525
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 Conditioners: None	-	\$ -	\$ -	\$ -
R-8 Attic Ducts	-	\$ -	\$ -	\$ -
Reduced Duct Leakage/Testing (HERS)	-	\$ -	\$ -	\$ -
(2) 50 Gallon Gas Water Heaters: EF=0.62 (from EF=0.60)	Upgrade	\$ 200	\$ 400	\$ 300
<b>Total Incremental Cost of Energy Efficiency Measures:</b>		<b>\$ 2,827</b>	<b>\$ 5,231</b>	<b>\$ 4,029</b>
<b>Total Incremental Cost per Square Foot:</b>		<b>\$ 0.57</b>	<b>\$ 1.05</b>	<b>\$ 0.81</b>

**Incremental Cost Estimate to Exceed Title 24 by 20%**  
**Single Family Prototype: 5,000 SF, Option 2**

5000 sf

Climate Zone 3

Energy Efficiency Measures	Change Type	Incremental Cost Estimate		
		Min	Max	Avg
R-30 Roof w/ Radiant Barrier	-	\$ -	\$ -	\$ -
R-19 Walls (from R-13): 2,616 sf @ \$0.31 to \$0.54/sf	Upgrade	\$ 811	\$ 1,413	\$ 1,112
R-19 Raised Floor	-	\$ -	\$ -	\$ -
Low E2 Vinyl Windows, U=0.36, SHGC=0.30	-	\$ -	\$ -	\$ -
(2) Furnaces: 80% AFUE	-	\$ -	\$ -	\$ -
Air Conditioners: None	-	\$ -	\$ -	\$ -
R-6 Attic Ducts (from R-8)	Downgrade	\$ (650)	\$ (450)	\$ (550)
Reduced Duct Leakage/Testing (HERS)	-	\$ -	\$ -	\$ -
(2) Instantaneous Gas Water Heater: RE=0.80 (from (2) 50 Gal Gas: EF=0.60)	Upgrade	\$ 2,000	\$ 3,400	\$ 2,700
<b>Total Incremental Cost of Energy Efficiency Measures:</b>		<b>\$ 2,161</b>	<b>\$ 4,363</b>	<b>\$ 3,262</b>
<b>Total Incremental Cost per Square Foot:</b>		<b>\$ 0.43</b>	<b>\$ 0.87</b>	<b>\$ 0.65</b>

For homes  $\geq$  5,500 square feet to 6,999 square feet, the following tables list the energy measures needed to improve a 6,500 square foot home so that it uses at least 30% less TDV energy than the corresponding Title 24 base case design.

**Incremental Cost Estimate to Exceed Title 24 by 20%**  
**Single Family Prototype: 6,500 SF, Option 1**

6500 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): 3,900 sf @ 0.15 to 0.20/sf	Upgrade	\$ 585	\$ 780	\$ 683
R-21 Walls (from R-13): 2,808 sf @ \$0.45 to \$0.70/sf	Upgrade	\$ 1,264	\$ 1,966	\$ 1,615
R-30 Raised Floor (from R-19): 3,900 sf @ \$0.25 to \$0.35	Upgrade	\$ 975	\$ 1,365	\$ 1,170
Quality Insulation Installation (HERS)	-	\$ -	\$ -	\$ -
Low E2 Vinyl Windows, U=0.36, SHGC=0.30	-	\$ -	\$ -	\$ -
(3) Furnaces: 80% AFUE	-	\$ -	\$ -	\$ -
Air Conditioners: None	-	\$ -	\$ -	\$ -
R-8 Attic Ducts	-	\$ -	\$ -	\$ -
Reduced Duct Leakage/Testing (HERS)	-	\$ -	\$ -	\$ -
(3) Instantaneous Gas Water Heater: RE=0.80 (from (3) 50 Gal Gas: EF=0.60)	Upgrade	\$ 3,000	\$ 5,100	\$ 4,050
Pipe Insulation	Upgrade	\$ 450	\$ 600	\$ 525
<b>Total Incremental Cost of Energy Efficiency Measures:</b>		<b>\$ 6,274</b>	<b>\$ 9,811</b>	<b>\$ 8,042</b>
<b>Total Incremental Cost per Square Foot:</b>		<b>\$ 0.97</b>	<b>\$ 1.51</b>	<b>\$ 1.24</b>

**Incremental Cost Estimate to Exceed Title 24 by 20%**  
**Single Family Prototype: 6,500 SF, Option 2**

6500 sf

Climate Zone 3

Energy Efficiency Measures	Change Type	Incremental Cost Estimate		
		Min	Max	Avg
R-30 Roof w/ Radiant Barrier	-	\$ -	\$ -	\$ -
R-19 Walls (from R-13): 2,808 sf @ \$0.31 to \$0.54/sf	Upgrade	\$ 870	\$ 1,516	\$ 1,193
R-19 Raised Floor	-	\$ -	\$ -	\$ -
Quality Insulation Installation (HERS)	-	\$ -	\$ -	\$ -
Low E2 Vinyl Windows, U=0.36, SHGC=0.30	-	\$ -	\$ -	\$ -
(3) Furnaces: 92% AFUE (from 80% AFUE)	Upgrade	\$ 1,500	\$ 3,600	\$ 2,550
Air Conditioners: None	-	\$ -	\$ -	\$ -
R-8 Attic Ducts	-	\$ -	\$ -	\$ -
Reduced Duct Leakage/Testing (HERS)	-	\$ -	\$ -	\$ -
(3) Instantaneous Gas Water Heater: RE=0.80 (from (3) 50 Gal Gas: EF=0.60)	Upgrade	\$ 3,000	\$ 5,100	\$ 4,050
<b>Total Incremental Cost of Energy Efficiency Measures:</b>		<b>\$ 5,370</b>	<b>\$ 10,216</b>	<b>\$ 7,793</b>
<b>Total Incremental Cost per Square Foot:</b>		<b>\$ 0.83</b>	<b>\$ 1.57</b>	<b>\$ 1.20</b>

For homes  $\geq 7,000$  square feet the following tables list the energy measures needed to improve a 7,500 square foot home so that its net Title 24 TDV energy use is zero (i.e. Net Zero TDV Energy) as compared with the corresponding Title 24 base case design. To achieve this level of performance, a solar PV system is added to the home sized to just meet the Net Zero Energy threshold by rounding up to the next largest whole KW of nominal solar PV capacity.

**Incremental Cost Estimate to Exceed Title 24 by 20%**  
**Single Family Prototype: 7,500 SF, Option 1**

7500 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): 4,500 sf @ 0.15 to 0.20/sf	Upgrade	\$ 675	\$ 900	\$ 788
R-21 Walls (from R-13): 2,904 sf @ \$0.45 to \$0.70/sf	Upgrade	\$ 1,307	\$ 2,033	\$ 1,670
R-30 Raised Floor (from R-19): 4,500 sf @ \$0.25 to \$0.35	Upgrade	\$ 1,125	\$ 1,575	\$ 1,350
Quality Insulation Installation (HERS)	-	\$ -	\$ -	\$ -
Housewrap: 2,904 sf @ \$0.50 to \$0.75/sf	Upgrade	\$ 1,452	\$ 2,178	\$ 1,815
Low E2 Vinyl Windows, U=0.36, SHGC=0.30	-	\$ -	\$ -	\$ -
(3) Furnaces: 92% AFUE (from 80% AFUE)	Upgrade	\$ 1,500	\$ 3,600	\$ 2,550
Air Conditioners: None	-	\$ -	\$ -	\$ -
R-6 Attic Ducts	-	\$ -	\$ -	\$ -
Reduced Duct Leakage/Testing (HERS)	-	\$ -	\$ -	\$ -
(3) Instantaneous Gas Water Heater: RE=0.82 (from (3) 50 Gal Gas: EF=0.60)	Upgrade	\$ 3,600	\$ 6,000	\$ 4,800
Solar Photovoltaic (PV) System: 2 KW	Upgrade	\$ 9,000	\$ 13,000	\$ 11,000
<b>Total Incremental Cost of Energy Efficiency Measures:</b>		<b>\$ 18,659</b>	<b>\$ 29,286</b>	<b>\$ 23,972</b>
<b>Total Incremental Cost per Square Foot:</b>		<b>\$ 2.49</b>	<b>\$ 3.90</b>	<b>\$ 3.20</b>

**Incremental Cost Estimate to Exceed Title 24 by 20%**  
**Single Family Prototype: 7,500 SF, Option 2**

7500 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): 4,500 sf @ 0.15 to 0.20/sf	Upgrade	\$ 675	\$ 900	\$ 788
R-21 Walls (from R-13): 2,904 sf @ \$0.45 to \$0.70/sf	Upgrade	\$ 1,307	\$ 2,033	\$ 1,670
R-38 Raised Floor (from R-19): 4,500 sf @ \$0.30 to \$0.45	Upgrade	\$ 1,350	\$ 2,025	\$ 1,688
Quality Insulation Installation (HERS)	-	\$ -	\$ -	\$ -
Low E2 Vinyl Windows, U=0.36, SHGC=0.30	-	\$ -	\$ -	\$ -
(3) Furnaces: 94% AFUE (from 80% AFUE)	Upgrade	\$ 2,700	\$ 5,400	\$ 4,050
Air Conditioners: None	-	\$ -	\$ -	\$ -
R-8 Attic Ducts (from R-6)	Upgrade	\$ -	\$ -	\$ -
Reduced Duct Leakage/Testing (HERS)	-	\$ -	\$ -	\$ -
(3) Instantaneous Gas Water Heater: RE=0.84 (from (3) 50 Gal Gas: EF=0.60)	Upgrade	\$ 4,200	\$ 7,200	\$ 5,700
Pipe Insulation	Upgrade	\$ 450	\$ 600	\$ 525
Solar Photovoltaic (PV) System: 2 KW	Upgrade	\$ 9,000	\$ 13,000	\$ 11,000
<b>Total Incremental Cost of Energy Efficiency Measures:</b>		<b>\$ 19,682</b>	<b>\$ 31,158</b>	<b>\$ 25,420</b>
<b>Total Incremental Cost per Square Foot:</b>		<b>\$ 2.62</b>	<b>\$ 4.15</b>	<b>\$ 3.39</b>

## 2.2 Low-rise Multi-family Residential Building

The following is the energy design description of the low-rise multifamily building prototype which just meets the 2008 Title 24 Building Energy Efficiency Standards:

### CZ2: Low-rise Multi-family: 2-story 8,442 square feet, 8 units, 12.5% glazing

Energy Efficiency Measures
R-38 Roof w/ Radiant Barrier
R-15 Walls
R-0 Slab on Grade
Low E2 Vinyl Windows, U=0.36, SHGC=0.30
(8) Furnaces: 80% AFUE
(8) Air Conditioners: 13 SEER
R-8 Attic Ducts
(8) 40 Gallon Gas Water Heaters: EF=0.63

**CZ3: Low-rise Multi-family: 2-story 8,442 square feet, 8 units, 12.5% glazing**

<b>Energy Efficiency Measures to Meet Title 24</b>
R-38 Roof w/ Radiant Barrier
R-13 Walls
Slab-on-grade 1st floor
Low E2 Vinyl Windows, U=0.39, SHGC=0.33; no overhangs
Furnace: 80% AFUE; No Cooling
R-6 Attic Ducts
50 gallon Gas DHW: EF=0.575; no extra pipe insulation

**Climate Zone 2 Energy Measures Needed to Meet the Ordinance**

See Section 2.0 for the description of the approach used to establish which energy measures are used to meet the proposed Ordinance for this prototype building design.

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

**Low-rise Multifamily Prototype: 8,442 SF, Option 1**

**8442 sf**

**Climate Zone 2**

<b>Energy Efficiency Measures</b>	<b>Change Type</b>	<b>Incremental Cost Estimate</b>		
		<b>Min</b>	<b>Max</b>	<b>Avg</b>
R-38 Roof w/ Radiant Barrier	-	\$ -	\$ -	\$ -
R-21 Walls (from R-15): 10,146 sf @ \$0.50 to \$0.75/sf	Upgrade	\$ 5,073	\$ 7,510	\$ 6,292
R-0 Slab on Grade	-	\$ -	\$ -	\$ -
Low E2 Vinyl Windows, U=0.36, SHGC=0.30	-	\$ -	\$ -	\$ -
(8) Furnaces: 80% AFUE	-	\$ -	\$ -	\$ -
(8) Air Conditioner: 13 SEER, 11 EER (HERS)	Upgrade	\$ 200	\$ 600	\$ 400
(8) Air Conditioner: Refrig. Charge (HERS)	Upgrade	\$ 1,200	\$ 1,600	\$ 1,400
R-8 Attic Ducts	-	\$ -	\$ -	\$ -
(8) 40 Gallon Gas Water Heaters: EF=0.63	-	\$ -	\$ -	\$ -
<b>Total Incremental Cost of Energy Efficiency Measures:</b>		<b>\$ 6,473</b>	<b>\$ 9,710</b>	<b>\$ 8,092</b>
<b>Total Incremental Cost per Square Foot:</b>		<b>\$ 0.77</b>	<b>\$ 1.15</b>	<b>\$ 0.96</b>

**Incremental Cost Estimate to Exceed Title 24 by 15%**  
**Low-rise Multifamily Prototype: 8,442 SF, Option 2**

8442 sf

Climate Zone 2

Energy Efficiency Measures	Change Type	Incremental Cost Estimate		
		Min	Max	Avg
R-38 Roof w/ Radiant Barrier	-	\$ -	\$ -	\$ -
R-19 Walls (from R-15): 10,146 sf @ \$0.45 to \$0.75/sf	Upgrade	\$ 4,566	\$ 7,610	\$ 6,088
R-0 Slab on Grade	-	\$ -	\$ -	\$ -
Low E2 Vinyl Windows, U=0.36, SHGC=0.30	-	\$ -	\$ -	\$ -
(8) Furnaces: 80% AFUE	-	\$ -	\$ -	\$ -
(8) Air Conditioners: 13 SEER	-	\$ -	\$ -	\$ -
R-4.2 Attic Ducts (from R-8)	Downgrade	\$ (3,000)	\$ (2,000)	\$ (2,500)
Reduced Duct Leakage/Testing (HERS)	Upgrade	\$ 2,000	\$ 4,000	\$ 3,000
(8) 40 Gallon Gas Water Heaters: EF=0.62 (from 0.63 EF)	Downgrade	\$ -	\$ (400)	\$ (200)
<b>Total Incremental Cost of Energy Efficiency Measures:</b>		<b>\$ 3,566</b>	<b>\$ 9,210</b>	<b>\$ 6,388</b>
<b>Total Incremental Cost per Square Foot:</b>		<b>\$ 0.42</b>	<b>\$ 1.09</b>	<b>\$ 0.76</b>

**Climate Zone 3 Energy Measures Needed to Meet the Ordinance**

**Incremental Cost Estimate to Exceed Title 24 by 15%**  
**Multifamily Prototype: 8,442 SF, Option 1**

Climate Zone 3

Energy Efficiency Measures to Exceed Title 24 by 15%	Change Type	Incremental Cost Estimate		
		Min	Max	Avg
Furnace: (8) @ 92% AFUE	Upgrade	\$ 4,000	\$ 9,600	\$ 6,800
Reduced Duct Leakage/Testing (HERS)	Upgrade	\$ 2,000	\$ 4,000	\$ 3,000
House wrap: 9,266 sf @ \$0.08 to \$0.12/sf	Upgrade	\$ 745	\$ 1,115	\$ 930
R-49 roof insulation: 2,880 sf \$0.19 to \$0.22/sf	Upgrade	\$ 550	\$ 635	\$ 593
50 gallon DHW: EF=0.62 (from EF=0.58)	-	\$ -	\$ -	\$ -
R-15 Wall Insulation: 9,266 sf @ \$0.06 to \$0.08/sf	Upgrade	\$ 560	\$ 745	\$ 653
All DHW Pipe Insulation	-	\$ -	\$ -	\$ -
<b>Total Incremental Cost of Energy Efficiency Measures:</b>		<b>\$ 7,855</b>	<b>\$ 16,095</b>	<b>\$ 11,975</b>
<b>Total Incremental Cost per Square Foot:</b>		<b>\$ 0.93</b>	<b>\$ 1.91</b>	<b>\$ 1.42</b>

## 2.3 High-rise Multifamily Building

The following is the energy design description of the high-rise multifamily building prototype which just meets the 2008 Title 24 Building Energy Efficiency Standards:

### CZ2: High-rise Residential: 4-story 36,800 sf, 40 units, Window Wall Ratio=35.2%

Energy Efficiency Measures to Meet Title 24
R-30 Attic; Cool Roof Reflectance=0.70, Emittance=0.75
R-19 in Metal Frame Walls
R-6 (2" K-13 spray-on) Raised Slab over parking garage
Vinyl Windows, NFRC U=0.36, SHGC=0.35
Split Heat Pumps: HSPF=7.2, EER=10.2
Central DHW boiler: 82.7% AFUE and recirculating system w/ timer-temperature controls & VSD hot water pump

### CZ3: High-rise Residential: 4-story 36,800 sf, 40 units, Window Wall Ratio=35.2%

Energy Efficiency Measures to Meet Title 24
R-30 Attic w/ Cool Roof Reflectance=0.30, Emittance=0.75
R-19 in Metal Frame Walls
R-0 (un-insulated) raised slab over parking garage
Low E2 Vinyl Windows, U=0.33, SHGC=0.30 (see Note 1)
Split heat pumps: HSPF=7.2, EER=10.2
Central domestic DHW boiler: 82.7% AFUE and recirculating system w/ timer-temperature controls & VSD hot water pump

*Note 1: Includes a small amount of fixed overhangs above first floor front fenestration*

## CZ 2: Energy Measures Needed to Meet the County's Ordinance

Incremental Cost Estimate to Exceed Title 24 by 15%

High-rise Residential Prototype: 36,800 SF, Option 1

Climate Zone 2

Energy Efficiency Measures to Exceed Title 24 by 15%	Change Type	Incremental Cost Estimate		
		Min	Max	Avg
R-30 Attic; Cool Roof Reflectance=0.70, Emittance=0.75	-	\$ -	\$ -	\$ -
R-19 in Metal Frame Walls	-	\$ -	\$ -	\$ -
R-8 (2.5" K-13 spray-on) Raised Slab over parking garage	Upgrade	\$ 3,680	\$ 5,520	\$ 4,600
Vinyl Windows, NFRC U=0.33, SHGC=0.25; 6,240 sf @ \$1.40 to \$1.60/sf	Upgrade	\$ 8,736	\$ 9,984	\$ 9,360
(80) Room Heat Pumps: HSPF=7.84, eer=11.2 (No Ducts) @ \$150 to \$250/unit	Upgrade	\$ 12,000	\$ 20,000	\$ 16,000
Premium Efficiency DHW Hot Water Pump	Upgrade	\$ 150	\$ 250	\$ 200
<b>Total Incremental Cost of Energy Efficiency Measures:</b>		<b>\$ 24,566</b>	<b>\$ 35,754</b>	<b>\$ 30,160</b>
<b>Total Incremental Cost per Square Foot:</b>		<b>\$ 0.67</b>	<b>\$ 0.97</b>	<b>\$ 0.82</b>

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

Climate Zone 2

Energy Efficiency Measures to Exceed Title 24 by 15%	Change Type	Incremental Cost Estimate		
		Min	Max	Avg
R-30 Attic; Cool Roof Reflectance=0.70, Emittance=0.75	-	\$ -	\$ -	\$ -
R-19 in Metal Frame Walls + R-5 exterior rigid insulation 11,472 sf @ \$5.00 to \$8.00/sf	Upgrade	\$ 57,360	\$ 91,776	\$ 74,568
R-6 (2" K-13 spray-on) Raised Slab over parking garage	-	\$ -	\$ -	\$ -
Vinyl Windows, NFRC U=0.33, SHGC=0.25; 6,240 sf @ \$1.40 to \$1.60/sf	Upgrade	\$ 8,736	\$ 9,984	\$ 9,360
Split Heat Pumps: HSPF=7.2, EER=10.2	-	\$ -	\$ -	\$ -
(2) 94% AFUE DHW boilers @ \$1500 to \$2500 each	Upgrade	\$ 3,000	\$ 5,000	\$ 4,000
<b>Total Incremental Cost of Energy Efficiency Measures:</b>		<b>\$ 69,096</b>	<b>\$106,760</b>	<b>\$ 87,928</b>
<b>Total Incremental Cost per Square Foot:</b>		<b>\$ 1.88</b>	<b>\$ 2.90</b>	<b>\$ 2.39</b>

**CZ 3: Energy Measures Needed to Meet the County's Ordinance**

See Section 2.1 for the description of the approach used to establish which energy measures are used to meet the proposed Ordinance for this prototype building design.

**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-30 Attic; Cool Roof Reflectance=0.30, Emittance=0.75	-	\$ -	\$ -	\$ -
R-19 in Metal Frame Walls	-	\$ -	\$ -	\$ -
R-3 (1" K-13 spray-on) Raised Slab over parking garage 9,200 sf @ \$1.20 to \$1.50 sf	Upgrade	\$ 11,040	\$ 13,800	\$ 12,420
Vinyl Windows, NFRC U=0.33, SHGC=0.23; 6,240 sf @ \$1.40 to \$1.60/sf	Upgrade	\$ 8,425	\$ 9,360	\$ 8,893
(80) Room Heat Pumps: HSPF=7.84, eer=11.2 (No Ducts) @ \$150 to \$250/unit	Upgrade	\$ 12,000	\$ 20,000	\$ 16,000
(2) 94% AFUE DHW boilers @ \$1500 to \$2500 each	Upgrade	\$ 3,000	\$ 5,000	\$ 4,000
<b>Total Incremental Cost of Energy Efficiency Measures:</b>		<b>\$ 34,465</b>	<b>\$ 48,160</b>	<b>\$ 41,313</b>
<b>Total Incremental Cost per Square Foot:</b>		<b>\$ 0.94</b>	<b>\$ 1.31</b>	<b>\$ 1.12</b>

## 2.4 Nonresidential Buildings

The following is the energy design description of the nonresidential building prototypes which just meet the 2008 Title 24 Building Energy Efficiency Standards:

### **CLIMATE ZONE 2**

The following energy design descriptions of nonresidential building prototypes just meet the 2008 Title 24 Building Energy Efficiency Standards in **Climate Zone 2**:

#### **CZ2: Nonresidential 2-story office building: 21,160 sf, Window Wall Ratio= 37.1%**

<b>Energy Efficiency Measures to Meet Title 24</b>
R-38 Attic w/ No Cool Roof R-19 in Metal Frame Walls R-0 (un-insulated) slab-on-grade 1st floor Windows NFRC U=0.50 and SHGCc=0.38, no exterior shading (248) 2-lamp 4' T8 fixtures, 62w each; and (104) 26w CFLs @ 26w each; no lighting controls (beyond mandatory) (4) 10-ton Packaged DX units EER=11.0, 4,000 cfm; and (4) 7.5-ton Packaged DX units EER=11.0, 3,000 cfm; all standard efficiency fan motors R-4.2 duct insulation w/ ducts in conditioned space Standard 50 gallon gas water heater, EF=0.575

#### **CZ2: Nonresidential 5-story office building: 52,900 sf, Window Wall Ratio= 29.1%**

<b>Energy Efficiency Measures to Meet Title 24</b>
R-38 Attic w/ No Cool Roof R-19 in Metal Frame Walls R-0 (un-insulated) slab-on-grade 1st floor Windows NFRC U=0.50 and SHGCc=0.31, 2' overhang 1st floor front elevation only (720) 2-lamp 4' T8 fixtures w/ high efficiency instant start ballasts & premium lamps, 50w; and (300) 18w CFLs @ 18w each; no lighting controls (beyond mandatory) (5) 30-ton Packaged VAV units EER=10.4, 10,000 cfm; 20% VAV boxes w/ reheat; all standard efficiency fan motors R-4.2 duct insulation w/ ducts in conditioned space Standard hot water boiler, AFUE=80%

**CZ2: Nonresidential 2-story office building: 21,160 sf, Window Wall Ratio= 37.1%**

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

**Nonresidential Prototype: 21,160 SF, Option 1**

**Climate Zone 2**

Energy Efficiency Measures to Exceed Title 24 by 15%	Change Type	Incremental Cost Estimate		
		Min	Max	Avg
R-38 Attic w/ No Cool Roof	-	\$ -	\$ -	\$ -
R-19 in Metal Frame Walls	-	\$ -	\$ -	\$ -
R-0 (un-insulated) slab-on-grade 1st floor				
Windows, NFRC U=0.50, SHGC=0.31; 5,160 sf @ \$2.00 to \$3.00/sf	Upgrade	\$ 10,320	\$ 15,480	\$ 12,900
(248) 2-lamp 4' T8 fixtures w/ high efficiency instant start ballasts & premium lamps, 50w @ \$25.00 - \$30.00 each	Upgrade	\$ 6,000	\$ 7,200	\$ 6,600
(4) 10-ton Packaged DX units, EER= 13.4 @ \$2300 - \$2600 ea,	Upgrade	\$ 16,000	\$ 24,000	\$ 20,000
(4) 7.5-ton Packaged DX units, EER= 13.4 @ \$1950 - \$2450 ea,	Upgrade	\$ 12,000	\$ 18,800	\$ 15,400
(8) Premium Efficiency supply fans @ \$100 to \$200 each	Upgrade	\$ 800	\$ 1,600	\$ 1,200
R-4.2 duct insulation w/ ducts in conditioned space	-	\$ -	\$ -	\$ -
Standard 50 gallon gas water heater, EF=0.575	-	\$ -	\$ -	\$ -
<b>Total Incremental Cost of Energy Efficiency Measures:</b>		<b>\$ 45,120</b>	<b>\$ 67,080</b>	<b>\$ 56,100</b>
<b>Total Incremental Cost per Square Foot:</b>		<b>\$ 2.13</b>	<b>\$ 3.17</b>	<b>\$ 2.65</b>

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

**Nonresidential Prototype: 21,160 SF, Option 2**

**Climate Zone 2**

Energy Efficiency Measures to Exceed Title 24 by 15%	Change Type	Incremental Cost Estimate		
		Min	Max	Avg
R-38 Attic w/ No Cool Roof	-	\$ -	\$ -	\$ -
R-19 in Metal Frame Walls + R-6.5 (1") rigid insulation 8,752 sf @ \$3.00 to \$4.00/sf	-	\$ 26,256	\$ 35,008	\$ 30,632
R-0 (un-insulated) slab-on-grade 1st floor				
Windows, NFRC U=0.50, SHGC=0.28; 5,160 sf @ \$3.50 to \$4.50/sf	Upgrade	\$ 18,060	\$ 23,220	\$ 20,640
(72) [30% of] 2-lamp 4' T8 fixtures on (36) multi-level occupant sensors in small offices @ \$65.00 to \$85.00 each	Upgrade	\$ 2,340	\$ 3,060	\$ 2,700
(248) 2-lamp 4' T8 fixtures w/ high efficiency instant start ballasts & premium lamps, 50w @ \$25.00 - \$30.00 each	Upgrade	\$ 6,000	\$ 7,200	\$ 6,600
(4) 10-ton Packaged DX units EER=11.0, 4,000 cfm; and (4) 7.5-ton Packaged DX units EER=11.0, 3,000 cfm; all standard efficiency fan motors	-	\$ -	\$ -	\$ -
R-4.2 duct insulation w/ ducts in conditioned space	-	\$ -	\$ -	\$ -
Standard 50 gallon gas water heater, EF=0.575	-	\$ -	\$ -	\$ -
<b>Total Incremental Cost of Energy Efficiency Measures:</b>		<b>\$ 52,656</b>	<b>\$ 68,488</b>	<b>\$ 60,572</b>
<b>Total Incremental Cost per Square Foot:</b>		<b>\$ 2.49</b>	<b>\$ 3.24</b>	<b>\$ 2.86</b>

**CZ2: Nonresidential 5-story office building: 52,900 sf, Window Wall Ratio= 29.1%**

Energy Efficiency Measures to Exceed Title 24 by 15%	Change Type	Incremental Cost Estimate		
		Min	Max	Avg
R-38 Attic w/ Cool Roof Reflectance=0.70, Emittance=0.75 10,580 sf @ \$0.40 to \$0.60/sf	Upgrade	\$ 4,235	\$ 6,348	\$ 5,292
R-19 in Metal Frame Walls	-	\$ -	\$ -	\$ -
R-0 (un-insulated) slab-on-grade 1st floor				
Windows, NFRC U=0.50, SHGC=0.31; 5,160 sf @ \$2.00 to \$3.00/sf	-	\$ -	\$ -	\$ -
(180) [25% of] 2-lamp 4' T8 fixtures on (90) multi-level occupant sensors in small offices @ \$65.00 to \$85.00 each	Upgrade	\$ 5,850	\$ 7,650	\$ 6,750
(5) 10-ton Packaged DX units, EER= 11.0 w/ Premium fan motors @ \$10,800 to \$15,600 ea,	Upgrade	\$ 54,000	\$ 78,000	\$ 66,000
R-4.2 duct insulation w/ ducts in conditioned space	-	\$ -	\$ -	\$ -
Standard hot water boiler, AFUE=80%	-	\$ -	\$ -	\$ -
<b>Total Incremental Cost of Energy Efficiency Measures:</b>		<b>\$ 59,850</b>	<b>\$ 85,650</b>	<b>\$ 72,750</b>
<b>Total Incremental Cost per Square Foot:</b>		<b>\$ 1.13</b>	<b>\$ 1.62</b>	<b>\$ 1.38</b>

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

**Climate Zone 2**

Energy Efficiency Measures to Exceed Title 24 by 15%	Change Type	Incremental Cost Estimate		
		Min	Max	Avg
R-38 Attic w/ Cool Roof Reflectance=0.70, Emittance=0.75 10,580 sf @ \$0.40 to \$0.60/sf	Upgrade	\$ 4,235	\$ 6,348	\$ 5,292
R-19 in Metal Frame Walls + R-6.5 (1") rigid insulation 8,752 sf @ \$3.00 to \$4.00/sf	Upgrade	\$ 26,256	\$ 35,008	\$ 30,632
R-0 (un-insulated) slab-on-grade 1st floor				
Windows, NFRC U=0.50, SHGC=0.28; 8,500 sf @ \$2.00 to \$3.00/sf	Upgrade	\$ 17,000	\$ 25,500	\$ 21,250
(180) [25% of] 2-lamp 4' T8 fixtures on (90) multi-level occupant sensors in small offices @ \$65.00 to \$85.00 each	Upgrade	\$ 5,850	\$ 7,650	\$ 6,750
(248) 2-lamp 4' T8 fixtures w/ high efficiency instant start ballasts & premium lamps, 50w @ \$25.00 - \$30.00 each	Upgrade	\$ 6,000	\$ 7,200	\$ 6,600
(5) 30-ton Packaged VAV units EER=10.4, 10,000 cfm; 20% VAV boxes w/ reheat; (10) Premium Efficiency fan motors	Upgrade	\$ 1,000	\$ 1,500	\$ 1,250
R-4.2 duct insulation w/ ducts in conditioned space	-	\$ -	\$ -	\$ -
Standard hot water boiler, AFUE=80%	-	\$ -	\$ -	\$ -
<b>Total Incremental Cost of Energy Efficiency Measures:</b>		<b>\$ 56,106</b>	<b>\$ 76,858</b>	<b>\$ 66,482</b>
<b>Total Incremental Cost per Square Foot:</b>		<b>\$ 1.06</b>	<b>\$ 1.45</b>	<b>\$ 1.26</b>

### **CLIMATE ZONE 3**

The following energy design descriptions of nonresidential building prototypes just meet the 2008 Title 24 Building Energy Efficiency Standards in **Climate Zone 3**:

#### **CZ3: Nonresidential 2-story office building: 21,160 sf, Window Wall Ratio= 37.1%**

<b>Energy Efficiency Measures to Meet Title 24</b>
R-38 Attic w/ No Cool Roof R-19 in Metal Frame Walls R-0 (un-insulated) slab-on-grade 1st floor Windows NFRC U=0.50 and SHGCc=0.38, no exterior shading (248) 2-lamp 4' T8 fixtures, 62w each; and (104) 26w CFLs @ 26w each; no lighting controls (beyond mandatory) (4) 10-ton Packaged DX units EER=11.0, 4,000 cfm; and (4) 7.5-ton Packaged DX units EER=11.0, 3,000 cfm; all standard efficiency fan motors R-4.2 duct insulation w/ ducts in conditioned space Standard 50 gallon gas water heater, EF=0.575

#### **CZ3: Nonresidential 5-story office building: 52,900 sf, Window Wall Ratio= 29.1%**

<b>Energy Efficiency Measures to Meet Title 24</b>
R-30 Attic w/ No Cool Roof R-19 in Metal Frame Walls R-0 (un-insulated) slab-on-grade 1st floor Windows NFRC U=0.50 and SHGCc=0.38, no exterior shading (720) 2-lamp 4' T8 fixtures w/ high efficiency instant start ballasts & premium lamps, 50w; and (260) 26w CFLs @ 26w each; no lighting controls (beyond mandatory) (5) 30-ton Packaged VAV units EER=10.4, 10,000 cfm; 20% VAV boxes w/ reheat; all standard efficiency fan motors R-4.2 duct insulation w/ ducts in conditioned space Standard hot water boiler, AFUE=80%

**CZ3: Nonresidential 2-story office building: 21,160 sf, Window Wall Ratio= 37.1%**

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

**Nonresidential Prototype: 21,160 SF, Option 1**

**Climate Zone 3**

Energy Efficiency Measures to Exceed Title 24 by 15%	Change Type	Incremental Cost Estimate		
		Min	Max	Avg
R-38 Attic + R-10 rigid insulation w/ Cool Roof Reflectance = 0.70, Emittance = 0.75; 10,580 sf @ \$1.75 to \$2.35/sf	Upgrade	\$ 18,515	\$ 24,865	\$ 21,690
R-19 in Metal Frame Walls	-	\$ -	\$ -	\$ -
R-0 (un-insulated) slab-on-grade 1st floor				
Windows, NFRC U=0.50, SHGC=0.31; 5,160 sf @ \$2.00 to \$3.00/sf	Upgrade	\$ 10,320	\$ 15,480	\$ 12,900
(248) 2-lamp 4' T8 fixtures w/ high efficiency instant start ballasts & premium lamps, 50w @ \$25.00 - \$30.00 each	Upgrade	\$ 6,200	\$ 7,440	\$ 6,820
(64) [26% of] 2-lamp 4' T8 fixtures on (32) multi-level occupant sensors in small offices @ \$65.00 to \$85.00 each	Upgrade	\$ 2,080	\$ 2,720	\$ 2,400
(24) additional recessed CFL fixtures w/ all CFLs 18w lamps @ \$175 to \$250 each	Upgrade	\$ 4,200	\$ 6,000	\$ 5,100
(4) 10-ton Packaged DX units EER=11.0, 4,000 cfm; (4) 7.5-ton Packaged DX units EER=11.0, 3,000 cfm; and (8) Premium Efficiency fan motors @ \$100 to \$200 each	Upgrade	\$ 800	\$ 1,600	\$ 1,200
R-4.2 duct insulation w/ ducts in conditioned space	-	\$ -	\$ -	\$ -
Standard 50 gallon gas water heater, EF=0.575	-	\$ -	\$ -	\$ -
<b>Total Incremental Cost of Energy Efficiency Measures:</b>		<b>\$ 42,115</b>	<b>\$ 58,105</b>	<b>\$ 50,110</b>
<b>Total Incremental Cost per Square Foot:</b>		<b>\$ 1.99</b>	<b>\$ 2.75</b>	<b>\$ 2.37</b>

**CZ3: Nonresidential 5-story office building: 52,900 sf, Window Wall Ratio= 29.1%**

**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-30 Attic w/ No Cool Roof	-	\$ -	\$ -	\$ -
R-19 in Metal Frame Walls	-	\$ -	\$ -	\$ -
R-0 (un-insulated) slab-on-grade 1st floor				
Windows NFRC U=0.50 and SHGCc=0.38, no exterior shading	-	\$ -	\$ -	\$ -
(720) 2-lamp 4' T8 fixtures w/ high efficiency instant start ballasts & premium lamps, 50w @ \$25.00 - \$30.00 each	Upgrade	\$ 18,000	\$ 21,600	\$ 19,800
(240) 33% of] 2-lamp 4' T8 fixtures on (120) multi-level occupant sensors in small offices @ \$65.00 to \$85.00 each	Upgrade	\$ 7,800	\$ 10,200	\$ 9,000
(40) additional recessed CFL fixtures w/ all CFLs 18w lamps @ \$175 to \$250 each	Upgrade	\$ 7,000	\$ 10,000	\$ 8,500
(5) 10-ton Packaged DX units, EER= 11.0 w/ Premium fan motors @ \$10,800 to \$15,600 ea,	Upgrade	\$ 54,000	\$ 78,000	\$ 66,000
R-4.2 duct insulation w/ ducts in conditioned space	-	\$ -	\$ -	\$ -
Standard hot water boiler, AFUE=80%	-	\$ -	\$ -	\$ -
<b>Total Incremental Cost of Energy Efficiency Measures:</b>		<b>\$ 86,800</b>	<b>\$119,800</b>	<b>\$103,300</b>
<b>Total Incremental Cost per Square Foot:</b>		<b>\$ 1.64</b>	<b>\$ 2.26</b>	<b>\$ 1.95</b>

### **3.0 Cost Effectiveness**

The summary of results in this section are based upon the following assumptions:

- Annual site electricity (kWh) and natural gas (therms) saved are calculated using a beta version of the state-approved energy compliance software for the 2008 Building Energy Efficiency Standards, Micropas 8.
- Average utility rates of **\$0.173/kWh** for electricity and **\$1.15/therm** for natural gas in current constant dollars
- No change (i.e., no inflation or deflation) of utility rates in constant dollars
- No increase in summer temperatures from global climate change

The Simple Payback data includes a cost-effectiveness analysis of the Ordinance with respect to each case study building design and assumes:

- No external cost of global climate change -- and corresponding value of additional investment in energy efficiency and CO2 reduction – is included
- The cost of money (e.g, opportunity cost) invested in the incremental cost of energy efficiency measures is not included.

### 3.1 New Single Family Houses

#### Climate Zone 2: 15% Better Than Title 24

##### 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)	399	69	\$2,011	\$148	13.5
2,025 sf (Option 2)	348	81	\$2,104	\$153	13.7
Averages:	374	75	\$2,057	\$151	13.6

**Annual Reduction in CO2-equivalent:** 1,041 lb./building-year  
0.51 lb./sq.ft.-year

Building Description	Total Annual KWh Saving	Total Annual Therms Saving	Incremental First Cost (\$)	Annual Energy Cost Savings (\$)	Simple Payback (Years)
2,682 sf (Option 1)	524	71	\$2,072	\$172	12.0
2,682 sf (Option 2)	338	111	\$2,549	\$186	13.7
2,682 sf (Option 3)	427	92	\$2,327	\$180	12.9
Averages:	430	91	\$2,316	\$179	12.9

**Annual Reduction in CO2-equivalent:** 1,256 lb./building-year  
0.47 lb./sq.ft.-year

#### Climate Zone 3: 15% Better Than Title 24

##### Single Family

Building Description	Total Annual KWh Saving	Total Annual Therms Saving	Incremental First Cost (\$)	Annual Energy Cost Savings (\$)	Simple Payback (Years)
1,582 sf (Option 1)	63	67	\$1,888	\$88	21.5

**Annual Reduction in CO2-equivalent:** 808 lb./building-year  
0.51 lb./sq.ft.-year

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)	81	88	\$1,555	\$115	13.5

**Annual Reduction in CO2-equivalent:** 1,061 lb./building-year  
0.52 lb./sq.ft.-year

**Climate Zone 2: 20% Better Than Title 24**

**Large Single Family**

Building Description	Total Annual KWh Saving	Total Annual Therms Saving	Incremental First Cost (\$)	Annual Energy Cost Savings (\$)	Simple Payback (Years)
5,000 sf (Option 1)	908	129	\$5,237	\$305	17.1
5,000 sf (Option 2)	1040	116	\$4,637	\$313	14.8
5,000 sf (Option 3)	850	148	\$5,087	\$317	16.0
Averages:	933	131	\$4,987	\$312	16.0

**Annual Reduction in CO2-equivalent: 1,945 lb./building-year**  
**0.39 lb./sq.ft.-year**

**Climate Zone 3: 20% Better Than Title 24**

**Large Single Family**

Building Description	Total Annual KWh Saving	Total Annual Therms Saving	Incremental First Cost (\$)	Annual Energy Cost Savings (\$)	Simple Payback (Years)
5,000 sf (Option 1)	171	146	\$4,029	\$197	20.4
5,000 sf (Option 2)	93	161	\$3,262	\$201	16.2
Averages:	132	154	\$3,646	\$199	18.3

**Annual Reduction in CO2-equivalent: 1,846 lb./building-year**  
**0.37 lb./sq.ft.-year**

**Climate Zone 2: 30% Better Than Title 24**

**Large Single Family**

Building Description	Total Annual KWh Saving	Total Annual Therms Saving	Incremental First Cost (\$)	Annual Energy Cost Savings (\$)	Simple Payback (Years)
6,500 sf (Option 1)	1130	321	\$12,020	\$565	21.3
6,500 sf (Option 2)	1029	26	\$9,253	\$398	23.2
Averages:	1080	174	\$10,636	\$481	22.3

**Annual Reduction in CO2-equivalent: 2,753 lb./building-year**  
**0.42 lb./sq.ft.-year**

**Climate Zone 3: 30% Better Than Title 24**

**Large Single Family**

Building Description	Total Annual KWh Saving	Total Annual Therms Saving	Incremental First Cost (\$)	Annual Energy Cost Savings (\$)	Simple Payback (Years)
6,500 sf (Option 1)	165	275	\$8,043	\$345	23.3
6,500 sf (Option 2)	95	281	\$7,793	\$340	22.9
Averages:	130	278	\$7,918	\$342	23.1

**Annual Reduction in CO2-equivalent: 3,294 lb./building-year**  
**0.51 lb./sq.ft.-year**

**Climate Zone 2: Net Zero TDV Energy**  
**Large Single Family**

Building Description	Total Annual KWh Saving	Total Annual Therms Saving	Incremental First Cost (\$)	Annual Energy Cost Savings (\$)	Simple Payback (Years)
7,500 sf (Option 1)	1568	378	\$41,119	\$1,467	28.0
7,500 sf (Option 2)	1582	378	\$40,661	\$1,470	27.7
Averages:	1575	378	\$40,890	\$1,468	27.8

**Annual Reduction in CO2-equivalent:** 7,089 lb./building-year  
0.95 lb./sq.ft.-year

**Climate Zone 3: Net Zero TDV Energy**  
**Large Single Family**

Building Description	Total Annual KWh Saving	Total Annual Therms Saving	Incremental First Cost (\$)	Annual Energy Cost Savings (\$)	Simple Payback (Years)
7,500 sf (Option 1)	212	375	\$23,973	\$849	28.3
7,500 sf (Option 2)	205	375	\$25,420	\$847	30.0
Averages:	209	375	\$24,696	\$848	29.1

**Annual Reduction in CO2-equivalent:** 5,449 lb./building-year  
0.73 lb./sq.ft.-year

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

**Climate Zone 2: 15% Better Than Title 24**  
**Low-rise Apartments**

Building Description	Total Annual KWh Saving	Total Annual Therms Saving	Incremental First Cost (\$)	Annual Energy Cost Savings (\$)	Simple Payback (Years)
8,442 sf (Option 1)	1575	261	\$8,089	\$573	14.1
8,442 sf (Option 2)	1468	284	\$6,388	\$581	11.0
Averages:	1522	273	\$7,238	\$577	12.6

**Annual Reduction in CO2-equivalent:** 3,857 lb./building-year  
0.10 lb./sq.ft.-year

**Climate Zone 3: 15% Better Than Title 24**  
**Low-rise Apartments**

Building Description	Total Annual KWh Saving	Total Annual Therms Saving	Incremental First Cost (\$)	Annual Energy Cost Savings (\$)	Simple Payback (Years)
8,442 sf (Option 1)	363	318	\$11,975	\$428	27.9

**Annual Reduction in CO2-equivalent:** 3,865 lb./building-year  
0.46 lb./sq.ft.-year

### 3.3 High-rise Multi-family Building

#### Climate Zone 2: 15% Better Than Title 24

##### High-rise 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)	14292	0	\$30,160	\$2,473	12.2
36,800 sf (Option 2)	9590	268	\$87,428	\$1,967	44.4
Averages:	11941	134	\$58,794	\$2,220	28.3

**Annual Reduction in CO2-equivalent:** 6,933 lb./building-year  
0.19 lb./sq.ft.-year

#### Climate Zone 3: 15% Better Than Title 24

##### High-rise 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)	10032	179	\$40,513	\$1,941	20.9

**Annual Reduction in CO2-equivalent:** 6,598 lb./building-year  
0.18 lb./sq.ft.-year

### 3.4 Nonresidential Buildings

#### Climate Zone 2: 15% Better Than Title 24

##### 2-Story Office Building

Building Description	Total Annual KWh Saving	Total Annual Therms Saving	Incremental First Cost (\$)	Annual Energy Cost Savings (\$)	Simple Payback (Years)
21,160 sf (Option 1)	19085	-95	\$56,100	\$3,192	17.6
21,160 sf (Option 2)	15862	90	\$60,572	\$2,848	21.3
Averages:	17474	-3	\$58,336	\$3,020	19.4

**Annual Reduction in CO2-equivalent:** 7,834 lb./building-year  
0.37 lb./sq.ft.-year

#### Climate Zone 3: 15% Better Than Title 24

##### 2-Story Office Building

Building Description	Total Annual KWh Saving	Total Annual Therms Saving	Incremental First Cost (\$)	Annual Energy Cost Savings (\$)	Simple Payback (Years)
21,160 sf (Option 1)	19294	-75	\$49,670	\$3,252	15.3

**Annual Reduction in CO2-equivalent:** 7,809 lb./building-year  
0.37 lb./sq.ft.-year

