

# Creating Energy-Efficient Communities in California: A Technical Reference Guide to Building and Site Design

## Attachment I Building Modeling Assumptions



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for Sustainable Communities



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## Authors

Doug Newman - National Energy Center for Sustainable Communities [[www.necsc.us](http://www.necsc.us)]

Marek Czachorski - Gas Technology Institute [[www.gastechnology.org](http://www.gastechnology.org)]

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## ***List of Acronyms***

AER	Appliance Efficiency Regulations (California)
AFUE	Annual Fuel Utilization Efficiency (furnace)
AV	Adjusted Volume of Refrigerator Appliance (per CEC AER)
BEA	Building Energy Analyzer Modeling Software
BPB	Builder Proposed Baseline modeling option
BUR	Built Up Roof Assembly
Btu	British thermal unit
CEC	California Energy Commission
CEC AER	California Energy Commission Appliance Efficiency Regulations
CFL	Compact Fluorescent Light Bulb
CHP	Combined Heat and Power, on-site power generation with heat recovery
CVRP	Chula Vista Research Project
DHW	Domestic Hot Water
DG	Distributed Generation, on-site power generation
DOE2.1e	Building Energy Modeling Software
EE	Energy Efficiency and Energy Efficiency package modeling option
EE-PV	Energy Efficiency package supplemented with PV modeling option
EE-DG	Energy Efficiency package supplemented with DG modeling option
EEM	Energy Efficiency Measure
EER	Energy Efficiency Rating (air conditioning).
EF	Energy Efficiency Factor (furnace, water heater)
EUC	Eastern Urban Center
kBtu	Thousand Btu
kW	Kilowatt or Thousand Watts
LCC	Life Cycle Cost
LPW	Lumens per Watt (lights)
MMBtu	Million Btu
MEF	Minimum Energy Factor of Dishwasher (per CEC AER)
MMEF	Minimum Modified Energy Factor of Clothes Washer (per CEC AER)
PV	Photo-Voltaic panels
R	A Measure of the Heat Conductivity of Material
RT	Refrigerating Ton (12,000 Btu/hour)
ROI	Return on Investment
SEER	Seasonal Energy Efficiency Rating (air conditioning)
SGIP	CA Self-Generation Initiative Program
sf	square foot
Title-24, T24	California Title-24 2005 Building Energy Efficiency Standard
TDV	Time Dependent Valuation of Building Specific Energy Consumption calculated per Title-25 2005 standard (considers different categories of energy uses for residential and non-residential structures)
TDVI	Time Dependent Valuation Inclusive (accounts for all building energy uses including appliances independent of building type)
U	Heat transfer coefficient of material

# Urban Site: Building Energy Modeling Assumptions

## External Walls

### External Walls – Prototype 6

<b>Applicable to the following Type I commercial prototypes:</b>	<b>Prototype #</b>
Office Building – High-rise	6

Title 24	
T24 Mandatory	T24 Prescriptive
None	Min Insulation R11

Modeling Scenarios			
Proposed Baseline	Alternative 1	Alternative 2	Alternative 3
Metal frame, metal studs 2x6.16 16 Ga. R11 mineral batt, 1" stone tile ext. on lath/plaster, 5/8" GWB int.	Metal frame, metal studs 2x6.16 16 Ga. R19 mineral batt, 1" stone tile ext. on lath/plaster, 5/8" GWB int.	Metal frame, metal studs 2x6.16 16 Ga. R21 mineral batt, 1" stone tile ext. on lath/plaster, 5/8" GWB int.	Metal frame, metal studs 2x6.16 16 Ga. R21 mineral batt, 1" stone tile ext. on lath/plaster over 1" R5 rigid insul, 5/8" GWB int.
Overall U = 0.158	Overall U = 0.136	Overall U = 0.132	Overall U = 0.080

Alternative Incremental Costs (Alt X – Baseline)		
Alternative 1	Alternative 2	Alternative 3
\$0.11/sqft	\$0.15/sqft	\$0.29/sqft

## External Walls – Prototypes 5, 7, 10, 11, and 12

Applicable to the following Type II commercial prototypes:	Prototype #
Office Building – Mid-rise	5
Hotel – Large	7
Retail/Residential Mixed Use Mid-rise Building (Retail only)	10
Retail/Residential Mixed Use Low-Rise Building (Retail only)	11
Civic/Commercial Mixed Use	12

Title 24	
T24 Mandatory	T24 Prescriptive
None	Min Insulation R11

Modeling Scenarios			
Proposed Baseline	Alternative 1	Alternative 2	Alternative 3
5" poured-in-place conc, metal studs 2x6.16 16 Ga. R11 mineral batt, 1" plaster ext, 5/8" GWB int.	5" poured-in-place conc, metal studs 2x6.16 16 Ga. R19 mineral batt, 1" plaster ext, 5/8" GWB int.	5" poured-in-place conc, metal studs 2x6.16 16 Ga. R21 mineral batt, 1" plaster ext, 5/8" GWB int.	5" poured-in-place conc, metal studs 2x6.16 16 Ga. R21 mineral batt, 1" plaster over 1" R5 rigid insul, 5/8" GWB int.
Overall U = 0.152	Overall U = 0.118	Overall U = 0.112	Overall U = 0.070

Alternative Incremental Costs (Alt X – Baseline)		
Alternative 1	Alternative 2	Alternative 3
\$0.11/sqft	\$0.15/sqft	\$0.29/sqft

## External Walls – Prototypes 1, 2, 3, 4, 8, and 9

Applicable to the following Type III commercial prototypes:	Prototype #
Freestanding Full-Service Restaurant Building	1
Multi-tenant Retail Shop Building	2
Major Retailer Building	3
Office Building – Low-rise	4
Hotel – Small	8
Retail/Commercial Mixed Use Building	9

Title 24	
T24 Mandatory	T24 Prescriptive
None	Min Insulation R11

Modeling Scenarios			
Proposed Baseline	Alternative 1	Alternative 2	Alternative 3
Wood frame, wood studs 2x6.16 w/ R11 mineral batt, 3" brick veneer ext. on lath/plaster, 5/8" GWB int.	Wood frame, wood studs 2x6.16 w/ R19 mineral batt, 3" brick veneer ext. on lath/plaster, 5/8" GWB int.	Wood frame, wood studs 2x6.16 w/ R21 mineral batt, 3" brick veneer ext. on lath/plaster, 5/8" GWB int.	Wood frame, wood studs 2x6.16 w/ R21 mineral batt, 3" brick veneer ext. on lath/plaster over 1" R5 rigid insul, 5/8" GWB int.
Overall U = 0.086	Overall U = 0.062	Overall U = 0.056	Overall U = 0.042

Alternative Incremental Costs (Alt X – Baseline)		
Alternative 1	Alternative 2	Alternative 3
\$0.11/sqft	\$0.15/sqft	\$0.40/sqft

## External Walls – Prototype 15

<b>Applicable to the following Type III residential prototypes:</b>	<b>Prototype #</b>
Residential Mid-rise	15

<b>Title 24</b>	
<b>T24 Mandatory</b>	<b>T24 Prescriptive</b>
None	Min Insulation R13

<b>Modeling Scenarios</b>			
<b>Proposed Baseline</b>	<b>Alternative 1</b>	<b>Alternative 2</b>	<b>Alternative 3</b>
Wood frame, wood studs 2x6.16 w/ R13 mineral batt, 3" brick veneer ext. on lath/plaster, 5/8" GWB int.	Wood frame, wood studs 2x6.16 w/ R19 mineral batt, 3" brick veneer ext. on lath/plaster, 5/8" GWB int.	Wood frame, wood studs 2x6.16 w/ R21 mineral batt, 3" brick veneer ext. on lath/plaster, 5/8" GWB int.	Wood frame, wood studs 2x6.16 w/ R21 mineral batt, 3" brick veneer ext. on lath/plaster over 1" R5 rigid insul, 5/8" GWB int.
Overall U = 0.076	Overall U = 0.062	Overall U = 0.056	Overall U = 0.042

<b>Alternative Incremental Costs (Alt X – Baseline)</b>		
<b>Alternative 1</b>	<b>Alternative 2</b>	<b>Alternative 3</b>
\$0.09/sqft	\$0.13/sqft	\$0.38/sqft

## External Walls – Prototype 10, 11, 13, and 14

Applicable to the following Type V residential prototypes:	Prototype #
Retail/Residential Mixed Use Mid-rise Building (Residential only)	10
Retail/Residential Mixed Use Low-Rise Building (Residential only)	11
Residential Multi-Family	13
Residential Low-Rise	14

Title 24	
T24 Mandatory	T24 Prescriptive
None	Min Insulation R13

Modeling Scenarios			
Proposed Baseline	Alternative 1	Alternative 2	Alternative 3
Wood frame, wood studs 2x6.16 w/ R13 mineral batt, 1" plaster ext, 5/8" GWB int.	Wood frame, wood studs 2x6.16 w/ R19 mineral batt, 1" plaster ext, 5/8" GWB int.	Wood frame, wood studs 2x6.16 w/ R21 mineral batt, 1" plaster ext, 5/8" GWB int.	Wood frame, wood studs 2x6.16 w/ R21 mineral batt, 1" plaster ext over 1" R5 rigid insul, 5/8" GWB int.
Overall U = 0.078	Overall U = 0.064	Overall U = 0.058	Overall U = 0.042

Alternative Incremental Costs (Alt X – Baseline)		
Alternative 1	Alternative 2	Alternative 3
\$0.09/sqft	\$0.13/sqft	\$0.38/sqft

# Roofing Material

## Roofing Material – Prototype 6

<b>Applicable to the following Type I commercial prototype:</b>	<b>Prototype #</b>
Office Building – High-rise	6

<b>Title 24</b>	
<b>T24 Mandatory</b>	<b>T24 Prescriptive</b>
None	Min Insulation R11
None	Reflectance > 0.70
None	Thermal Emittance > 0.75

<b>Modeling Scenarios</b>			
<b>Proposed Baseline</b>	<b>Alternative 1</b>	<b>Alternative 2</b>	<b>Alternative 3</b>
3-ply BUR over 5.5” lightweight concrete over 20 Ga. metal deck	3-ply BUR over 1” R5 rigid insul over 5.5” lightweight concrete over 20 Ga. metal deck	3-ply BUR over 2” R5 rigid insul over 5.5” lightweight concrete over 20 Ga. metal deck	3-ply BUR w/ white elastomeric roof coating over 5.5” lightweight concrete over 20 Ga. metal deck
Overall U = 0.148	Overall U = 0.084	Overall U = 0.060	Overall U = 0.148
Reflectance > 0.70	Reflectance > 0.70	Reflectance > 0.70	Reflectance > 0.84
Thermal Emittance > 0.75	Thermal Emittance > 0.75	Thermal Emittance > 0.75	Thermal Emittance > 0.89

<b>Alternative Incremental Costs (Alt X – Baseline)</b>		
<b>Alternative 1</b>	<b>Alternative 2</b>	<b>Alternative 3</b>
\$0.25/sqft	\$0.45/sqft	\$0.33/sqft

## Roofing Material – Prototypes 5 and 12

Applicable to the following Type II commercial prototypes:	Prototype #
Office Building – Mid-rise	5
Civic/Commercial Mixed Use	12

Title 24	
T24 Mandatory	T24 Prescriptive
None	Min Insulation R11
None	Reflectance > 0.70
None	Thermal Emittance > 0.75

Modeling Scenarios			
Proposed Baseline	Alternative 1	Alternative 2	Alternative 3
3-ply BUR over 2" R10 rigid insul over 20 Ga. metal deck	3-ply BUR over 3" R15 rigid insul over 20 Ga. metal deck	3-ply BUR over 4" R20 rigid insul over 20 Ga. metal deck	3-ply BUR w/ white elastomeric roof coating over 2" R10 rigid insul over 20 Ga. metal deck
Overall U = 0.088	Overall U = 0.062	Overall U = 0.046	Overall U = 0.088
Reflectance > 0.70	Reflectance > 0.70	Reflectance > 0.70	Reflectance > 0.84
Thermal Emittance > 0.75	Thermal Emittance > 0.75	Thermal Emittance > 0.75	Thermal Emittance > 0.89

Alternative Incremental Costs (Alt X – Baseline)		
Alternative 1	Alternative 2	Alternative 3
\$0.25/sqft	\$0.45/sqft	\$0.33/sqft

## Roofing Material – Prototype 7

<b>Applicable to the following Type II commercial prototype:</b>	<b>Prototype #</b>
Hotel – Large	7

<b>Title 24</b>	
<b>T24 Mandatory</b>	<b>T24 Prescriptive</b>
None	Min Insulation R19
None	Reflectance > 0.70
None	Thermal Emittance > 0.75

<b>Modeling Scenarios</b>			
<b>Proposed Baseline</b>	<b>Alternative 1</b>	<b>Alternative 2</b>	<b>Alternative 3</b>
3-ply BUR over 4" R20 rigid insul over 20 Ga. metal deck	3-ply BUR over 5" R25 rigid insul over 20 Ga. metal deck	3-ply BUR over 6" R30 rigid insul over 20 Ga. metal deck	3-ply BUR w/ white elastomeric roof coating over 4" R20 rigid insul over 20 Ga. metal deck
Overall U = 0.046	Overall U = 0.038	Overall U = 0.032	Overall U = 0.046
Reflectance > 0.70	Reflectance > 0.70	Reflectance > 0.70	Reflectance > 0.84
Thermal Emittance > 0.75	Thermal Emittance > 0.75	Thermal Emittance > 0.75	Thermal Emittance > 0.89

<b>Alternative Incremental Costs (Alt X – Baseline)</b>		
<b>Alternative 1</b>	<b>Alternative 2</b>	<b>Alternative 3</b>
\$0.25/sqft	\$0.45/sqft	\$0.33/sqft

## Roofing Material – Prototypes 1, 2, 3, 4, and 9

Applicable to the following Type III commercial prototypes:	Prototype #
Freestanding Full-Service Restaurant Building	1
Multi-tenant Retail Shop Building	2
Major Retailer Building	3
Office Building – Low-rise	4
Retail/Commercial Mixed Use Building	9

Title 24	
T24 Mandatory	T24 Prescriptive
None	Min Insulation R11
None	Reflectance > 0.70
None	Thermal Emittance > 0.75

Modeling Scenarios			
Proposed Baseline	Alternative 1	Alternative 2	Alternative 3
3-ply BUR over 2" R10 rigid insul over ¾" plywood and wood truss	3-ply BUR over 3" R15 rigid insul over ¾" plywood and wood truss	3-ply BUR over 4" R20 rigid insul over ¾" plywood and wood truss	3-ply BUR w/ white elastomeric roof coating over 2" R10 rigid insul over ¾" plywood and wood truss
Overall U = 0.082	Overall U = 0.058	Overall U = 0.044	Overall U = 0.082
Reflectance > 0.70	Reflectance > 0.70	Reflectance > 0.70	Reflectance > 0.84
Thermal Emittance > 0.75	Thermal Emittance > 0.75	Thermal Emittance > 0.75	Thermal Emittance > 0.89

Alternative Incremental Costs (Alt X – Baseline)		
Alternative 1	Alternative 2	Alternative 3
\$0.25/sqft	\$0.45/sqft	\$0.33/sqft

## Roofing Material – Prototype 8

<b>Applicable to the following Type III commercial prototypes:</b>	<b>Prototype #</b>
Hotel – Small	8

<b>Title 24</b>	
<b>T24 Mandatory</b>	<b>T24 Prescriptive</b>
None	Min Insulation R19
None	Reflectance > 0.70
None	Thermal Emittance > 0.75

<b>Modeling Scenarios</b>			
<b>Proposed Baseline</b>	<b>Alternative 1</b>	<b>Alternative 2</b>	<b>Alternative 3</b>
3-ply BUR over 4" R20 rigid insul over ¾" plywood and wood truss	3-ply BUR over 5" R25 rigid insul over ¾" plywood and wood truss	3-ply BUR over 6" R30 rigid insul over ¾" plywood and wood truss	3-ply BUR w/ white elastomeric roof coating over 4" R20 rigid insul over ¾" plywood and wood truss
Overall U = 0.044	Overall U = 0.036	Overall U = 0.030	Overall U = 0.044
Reflectance > 0.70	Reflectance > 0.70	Reflectance > 0.70	Reflectance > 0.84
Thermal Emittance > 0.75	Thermal Emittance > 0.75	Thermal Emittance > 0.75	Thermal Emittance > 0.89

<b>Alternative Incremental Costs (Alt X – Baseline)</b>		
<b>Alternative 1</b>	<b>Alternative 2</b>	<b>Alternative 3</b>
\$0.25/sqft	\$0.45/sqft	\$0.33/sqft

## Roofing Material – Prototypes 10, 11, 14, and 15

Applicable to the following Type V residential prototypes:	Prototype #
Retail/Residential Mixed Use Mid-Rise	10
Retail/Residential Mixed Use Low-Rise	11
Residential Low-Rise	14
Residential Mid-Rise	15

Title 24	
T24 Mandatory	T24 Prescriptive
None	Min Insulation R30
None	Reflectance > 0.40
None	Thermal Emittance > 0.75

Modeling Scenarios			
Proposed Baseline	Alternative 1	Alternative 2	Alternative 3
3-ply BUR over ¾" plywood and wood truss, R30 mineral batt under deck	3-ply BUR over ¾" plywood and wood truss, R38 mineral batt under deck	3-ply BUR over ¾" plywood and wood truss, R49 mineral batt under deck	3-ply BUR w/ white elastomeric roof coating over ¾" plywood and wood truss, R30 mineral batt under deck
Overall U = 0.030	Overall U = 0.024	Overall U = 0.018	Overall U = 0.030
Reflectance > 0.40	Reflectance > 0.40	Reflectance > 0.40	Reflectance > 0.84
Thermal Emittance > 0.75	Thermal Emittance > 0.75	Thermal Emittance > 0.75	Thermal Emittance > 0.89

Alternative Incremental Costs (Alt X – Baseline)		
Alternative 1	Alternative 2	Alternative 3
\$0.19/sqft	\$0.66/sqft	\$0.33/sqft

## Roofing Material – Prototype 13

<b>Applicable to the following Type V residential prototype:</b>	<b>Prototype #</b>
Residential Multi-Family	13

<b>Title 24</b>	
<b>T24 Mandatory</b>	<b>T24 Prescriptive</b>
None	Min Insulation R30
None	Reflectance > 0.40
None	Thermal Emittance > 0.75

<b>Modeling Scenarios</b>			
<b>Proposed Baseline</b>	<b>Alternative 1</b>	<b>Alternative 2</b>	<b>Alternative 3</b>
Pitched 2x4 truss, Conc. shingles over ½" plywood, R30 mineral batt at attic floor	Pitched 2x4 truss, Conc. shingles over ½" plywood, R38 mineral batt at attic floor	Pitched 2x4 truss, Conc. shingles over ½" plywood, R49 mineral batt at attic floor	NA
Overall U = 0.030	Overall U = 0.024	Overall U = 0.018	
Reflectance > 0.40	Reflectance > 0.40	Reflectance > 0.40	
Thermal Emittance > 0.75	Thermal Emittance > 0.75	Thermal Emittance > 0.75	

<b>Alternative Incremental Costs (Alt X – Baseline)</b>		
<b>Alternative 1</b>	<b>Alternative 2</b>	<b>Alternative 3</b>
\$0.19/sqft	\$0.66/sqft	NA

# Windows

## Windows – Prototypes 11, 13, and 14

Applicable to the following prototypes:	Prototype #	WWR
Retail/Residential Mixed Use Low-Rise (Residential only)	11	9%
Residential Multi-Family/Town Homes	13	11%
Residential Low Rise	14	8%

Title 24	
T24 Mandatory	T24 Prescriptive
None	Max 20% of gross floor area Max 5% West facing area
Max Air leakage = 0.30 cfm/sf	None
None	U = 0.670
None	SHGC = 0.400

Modeling Scenarios			
Proposed Baseline	Alternative 1	Alternative 2	Alternative 3
2-pane, tinted/clear	2-pane, LowE	2-pane, LowE	←
Max Air leakage = 0.30 cfm/sf	←	←	←
U = 0.56	U = 0.43	U = 0.26	U = 0.22
SHGC = 0.42	SHGC = 0.39	SHGC = 0.37	SHGC = 0.22

Alternative Incremental Costs (Alt X – Baseline)		
Alternative 1	Alternative 2	Alternative 3
\$0.82/sqft	\$2.45/sqft	\$7.48/sqft

## Windows – Prototypes 7, 8, 10, and 15

Applicable to the following prototypes:	Prototype #	WWR
Hotel – Large (Guest rooms, lobby and meeting rooms)	7	40%
Hotel – Small (Guest rooms, lobby and meeting rooms)	8	31%
Retail/Residential Mixed Use High-rise (Residential only)	10	8%
Residential High-rise	15	8%

Title 24			
T24 Mandatory		T24 Prescriptive	
None		Max 40% of gross wall area	
Max Air leakage = 0.30 cfm/sf		NA	
None		U = 0.47	
None	SHGC	Non-North	North
	0-10% WWR	0.47	0.61
	11-21% WWR	0.4	0.61
	21-30% WWR	0.36	0.61
	31-40% WWR	0.31	0.61

Modeling Scenarios			
Proposed Baseline	Alternative 1	Alternative 2	Alternative 3
1- or 2-pane, clear Max 40% of gross fl area	2-pane, LowE Max 40% of gross fl area	2-pane, LowE Max 40% of gross fl area	←
Max Air leakage = 0.30 cfm/sf	←	←	←
Hotel U = 0.43	Hotel U = 0.26	Hotel U = 0.26	Hotel U = NA
Residential U = 0.48	Residential U = 0.43	Residential U = 0.26	Residential U = 0.22
Hotel SHG = 0.39	Hotel SHG = 0.37	Hotel SHG = 0.37	Hotel SHG = NA
Res SHGC = 0.47	Res SHGC = 0.39	Res SHGC = 0.37	Res SHGC = 0.22

Alternative Incremental Costs (Alt X – Baseline)		
Alternative 1	Alternative 2	Alternative 3
Residential \$0.82/sqft	Residential \$2.45/sqft	Residential \$7.48/sqft
Hotel \$2.45/sqft	Hotel \$7.48/sqft	NA

## Windows – Prototypes 1-6, and 9-12

Applicable to the following prototypes:	Prototype #	WWR
Freestanding Full-Service Restaurant Building	1	20%
Multi-tenant Retail Shop Building (Internal/Corner)	2	10%/20%
Major Retailer Building	3	10%
Office Building – Low-rise	4	40%
Office Building – Mid-rise	5	40%
Office Building – High-rise	6	40%
Hotel – Large (Restaurant)	7	15%
Hotel – Small (Restaurant)	8	15%
Hotel – Small (Commercial)	8	35%
Hotel – Small (Retail – Internal/End)	8	10%/28%
Retail/Commercial Mixed Use (Commercial)	9	40%
Retail/Commercial Mixed Use (Retail – Internal/Corner)	9	10%/20%
Retail/Residential MU High-rise (Retail – Internal/Corner)	10	10%/20%
Retail/Residential MU Low-Rise (Retail – Internal/Corner)	11	10%/20%
Civic/Commercial Mixed Use	12	40%

Title 24			
T24 Mandatory	T24 Prescriptive		
None	Max 40% of gross wall area		
Max Air leakage = 0.30 cfm/sf	NA		
None	U = 0.77		
None	SHGC	Non-North	North
	0-10% WWR	0.61	0.61
	11-21% WWR	0.61	0.61
	21-30% WWR	0.39	0.61
	31-40% WWR	0.34	0.61

<b>Modeling Scenarios</b>			
<b>Proposed Baseline</b>	<b>Alternative 1</b>	<b>Alternative 2</b>	<b>Alternative 3</b>
1- or 2-pane, clear/tinted	2-pane, LowE	2-pane, LowE	←
Max Air leakage = 0.30 cfm/sf	←	←	←
0% - 21% WWR U = 0.57	0% - 21% WWR U = 0.43	0% - 21% WWR U = 0.26	0% - 21% WWR U = 0.22
21% - 40% WWR U = 0.56	0% - 21% WWR U = 0.43	0% - 21% WWR U = 0.26	0% - 21% WWR U = 0.22
0% - 21% WWR SHGC = 0.61	0% - 21% WWR SHGC = 0.39	0% - 21% WWR SHGC = 0.37	0% - 21% WWR SHGC = 0.22
0% - 21% WWR SHGC = 0.42	0% - 21% WWR SHGC = 0.39	0% - 21% WWR SHGC = 0.37	0% - 21% WWR SHGC = 0.22

<b>Alternative Incremental Costs (Alt X – Baseline)</b>		
<b>Alternative 1</b>	<b>Alternative 2</b>	<b>Alternative 3</b>
\$0.82/sqft	\$2.45/sqft	\$7.48/sqft

# Entry Doors

## Entry Doors – Prototypes 1-15

<b>Applicable to the following prototypes:</b>	<b>Prototype #</b>
All	

Title 24	
T24 Mandatory	T24 Prescriptive
Max Air leakage = 0.30 cfm/sf	NA

Modeling Scenarios			
Proposed Baseline	Alternative 1	Alternative 2	Alternative 3
Foam-core insulated steel panel	Not Applicable	Not Applicable	Not Applicable
Max air leakage = 0.30 cfm/sf			
U = 0.18			

Alternative Incremental Costs (Alt X – Baseline)		
Alternative 1	Alternative 2	Alternative 3
Not Applicable	Not Applicable	Not Applicable

# Foundation

## Foundation – Prototypes 1-5, and 7-14

Applicable to the following prototypes:	Prototype #
Freestanding Full-Service Restaurant Building	1
Multi-tenant Retail Shop Building	2
Major Retailer Building	3
Office Building – Low-rise	4
Office Building – Mid-rise	5
Hotel – Large	7
Hotel – Small	8
Retail/Commercial Mixed Use Building	9
Retail/Residential Mixed Use High-rise Building	10
Retail/Residential Mixed Use Low-Rise Building	11
Civic/Commercial Mixed Use	12
Residential Multi-Family/Town Homes	13
Residential Low Rise	14

Title 24	
T24 Mandatory	T24 Prescriptive
R5 (for heated slabs only)	None

Modeling Scenarios			
Proposed Baseline	Alternative 1	Alternative 2	Alternative 3
Concrete slab on grade	Not Applicable	Not Applicable	Not Applicable
No slab insulation			

Alternative Incremental Costs (Alt X – Baseline)		
Alternative 1	Alternative 2	Alternative 3
Not Applicable	Not Applicable	Not Applicable

## Foundation – Prototype 6

Applicable to the following prototypes:	Prototype #
Office Building – High-rise	6

Title 24	
T24 Mandatory	T24 Prescriptive
R5 (for heated slabs only)	None

Modeling Scenarios			
Proposed Baseline	Alternative 1	Alternative 2	Alternative 3
Underground basement	Not Applicable	Not Applicable	Not Applicable
No slab insulation			

Alternative Incremental Costs (Alt X – Baseline)		
Alternative 1	Alternative 2	Alternative 3
Not Applicable	Not Applicable	Not Applicable

## Foundation – Prototype 15

Applicable to the following prototypes:	Prototype #
Residential High-rise	15

Title 24	
T24 Mandatory	T24 Prescriptive
R5 (for heated slabs only)	None

Modeling Scenarios			
Proposed Baseline	Alternative 1	Alternative 2	Alternative 3
Underground Parking	Not Applicable	Not Applicable	Not Applicable
No slab insulation			

Alternative Incremental Costs (Alt X – Baseline)		
Alternative 1	Alternative 2	Alternative 3
Not Applicable	Not Applicable	Not Applicable

# Raised Floors

## Raised Floors – Prototypes 6 and 15

Applicable to the following prototypes:	Prototype #
Office Building – High-rise	6
Residential High-rise	15

Title 24	
T24 Mandatory	T24 Prescriptive
None	R11

Modeling Scenarios			
Proposed Baseline	Alternative 1	Alternative 2	Alternative 3
Plywood sheathing over TJI floor joists	Not Applicable	Not Applicable	Not Applicable
R11 insulation			

Alternative Incremental Costs (Alt X – Baseline)		
Alternative 1	Alternative 2	Alternative 3
Not Applicable	Not Applicable	Not Applicable

# HVAC – Summary

Applicable to the following prototypes:	Prototype #	Cooling	Heating
Freestanding Full-Service Restaurant Building	1	Unitary Packaged AC	Furnace
Multi-tenant Retail Shop Building	2	Individual Split System Heat Pumps	
Major Retailer Building	3	Central Chiller Positive Disp.	Central Boiler
Office Building – Low-rise	4	Individual Split System Heat Pumps	
Office Building – Mid-rise	5	Central Chiller Positive Disp.	Central Boiler
Office Building – High-rise	6	Central Chiller Centrifugal	Central Boiler
Hotel – Large	7	Central Chiller Centrifugal	Central Boiler
Hotel – Small	8	Central Chiller Centrifugal	Central Boiler
Retail/Commercial Mixed Use (Retail)	9	Individual Split System Heat Pumps	
Retail/Commercial Mixed Use (Commercial)	9	Individual Split System Heat Pumps	
Retail/Residential Mixed Use High-rise (Retail)	10	Individual Split System Heat Pumps	
Retail/Residential Mixed Use High-rise (Residential)	10	Central Chiller Centrifugal	Central Boiler
Retail/Residential Mixed Use Low-Rise (Retail)	11	Individual Split System Heat Pumps	
Retail/Residential Mixed Use Low-Rise (Residential)	11	Individual Split System Heat Pumps	
Civic/Commercial Mixed Use (Civic)	12	Central Chiller Positive Disp.	Central Boiler
Civic/Commercial Mixed Use (Commercial)	12	Central Chiller Positive Disp.	Central Boiler
Residential Multi-Family/Town Homes	13	Individual Split System Heat Pumps	
Residential Low Rise	14	Individual Split System Heat Pumps	
Residential High-rise	15	Central Chiller Centrifugal	Central Boiler

# HVAC – Cooling Details

## HVAC Cooling – Prototypes 1 and 12

Applicable to the following prototypes:	Prototype #	Size Category
Freestanding Full-Service Restaurant Building	1	240 kBtuh–760 kBtuh

Title 24	
T24 Mandatory	T24 Prescriptive
EER: 9.5	Economizer for systems greater than 75 kBtuh
OAR: 0.38 cfm/sf	

Modeling Scenarios			
Proposed Baseline	Alternative 1	Alternative 2	Alternative 3
Elec. operated air-cooled unitary packaged AC with economizer	←	←	←
SEER 11 EER 9.5	SEER 12 EER 10.5	SEER 13 EER 11.5	SEER 14 EER 12.5

Alternative Incremental Costs (Alt X – Baseline)			
Parameter	Alternative 1	Alternative 2	Alternative 3
20-63 tons	\$371/ton	\$415/ton	\$442/ton

## HVAC Cooling – Prototypes 11, 13, and 14

Applicable to the following prototypes:	Prototype #	Size Category
Retail/Residential Mixed Use Low-rise (Residential)	11	< 65 kBtuh
Residential Multi-Family/Town Homes	13	
Residential Low Rise	14	

Title 24	
T24 Mandatory	T24 Prescriptive
SEER: 13	Not Applicable
OAR: 0.03 cfm/sf + 7.5 cfm/person	

Modeling Scenarios			
Proposed Baseline	Alternative 1	Alternative 2	Alternative 3
Individual Split System Heat Pump with cooling	←	←	←
SEER 13, COP 3.28	SEER 14, COP 3.52	SEER 16, COP 3.48	SEER 18, COP 3.32

Alternative Incremental Costs (Alt X – Baseline)			
Parameter	Alternative 1	Alternative 2	Alternative 3
2 tons	\$128/ton	\$385/ton	\$642/ton
3 tons	\$98/ton	\$294/ton	\$490/ton
4 tons	\$83/ton	\$248/ton	\$413/ton
5 tons	\$74/ton	\$221/ton	\$368/ton

## HVAC Cooling – Prototypes 2, 4, and 9-12

Applicable to the following prototypes:	Prototype #	Size Category
Multi-tenant Retail Shop Building	2	65k-135k Btu/h
Office Building – Low-rise	4	
Retail/Commercial Mixed Use Building (Retail)	9	
Retail/Commercial Mixed Use Building (Commercial)	9	
Retail/Residential Mixed Use High-rise Building (Retail)	10	
Retail/Residential Mixed Use Low-rise (Retail)	11	

Title 24	
T24 Mandatory	T24 Prescriptive
65k-135k Btu/h EER: 10.1 135k-240k Btu/h EER: 9.3 > 240k Btu/h EER: 9.0	Not Applicable
Hotel OAR: 30 cfm/room Retail OAR: 0.20 cfm/sf	

Modeling Scenarios			
Proposed Baseline	Alternative 1	Alternative 2	Alternative 3
Individual Split System Heat Pumps	Individual Split System Heat Pumps	Individual Split System Heat Pumps	Individual Split System Heat Pumps
SEER 13, COP 3.28 EER 11.07 8.1 HSPF	SEER 14, COP 3.52 EER 12.19 8.6 HSPF	SEER 16, COP 3.48 EER 12.06 8.4 HSPF	SEER 18, COP 3.32 EER 12.8 9.2 HSPF

Alternative Incremental Costs (Alt X – Baseline)			
Parameter	Alternative 1	Alternative 2	Alternative 3
5 tons	\$97.93/ton	\$293.80/ton	\$489.68/ton

## HVAC Cooling – Prototype 3 and 5

Applicable to the following prototypes:	Prototype #	Size Category
Major Retailer Building	3	< 150 tons
Office Building – Mid-rise	5	150–299 tons
Civic/Commercial Mixed Use	12	150–299 tons

Title 24	
T24 Mandatory	T24 Prescriptive
COP: 4.20	Not Applicable
Retail OAR: 0.22 cfm/sf	
Office OAR: 0.15 cfm/sf	

Modeling Scenarios			
Proposed Baseline	Alternative 1	Alternative 2	Alternative 3
Water cooled chiller, electrically operated, positive displacement, VAV with economizer	←	←	←
< 150 tons: COP 4.45	< 150 tons: COP 5.57	Not Applicable	Not Applicable
150-299 tons: COP 4.90	150-299 tons: COP 6.13		

Alternative Incremental Costs (Alt X – Baseline)			
Parameter	Alternative 1	Alternative 2	Alternative 3
< 150 tons	\$49/ton	Not Applicable	Not Applicable
150-299 tons	\$25/ton		

## HVAC Cooling – Prototypes 6, 7, 8, 10, and 15

Applicable to the following prototypes:	Prototype #	Size Category
Office Building – High-rise	6	> 299 tons
Hotel – Large	7	
Hotel - Small	8	
Retail/Residential Mixed Use High-rise (Residential)	10	
Residential High-rise	15	

Title 24	
T24 Mandatory	T24 Prescriptive
COP: 6.10	Not Applicable
Hotel OAR: 30 cfm/room Res OAR: 0.03 cfm/sf + 7.5 cfm/person Office OAR: 0.15 cfm/sf	

Modeling Scenarios			
Proposed Baseline	Alternative 1	Alternative 2	Alternative 3
Water cooled chiller, electrically operated, Centrifugal-inlet, VAV with economizer	←	←	←
COP 6.10	COP 7.63	Not Applicable	Not Applicable

Alternative Incremental Costs (Alt X – Baseline)			
Parameter	Alternative 1	Alternative 2	Alternative 3
> 299 tons	\$66/ton	Not Applicable	Not Applicable

# HVAC - Space Heating

## Central Boiler – Prototypes 3, 5-8, 10, and 15

Applicable to the following prototypes:	Prototype #	Size Category
Major Retailer Building	3	>300 kBtuh and < 2,500 kBtuh
Office Building – Mid-rise	5	
Office Building – High-rise	6	
Hotel – Large	7	
Hotel - Small	8	
Retail/Residential Mixed Use High-rise (Residential)	10	
Residential High-rise	15	

Title 24	
<b>T24 Mandatory</b>	<b>T24 Prescriptive</b>
Thermal Efficiency 75%	Not Applicable

Modeling Scenarios			
Proposed Baseline	Alternative 1	Alternative 2	Alternative 3
Central gas-fired boiler	←	Not Applicable	Not Applicable
AFUE = 75%	AFUE = 85%		

Alternative Incremental Costs (Alt X – Baseline)			
Parameter	Alternative 1	Alternative 2	Alternative 3
> 300 kBtuh kBtu	\$3.57/kBtuh	Not Applicable	Not Applicable

## Central Furnace – Prototypes 1 and 12

Applicable to the following prototypes:	Prototype #	Size Category
Freestanding Full-Service Restaurant Building	1	> 225,000 Btu/hr
Civic/Commercial Mixed Use (Civic – Library)	12	

Title 24	
T24 Mandatory	T24 Prescriptive
Thermal Efficiency 80%	Not Applicable

Modeling Scenarios			
Proposed Baseline	Alternative 1	Alternative 2	Alternative 3
Central gas-fired Furnace	←	Not Applicable	Not Applicable
AFUE = 80%	AFUE = 94%		

Alternative Incremental Costs (Alt X – Baseline)			
Parameter	Alternative 1	Alternative 2	Alternative 3
> 225,000 Btu/hr	\$1000/appliance	Not Applicable	Not Applicable

# Appliances

## Domestic Hot Water – Prototypes 1-15

Applicable to the following prototypes:	Prototype #
Freestanding Full-Service Restaurant Building	1
Multi-tenant Retail Shop Building	2
Major Retailer Building	3
Office Building – Low-rise	4
Office Building – Mid-rise	5
Office Building – High-rise	6
Hotel – Large	7
Hotel – Small	8
Retail/Commercial Mixed Use Building	9
Retail/Residential Mixed Use High-rise Building	10
Retail/Residential Mixed Use Low-Rise Building	11
Civic/Commercial Mixed Use	12
Residential Multi-Family/Town Homes	13
Residential Low Rise	14
Residential High-rise	15

Title 24	
T24 Mandatory	T24 Prescriptive
Gas heating	Not Applicable
EF = 0.575 (50 gal)	

Modeling Scenarios			
Proposed Baseline	Alternative 1	Alternative 2	Alternative 3
50 gal Gas-fired storage-type water heater	50 gal Gas-fired storage-type water heater	50 gal equivalent Gas-fired tankless water heater	Not Applicable
EF = 0.594	EF = 0.64	EF = 0.823	

Alternative Incremental Costs (Alt X – Baseline)		
Alternative 1	Alternative 2	Alternative 3
\$309.77/appliance	\$370.64/appliance	Not Applicable

## Dishwasher – Prototypes 10, 11, and 13-5

<b>Applicable to the following prototypes:</b>	<b>Prototype #</b>
Retail/Residential Mixed Use High-rise Building	10
Retail/Residential Mixed Use Low-Rise Building	11
Residential Multi-Family/Town Homes	13
Residential Low Rise	14
Residential High-rise	15

<b>Title 24</b>	
<b>T24 Mandatory</b>	<b>T24 Prescriptive</b>
CEC AER	Not Applicable
EF = 0.46	

<b>Modeling Scenarios</b>			
<b>Proposed Baseline</b>	<b>Alternative 1</b>	<b>Alternative 2</b>	<b>Alternative 3</b>
160 cycles/yr	←	Not Applicable	Not Applicable
EF = 0.46	EF = 0.64		

<b>Alternative Incremental Costs (Alt X – Baseline)</b>		
<b>Alternative 1</b>	<b>Alternative 2</b>	<b>Alternative 3</b>
\$133.64/appliance	Not Applicable	Not Applicable

## Clothes Washer – Prototypes 10, 11, and 13-5

<b>Applicable to the following prototypes:</b>	<b>Prototype #</b>
Retail/Residential Mixed Use High-rise Building	10
Retail/Residential Mixed Use Low-Rise Building	11
Residential Multi-Family/Town Homes	13
Residential Low Rise	14
Residential High-rise	15

<b>Title 24</b>	
<b>T24 Mandatory</b>	<b>T24 Prescriptive</b>
CEC AER	Not Applicable
MMEF = 1.26	

<b>Modeling Scenarios</b>			
<b>Proposed Baseline</b>	<b>Alternative 1</b>	<b>Alternative 2</b>	<b>Alternative 3</b>
160 wash cycles/yr	←	←	Not Applicable
MMEF = 1.26	MMEF = 2.00	MMEF = 2.20	

<b>Alternative Incremental Costs (Alt X – Baseline)</b>		
<b>Alternative 1</b>	<b>Alternative 2</b>	<b>Alternative 3</b>
\$131/appliance	\$225/appliance	Not Applicable

## Refrigerator – Prototypes 10, 11, and 13-5

<b>Applicable to the following prototypes:</b>	<b>Prototype #</b>
Retail/Residential Mixed Use High-rise Building	10
Retail/Residential Mixed Use Low-Rise Building	11
Residential Multi-Family/Town Homes	13
Residential Low Rise	14
Residential High-rise	15

<b>Title 24</b>	
<b>T24 Mandatory</b>	<b>T24 Prescriptive</b>
CEC AER	Not Applicable
$7.55AV + 258.3$	
$AV = 1.44 \times \text{freezer} + \text{refrig vol}$	

<b>Modeling Scenarios</b>			
<b>Proposed Baseline</b>	<b>Alternative 1</b>	<b>Alternative 2</b>	<b>Alternative 3</b>
26 cu-ft upright 9 cu-ft freezer 17 cu-ft refrigerator	Not Applicable	Not Applicable	Not Applicable
485 kWh/yr			

<b>Alternative Incremental Costs (Alt X – Baseline)</b>		
<b>Alternative 1</b>	<b>Alternative 2</b>	<b>Alternative 3</b>
Not Applicable	Not Applicable	Not Applicable

# Lighting

## Lighting – Prototypes 11, 13, and 14

Applicable to the following prototypes:	Prototype #
Retail/Residential Mixed Use Low-Rise (Residential only)	11
Residential Multi-Family/Town Homes	13
Residential Low Rise	14

Title 24	
T24 Mandatory	T24 Prescriptive
$\leq 15$ watts – 40 LPW 15-40 watts 50 LPW >40 watts 60 LPW (With exceptions)	Not Applicable

Modeling Scenarios			
Proposed Baseline	Alternative 1	Alternative 2	Alternative 3
Mix of 60 LPW screw-in CFL and dimmable incandescent	Replace CFLs w/ 69 LPW recessed fixture with 4-pin triple tube	Not Applicable	Not Applicable
0.702 watts/sqft	0.648 watts/sqft		

Alternative Incremental Costs (Alt X – Baseline)		
Alternative 1	Alternative 2	Alternative 3
\$90/fixture	Not Applicable	Not Applicable

## Lighting – Prototypes 10 and 15

<b>Applicable to the following prototypes:</b>	<b>Prototype #</b>
Retail/Residential Mixed Use High-rise (Residential only)	10
Residential High-rise	15

<b>Title 24</b>	
<b>T24 Mandatory</b>	<b>T24 Prescriptive</b>
Not Applicable	1.0 watts/sqft Residential

<b>Modeling Scenarios</b>			
<b>Proposed Baseline</b>	<b>Alternative 1</b>	<b>Alternative 2</b>	<b>Alternative 3</b>
Mix of 60 LPW screw-in CFL and dimmable incandescent	Replace CFLs w/ 69 LPW recessed fixture with 4-pin triple tube	Not Applicable	Not Applicable
0.626 watts/sqft	0.586 watts/sqft		

<b>Alternative Incremental Costs (Alt X – Baseline)</b>		
<b>Alternative 1</b>	<b>Alternative 2</b>	<b>Alternative 3</b>
\$90/fixture	Not Applicable	Not Applicable

# Lighting – Prototype 1

<b>Applicable to the following prototype:</b>	<b>Prototype #</b>
Freestanding Full-Service Restaurant Building	1

<b>Title 24</b>	
<b>T24 Mandatory</b>	<b>T24 Prescriptive</b>
None	1.1 watts/sqft

<b>Modeling Scenarios</b>			
<b>Proposed Baseline</b>	<b>Alternative 1</b>	<b>Alternative 2</b>	<b>Alternative 3</b>
Fluorescent	Not Applicable	Not Applicable	Not Applicable
1.1 w/sf			

<b>Alternative Incremental Costs (Alt X – Baseline)</b>		
<b>Alternative 1</b>	<b>Alternative 2</b>	<b>Alternative 3</b>
Not Applicable	Not Applicable	Not Applicable

## Lighting – Prototypes 7 and 8

Applicable to the following prototypes:	Prototype #
Hotel – Large	7
Hotel – Small	8

Title 24	
T24 Mandatory	T24 Prescriptive
None	1.4 watts/sqft

Modeling Scenarios			
Proposed Baseline	Alternative 1	Alternative 2	Alternative 3
Mix of 60 LPW screw-in CFL and dimmable incandescent	Replace CFLs w/ 69 LPW recessed fixture with 4-pin triple tube		Not Applicable
1.4 w/sf	1.19 w/sf		

Alternative Incremental Costs (Alt X – Baseline)		
Alternative 1	Alternative 2	Alternative 3
\$90.00/fixture	Not Applicable	Not Applicable

## Lighting – Prototypes 2, 3, and 9-11

Applicable to the following prototypes:	Prototype #
Multi-tenant Retail Shop Building	2
Major Retailer	3
Retail/Commercial Mixed Use Building (Retail Only)	9
Retail/Residential Mixed Use High-rise (Retail only)	10
Retail/Residential Mixed Use Low-Rise (Retail only)	11

Title 24	
T24 Mandatory	T24 Prescriptive
None	1.5 watts/sf

Modeling Scenarios			
Proposed Baseline	Alternative 1	Alternative 2	Alternative 3
Typical T8 fluorescent	Not Applicable	Not Applicable	Not Applicable
1.50 watts/sf			

Alternative Incremental Costs (Alt X – Baseline)		
Alternative 1	Alternative 2	Alternative 3
Not Applicable	Not Applicable	Not Applicable

## Lighting – Prototype 12

<b>Applicable to the following prototype:</b>	<b>Prototype #</b>
Civic/Commercial Mixed Use	12

Title 24	
T24 Mandatory	T24 Prescriptive
None	1.3 watts/sf

Modeling Scenarios			
Proposed Baseline	Alternative 1	Alternative 2	Alternative 3
Typical T8 fluorescent	Ambient lighting via T8 ceiling-mounted, plus under-cabinet T8 task lighting (Note 1)	Not Applicable	Not Applicable
1.3 watts/sf	1.02 watts/sqft		

Alternative Incremental Costs (Alt X – Baseline)		
Alternative 1	Alternative 2	Alternative 3
\$90.0/sqft	Not Applicable	Not Applicable

## Lighting – Prototypes 4-6, 9, and 12

Applicable to the following prototypes:	Prototype #
Office Building – Low-rise	4
Office Building – Mid-rise	5
Office Building – High-rise	6
Retail/Commercial Mixed Use Building (Commercial only)	9
Civic/Commercial Mixed Use (Commercial only)	12

Title 24	
T24 Mandatory	T24 Prescriptive
None	1.1 watts/sqft

Modeling Scenarios			
Proposed Baseline	Alternative 1	Alternative 2	Alternative 3
Typical T8 fluorescent	Ambient lighting via T8 ceiling-mounted, plus under-cabinet T8 task lighting (Note 1)	Not Applicable	Not Applicable
1.10 watts/sqft	Offices: 0.90 watts/sqft		

Alternative Incremental Costs (Alt X – Baseline)		
Alternative 1	Alternative 2	Alternative 3
\$0.0/sqft	Not Applicable	Not Applicable

**Note 1:** Reference the New Building Institute Inc. Advanced Lighting Guidelines for strategies to minimize total connected lighting power load.

# Lighting – Parking Garage

Title 24	
T24 Mandatory	T24 Prescriptive
NA	0.4 watts/sqft

Modeling Scenarios			
Proposed Baseline	Alternative 1	Alternative 2	Alternative 3
76 LPW T12 fluorescent pendant mounted troffer	85 LPW T5 SHO fluorescent pendant mounted troffer	NA	NA
0.4 watts/sqft	0.36 watts/sqft		

Alternative Incremental Costs (Alt X – Baseline)		
Alternative 1	Alternative 2	Alternative 3
\$0.069/sqft	NA	NA

# Lighting – Low-rise Residential Floor Plans 1 and 1x



Plan1	Lum/sf	SF	%	Lumens	Wattage	Proposed Baseline					Alternative 1	
						Lum/watt	Watts	Equiv Inc	Watts/SF	Weighted	Lum/watt	Weighted
Bath	35	174	14.1%	6090	>40	35	174	649	1.00	0.141	40	0.125
Entryway	6	90	7.3%	541	>40	60	9	34	0.10	0.007	69	0.006
Hallway/closet	13.25	239	19.5%	3170	>40	35	91	338	0.38	0.074	40	0.065
Bedroom	10.5	290	23.5%	3040	>40	60	51	189	0.18	0.041	69	0.036
Kitchen	35	79	6.4%	2765	>40	35	79	295	1.00	0.064	40	0.057
Kitchen Counters	41.25	47	3.8%	1918	>40	10	192	716	4.13	0.156	10	0.156
Living Room	10.5	209	17.0%	2197	>40	60	37	137	0.18	0.030	69	0.026
Dining Room	13	102	8.3%	1328	>40	10	133	495	1.30	0.108	10	0.108
Garage	17.5	554	45.0%	9693	>40	60	162	603	0.29	0.131	69	0.114
		1230								0.753		0.694

Townhouse floor plan 1, Baseline and Alternative weighted lighting load watts/sqft

Plan1x	Lum/sf	SF	%	Lumens	Wattage	Proposed Baseline					Alternative 1	
						Lum/watt	Watts	Equiv Inc	Watts/SF	Weighted	Lum/watt	Weighted
Bath	35	182	14.1%	6383	>40	35	182	681	1.00	0.141	40	0.125
Entryway	6	118	9.1%	707	>40	60	12	44	0.10	0.009	69	0.008
Hallway/closet	13.25	233	18.0%	3091	>40	35	88	329	0.38	0.068	40	0.061
Bedroom	10.5	300	23.2%	3154	>40	60	53	196	0.18	0.041	69	0.035
Kitchen	35	79	6.1%	2752	>40	35	79	293	1.00	0.061	40	0.054
Kitchen Counters	41.25	47	3.6%	1918	>40	10	192	716	4.13	0.148	10	0.148
Living Room	10.5	203	15.7%	2128	>40	60	35	132	0.18	0.027	69	0.024
Dining Room	13	131	10.1%	1698	>40	10	170	634	1.30	0.131	10	0.131
Garage	17.5	452	35.0%	7908	>40	60	132	492	0.29	0.102	69	0.089
		1292								0.729		0.675

Townhouse floor plan 1X, Baseline and Alternative weighted lighting load watts/sqft

# Lighting – Low-rise Residential Floor Plans 2 and 4



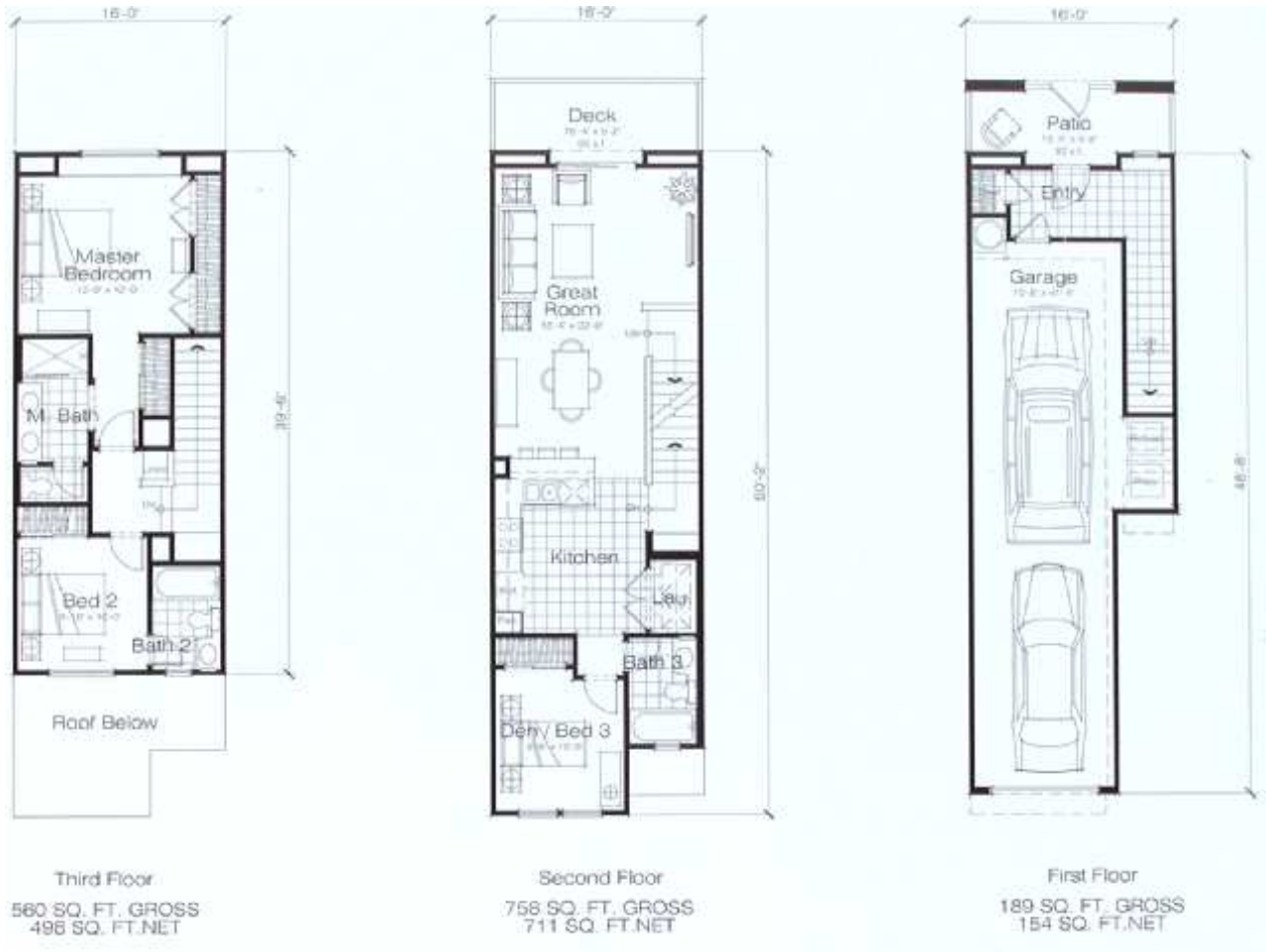
Plan2	Lum/sf	SF	%	Lumens	Wattage	Proposed Baseline					Alternative 1	
						Lum/watt	Watts	Equiv Inc	Watts/SF	Weighted	Lum/watt	Weighted
Bath	35	138	10.4%	4843	>40	35	138	516	1.00	0.104	40	0.092
Entryway	6	53	3.9%	315	>40	60	5	20	0.10	0.004	69	0.003
Hallway/closet	13.25	306	22.9%	4055	>40	35	116	432	0.38	0.087	40	0.077
Bedroom	10.5	277	20.7%	2906	>40	60	48	181	0.18	0.036	69	0.032
Kitchen	35	61	4.6%	2131	>40	35	61	227	1.00	0.046	40	0.040
Kitchen Counters	41.25	58	4.3%	2387	>40	10	239	891	4.13	0.179	10	0.179
Living Room	10.5	287	21.5%	3009	>40	60	50	187	0.18	0.038	69	0.033
Dining Room	13	155	11.6%	2015	>40	10	201	752	1.30	0.151	10	0.151
Garage	17.5	463	34.7%	8103	>40	60	135	504	0.29	0.101	69	0.088
		1334								0.745		0.695

Townhouse floor plan 2, Baseline and Alternative weighted lighting load watts/sqft

Plan4	Lum/sf	SF	%	Lumens	Wattage	Proposed Baseline					Alternative 1	
						Lum/watt	Watts	Equiv Inc	Watts/SF	Weighted	Lum/watt	Weighted
Bath	35	260	17.1%	9109	>40	35	260	971	1.00	0.171	40	0.151
Entryway	6	90	5.9%	540	>40	60	9	34	0.10	0.006	69	0.005
Hallway/closet	13.25	243	15.9%	3220	>40	35	92	343	0.38	0.060	40	0.053
Bedroom	10.5	465	30.5%	4878	>40	60	81	303	0.18	0.053	69	0.046
Kitchen	35	82	5.4%	2859	>40	35	82	305	1.00	0.054	40	0.047
Kitchen Counters	41.25	47	3.0%	1918	>40	10	192	716	4.13	0.126	10	0.126
Living Room	10.5	202	13.2%	2116	>40	60	35	132	0.18	0.023	69	0.020
Dining Room	13	138	9.0%	1788	>40	10	179	667	1.30	0.117	10	0.117
Garage	17.5	460	30.1%	8041	>40	60	134	500	0.29	0.088	69	0.076
		1525								0.698		0.643

Townhouse floor plan 4, Baseline and Alternative weighted lighting load watts/sqft

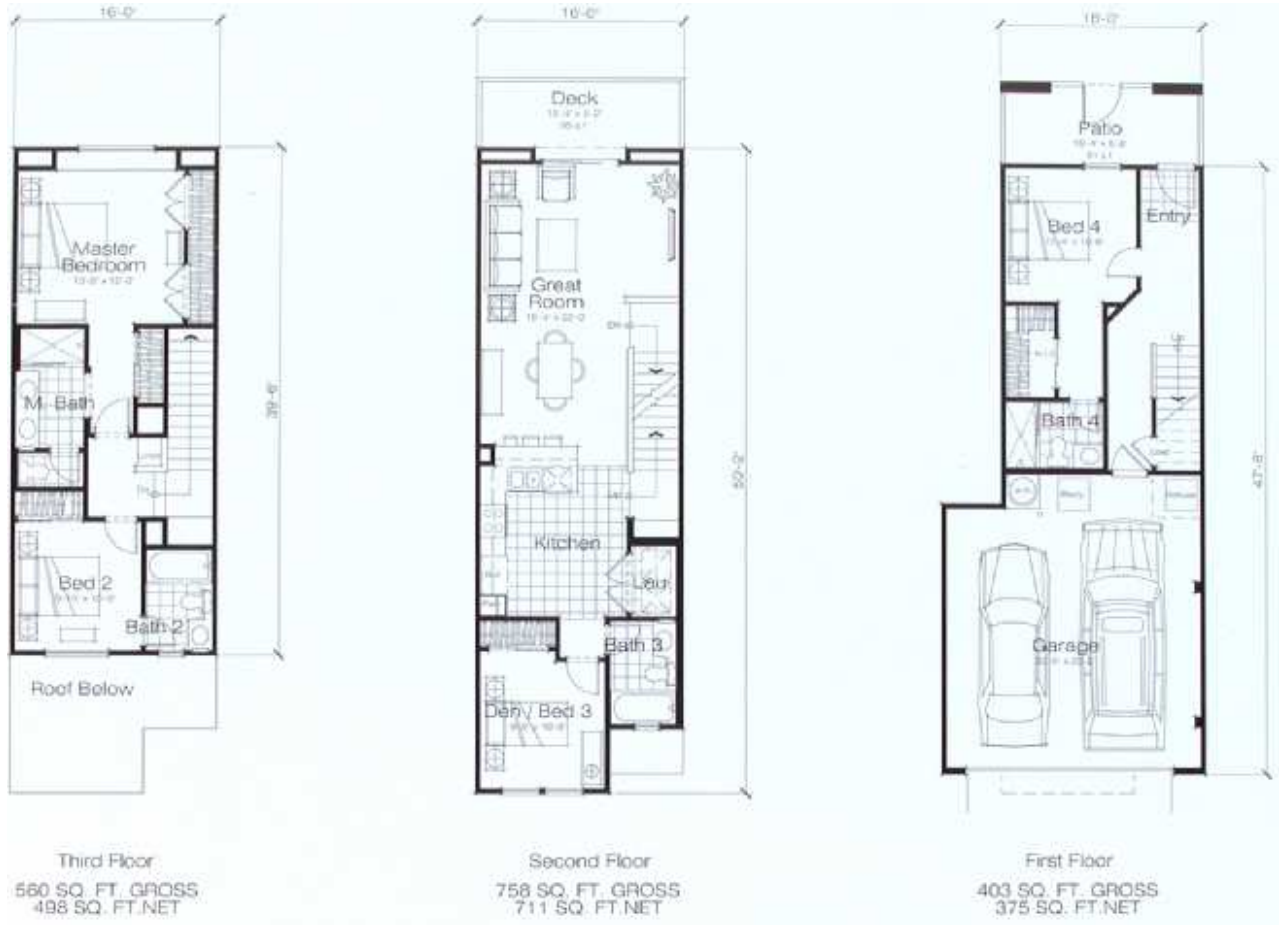
# Lighting – Low-rise Residential Floor Plan 3



Plan3	Lum/sf	SF	%	Lumens	Wattage	Proposed Baseline					Alternative 1	
						Lum/watt	Watts	Equiv Inc	Watts/SF	Weighted	Lum/watt	Weighted
Bath	35	141	10.4%	4944	>40	35	141	527	1.00	0.104	40	0.092
Entryway	6	112	8.2%	670	>40	60	11	42	0.10	0.008	69	0.007
Hallway/closet	13.25	302	22.2%	4002	>40	35	114	427	0.38	0.084	40	0.074
Bedroom	10.5	371	27.2%	3898	>40	60	65	242	0.18	0.048	69	0.041
Kitchen	35	98	7.2%	3421	>40	35	98	365	1.00	0.072	40	0.064
Kitchen Counters	41.25	35	2.5%	1423	>40	10	142	531	4.13	0.104	10	0.104
Living Room	10.5	155	11.4%	1628	>40	60	27	101	0.18	0.020	69	0.017
Dining Room	13	150	11.0%	1944	>40	10	194	725	1.30	0.143	10	0.143
Garage	17.5	487	35.8%	8530	>40	60	142	530	0.29	0.104	69	0.091
		1363								0.686		0.633

Townhouse floor plan 3, Baseline and Alternative weighted lighting load watts/sqft

# Lighting – Low-rise Residential Floor Plan 5



Plan5	Lum/sf	SF	%	Lumens	Wattage	Proposed Baseline					Alternative 1	
						Lum/watt	Watts	Equiv Inc	Watts/SF	Weighted	Lum/watt	Weighted
Bath	35	180	11.4%	6300	>40	35	180	672	1.00	0.114	40	0.101
Entryway	6	47	3.0%	284	>40	60	5	18	0.10	0.003	69	0.003
Hallway/closet	13.25	405	25.5%	5366	>40	35	153	572	0.38	0.097	40	0.086
Bedroom	10.5	506	31.9%	5312	>40	60	89	330	0.18	0.056	69	0.049
Kitchen	35	108	6.8%	3789	>40	35	108	404	1.00	0.068	40	0.060
Kitchen Counters	41.25	35	2.2%	1423	>40	10	142	531	4.13	0.090	10	0.090
Living Room	10.5	155	9.8%	1628	>40	60	27	101	0.18	0.017	69	0.015
Dining Room	13	150	9.4%	1944	>40	10	194	725	1.30	0.123	10	0.123
Garage	17.5	441	27.8%	7711	>40	60	129	480	0.29	0.081	69	0.070
		1585								0.648		0.596

Townhouse floor plan 5, Baseline and Alternative weighted lighting load watts/sqft

# Lighting – High-rise Residential Floor Plans 1 and 3



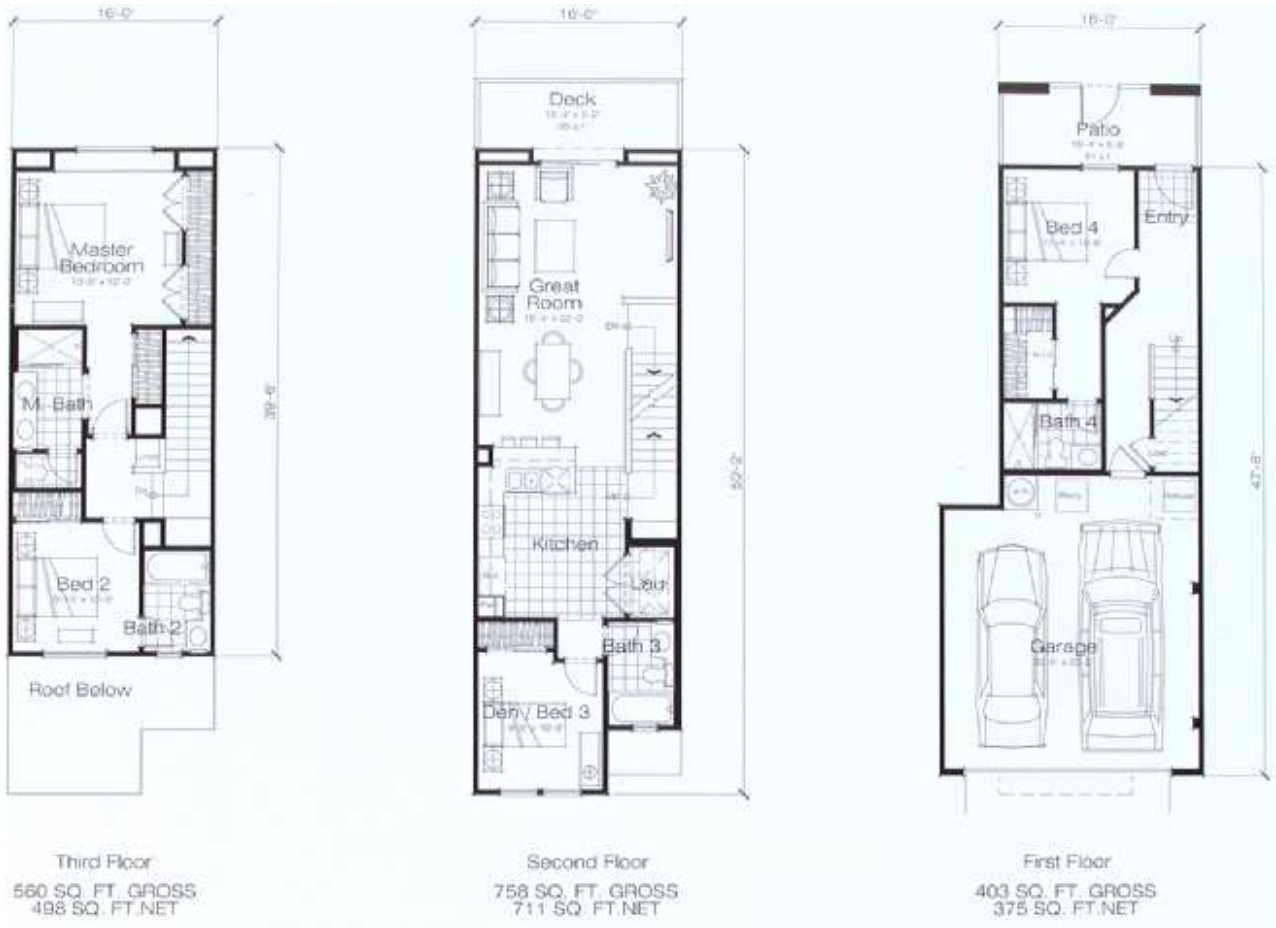
Plan1	Lum/sf	SF	%	Lumens	Wattage	Proposed Baseline					Alternative 1	
						Lum/watt	Watts	Equiv Inc	Watts/SF	Weighted	Lum/watt	Weighted
Bath	35	132	13.6%	4620	>40	35	132	493	1.00	0.136	40	0.120
Entryway	6	36	3.7%	216	>40	60	4	13	0.10	0.004	69	0.003
Hallway/closet	13.25	163	16.8%	2156	>40	35	62	230	0.38	0.063	40	0.056
Bedroom	10.5	300	30.8%	3145	>40	60	52	196	0.18	0.054	69	0.047
Kitchen	35	50	5.1%	1750	>40	35	50	187	1.00	0.051	40	0.046
Kitchen Counters	41.25	45	4.6%	1856	>40	10	186	693	4.13	0.191	10	0.191
Living Room	10.5	156	16.1%	1638	>40	60	27	102	0.18	0.028	69	0.024
Dining Room	13	90	9.3%	1170	>40	10	117	437	1.30	0.120	10	0.120
		971								0.648		0.608

High-rise floor plan 1, Baseline and Alternative weighted lighting load watts/sqft

Plan3	Lum/sf	SF	%	Lumens	Wattage	Proposed Baseline					Alternative 1	
						Lum/watt	Watts	Equiv Inc	Watts/SF	Weighted	Lum/watt	Weighted
Bath	35	148	13.1%	5189	>40	35	148	553	1.00	0.131	40	0.116
Entryway	6	49	4.3%	293	>40	60	5	18	0.10	0.004	69	0.004
Hallway/closet	13.25	193	17.1%	2554	>40	35	73	272	0.38	0.065	40	0.057
Bedroom	10.5	312	27.6%	3276	>40	60	55	204	0.18	0.048	69	0.042
Kitchen	35	67	5.9%	2336	>40	35	67	249	1.00	0.059	40	0.052
Kitchen Counters	41.25	47	4.2%	1939	>40	10	194	723	4.13	0.172	10	0.172
Living Room	10.5	181	16.1%	1903	>40	60	32	118	0.18	0.028	69	0.024
Dining Room	13	132	11.7%	1713	>40	10	171	639	1.30	0.152	10	0.152
		1129								0.659		0.620

High-rise floor plan 3, Baseline and Alternative weighted lighting load watts/sqft

## Lighting – High-rise Residential Floor Plan 2



Plan2	Lum/sf	SF	%	Lumens	Wattage	Proposed Baseline					Alternative 1	
						Lum/watt	Watts	Equip Inc	Watts/SF	Weighted	Lum/watt	Weighted
Bath	35	37	6.4%	1308	>40	35	37	139	1.00	0.064	40	0.057
Entryway	6	30	5.1%	178	>40	60	3	11	0.10	0.005	69	0.004
Hallway/closet	13.25	62	10.6%	818	>40	35	23	87	0.38	0.040	40	0.036
Bedroom	10.5	0	0.0%	0	>40	60	0	0	0.18	0.000	69	0.000
Kitchen	35	92	15.9%	3220	>40	35	92	343	1.00	0.159	40	0.140
Kitchen Counters	41.25	46	7.8%	1877	>40	10	188	700	4.13	0.323	10	0.323
Living Room	10.5	193	33.2%	2022	>40	60	34	126	0.18	0.058	69	0.050
Dining Room	13	122	20.9%	1580	>40	10	158	589	1.30	0.272	10	0.272
		580								0.922		0.884

High-rise floor plan 2, Baseline and Alternative weighted lighting load watts/sqft

# Lighting – High-rise Residential Floor Plans 4 and 5



Plan4	Lum/sf	SF	%	Lumens	Wattage	Proposed Baseline					Alternative 1	
						Lum/watt	Watts	Equip Inc	Watts/SF	Weighted	Lum/watt	Weighted
Bath	35	160	13.1%	5591	>40	35	160	596	1.00	0.131	40	0.116
Entryway	6	36	2.9%	214	>40	60	4	13	0.10	0.003	69	0.003
Hallway/closet	13.25	188	15.4%	2490	>40	35	71	265	0.38	0.058	40	0.052
Bedroom	10.5	443	36.3%	4652	>40	60	78	289	0.18	0.063	69	0.055
Kitchen	35	50	4.1%	1750	>40	35	50	187	1.00	0.041	40	0.036
Kitchen Counters	41.25	50	4.1%	2063	>40	10	206	770	4.13	0.169	10	0.169
Living Room	10.5	182	14.9%	1914	>40	60	32	119	0.18	0.026	69	0.023
Dining Room	13	113	9.2%	1463	>40	10	146	546	1.30	0.120	10	0.120
		1221								0.611		0.573

High-rise floor plan 4, Baseline and Alternative weighted lighting load watts/sqft

Plan5	Lum/sf	SF	%	Lumens	Wattage	Proposed Baseline					Alternative 1	
						Lum/watt	Watts	Equip Inc	Watts/SF	Weighted	Lum/watt	Weighted
Bath	35	181	15.0%	6326	>40	35	181	674	1.00	0.150	40	0.133
Entryway	6	45	3.7%	270	>40	60	5	17	0.10	0.004	69	0.003
Hallway/closet	13.25	218	18.1%	2883	>40	35	82	307	0.38	0.068	40	0.061
Bedroom	10.5	323	26.8%	3395	>40	60	57	211	0.18	0.047	69	0.041
Kitchen	35	70	5.8%	2450	>40	35	70	261	1.00	0.058	40	0.051
Kitchen Counters	41.25	47	3.9%	1939	>40	10	194	723	4.13	0.161	10	0.161
Living Room	10.5	186	15.4%	1948	>40	60	32	121	0.18	0.027	69	0.023
Dining Room	13	136	11.3%	1768	>40	10	177	660	1.30	0.147	10	0.147
		1205								0.662		0.620

High-rise floor plan 5, Baseline and Alternative weighted lighting load watts/sqft

# Lighting – High-rise Residential Floor Plan 6



Plan6	Lum/sf	SF	%	Lumens	Wattage	Proposed Baseline					Alternative 1	
						Lum/watt	Watts	Equiv Inc	Watts/SF	Weighted	Lum/watt	Weighted
Bath	35	170	13.7%	5959	>40	35	170	635	1.00	0.137	40	0.122
Entryway	6	19	1.5%	115	>40	60	2	7	0.10	0.002	69	0.001
Hallway/closet	13.25	192	15.5%	2542	>40	35	73	271	0.38	0.059	40	0.052
Bedroom	10.5	377	30.4%	3959	>40	60	66	246	0.18	0.053	69	0.046
Kitchen	35	148	11.9%	5180	>40	35	148	552	1.00	0.119	40	0.106
Kitchen Counters	41.25	41	3.3%	1671	>40	10	167	623	4.13	0.135	10	0.135
Living Room	10.5	176	14.2%	1843	>40	60	31	115	0.18	0.025	69	0.022
Dining Room	13	117	9.4%	1521	>40	10	152	568	1.30	0.123	10	0.123
		1239								0.653		0.606

High-rise floor plan 6, Baseline and Alternative weighted lighting load watts/sqft

# Lighting – High-rise Residential Floor Plan 7



Plan7	Lum/sf	SF	%	Lumens	Wattage	Proposed Baseline					Alternative 1	
						Lum/watt	Watts	Equiv Inc	Watts/SF	Weighted	Lum/watt	Weighted
Bath	35	236	15.2%	8260	>40	35	236	881	1.00	0.152	40	0.135
Entryway	6	48	3.1%	288	>40	60	5	18	0.10	0.003	69	0.003
Hallway/closet	13.25	329	21.2%	4353	>40	35	124	464	0.38	0.080	40	0.071
Bedroom	10.5	510	32.9%	5351	>40	60	89	333	0.18	0.058	69	0.050
Kitchen	35	85	5.5%	2966	>40	35	85	316	1.00	0.055	40	0.049
Kitchen Counters	41.25	45	2.9%	1867	>40	10	187	696	4.13	0.121	10	0.121
Living Room	10.5	176	11.3%	1843	>40	60	31	115	0.18	0.020	69	0.017
Dining Room	13	120	7.8%	1563	>40	10	156	583	1.30	0.101	10	0.101
		1548								0.590		0.546

High-rise floor plan 7, Baseline and Alternative weighted lighting load watts/sqft

## Lighting – High-rise Residential Floor Plan 8



Plan8	Lum/sf	SF	%	Lumens	Wattage	Proposed Baseline					Alternative 1	
						Lum/watt	Watts	Equip Inc	Watts/SF	Weighted	Lum/watt	Weighted
Bath	35	221	13.7%	7739	>40	35	221	825	1.00	0.137	40	0.121
Entryway	6	32	2.0%	189	>40	60	3	12	0.10	0.002	69	0.002
Hallway/closet	13.25	497	30.8%	6586	>40	35	188	702	0.38	0.117	40	0.103
Bedroom	10.5	437	27.1%	4587	>40	60	76	285	0.18	0.047	69	0.041
Kitchen	35	45	2.8%	1584	>40	35	45	169	1.00	0.028	40	0.025
Kitchen Counters	41.25	42	2.6%	1743	>40	10	174	650	4.13	0.108	10	0.108
Living Room	10.5	173	10.7%	1820	>40	60	30	113	0.18	0.019	69	0.016
Dining Room	13	167	10.3%	2166	>40	10	217	808	1.30	0.134	10	0.134
		1614								0.592		0.551

High-rise floor plan 8, Baseline and Alternative weighted lighting load watts/sqft

# On-site Power Generation

## Photovoltaics

Parameter	Proposed Alternative
Power Output	12.86 watts/sf
Azimuth	South
Tilt	28 deg
Power Deg Coefficient	0.278 %/deg F
Rating Point Temp	77 deg F
Nominal Operating Temp	113 deg F
Inverter Efficiency	77%

Photovoltaics, alternative modeling scenarios

Panels	Sqft	kW	\$/kW***
8	112	1.44	\$11,748
10	140	1.80	\$10,390
16	224	2.88	\$8,464
20	280	3.60	\$7,930
30	420	5.40	\$7,427
40	560	7.20	\$6,911
50	700	9.00	\$6,831
60	840	10.88	\$6,577
70	980	12.60	\$6,416

Each modular solar panel is roughly 32.5" x 62"

\*\*\*Photovoltaic Installed costs as shown include metering and switchgear. The cost does not include a \$2.55/watt PV Subsidy, which was applied to all systems. Additionally, PV is net-metered allowing generation of utility credits. Annual O&M cost = 0.12% of installed cost (before rebate)

Orientation/Tilt Energy Correction Factor						
Facing	0	15	30	45	60	90
South	0.89	0.97	1.00	0.97	0.88	0.56
SSE, SSW	0.89	0.97	0.99	0.96	0.87	0.57
SE, SW	0.89	0.95	0.96	0.93	0.85	0.59
ESE, WSW	0.89	0.92	0.91	0.87	0.79	0.57
E,W	0.89	0.88	0.84	0.78	0.70	0.51

Photovoltaics correction factors for orientation

## Internal Combustion Engines in CHP Configuration

Installed cost \$/kW for IC engine based CHP system is defined by:

- $Y = (6067.1X^{-0.2885}) * 1.3$ , where  $X = \text{kW}$
- O&M cost for CHP system is \$0.01155/kWh
- CHP system maximum efficiencies are:
  - < 900 kW: Electric = 34%, Total = 76%
  - > 900 kW: Electric = 35%, Total = 77%
  - < 900 kW: Jacket water temp = 215 F, Exhaust temp = 900 F
  - > 900 kW: Jacket water temp = 235 F, Exhaust temp = 850 F
- CHP systems recover heat to domestic hot water, space heating, and in some cases, absorption cooling.
- CHP systems are configured to track electric load.
- CHP systems are configured to run during mid- and/or on-peak utility periods

## Microturbines in CHP Configuration

Installed cost \$/kW for microturbine based CHP system is defined by:

- $Y = 2366.8X^{-0.136}$ , where  $X = \text{kW}$
- O&M cost for CHP system is \$0.0105/kWh
- CHP system maximum efficiencies are:
  - Electric = 28%, Total = 78%
- CHP systems recover heat to domestic hot water, space heating, and in some cases, absorption cooling.
- CHP systems are configured to track electric load.
- CHP systems are configured to run during mid- and/or on-peak utility periods

## CHP Systems Equipment

Installed cost \$/RT for single effect absorption chillers is defined by:

- < 300 RT: \$520/RT
- 300 to 500 RT: \$430/RT
- 500 to 1000 RT: \$365/RT

- Installed cost \$/RT for double effect absorption chillers is defined by:  
\$625/RT
- Installed cost \$/RT for electric chillers is defined by:  
< 500 RT: \$340/RT  
500 to 1000 RT: \$350/RT
- O&M cost for absorption chillers is defined by:  
 $Y = 644.61X^{-0.8454}$ , where  $X = RT$

## Thermal Storage

- Ice-on-coil system @ \$70/ton-hr applied to buildings with chillers only
- Charge during mid- and on-peak periods
- Serves 50% to 75% of the cooling capacity (optimized on a case-by-case basis)
- Starting efficiency equals baseline chiller efficiency. Ending efficiency equals approx. 40% lower.

## Solar Thermal

Passive, glazed flat-plate collector system @ \$7,055 per unit applied to single-family town homes only (Prototype #13). System per dwelling includes two standard 3’x7’ black chrome collector panels, 100 gallon hot water storage tank/heater, and all required piping, valves and fittings. Panel square footage is based on 20 sqft per first two family members plus 8 sqft for every additional person. Rough tank sizing is approximately 1.5 to 2.0 gallons per sqft of collector.

Parameter	Proposed Alternative
Collector Efficiency Curve Intercept %	0.7%
Collector Efficiency Curve Slope	0.7 Btu/hr-sqft-F
Solar Collector Loss Factor	12%
Hourly Storage Loss Factor	2%
Plane Surface Tilt Angle	18 deg
Plane Surface Azimuth Angle	180 deg

# Utility Rates

## Residential Utility Rates - Electric

### SDG&E Residential Electric Rate Schedule DR

Season Schedule												
Months	1	2	3	4	5	6	7	8	9	10	11	12
Summer												
Winter												

Price Component	Cutoff (kWh)	Price	Units
Summer Energy "First"	11.80	0.13040	\$/kwh
Summer Energy "Up to"	15.34	0.15057	\$/kwh
Summer Energy "Up to"	23.60	0.22730	\$/kwh
Summer Energy "Up to"	35.40	0.23637	\$/kwh
Summer Energy "Over"	35.40	0.25220	\$/kwh
Winter Energy "First"	11.80	0.13040	\$/kwh
Winter Energy "Up to"	15.34	0.15057	\$/kwh
Winter Energy "Up to"	23.60	0.21187	\$/kwh
Winter Energy "Up to"	35.40	0.22069	\$/kwh
Winter Energy "Over"	35.40	0.23877	\$/kwh

## Residential and Commercial Utility Rates – Natural Gas

### SDG&E Residential Gas Rate Schedule GR

Season Schedule												
Months	1	2	3	4	5	6	7	8	9	10	11	12
Summer												
Winter												

Schedule GR	Price Component	Cutoff (Therms/day)	Price	Units
GR	Energy "First"	0.493	1.07601	\$/therm
GR	Energy "Over"	0.493	1.31619	\$/therm

Rate varies monthly. Rate above is as of 10/09/07

# Commercial Utility Rates – Electric

## SDG&E Commercial Electric Rate Schedule AL-TOU

Weekday Rate Schedule												
Summer	1	2	3	4	5	6	7	8	9	10	11	12
	On-Peak											
Semi-Peak												
Off-Peak												
Weekday Rate Schedule												
Winter	1	2	3	4	5	6	7	8	9	10	11	12
	On-Peak											
Semi-Peak												
Off-Peak												
Weekend Rate Schedule												
Summer/ Winter	1	2	3	4	5	6	7	8	9	10	11	12
	On-Peak											
Semi-Peak												
Off-Peak												

Price Component	Price	Units
Service Fee	48.52	\$/mo
Non-Coincident Demand	10.8	\$/kW
Summer On-Peak Demand	4.87	\$/kW
Summer On-Peak Energy	0.15349	\$/kWh
Summer Semi-Peak Energy	0.09791	\$/kWh
Summer Off-Peak Energy	0.07441	\$/kWh
Winter On-Peak Demand	3.64	\$/kW
Winter On-Peak Energy	0.1531	\$/kWh
Winter Semi-Peak Energy	0.09791	\$/kWh
Winter Off-Peak Energy	0.07441	\$/kWh

Standby: \$5.55/kW Contract Demand

## Electric Power Generation, CHP, and Residential Heating Emission Factors

	Emission Conversion Factors		
	Mixed Fuels Central Power lb/MWh	Natural Gas Residential Heating lb/MMBtu	Natural Gas CHP lb/MMBtu
CO <sub>2</sub>	700.4	117.6	117.6
SO <sub>2</sub>	0.128	0.00059	0.00059
NO <sub>x</sub>	0.342	0.092	0.015

*Note; End use delivery efficiency of 92% is assumed for electricity and 98.4% for natural gas. CHP emission factors for natural gas engine with NSCR catalyst.*

## Energy Efficiency Measure Useful Life

Measure	Useful Life (yrs)
Wall Insulation	50
Roof Insulation	50
Cool Roof	15
Windows	20
Doors	20
Appliances	14
DHW Heater	14
Lighting	12
Photovoltaics	30
HVAC	18
CHP	20
Thermal Storage	18
Solar Thermal	30

# Residential Site: Building Energy Modeling Assumptions

## External Walls

### External Walls – Prototypes 3-5 (Retail Space)

Applicable to the following Type II commercial prototypes:	Prototype #
Retail/Residential Mixed Use Low-Rise Building (ground floor only)	3
Retail/Residential Mixed Use Low-Rise Building (ground floor only)	4
Retail/Residential Mixed Use Mid-Rise Building (ground floor only)	5

Title 24	
T24 Mandatory	T24 Prescriptive
None	Min Insulation R11

Modeling Scenarios			
Proposed Baseline	Alternative 1	Alternative 2	Alternative 3
5" poured-in-place conc, metal studs 2x4.16 16 Ga. R13 mineral batt, 1" plaster ext, 5/8" GWB int.	5" poured-in-place conc, metal studs 2x6.16 16 Ga. R19 mineral batt, 1" plaster ext, 5/8" GWB int.	5" poured-in-place conc, metal studs 2x6.16 16 Ga. R21 mineral batt, 1" plaster ext, 5/8" GWB int.	5" poured-in-place conc, metal studs 2x6.16 16 Ga. R21 mineral batt, 1" plaster over 1" R5 rigid insul, 5/8" GWB int.
Overall U = 0.142	Overall U = 0.118	Overall U = 0.112	Overall U = 0.070

Alternative Incremental Costs (Alt X – Baseline)		
Alternative 1	Alternative 2	Alternative 3
\$0.13/sqft	\$0.24/sqft	\$1.52/sqft

## External Walls – Prototype 5 (Residential Space)

<b>Applicable to the following Type III residential prototypes:</b>	<b>Prototype #</b>
Retail/Residential Mixed Use Mid-Rise Building (residential only)	5

Title 24	
T24 Mandatory	T24 Prescriptive
None	Min Insulation R13

Modeling Scenarios			
Proposed Baseline	Alternative 1	Alternative 2	Alternative 3
Wood frame, wood studs 2x4.16 w/ R13 mineral batt, 3" brick veneer ext. on lath/plaster, 5/8" GWB int.	Wood frame, wood studs 2x6.16 w/ R19 mineral batt, 3" brick veneer ext. on lath/plaster, 5/8" GWB int.	Wood frame, wood studs 2x6.16 w/ R21 mineral batt, 3" brick veneer ext. on lath/plaster, 5/8" GWB int.	Wood frame, wood studs 2x6.16 w/ R21 mineral batt, 3" brick veneer ext. on lath/plaster over 1" R5 rigid insul, 5/8" GWB int.
Overall U = 0.076	Overall U = 0.062	Overall U = 0.056	Overall U = 0.042

Alternative Incremental Costs (Alt X – Baseline)		
Alternative 1	Alternative 2	Alternative 3
\$0.13/sqft	\$0.24/sqft	\$1.52/sqft

## External Walls – Prototypes 1-4 (Residential Space)

Applicable to the following Type V residential prototypes:	Prototype #
Residential Single-Family Detached Home	1
Residential Multi-Family/Town Home	2
Retail/Residential Mixed Use Low-Rise Building (residential only)	3
Retail/Residential Mixed Use Low-Rise Building (residential only)	4

Title 24	
T24 Mandatory	T24 Prescriptive
None	Min Insulation R13

Modeling Scenarios			
Proposed Baseline	Alternative 1	Alternative 2	Alternative 3
Wood frame, wood studs 2x4.16 w/ R13 mineral batt, 1" plaster ext, 5/8" GWB int.	Wood frame, wood studs 2x6.16 w/ R19 mineral batt, 1" plaster ext, 5/8" GWB int.	Wood frame, wood studs 2x6.16 w/ R21 mineral batt, 1" plaster ext, 5/8" GWB int.	Wood frame, wood studs 2x6.16 w/ R21 mineral batt, 1" plaster ext over 1" R5 rigid insul, 5/8" GWB int.
Overall U = 0.078	Overall U = 0.064	Overall U = 0.058	Overall U = 0.042

Alternative Incremental Costs (Alt X – Baseline)		
Alternative 1	Alternative 2	Alternative 3
\$0.13/sqft	\$0.24/sqft	\$1.52/sqft

# Roofing Material

## Roofing Material – Prototypes 3 to 5

Applicable to the following Type III & V residential prototypes:	Prototype #
Retail/Residential Mixed Use Low-Rise Building	3
Retail/Residential Mixed Use Low-Rise Building	4
Retail/Residential Mixed Use Mid-Rise Building	5

Title 24	
T24 Mandatory	T24 Prescriptive
None	Min Insulation R30
None	Reflectance > 0.40
None	Thermal Emittance > 0.75

Modeling Scenarios			
Proposed Baseline	Alternative 1	Alternative 2	Alternative 3
3-ply BUR over ¾" plywood and wood truss, R19 mineral batt under deck	3-ply BUR over ¾" plywood and wood truss, R30 mineral batt under deck	3-ply BUR over ¾" plywood and wood truss, R38 mineral batt under deck	3-ply BUR w/ white elastomeric roof coating over ¾" plywood and wood truss, R19 mineral batt under deck
Overall U = 0.046	Overall U = 0.030	Overall U = 0.024	Overall U = 0.046
Cool Roof Characteristics for Prototypes 3 and 4			
Reflectance > 0.40	Reflectance > 0.40	Reflectance > 0.40	Reflectance > 0.84
Thermal Emittance > 0.75	Thermal Emittance > 0.75	Thermal Emittance > 0.75	Thermal Emittance > 0.89
Absorptance = 0.70	Absorptance = 0.70	Absorptance = 0.70	Absorptance = 0.25
Cool Roof Characteristics for Prototypes 5			
Reflectance > 0.70	Reflectance > 0.70	Reflectance > 0.70	Reflectance > 0.84
Thermal Emittance > 0.75	Thermal Emittance > 0.75	Thermal Emittance > 0.75	Thermal Emittance > 0.89
Absorptance = 0.40	Absorptance = 0.40	Absorptance = 0.40	Absorptance = 0.25

Alternative Incremental Costs (Alt X – Baseline)		
Alternative 1	Alternative 2	Alternative 3
\$0.18/sqft	\$0.30sqft	\$0.33/sqft

## Roofing Material – Prototype 1 and 2

Applicable to the following Type V residential prototype:	Prototype #
Residential Single-Family Detached Home	1
Residential Multi-Family/Town Home	2

Title 24	
T24 Mandatory	T24 Prescriptive
None	Min Insulation R30
None	Reflectance > 0.40
None	Thermal Emittance > 0.75

Modeling Scenarios			
Proposed Baseline	Alternative 1	Alternative 2	Alternative 3
Pitched 2x4 truss, Conc. shingles over ½” plywood, R30 mineral batt at attic floor	Pitched 2x4 truss, Conc. shingles over ½” plywood, R38 mineral batt at attic floor	Pitched 2x4 truss, Conc. shingles over ½” plywood, R49 mineral batt at attic floor	NA
Overall U = 0.030	Overall U = 0.024	Overall U = 0.018	
Reflectance > 0.40	Reflectance > 0.40	Reflectance > 0.40	
Thermal Emittance > 0.75	Thermal Emittance > 0.75	Thermal Emittance > 0.75	
Absorptance = 0.70	Absorptance = 0.70	Absorptance = 0.70	

Alternative Incremental Costs (Alt X – Baseline)		
Alternative 1	Alternative 2	Alternative 3
\$0.12/sqft	\$0.55/sqft	NA

# Windows

## Windows – Prototypes 1-4 (Residential)

Applicable to the following Residential prototypes:	Prototype #	WWR
Residential Single-Family Detached Home	1	20%
Residential Multi-Family/Town Home	2	13%
Retail/Residential Mixed Use Low-Rise Building (Res)	3	7%
Retail/Residential Mixed Use Low-Rise Building (Res)	4	11%

Title 24	
T24 Mandatory	T24 Prescriptive
None	Max 20% of gross floor area Max 5% West facing area
Max Air leakage = 0.30 cfm/sf	None
None	U = 0.670
None	SHGC = 0.400

Modeling Scenarios			
Proposed Baseline	Alternative 1	Alternative 2	NA
2-pane, LowE	2-pane, LowE	2-pane, LowE	
Max Air leakage = 0.30 cfm/sf	←	←	
U = 0.43	U = 0.26	U = 0.22	
SHGC = 0.39	SHGC = 0.37	SHGC = 0.22	

Alternative Incremental Costs (Alt X – Baseline)		
Alternative 1	Alternative 2	Alternative 3
\$2.45/sqft	\$7.48/sqft	NA

## Windows – Prototype 5 (Residential)

Applicable to the following prototypes:	Prototype #	WWR
Retail/Residential Mixed Use Mid-Rise Building (Res)	5	8%

Title 24			
T24 Mandatory	T24 Prescriptive		
None	Max 40% of gross wall area		
Max Air leakage = 0.30 cfm/sf	NA		
None	U = 0.47		
None	SHGC	Non-North	North
	0-10% WWR	0.47	0.61
	11-21% WWR	0.4	0.61
	21-30% WWR	0.36	0.61
	31-40% WWR	0.31	0.61

Modeling Scenarios			
Proposed Baseline	Alternative 1	Alternative 2	Alternative 3
2-pane, LowE Max 40% of gross fl area	2-pane, LowE Max 40% of gross fl area	2-pane, LowE Max 40% of gross fl area	NA
Max Air leakage = 0.30 cfm/sf	←	←	
U = 0.43	U = 0.26	U = 0.22	
SHGC = 0.39	SHGC = 0.37	SHGC = 0.22	

Alternative Incremental Costs (Alt X – Baseline)		
Alternative 1	Alternative 2	Alternative 3
Residential \$2.45/sqft	Residential \$7.48/sqft	NA

## Windows – Prototypes 3 to 5 (Retail)

Applicable to the following Commercial prototypes:	Prototype #	WWR
Retail/Residential Mixed Use Low-Rise Building (Corner Retail)	3	16%
Retail/Residential Mixed Use Low-Rise Building (Corner Retail)	4	16%
Retail/Residential Mixed Use Low-Rise Building (Internal Retail)	4	10%
Retail/Residential Mixed Use Mid-Rise Building (Corner Retail)	5	16%
Retail/Residential Mixed Use Mid-Rise Building (Internal Retail)	5	8%

Title 24			
T24 Mandatory		T24 Prescriptive	
None		Max 40% of gross wall area	
Max Air leakage = 0.30 cfm/sf		NA	
None		U = 0.77	
None	SHGC	Non-North	North
	0-10% WWR	0.61	0.61
	11-21% WWR	0.61	0.61
	21-30% WWR	0.39	0.61
	31-40% WWR	0.34	0.61

Modeling Scenarios			
Proposed Baseline	Alternative 1	Alternative 2	Alternative 3
2-pane, LowE	2-pane, LowE	2-pane, LowE	NA
Max Air leakage = 0.30 cfm/sf	←	←	
U = 0.43	U = 0.26	U = 0.22	
SHGC = 0.39	SHGC = 0.37	SHGC = 0.22	

Alternative Incremental Costs (Alt X – Baseline)		
Alternative 1	Alternative 2	Alternative 3
\$2.45/sqft	\$7.48/sqft	NA

# Entry Doors

## Entry Doors – Prototypes 1 to 5

<b>Applicable to the following prototypes:</b>	<b>Prototype #</b>
All	

Title 24	
T24 Mandatory	T24 Prescriptive
Max Air leakage = 0.30 cfm/sf	NA

Modeling Scenarios			
Proposed Baseline	Alternative 1	Alternative 2	Alternative 3
Foam-core insulated steel panel	Not Applicable	Not Applicable	Not Applicable
Max air leakage = 0.30 cfm/sf			
U = 0.18			

Alternative Incremental Costs (Alt X – Baseline)		
Alternative 1	Alternative 2	Alternative 3
Not Applicable	Not Applicable	Not Applicable

# Foundation

## Foundation – Prototypes 1 to 4

Applicable to the following prototypes:	Prototype #
Residential Single-Family Detached Home	1
Residential Multi-Family/Town Home	2
Retail/Residential Mixed Use Low-Rise Building	3
Retail/Residential Mixed Use Low-Rise Building	4

Title 24	
T24 Mandatory	T24 Prescriptive
R5 (for heated slabs only)	None

Modeling Scenarios			
Proposed Baseline	Alternative 1	Alternative 2	Alternative 3
Concrete slab on grade	Not Applicable	Not Applicable	Not Applicable
No slab insulation			

Alternative Incremental Costs (Alt X – Baseline)		
Alternative 1	Alternative 2	Alternative 3
Not Applicable	Not Applicable	Not Applicable

## Foundation – Prototype 5

Applicable to the following prototypes:	Prototype #
Retail/Residential Mixed Use Mid-Rise Building	5

Title 24	
T24 Mandatory	T24 Prescriptive
R5 (for heated slabs only)	None

Modeling Scenarios			
Proposed Baseline	Alternative 1	Alternative 2	Alternative 3
Underground Parking	Not Applicable	Not Applicable	Not Applicable
No slab insulation			

Alternative Incremental Costs (Alt X – Baseline)		
Alternative 1	Alternative 2	Alternative 3
Not Applicable	Not Applicable	Not Applicable

# Raised Floors

## Raised Floors – Prototype 5

<b>Applicable to the following prototypes:</b>	<b>Prototype #</b>
All Prototypes (Above garages only)	5

Title 24	
T24 Mandatory	T24 Prescriptive
None	R19

Modeling Scenarios			
Proposed Baseline	Alternative 1	Alternative 2	Alternative 3
Plywood sheathing over TJI floor joists	Not Applicable	Not Applicable	Not Applicable
R19 insulation			

Alternative Incremental Costs (Alt X – Baseline)		
Alternative 1	Alternative 2	Alternative 3
Not Applicable	Not Applicable	Not Applicable

## HVAC – Systems Summary

Prototype	Prototype #	Cooling	Heating
Residential Single-Family Detached Home	1	Split System AC	Forced-air Furnace
Residential Multi-Family/Town Home	2	Split System AC	Forced-air Furnace
Retail/Residential Mixed Use Low-Rise (Res)	3	Split System AC	Forced-air Furnace
Retail/Residential Mixed Use Low-Rise (Retail)	3	Individual Split System Heat Pumps	
Retail/Residential Mixed Use Low-Rise (Res)	4	Split System AC	Forced-air Furnace
Retail/Residential Mixed Use Low-Rise (Retail)	4	Individual Split System Heat Pumps	
Retail/Residential Mixed Use Mid-Rise (Res)	5	Individual Split System Heat Pumps	
Retail/Residential Mixed Use Mid-Rise (Retail)	5	Individual Split System Heat Pumps	

# HVAC - Details

## HVAC – Prototypes 1 to 4 (Residential)

Applicable to the following residential prototypes:	Prototype #	Size Category
Residential Single-Family Detached Home	1	2 to 5 tons
Residential Multi-Family/Town Home	2	
Retail/Residential Mixed Use Low-Rise (Res)	3	
Retail/Residential Mixed Use Low-Rise (Res)	4	

Title 24	
T24 Mandatory	T24 Prescriptive
SEER: 13, EER 11.09	Not Applicable
OAR: 0.03 cfm/sf + 7.5 cfm/person	

Modeling Scenarios			
Proposed Baseline	Alternative 1	Alternative 2	Alternative 3
Individual Split System AC	Individual Split System AC	Individual Split System AC	Individual Split System AC
SEER 13, EER 11.09	SEER 14, EER 11.99	SEER 15, EER 12.72	SEER 18, EER 13.37

Alternative Incremental Costs (Alt X – Baseline)			
Parameter	Alternative 1	Alternative 2	Alternative 3
2 tons	\$138.93/ton	\$277.86/ton	\$694.64/ton
2.5 tons	\$111.14/ton	\$222.28/ton	\$555.71/ton
3 tons	\$92.62/ton	\$185.24/ton	\$463.09/ton
3.5 tons	\$79.39/ton	\$158.77/ton	\$396.94/ton
4 tons	\$69.46/ton	\$138.93/ton	\$347.32/ton
5 tons	\$55.57/ton	\$111.14/ton	\$277.86/ton

## HVAC – Prototypes 3 to 5 (Retail) and 5 (Res)

Applicable to the following prototypes:	Prototype #	Size Category
Retail/Residential Mixed Use Low-Rise (Retail)	3	2 to 5 tons
Retail/Residential Mixed Use Low-Rise (Retail)	4	
Retail/Residential Mixed Use Mid-Rise (Retail)	5	
Retail/Residential Mixed Use Mid-Rise (Res)	5	

Title 24	
T24 Mandatory	T24 Prescriptive
65k-135k Btu/h EER: 10.1 135k-240k Btu/h EER: 9.3 > 240k Btu/h EER: 9.0	Not Applicable
Retail OAR: 0.20 cfm/sf	

Modeling Scenarios			
Proposed Baseline	Alternative 1	Alternative 2	Alternative 3
Individual Split System Heat Pumps	Individual Split System Heat Pumps	Individual Split System Heat Pumps	Individual Split System Heat Pumps
SEER 13, COP 3.28 EER 11.07 8.1 HSPF	SEER 14, COP 3.52 EER 12.19 8.6 HSPF	SEER 16, COP 3.74 EER 12.7 8.8 HSPF	SEER 18, COP 3.32 EER 12.88 9.2 HSPF

Alternative Incremental Costs (Alt X – Baseline)			
Parameter	Alternative 1	Alternative 2	Alternative 3
2 tons	\$128.46/ton	\$256.92/ton	\$642.29/ton
3 tons	\$97.94/ton	\$195.87/ton	\$489.68/ton
4 tons	\$82.67/ton	\$165.35/ton	\$413.37/ton
5 tons	\$73.52/ton	\$147.04/ton	\$367.59/ton

# Furnace Space Heating

## Central Furnace – Prototypes 1 to 4 (Residential)

Applicable to the following prototypes:	Prototype #	Size Category
Residential Single-Family Detached Home	1	> 225,000 Btu/hr
Residential Multi-Family/Town Home	2	
Retail/Residential Mixed Use Low-Rise (Res)	3	
Retail/Residential Mixed Use Low-Rise (Res)	4	

Title 24	
T24 Mandatory	T24 Prescriptive
Thermal Efficiency 80%	Not Applicable

Modeling Scenarios			
Proposed Baseline	Alternative 1	Alternative 2	Alternative 3
Central Gas-fired Forced-air Furnace	←	Not Applicable	Not Applicable
AFUE = 80%	AFUE = 94%		

Alternative Incremental Costs (Alt X – Baseline)			
Parameter	Alternative 1	Alternative 2	Alternative 3
> 225,000 Btu/hr	\$1000/appliance	Not Applicable	Not Applicable

# Appliances

## Domestic Hot Water – Prototypes 1 to 5

Applicable to the following prototypes:	Prototype #
Residential Single-Family Detached Home	1
Residential Multi-Family/Town Home	2
Retail/Residential Mixed Use Low-Rise Building (Residential)	3
Retail/Residential Mixed Use Low-Rise Building (Retail)	3
Retail/Residential Mixed Use Low-Rise Building (Residential)	4
Retail/Residential Mixed Use Low-Rise Building (Retail)	4
Retail/Residential Mixed Use Mid-Rise (Residential)	5
Retail/Residential Mixed Use Mid-Rise (Retail)	5

Title 24	
T24 Mandatory	T24 Prescriptive
Gas heating	Not Applicable
EF = 0.575 (50 gal)	

Modeling Scenarios			
Proposed Baseline	Alternative 1	Alternative 2	Alternative 3
50 gal Gas-fired storage-type water heater	50 gal equivalent Gas-fired tankless water heater	Not Applicable	Not Applicable
EF = 0.594	EF = 0.823		

Alternative Incremental Costs (Alt X – Baseline)		
Alternative 1	Alternative 2	Alternative 3
\$370.64/appliance	Not Applicable	Not Applicable

## Dishwasher – Prototypes 1 to 5 (Residential)

Applicable to the following prototypes:	Prototype #
Residential Single-Family Detached Home	1
Residential Multi-Family/Town Home	2
Retail/Residential Mixed Use Low-Rise Building (Residential)	3
Retail/Residential Mixed Use Low-Rise Building (Residential)	4
Retail/Residential Mixed Use Mid-Rise (Residential)	5

Title 24	
T24 Mandatory	T24 Prescriptive
CEC AER	Not Applicable
EF = 0.46	

Modeling Scenarios			
Proposed Baseline	Alternative 1	Alternative 2	Alternative 3
160 cycles/yr	←	Not Applicable	Not Applicable
EF = 0.46	EF = 0.64		

Alternative Incremental Costs (Alt X – Baseline)		
Alternative 1	Alternative 2	Alternative 3
\$133.64/appliance	Not Applicable	Not Applicable

## Clothes Washer – Prototypes 1 to 5 (Residential)

<b>Applicable to the following prototypes:</b>	<b>Prototype #</b>
Residential Single-Family Detached Home	1
Residential Multi-Family/Town Home	2
Retail/Residential Mixed Use Low-Rise Building (Residential)	3
Retail/Residential Mixed Use Low-Rise Building (Residential)	4
Retail/Residential Mixed Use Mid-Rise (Residential)	5

<b>Title 24</b>	
<b>T24 Mandatory</b>	<b>T24 Prescriptive</b>
CEC AER	Not Applicable
MMEF = 1.26	

<b>Modeling Scenarios</b>			
<b>Proposed Baseline</b>	<b>Alternative 1</b>	<b>Alternative 2</b>	<b>Alternative 3</b>
160 wash cycles/yr	←	←	Not Applicable
MMEF = 1.26	MMEF = 2.00	MMEF = 2.20	

<b>Alternative Incremental Costs (Alt X – Baseline)</b>		
<b>Alternative 1</b>	<b>Alternative 2</b>	<b>Alternative 3</b>
\$131/appliance	\$225/appliance	Not Applicable

## Refrigerator – Prototypes 1 to 5 (Residential)

Applicable to the following prototypes:	Prototype #
Residential Single-Family Detached Home	1
Residential Multi-Family/Town Home	2
Retail/Residential Mixed Use Low-Rise Building (Residential)	3
Retail/Residential Mixed Use Low-Rise Building (Residential)	4
Retail/Residential Mixed Use Mid-Rise (Residential)	5

Title 24	
T24 Mandatory	T24 Prescriptive
CEC AER	Not Applicable
$7.55AV + 258.3$ $AV = 1.44 \times \text{freezer} + \text{refrig vol}$	

Modeling Scenarios			
Proposed Baseline	Alternative 1	Alternative 2	Alternative 3
26 cu-ft upright 9 cu-ft freezer 17 cu-ft refrigerator 485 kWh/yr	Not Applicable	Not Applicable	Not Applicable

Alternative Incremental Costs (Alt X – Baseline)		
Alternative 1	Alternative 2	Alternative 3
Not Applicable	Not Applicable	Not Applicable

# Lighting

## Lighting – Prototypes 1 to 4 (Residential)

Applicable to the following prototypes:	Prototype #
Residential Single-Family Detached Home	1
Residential Multi-Family/Town Home	2
Retail/Residential Mixed Use Low-Rise Building (Residential)	3
Retail/Residential Mixed Use Low-Rise Building (Residential)	4

Title 24	
T24 Mandatory	T24 Prescriptive
≤ 15 watts – 40 LPW 15-40 watts 50 LPW >40 watts 60 LPW (With exceptions)	Not Applicable

Modeling Scenarios			
Proposed Baseline	Alternative 1	Alternative 2	Alternative 3
Mix of 64 LPW screw-in CFL and dimmable incandescent	Replace CFLs w/ 69 LPW recessed fixture with 4-pin triple tube	Not Applicable	Not Applicable
Proto 01: 0.532 w/sf	Proto 01: 0.508 w/sf		
Proto 02: 0.568 w/sf	Proto 02: 0.542 w/sf		
Proto 03: 0.618 w/sf	Proto 03: 0.587 w/sf		
Proto 04: 0.556 w/sf	Proto 04: 0.532 w/sf		

Alternative Incremental Costs (Alt X – Baseline)		
Alternative 1	Alternative 2	Alternative 3
\$90/fixture	Not Applicable	Not Applicable

## Lighting – Prototype 5

<b>Applicable to the following prototypes:</b>	<b>Prototype #</b>
Retail/Residential Mixed Use Mid-Rise (Residential)	5

<b>Title 24</b>	
<b>T24 Mandatory</b>	<b>T24 Prescriptive</b>
Not Applicable	1.0 watts/sqft Residential

<b>Modeling Scenarios</b>			
<b>Proposed Baseline</b>	<b>Alternative 1</b>	<b>Alternative 2</b>	<b>Alternative 3</b>
Mix of 60 LPW screw-in CFL and dimmable incandescent	Replace CFLs w/ 69 LPW recessed fixture with 4-pin triple tube	Not Applicable	Not Applicable
0.600 watts/sqft	0.573 watts/sqft		

<b>Alternative Incremental Costs (Alt X – Baseline)</b>		
<b>Alternative 1</b>	<b>Alternative 2</b>	<b>Alternative 3</b>
\$90/fixture	Not Applicable	Not Applicable

## Lighting – Prototypes 3 to 5 (Retail)

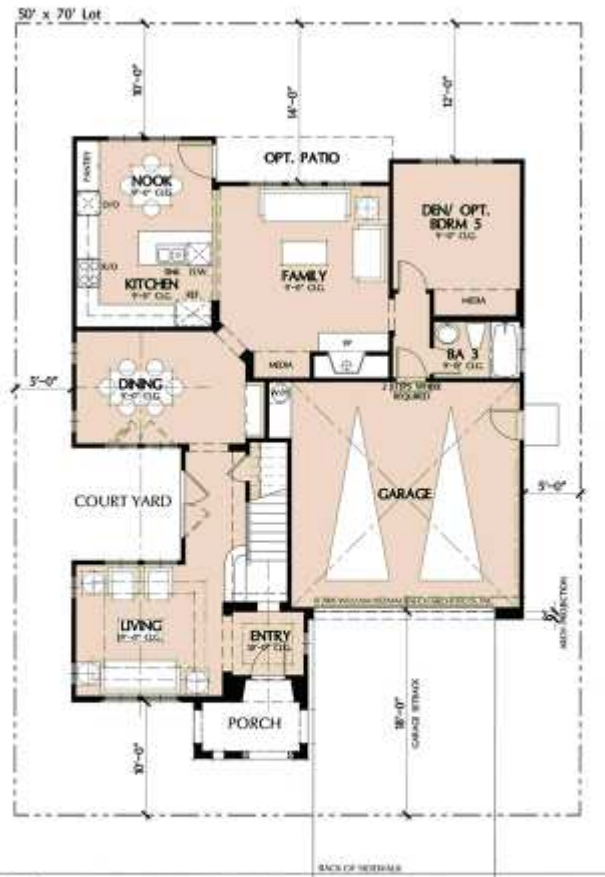
<b>Applicable to the following prototypes:</b>	<b>Prototype #</b>
Retail/Residential Mixed Use Low-Rise Building (Retail)	3
Retail/Residential Mixed Use Low-Rise Building (Retail)	4
Retail/Residential Mixed Use Mid-Rise (Retail)	5

<b>Title 24</b>	
<b>T24 Mandatory</b>	<b>T24 Prescriptive</b>
None	1.5 watts/sf

<b>Modeling Scenarios</b>			
<b>Proposed Baseline</b>	<b>Alternative 1</b>	<b>Alternative 2</b>	<b>Alternative 3</b>
Typical T8 fluorescent	Not Applicable	Not Applicable	Not Applicable
1.50 watts/sf			

<b>Alternative Incremental Costs (Alt X – Baseline)</b>		
<b>Alternative 1</b>	<b>Alternative 2</b>	<b>Alternative 3</b>
Not Applicable	Not Applicable	Not Applicable

# Lighting – Prototype 1 Floor Plan



**PLAN TWO**  
 French Country  
 2540 Sq.Ft. Total  
 4 Bdrm, 3 Ba, Opt. Bdrm. 5  
 2 Car Garage  
 50' x 70' Lots

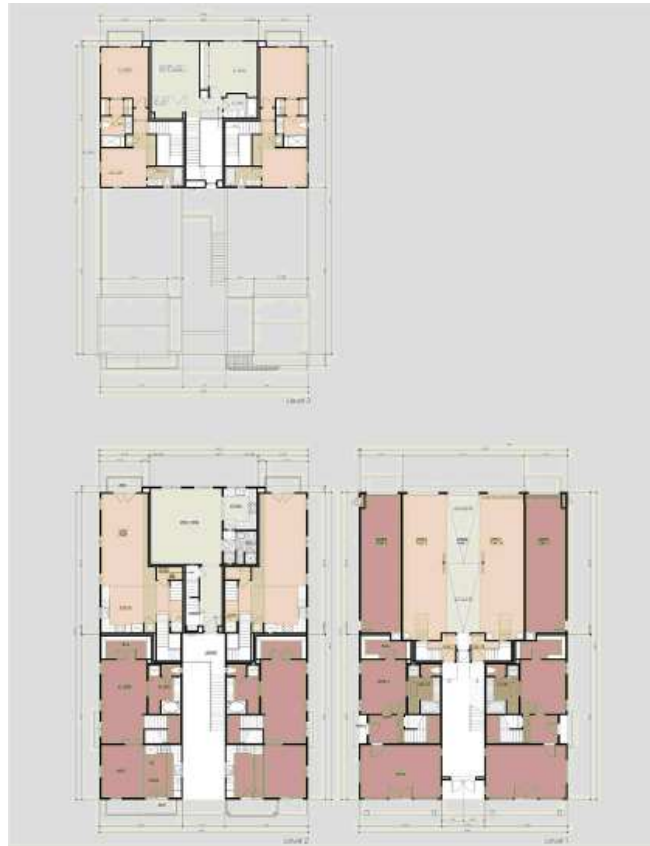
Luminara	1					Proposed Baseline					Alternative 1	
	Lum/sf	SF	%	Lumens	Wattage	Lum/watt	Watts	Equiv Inc	Watts/SF	Weighted	Lum/watt	Weighted
Plan 1 x 1												
Bath	35	252	9.9%	8812	>40	37	238	889	0.95	0.094	40	0.088
Entryway	6	39	1.5%	235	>40	64	4	14	0.09	0.001	69	0.001
Hallway/closet/Service	13.25	467	18.0%	6049	>40	37	163	610	0.36	0.064	40	0.060
Bedroom	10.5	982	38.7%	10316	>40	64	161	601	0.16	0.063	69	0.059
Kitchen	35	157	6.2%	5483	>40	37	148	553	0.95	0.058	40	0.055
Kitchen Counters	41.25	49	1.9%	2031	>40	10	203	758	4.13	0.080	10	0.080
Living/Family Room	10.5	425	16.7%	4465	>40	64	70	260	0.16	0.027	69	0.025
Dining Room	13	179	7.0%	2328	>40	10	233	868	1.30	0.092	10	0.092
Garage	17.5	490	18.9%	8400	>40	64	131	490	0.27	0.052	69	0.048
		2540					1352	5043		0.532		0.508

## Lighting - Prototype 2 Floor Plan



Chambray	2					Proposed Baseline					Alternative 1	
Plan 1 x 2	Lum/sf	SF	%	Lumens	Wattage	Lum/watt	Watts	Equiv Inc	Watts/SF	Weighted	Lum/watt	Weighted
Bath	35	172	11.5%	6005	>40	37	162	606	0.95	0.109	40	0.102
Entryway	6	55	3.7%	330	>40	64	5	19	0.09	0.003	69	0.003
Hallway/closet/Service	13.25	305	20.5%	4045	>40	37	109	408	0.36	0.073	40	0.069
Bedroom	10.5	419	28.1%	4401	>40	64	69	257	0.16	0.046	69	0.043
Kitchen	35	48	3.2%	1667	>40	37	46	168	0.95	0.030	40	0.028
Kitchen Counters	41.25	33	2.2%	1360	>40	10	136	507	4.13	0.091	10	0.091
Living/Family Room	10.5	355	23.8%	3728	>40	64	58	217	0.16	0.039	69	0.036
Dining Room	13	104	7.0%	1357	>40	10	136	506	1.30	0.091	10	0.091
Garage	17.5	462	31.0%	8077	>40	64	126	471	0.27	0.085	69	0.079
		1491					847	3159		0.568		0.542

## Lighting – Prototype 3 Floor Plans



Artisan		4				Proposed Baseline					Alternative 1	
Plan 1 x 4	Lum/sf	SF	%	Lumens	Wattage	Lum/watt	Watts	Equiv Inc	Watts/SF	Weighted	Lum/watt	Weighted
Bath	35	241	12.2%	8484	>40	37	228	851	0.95	0.116	40	0.107
Entryway	6	51	2.6%	309	>40	64	5	18	0.09	0.002	69	0.002
Hallway/closet	13.25	409	20.8%	5418	>40	37	146	546	0.36	0.074	40	0.069
Bedroom	10.5	483	24.5%	5070	>40	64	79	296	0.16	0.040	69	0.037
Kitchen	35	204	10.4%	7140	>40	37	193	720	0.95	0.098	40	0.091
Kitchen Counters	41.25	35	1.8%	1444	>40	10	144	539	4.13	0.073	10	0.073
Living Room	10.5	396	20.1%	4158	>40	64	65	242	0.16	0.033	69	0.031
Dining Room	13	150	7.6%	1950	>40	10	195	728	1.30	0.099	10	0.099
Garage	17.5	574	29.1%	10040	>40	64	157	585	0.27	0.080	69	0.074
		1969					1213	4525		0.616		0.583

Artisan		1				Proposed Baseline					Alternative 1	
Plan 2 x 1	Lum/sf	SF	%	Lumens	Wattage	Lum/watt	Watts	Equiv Inc	Watts/SF	Weighted	Lum/watt	Weighted
Bath	35	126	10.4%	4412	>40	37	119	445	0.95	0.098	40	0.091
Entryway	6	48	3.9%	287	>40	64	4	17	0.09	0.004	69	0.003
Hallway/closet	13.25	279	22.9%	3694	>40	37	100	372	0.36	0.082	40	0.076
Bedroom	10.5	252	20.7%	2647	>40	64	41	154	0.16	0.034	69	0.032
Kitchen	35	55	4.6%	1941	>40	37	52	196	0.95	0.043	40	0.040
Kitchen Counters	41.25	53	4.3%	2175	>40	10	217	812	4.13	0.179	10	0.179
Living Room	10.5	261	21.5%	2741	>40	64	43	160	0.16	0.035	69	0.033
Dining Room	13	141	11.6%	1835	>40	10	184	685	1.30	0.151	10	0.151
Garage	17.5	422	34.7%	7381	>40	64	115	430	0.27	0.095	69	
		1215					877	3271		0.626		0.604

# Lighting – Prototype 4 Floor Plans



Studio Walk	5					Proposed Baseline					Alternative 1	
Plan 1 x 5	Lum/sf	SF	%	Lumens	Wattage	Lum/watt	Watts	Equip Inc	Watts/SF	Weighted	Lum/watt	Weighted
Bath	35	190	11.9%	6650	>40	37	180	671	0.95	0.113	40	0.104
Entryway	6	47	3.0%	284	>40	64	4	17	0.09	0.003	69	0.003
Hallway/closet	13.25	405	25.4%	5366	>40	37	145	541	0.36	0.091	40	0.094
Bedroom	10.5	506	31.7%	5312	>40	64	83	310	0.16	0.052	69	0.048
Kitchen	35	108	6.8%	3789	>40	37	102	382	0.95	0.064	40	0.059
Kitchen Counters	41.25	35	2.2%	1423	>40	10	142	531	4.13	0.089	10	0.089
Living Room	10.5	155	9.7%	1628	>40	64	25	95	0.16	0.016	69	0.015
Dining Room	13	150	9.4%	1944	>40	10	194	725	1.30	0.122	10	0.122
Garage	17.5	441	27.6%	7711	>40	64	120	450	0.27	0.076	69	
		1595					997	3721		0.549		0.524

Studio Walk	5					Proposed Baseline					Alternative 1	
Plan 2 x 5	Lum/sf	SF	%	Lumens	Wattage	Lum/watt	Watts	Equip Inc	Watts/SF	Weighted	Lum/watt	Weighted
Bath	35	192	10.4%	6704	>40	37	181	676	0.95	0.098	40	0.091
Entryway	6	151	8.2%	908	>40	64	14	53	0.09	0.008	69	0.007
Hallway/closet	13.25	410	22.2%	5426	>40	37	147	547	0.36	0.079	40	0.073
Bedroom	10.5	503	27.2%	5286	>40	64	83	308	0.16	0.045	69	0.041
Kitchen	35	133	7.2%	4639	>40	37	125	468	0.95	0.068	40	0.063
Kitchen Counters	41.25	47	2.5%	1930	>40	10	193	720	4.13	0.104	10	0.104
Living Room	10.5	210	11.4%	2207	>40	64	34	129	0.16	0.019	69	0.017
Dining Room	13	203	11.0%	2635	>40	10	264	983	1.30	0.143	10	0.143
Garage	17.5	661	35.8%	11567	>40	64	181	674	0.27	0.098	69	
		1848					1222	4559		0.563		0.540

## Lighting – Prototype 5 Floor Plans

The following lighting tables are based on architectural plans for Gateway on 4<sup>th</sup>.

Gateway 12						Proposed Baseline					Alternative 1	
PlanA x 12	Lum/sf	SF	%	Lumens	Wattage	Lum/watt	Watts	Equiv Inc	Watts/SF	Weighted	Lum/watt	Weighted
Bath	35	127	14.9%	4445	>40	37	120	448	0.95	0.141	40	0.131
Entryway	6	15	1.8%	90	>40	64	1	5	0.09	0.002	69	0.002
Hallway/closet	13.25	150	17.6%	1988	>40	37	54	200	0.36	0.063	40	0.058
Bedroom	10.5	168	19.8%	1764	>40	64	28	103	0.16	0.032	69	0.030
Kitchen	35	154	18.1%	5390	>40	37	146	544	0.95	0.171	40	0.159
Kitchen Counters	41.25	54	6.4%	2228	>40	10	223	831	4.13	0.262	10	0.262
Living Room	10.5	182	21.4%	1911	>40	64	30	111	0.16	0.035	69	0.033
Dining Room	13	0	0.0%	0	>40	10	0	0	1.30	0.000	10	0.000
Garage	17.5	0	0.0%	0	>40	64	0	0	0.27	0.000	69	
		850					601	2243		0.707		0.674

Gateway 8						Proposed Baseline					Alternative 1	
PlanB x 8	Lum/sf	SF	%	Lumens	Wattage	Lum/watt	Watts	Equiv Inc	Watts/SF	Weighted	Lum/watt	Weighted
Bath	35	210	18.8%	7350	>40	37	199	741	0.95	0.178	40	0.165
Entryway	6	20	1.8%	120	>40	64	2	7	0.09	0.002	69	0.002
Hallway/closet	13.25	85	7.6%	1126	>40	37	30	114	0.36	0.027	40	0.025
Bedroom	10.5	340	30.5%	3570	>40	64	56	208	0.16	0.050	69	0.046
Kitchen	35	80	7.2%	2800	>40	37	76	282	0.95	0.068	40	0.063
Kitchen Counters	41.25	70	6.3%	2888	>40	10	289	1077	4.13	0.259	10	0.259
Living Room	10.5	310	27.8%	3255	>40	64	51	190	0.16	0.046	69	0.042
Dining Room	13	0	0.0%	0	>40	10	0	0	1.30	0.000	10	0.000
Garage	17.5	0	0.0%	0	>40	64	0	0	0.27	0.000	69	
		1115					702	2620		0.630		0.602

Gateway 14						Proposed Baseline					Alternative 1	
PlanC x 14	Lum/sf	SF	%	Lumens	Wattage	Lum/watt	Watts	Equiv Inc	Watts/SF	Weighted	Lum/watt	Weighted
Bath	35	300	20.7%	10500	>40	37	284	1059	0.95	0.196	40	0.181
Entryway	6	50	3.4%	300	>40	64	5	17	0.09	0.003	69	0.003
Hallway/closet	13.25	150	10.3%	1988	>40	37	54	200	0.36	0.037	40	0.034
Bedroom	10.5	330	22.8%	3465	>40	64	54	202	0.16	0.037	69	0.035
Kitchen	35	90	6.2%	3150	>40	37	85	318	0.95	0.059	40	0.054
Kitchen Counters	41.25	80	5.5%	3300	>40	10	330	1231	4.13	0.228	10	0.228
Living Room	10.5	450	31.0%	4725	>40	64	74	275	0.16	0.051	69	0.047
Dining Room	13	0	0.0%	0	>40	10	0	0	1.30	0.000	10	0.000
Garage	17.5	0	0.0%	0	>40	64	0	0	0.27	0.000	69	
		1450					885	3303		0.611		0.582

Gateway 4						Proposed Baseline					Alternative 1	
PlanD x 4	Lum/sf	SF	%	Lumens	Wattage	Lum/watt	Watts	Equiv Inc	Watts/SF	Weighted	Lum/watt	Weighted
Bath	35	250	15.8%	8750	>40	37	236	882	0.95	0.150	40	0.138
Entryway	6	44	2.8%	264	>40	64	4	15	0.09	0.003	69	0.002
Hallway/closet	13.25	142	9.0%	1882	>40	37	51	190	0.36	0.032	40	0.030
Bedroom	10.5	400	25.3%	4200	>40	64	66	245	0.16	0.042	69	0.039
Kitchen	35	90	5.7%	3150	>40	37	85	318	0.95	0.054	40	0.050
Kitchen Counters	41.25	80	5.1%	3300	>40	10	330	1231	4.13	0.209	10	0.209
Living Room	10.5	574	36.3%	6027	>40	64	94	351	0.16	0.060	69	0.055
Dining Room	13	0	0.0%	0	>40	10	0	0	1.30	0.000	10	0.000
Garage	17.5	0	0.0%	0	>40	64	0	0	0.27	0.000	69	
		1580					866	3233		0.548		0.523

Gateway 16						Proposed Baseline					Alternative 1	
PlanE x 16	Lum/sf	SF	%	Lumens	Wattage	Lum/watt	Watts	Equiv Inc	Watts/SF	Weighted	Lum/watt	Weighted
Bath	35	266	17.2%	9310	>40	37	252	939	0.95	0.163	40	0.151
Entryway	6	50	3.2%	300	>40	64	5	17	0.09	0.003	69	0.003
Hallway/closet	13.25	210	13.6%	2783	>40	37	75	281	0.36	0.049	40	0.046
Bedroom	10.5	420	27.2%	4410	>40	64	69	257	0.16	0.045	69	0.041
Kitchen	35	100	6.5%	3500	>40	37	95	353	0.95	0.061	40	0.057
Kitchen Counters	41.25	80	5.2%	3300	>40	10	330	1231	4.13	0.214	10	0.214
Living Room	10.5	419	27.1%	4400	>40	64	69	257	0.16	0.044	69	0.041
Dining Room	13	0	0.0%	0	>40	10	0	0	1.30	0.000	10	0.000
Garage	17.5	0	0.0%	0	>40	64	0	0	0.27	0.000	69	
		1545					894	3335		0.578		0.551

Gateway 20						Proposed Baseline					Alternative 1	
Plan F x 20	Lum/sf	SF	%	Lumens	Wattage	Lum/watt	Watts	Equiv Inc	Watts/SF	Weighted	Lum/watt	Weighted
Bath	35	266	16.2%	9310	>40	37	252	939	0.95	0.153	40	0.141
Entryway	6	50	3.0%	300	>40	64	5	17	0.09	0.003	69	0.003
Hallway/closet	13.25	210	12.8%	2783	>40	37	75	281	0.36	0.046	40	0.042
Bedroom	10.5	420	25.5%	4410	>40	64	69	257	0.16	0.042	69	0.039
Kitchen	35	110	6.7%	3850	>40	37	104	388	0.95	0.063	40	0.059
Kitchen Counters	41.25	80	4.9%	3300	>40	10	330	1231	4.13	0.201	10	0.201
Living Room	10.5	509	30.9%	5345	>40	64	84	312	0.16	0.051	69	0.047
Dining Room	13	0	0.0%	0	>40	10	0	0	1.30	0.000	10	0.000
Garage	17.5	0	0.0%	0	>40	64	0	0	0.27	0.000	69	
		1645					918	3425		0.568		0.531

Gateway 10						Proposed Baseline					Alternative 1	
Plan G x 10	Lum/sf	SF	%	Lumens	Wattage	Lum/watt	Watts	Equiv Inc	Watts/SF	Weighted	Lum/watt	Weighted
Bath	35	280	15.6%	9800	>40	37	265	988	0.95	0.148	40	0.136
Entryway	6	50	2.8%	300	>40	64	5	17	0.09	0.003	69	0.002
Hallway/closet	13.25	140	7.8%	1855	>40	37	50	187	0.36	0.028	40	0.026
Bedroom	10.5	420	23.4%	4410	>40	64	69	257	0.16	0.038	69	0.036
Kitchen	35	140	7.8%	4900	>40	37	132	494	0.95	0.074	40	0.068
Kitchen Counters	41.25	80	3.3%	2475	>40	10	248	924	4.13	0.138	10	0.138
Living Room	10.5	575	32.0%	6038	>40	64	94	352	0.16	0.053	69	0.049
Dining Room	13	130	7.2%	1690	>40	10	169	631	1.30	0.094	10	0.094
Garage	17.5	0	0.0%	0	>40	64	0	0	0.27	0.000	69	
		1795					1032	3650		0.575		0.549

## On-site Power Generation - Photovoltaics

Parameter	Proposed Alternative
Power Output	12.86 watts/sf
Azimuth	South
Tilt	0 deg (flat only)
Power Deg Coefficient	0.278 %/deg F
Rating Point Temp	77 deg F
Nominal Operating Temp	113 deg F
Inverter Efficiency	77%

**Note: Per builder's instructions, pitched roofs were not considered for photovoltaics, only flat roofs.**

Panels	Sqft	kW	\$/kW***
8	112	1.44	\$11,748
10	140	1.80	\$10,390
16	224	2.88	\$8,464
20	280	3.60	\$7,930
30	420	5.40	\$7,427
40	560	7.20	\$6,911
50	700	9.00	\$6,831
60	840	10.88	\$6,577
70	980	12.60	\$6,416

Each modular solar panel is roughly 32.5" x 62"

\*\*\*Photovoltaic Installed costs as shown include metering and switchgear. The cost does not include a \$2.55/watt PV Subsidy, which was applied to all systems. Additionally, PV is net-metered allowing generation of utility credits. Annual O&M cost = 0.12% of installed cost (before rebate)

Orientation/Tilt Energy Correction Factor						
Facing	0	15	30	45	60	90
South	0.89	0.97	1.00	0.97	0.88	0.56
SSE, SSW	0.89	0.97	0.99	0.96	0.87	0.57
SE, SW	0.89	0.95	0.96	0.93	0.85	0.59
ESE, WSW	0.89	0.92	0.91	0.87	0.79	0.57
E,W	0.89	0.88	0.84	0.78	0.70	0.51

## On-site Combined Heat and Power

### Microturbine CHP:

Installed cost for CHP system is defined by:

$Y = (6067.1X^{-0.2885}) * 1.3$ , where X = kW

O&M cost for CHP system is \$0.01155/kWh

Microturbine-based CHP system maximum efficiencies are:

Electric = 28%, Total = 78%, Exhaust temp = 540 F

CHP systems recover heat to domestic hot water, space heating, and in some cases, absorption cooling (only if central chillers are used).

CHP systems are configured to track electric load.

CHP systems are configured to run during mid- and/or on-peak utility periods

## On-site Thermal Storage

### Thermal Storage:

Chiller-based:

Ice-on-coil system @ \$70/ton-hr applied to buildings with chillers only

Charge during mid- and on-peak periods

Serves 50% to 75% of the cooling capacity (optimized on a case-by-case basis)

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

DX System-based;

IceBear system

\$17,200 to \$20,000 per 7.5 tons

## On-site Solar Thermal

Passive, glazed flat-plate collector system @ \$7,055 per unit applied to single-family town homes only (Prototype #13). System per dwelling includes two standard 3'x7' black chrome collector panels, 100 gallon hot water storage tank/heater, and all required piping, valves and fittings. Panel square footage is based on 20 sqft per first two family members plus 8 sqft for every additional person. Rough tank sizing is approximately 1.5 to 2.0 gallons per sqft of collector.

<b>Parameter</b>	<b>Proposed Alternative</b>
Collector Efficiency Curve Intercept %	0.7%
Collector Efficiency Curve Slope	0.7 Btu/hr-sqft-F
Solar Collector Loss Factor	12%
Hourly Storage Loss Factor	2%
Plane Surface Tilt Angle	18 deg
Plane Surface Azimuth Angle	180 deg

# Utility Rates

## Residential Utility Rates - Electric

### SDG&E Residential Electric Rate Schedule DR

Season Schedule												
Months	1	2	3	4	5	6	7	8	9	10	11	12
Summer												
Winter												

Price Component	Cutoff (kWh)	Price	Units
Summer Energy "First"	11.80	0.13040	\$/kwh
Summer Energy "Up to"	15.34	0.15057	\$/kwh
Summer Energy "Up to"	23.60	0.22730	\$/kwh
Summer Energy "Up to"	35.40	0.23637	\$/kwh
Summer Energy "Over"	35.40	0.25220	\$/kwh
Winter Energy "First"	11.80	0.13040	\$/kwh
Winter Energy "Up to"	15.34	0.15057	\$/kwh
Winter Energy "Up to"	23.60	0.21187	\$/kwh
Winter Energy "Up to"	35.40	0.22069	\$/kwh
Winter Energy "Over"	35.40	0.23877	\$/kwh

## Residential and Commercial Utility Rates – Natural Gas

### SDG&E Residential Gas Rate Schedule GR

Season Schedule												
Months	1	2	3	4	5	6	7	8	9	10	11	12
Summer												
Winter												

Schedule GR	Price Component	Cutoff (Therms/day)	Price	Units
GR	Energy "First"	0.493	1.07601	\$/therm
GR	Energy "Over"	0.493	1.31619	\$/therm

Rate varies monthly. Rate above is as of 10/09/07

# Commercial Utility Rates – Electric

## **SDG&E Commercial Electric Rate Schedule AL-TOU**

<b>Weekday Rate Schedule</b>																								
<b>Summer</b>	1		2		3		4		5		6		7		8		9		10		11		12	
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
	On-Peak																							
Semi-Peak																								
Off-Peak																								

<b>Weekday Rate Schedule</b>																								
<b>Winter</b>	1		2		3		4		5		6		7		8		9		10		11		12	
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
	On-Peak																							
Semi-Peak																								
Off-Peak																								

<b>Weekend Rate Schedule</b>																								
<b>Summer/ Winter</b>	1		2		3		4		5		6		7		8		9		10		11		12	
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
	On-Peak																							
Semi-Peak																								
Off-Peak																								

<b>Price Component</b>	<b>Price</b>	<b>Units</b>
Service Fee	48.52	\$/mo
Non-Coincident Demand	10.8	\$/kW
Summer On-Peak Demand	4.87	\$/kW
Summer On-Peak Energy	0.15349	\$/kWh
Summer Semi-Peak Energy	0.09791	\$/kWh
Summer Off-Peak Energy	0.07441	\$/kWh
Winter On-Peak Demand	3.64	\$/kW
Winter On-Peak Energy	0.1531	\$/kWh
Winter Semi-Peak Energy	0.09791	\$/kWh
Winter Off-Peak Energy	0.07441	\$/kWh

Standby: \$5.55/kW Contract Demand

## Electric Power Generation, CHP, and Residential Heating Emission Factors

	Emission Conversion Factors		
	Mixed Fuels Central Power lb/MWh	Natural Gas Residential Heating lb/MMBtu	Natural Gas CHP lb/MMBtu
CO2	700.4	117.6	117.6
SO2	0.128	0.00059	0.00059
NOX	0.342	0.092	0.00614

*Note; End use delivery efficiency of 92% is assumed for electricity and 98.4% for natural gas. CHP emission factors for natural gas microturbine (Capstone CARB version unit).*

## Energy Efficiency Measure Useful Life

Measure	Useful Life (yrs)
Wall Insulation	50
Roof Insulation	50
Cool Roof	15
Windows	20
Doors	20
Appliances	14
DHW Heater	14
Lighting	12
Photovoltaics	30
HVAC	18
CHP	20
Thermal Storage	18
Solar Thermal	30