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ENERGY-EFFICIENT COMMUNITY DEVELOPMENT IN CALIFORNIA: CHULA VISTA RESEARCH PROJECT

ATTACHMENT II: BUILDING ENERGY TECHNOLOGY MODELING ASSUMPTIONS AND RESULTS FOR SITE-B

PIER FINAL PROJECT REPORT

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End Use Solutions

Building Energy Technology Modeling Assumptions and Results for Site-B: The Chula Vista Research Project

June 2008

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Executive Summary

This report contains the findings of an engineering modeling study to determine the most cost-efficient means of reducing energy consumption and energy-related air emissions in the City of Chula Vista Site-B development project. This study was sponsored by the California Energy Commission and the U.S. Department of Energy to assist developers and builders in their efforts to construct more energy-efficient development projects.

The study examined a mixed-use residential/commercial[1] project called Site-B planned for development in the City of Chula Vista, CA. The project will consist of 4270 residential units with total of 6,776,027 square feet (sf) of living space and 357 retail store/commercial units representing total of 296,259 sf of commercial space. The total number of Site-B buildings structures will be 866.

The methodology employed in the study entailed detailed computer modeling and an examination of the energy consumption, costs and environmental impacts of both a conventional approach and a set of alternative approaches to the design of the buildings for the site. Specifically, the study modeled building envelope energy loses and internal energy loads for occupants and all fixtures, appliances and equipment, including space conditioning and ventilation systems.

The conventional approach, referred to as the "Builder Proposed Baseline," is defined as one in which the construction materials, lighting and operating equipment for each building structure are designed to meet the California Title-24, 2005 energy efficiency standard or to exceed it if specified as such in the builder's provided structure-specific building plans.

The alternative energy efficiency approaches are;

- "EE Package" design approach incorporating advanced energy efficiency measures including alternative grades of wall and roof insulation, windows, doors, lighting, HVAC equipment including thermal storage, appliances, and implementation of solar thermal technology,
- "EE Package with PV" design approach supplements EE Package with the solar PV-based power generation and,
- "EE Package with DG"[2] design approach which supplements EE Package with the fossil fuel (natural gas) microturbine-based power generation with heat recovery (combined heat and power or CHP).

The results of the modeling study indicate that the use of the "EE Package" approach could reduce Site-B annual TDVI[3] based energy consumption (kBtu/sf-year) by 8.2%

1 Commercial spaces share building code and energy rate parameters that are distinct from the residential areas.

[2] The latest 2008 SGIP eliminated all DG rebates except for the wind and fuel cell applications. That makes Site-B DG analysis more a "what if" case than a practical deployment target as the payback are may not be acceptable without the rebates. For additional comments see footnote 6 on page xx of this report.

below what would be expected if the buildings were built per builder specifications. Supplementing "EE Package" with the solar PV-based on-site power generation could further reduce the site TDVI to 36.4% below the builder's baseline. Substituting PV power generation technology with the microturbine-based DG/CHP generation systems would result in 11.7% reduction which is smaller than the "EE Package with PV" option but still better than the "EE Package" option alone.

Relative to natural gas, use of the "EE Package" approach would achieve a 17.4% reduction in annual gas consumption (MMBtu/year). Adding PV technology to the "EE Package" for obvious reasons would not change the site natural gas consumption. However, implementing gas-fired microturbine-based DG technology in place of PV could increase Site-B natural gas consumption by 94%.

With regard to electric energy consumption (kWh) and peak demand (kW), implementation of the "EE Package" approach would reduce site annual kWh by 5.8% and demand by 8.5% below the builder's baseline approach. Supplementing "EE Package" with the PV technology would result in a cumulative reduction of kWh by 42.6% and kW by 16.2%. Using DG technology with "EE Package" could reduce annual kWh by 30.5% and demand by 13.1%.

Given the reduction in energy consumption resulting from the use of the energy-efficient "EE Package" approach, energy-related air emissions are also significantly reduced. Specifically, Carbon Dioxide (CO_2) emissions would be reduced by 9.2%, Sulfur Dioxide (SO_x) emissions would be reduced by 6.0%, and Nitrogen Oxide (NO_x) emissions would be reduced by 10.5% as compared to the emissions expected from the builder's baseline approach. Similar numbers for the "EE Package with PV" option show reduction of 35.2% (CO2), 42.3% (SOx), and 32.5% (NOx). The "EE Package with DG" option is not as effective in reducing emissions as the "EE Package with PV" though it still provides SOx and NOx reductions of 29.1% and 48.9% respectively over the builder's baseline approach. However, the CO2 emission of the "EE Package with DG" is 5.2% higher than the builder's baseline approach. This is because the CO2 emissions from the deployed at Site-B mix of microturbine-based power generation and heat recovery technologies are higher than that released during production of electricity available from by CA central grid.

Annual utility costs savings associated with the use of the energy-efficient "EE Package" approach are estimated to be 6.8% when compared with the builder's baseline approach. Simple payback for the "EE Package" is estimated to be 9.8 years with ROI of 10.2%. The "EE Package with PV" option utility costs savings are 27.9%, simple payback is estimated at 14.8 years, and ROI 6.7%. Implementing "EE Package with DG" would

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[3] Calculated and reported in this report specific energy use TDVI accounts for all building energy uses including energy consumed by appliances, plug-in loads and lights. Such approach differs from the TDV calculations that are typically conducted for the Title 24 building compliance certification purpose where the energy used for cooling, heating and domestic hot water is used as indicator of residential building energy efficiency. Title 24 commercial building TDV method also accounts for lights and receptacles load. The modified TDVI approach applied to this study is one of the number of energy efficiency indications analyzed and discussed in this report and was used to show more realistic/complete impacts of EE measures on building energy consumption than that typically calculated by Title 24 certification software like Energy PRO 4.3 or Micropas7 v. 7.3.

result in annual utility cost savings of 19.8%, simple payback of 6.7 years, and ROI of 14.9%[4]

[4] Assumes SGIP rebates of 800/kW. See footnote 2 and 5 of this report for additional explanation.

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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)
kBtu	Thousand Btu
kW	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
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

Project Background and Objective

The Chula Vista Research Project (CVRP) was sponsored by the California Energy Commission and the U.S. Department of Energy to assist developers and builders in their efforts to construct more energy-efficient development projects.

The overall objective of the CVRP is to determine which actions and technologies in the California loading order can be combined with performance enabling community design options to increase the energy efficiency and air quality of California communities. The specific objective of the study presented in this report is to analyze the variable energy, economic and environmental impacts of the Site-B planned development site relative to both a conventional and a set of alternative approaches to buildings design and construction. The analytical results of this study will used by the CVRP team to conduct social science research to identify potential institutional (legislative and regulatory) and market barriers and solutions associated with energy-efficient community development. The CVRP project will conclude by translating this research into a set of practical transferable resources for California planning, design and building professionals.

Development Site Description

A specific component of the CVRP study presented in this report examines a mixed-use residential/commercial development project called Site-B planned for development in the City of Chula Vista, CA (see Figure 1). The project will consist of 4270 residential units with total of 6,776,027 sf of living space and 357 retail store/commercial units representing total of 296,259 sf of commercial space.

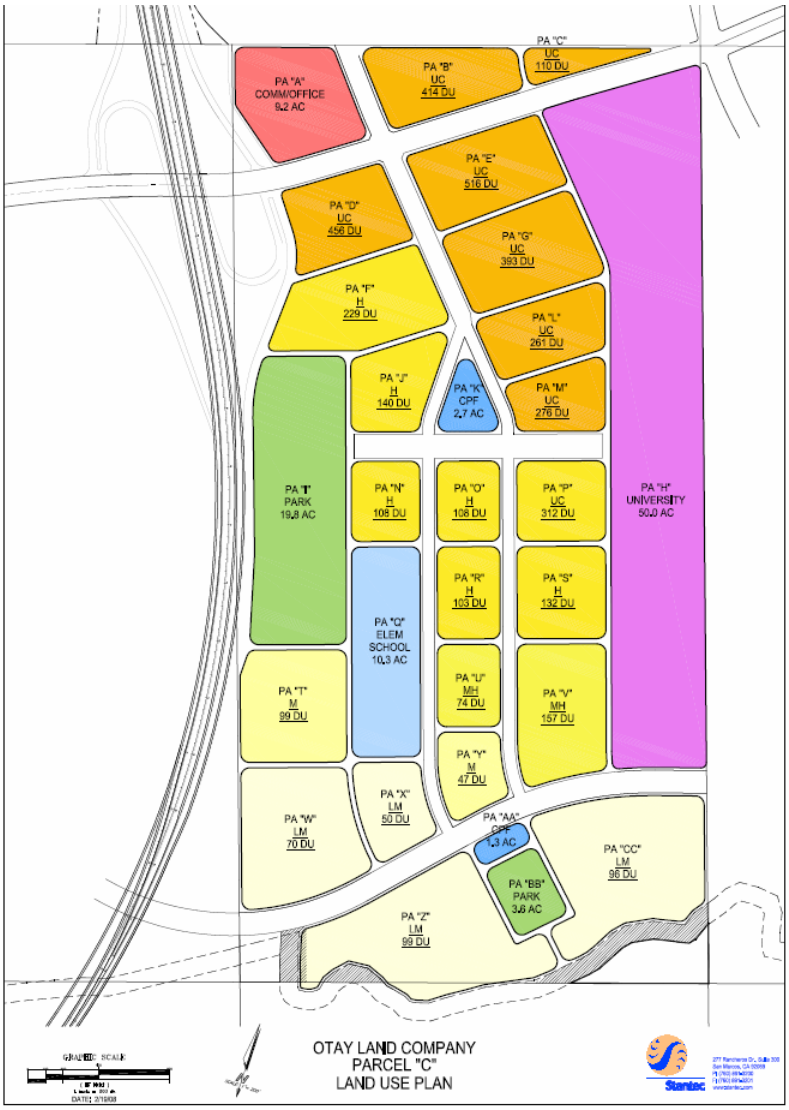

Figure 1 – Chula Vista Site-B Land Use Plan

The total number of Site-B buildings structures will be 866. For modeling purpose they are represented in this study by 5 distinct prototypical buildings. The prototypes

geometry, floor plans as well as other building details were developed in collaboration and approved by the Site-B builder. Table 8 on page 24 of this report summarizes important details of the modeled building prototypes and Figure 2 below shows Site-B land use plan of prototype buildings distribution.

Figure 2 – Chula Vista Site-B Land Use Plan Showing Placement of Prototypical Buildings

Approach

The research team led by the GTI and assisted by the Site-B developer/builder and by the National Energy Center for Sustainable Communities at San Diego State University, initiated the project with the compilation of the technical building design, construction and equipment assumptions that was used to guide the modeling work. The "Site-B Modeling Assumptions" section of this report (see Appendix A on page 59) provides details of modeled buildings' geometry and materials specifications. The Modeling Assumptions section also contains specific details of the modeling approach and itemizes the Title-24 compliant mandatory and prescriptive features for the modeled buildings as well as all evaluated alternative energy-efficient (EE) materials, equipment and control measures and their assumed installed costs. The economic assumptions necessary to calculate EE measures paybacks, like applicable local utility rate structures as well as applicable rebates (e.g.: for the PV system), are also provided. The Assumptions Manual was reviewed by the Site-B developer and other building industry professionals prior to use and was revised to ensure that a realistic set of assumptions was used as the basis for the Site-B modeling.

GTI used sophisticated computer modeling to analyze the variable energy, economic and environmental impacts of the development site relative to both a conventional and a set of alternative EE approaches to buildings design and construction.

The alternative EE measures included:

- Energy-efficient glazing,
- Alternative framing and improved envelope insulation (roof, floors, walls and doors),
- Energy-efficient lighting,
- High efficiency space cooling equipment,
- High efficiency heating, domestic hot water equipment,
- EnergyStar appliances
- Thermal storage,
- Solar thermal heating,
- On-site power generation using solar photo-voltaic (PV) system and,
- On-site power generation with heat recovery using microturbine-based system.

The analysis entailed detailed analysis of buildings envelope energy loses and internal energy loads for occupants and all fixtures and equipment, including space conditioning and ventilation systems. Specifically, the modeling included 8,760, hour-by-hour consumption of five types of building energy uses including:

- Electricity,
- Natural Gas,
- Cooling,
- Heating,
- Domestic Hot Water.

The software tools used to conduct the analysis included:

- Building Energy Analyzer™ (BEA), - a proprietary product of the Gas Technology Institute (GTI) that is based on the DOE2.1e computational engine; and
- Energy-10™ - a proprietary product of the Sustainable Building Industry Council.

BEA was used to model the energy, economic and environmental parameters for the commercial portions of the building structures. Energy-10™ was used to model details relating to the individual residential unit floor plans.

The modeling and EE analysis of Site-B was conducted in four phases defined as;

Phase-I, a conventional approach called **"Builder Proposed Baseline" (BPB)** is defined as one in which the construction materials, lighting and operating equipment for each structure are designed to meet the California Title-24, 2005 energy efficiency standard or to exceed it if specified as such in the builder's provided structure-specific building plans. Details of the conventional approach are described in the Modeling Assumptions section of this report (see Appendix A pages 60 to 99, Modeling Scenario tables' columns with heading "Proposed Baseline")

Phase-II, an alternative **"EE Package" (EE)** design approach that evaluates energy consumption, air emissions, and economic savings associated with the use of advanced energy efficiency measures including alternative grades of wall and roof insulation, windows, doors, lighting, HVAC equipment including thermal storage, appliances, and implementation of solar thermal technology. Details on these advanced energy efficiency measures are described in the Modeling Assumptions section of this report (see Appendix A pages 60 to 93, Modeling Scenario tables' columns with headings "Alternative 1 to 3", page 95 section "Thermal Storage", and page 96 section "Solar Thermal").

Phase-III, an alternative **"EE Package with PV" (EE-PV)** design approach that evaluates impacts of combining preferred EE packages with the solar photovoltaic-based onsite power generation. Details of solar photovoltaic-based systems are described in the Modeling Assumptions section of this report (see Appendix A page 94, "On-Site Power Generation – Photovoltaics").

Phase-IV, an alternative **"EE Package with DG" (EE-DG[5])** design approach that evaluates impacts of combining preferred EE packages with a fossil fuel-based (natural

[5] It should be noted that from the economics point of view (simple payback and ROI analysis) the EE-DG option has at this point in time more hypothetical than practical value. At the time the CVRP study analysis was initiated (mid of 2007) the DG analysis was based on applicable 2007 CA Self-Generation Initiative Program (SGIP) guidelines which provided rebate of $800/kW for microturbine-based systems with heat recovery. Unfortunately, the latest 2008 SGIP eliminated all DG rebates except for the wind and fuel cell applications. That makes Site-B DG analysis more a "what if" case than a practical deployment target as the payback are not acceptable without the rebates. An option of eliminating DG Scenario from the final report was discussed with the NECSC Project Manager; however in conclusion a decision was made to leave it in

gas) onsite power generation with heat recovery. Details of this system are described in the Modeling Assumptions section of this report (see Appendix A page 95, “On-Site Combined Heat and Power” – “Microturbine CHP”).

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the report to illustrate potential for energy efficiency and environmental impacts of targeted CHP deployment.

Builder's Baseline vs. Alternative Energy Efficiency Approaches - Key Findings

This chapter provides review of composite results of energy efficiency, environmental, and economic impacts from all four modeling phases of the Site-B project.

Energy - Gas and Electric Utility Use Impacts

Impacts of four different development scenarios on the annual consumption of utility provided energy (gas and electric) are shown in Figure 3 for all of the 866 Site-B building structures.

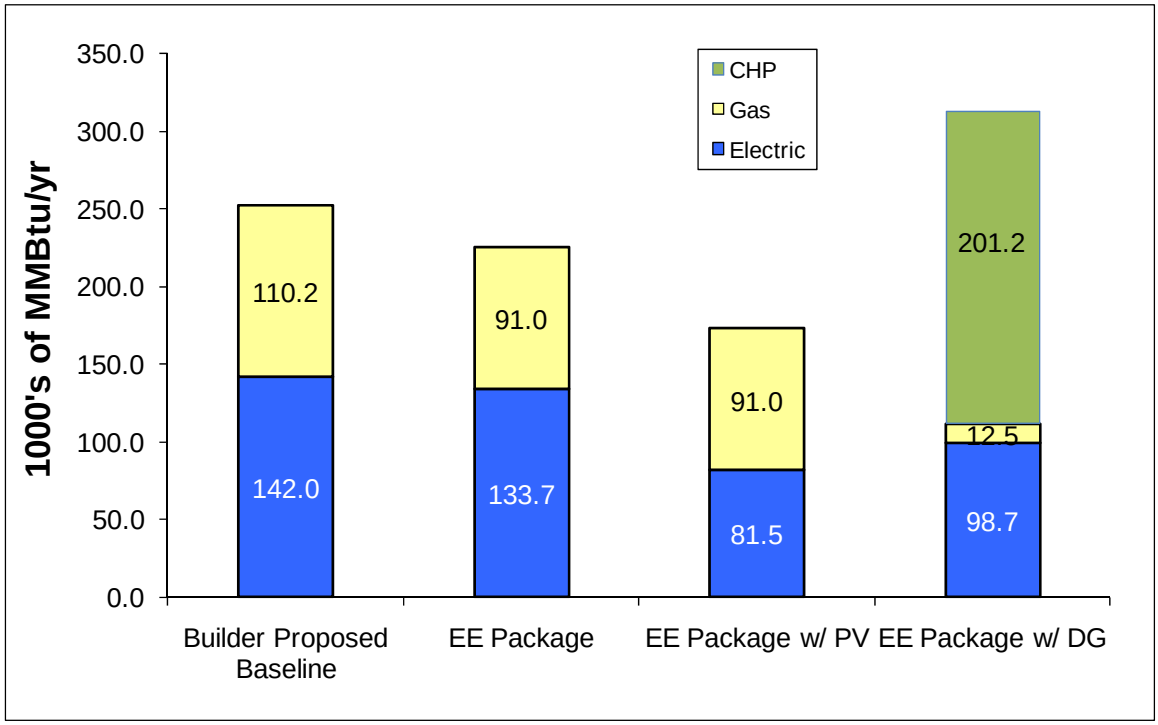


Figure 3. Total Annual Energy Consumption (all buildings)

The analysis showed that implementing all applicable and economically feasible EE options can lower Site-B annual energy consumption from the BPB baseline of 252,200 MMBtu to 224,700 MMBtu, or by 10.9%.

Implementing EE-PV option could further reduce electric grid and natural gas utility consumption to 172,500 MMBtu or by 32.6% compared to BPB option.

Deploying EE-DG option would not be as effective in reducing Site-B consumption of the grid provided electric energy as the EE-PV option, however it can still lower it to 98,700 MMBtu from 133,799 MMBtu for EE only option. On the other hand the natural gas consumption will increase significantly reaching 213,700 MMBtu as compared with 91,000 MMBtu for the EE option. Increased natural gas consumption would result in the highest requirements for the combined gas and electric utility provided energy than any other option, including BDB.

It should be noted that the Figure 3 shows consumed electric and natural gas energy expressed as a Btu or heat content of equivalent utilities. As such, although often used, the analysis may be missing other important factors associated with the value of energy imported/consumed by the community at different time of the day and year. Therefore, the results of the SITE-A energy efficiency analysis are also presented using the Title-24 prescribed Time Dependant Valuation (TDV[6]) approach. However, to provide a complete assessment of buildings total energy uses the TDV approach was here further enhanced to include appliances and other internal loads not accounted for by a standard TDV approach. This modified methodology used in the SITE-A study is called Time Dependant Valuation Inclusive (TDVI[7]).

[6] Time Dependent Valuation of Building Specific Energy Consumption calculated per Title-25 2005 standard. TDV value of electricity differs depending on time-of-use (hourly, daily, seasonal), and the value of natural gas differs depending on season. TDV better reflects value of building energy as it reflects varying cost to provide the energy at different times.

[7] Calculated and reported in this report specific energy use TDVI accounts for all building energy uses including energy consumed by appliances, plug-in loads and lights. Such approach differs from the TDV calculations that are typically conducted for the Title 24 building compliance certification purpose where the energy used for cooling, heating and domestic hot water is used as indicator of residential building energy efficiency. Title 24 commercial building TDV method also accounts for lights and receptacles load. The modified TDVI approach applied to this study is one of the number of energy efficiency indications analyzed and discussed in this report and was used to show more realistic/complete impacts of EE measures on building energy consumption than that typically calculated by Title 24 certification software like Energy PRO 4.3 or Micropas7 v. 7.3.

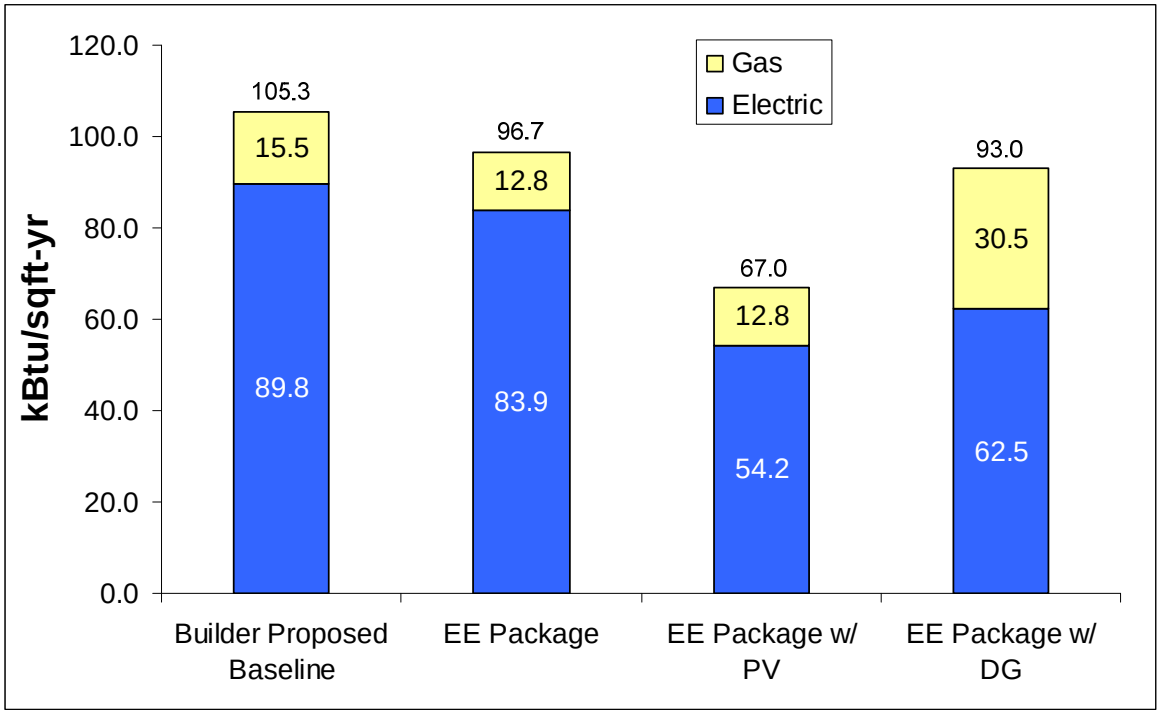


Figure 4. TDVI Energy Consumption (all buildings)

Figure 4 shows that implementing EE options can lower Site-B TDVI specific energy consumption from the BPB baseline of 105.3 kBtu/sf-year to 96.7 kBtu/sf-year, or by 8.2%.

Implementing EE-PV option could further reduce TDVI to 67 kBtu/sf-year or by total of 36.4% compared with the BPB baseline.

Similar to the results shown in Figure 3, deploying EE-DG option would not be as effective in reducing Site-B TDVI specific energy consumption as the EE-PV option. However in contrast to Figure 3, where the energy is expressed in Btu and EE-DG shows its highest use, at TDVI of 93 kBtu/sf-year the EE-DG option is 11.7% better than the BPB baseline TDVI. This shows benefits of DG technology which while increasing consumption of a low TDVI valued fuel like natural gas can significantly decrease grid import of high TDVI valued electricity.

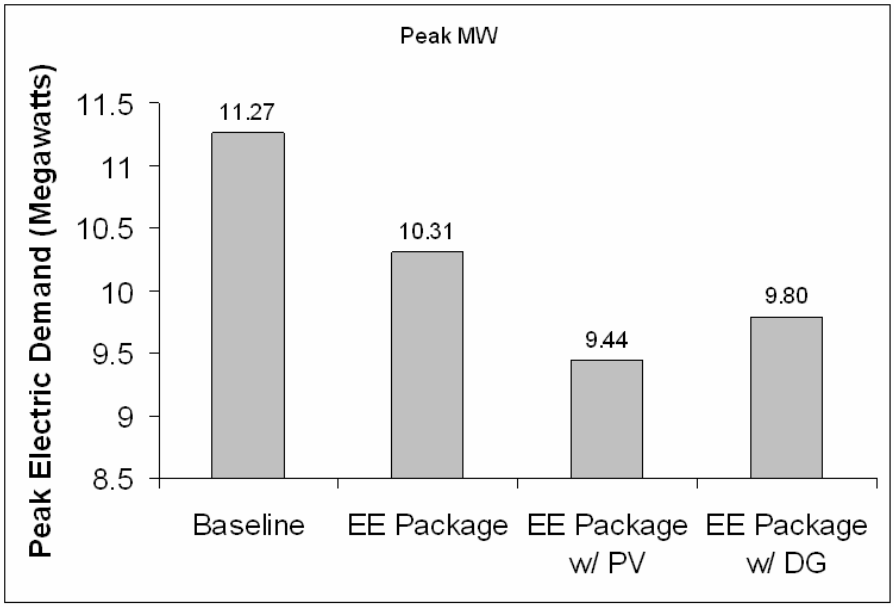


Figure 5. Peak Electric Demand (all buildings contributions)

Table 1 – Specific Cost of Electric Peak Demand Reduction

	Peak MW	Total Cost	$/kW for Reduced Peak Demand
Baseline	11.268	-	-
EE Package	10.308	$7,934,659	$8,265
EE Package w/ PV	9.442	$49,615,206	$27,172
EE Package w/ DG	9.797	$15,843,991	$10,771

Another important measure of implemented community energy efficiency options is their impact on the grid peak electric demand kW. Figure 5 shows Site-B peak demand for four analyzed alternatives and Table 1 lists specific cost of implementing them.

Implementing EE options would result in lowering Site-B electric peak demand from the BPB baseline of 11.27 MW to 10.31 MW, or by 8.8%. As see in Table 1, at $8,265 / kW this is also the least expensive of the three analyzed options to lower peak demand.

Implementing EE-PV option could further reduce electric peak demand to 9.44 MW or by total of 16.2% compared with the BPB baseline. At $8,265 / kW this is the most expensive of the three analyzed options to lower peak demand.

Implementing EE-DG option could reduce Site-B electric peak demand to 9.8 MW which is slightly less than EE_PV option but still 13% less compared with the BPB baseline. Specific cost of implementing it would be $10,771 / kW reduced[8].

[8] Based on incentives of $800/kW of installed DG. See footnote 6 on page 6 of this report for additional explanation.

Environmental Impacts

Impacts of different development scenarios on the cumulative annual emissions associated with Site-B electricity and natural gas consumption are shown in Figure 5 to 7. The calculations are based using conversion factors (see Appendix A, page 99 of this report) and assume end use delivery efficiency of 92% for electricity and 98.4% for natural gas.

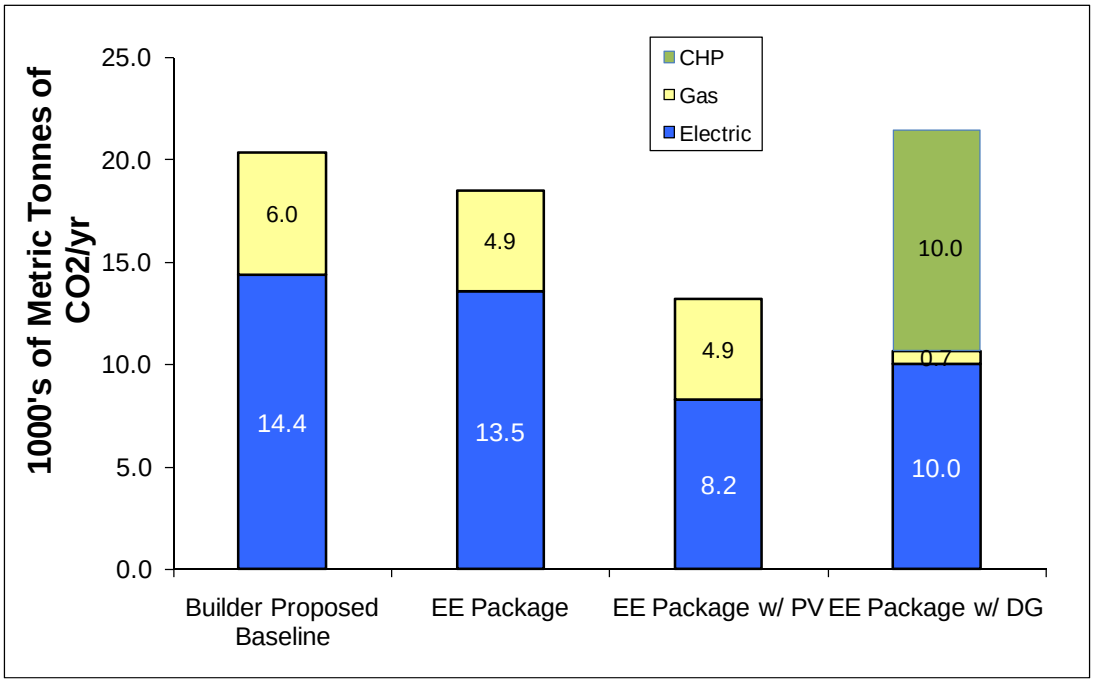


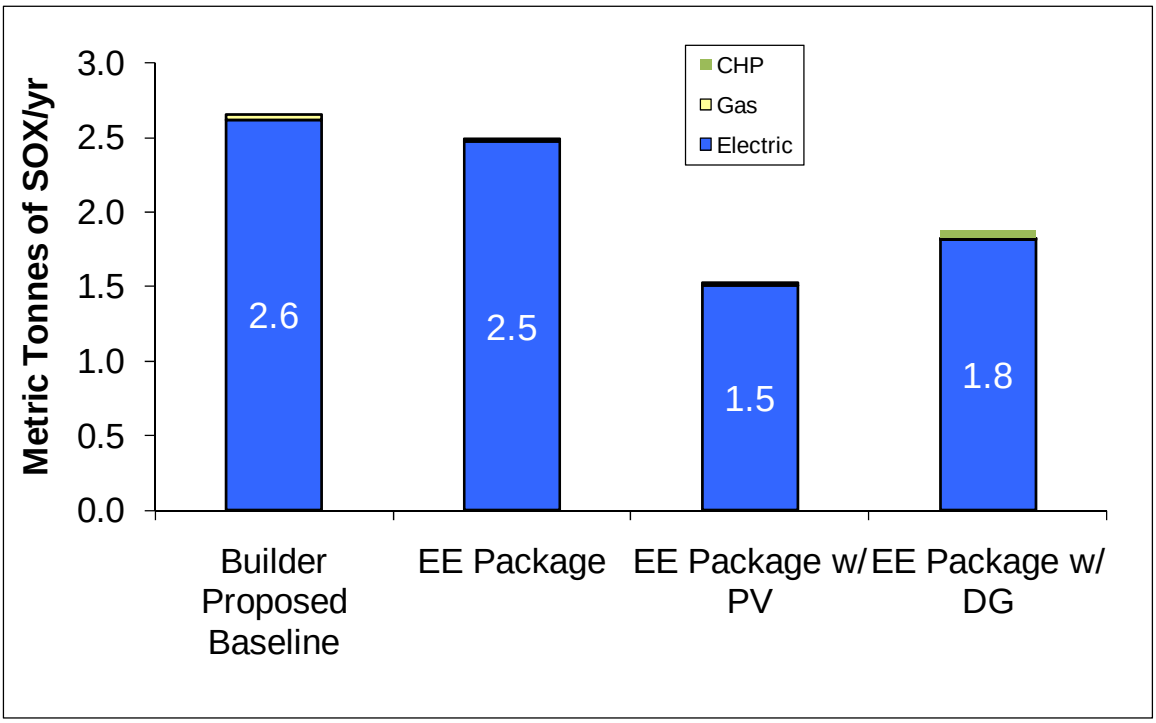
Figure 6. Total Annual CO2 Emissions (all buildings contributions)

Figure 6 shows that implementing EE options can lower Site-B annual CO2 emissions from the BPB baseline of 20,335 metric tons/ year to 18,459 metric tons/ year, or by 9.2%.

Implementing EE-PV option could further reduce CO2 emissions to 13,179 metric tons/ year, or by 35.2%.

Deploying EE-DG option would not be effective in reducing Site-B CO2 emissions and at 21,393 metric tons/ year it will be 5.2% higher than the BPB baseline emissions.

Figures 7 and 7 show SOx and NOx emissions impacts. The EE options can lower Site-B annual SOx emissions to 2.5 metric tons/ year from the BPB baseline of 2.66 metric tons/ year, or by 6.0%. NOx emissions would be 10.46 metric tons/ year with EE option implemented vs. 11.69 metric tons/ year for the BPB baseline, a reduction of 10.5%.



Note; Natural gas and CHP contributions to SOx emissions are too small to clearly show on this chart

Figure 7. Total Annual SOx Emissions (all buildings contributions)

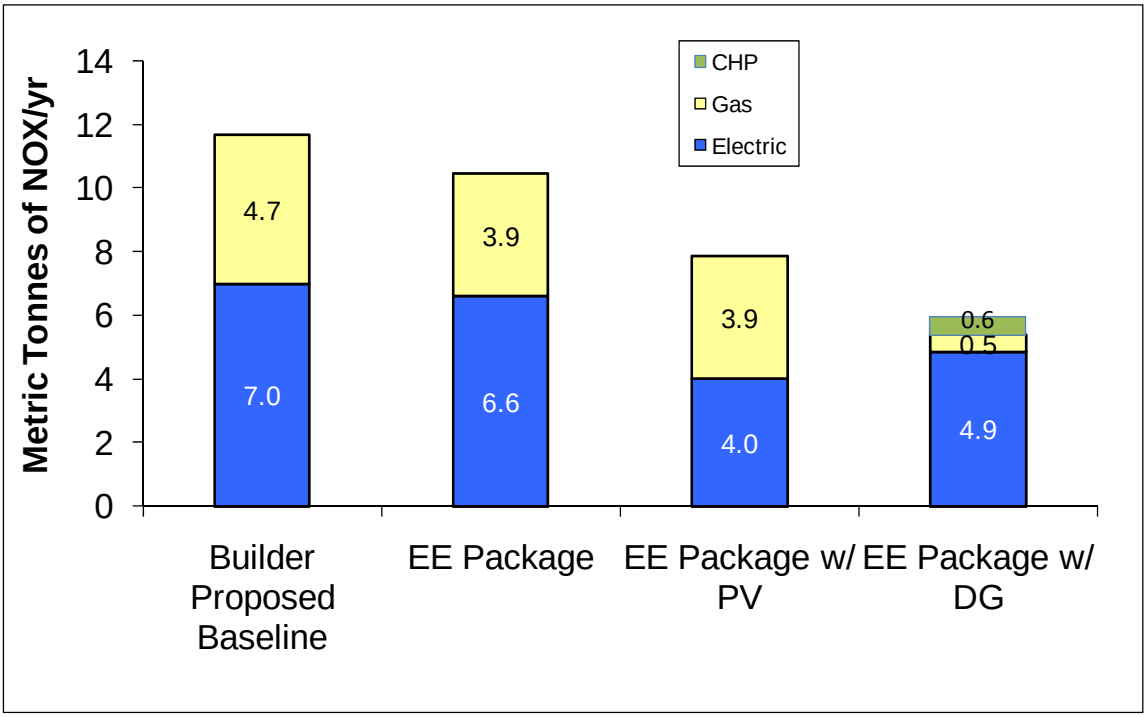


Figure 8. Total Annual NOx Emissions (all buildings contributions)

Implementing EE-PV option could further reduce SOx emissions to 1.53 metric tons/ year or by 42.3%, and NOx emissions to 7.88 metric tons/ year or by 32.5% as compared to the BPB baseline.

Implementing EE-DG option could reduce Site-B SOx emissions to 1.88 metric tons/ year or by 29.1% and NOx emissions at 5.97 metric tons/ year will be lower by 48.9% as compared to the BPB baseline.

TDVI Impacts by Building Prototype

To help reader better understand which prototype buildings are the most energy intensive and to what degree the total number them contribute to the Site-B annual energy consumption a number of charts was prepared. The charts shown in Figures 9 to 12 provide TDVI specific energy density for each of the 5 single prototype buildings as well as the total annual TDVI – based energy consumption for all the buildings of the same type (shown as a smaller chart insert).

Table 2 provides tabularized data showing percentage of each prototype building TDVI as that of the Site-B total TDVI. The results are given as a utility specific percentage per utility (electric and gas) as well as a utility specific percentage per site total TDVI.

In the Builder Proposed Baseline configuration the Gateway mixed-use residential/commercial building prototype has the highest TDVI of 98.9 kBtu/sf-year (Figure 9) and that all Gateway buildings contribute to more than 62% of the Site-B TDVI (Table 2).

As shown in Figures 10 to 12 the Gateway buildings contribute the most to Site-B TDVI energy consumption, therefore this prototype could be considered a prime target when selecting most attractive target for uniform implementation of selected Energy Efficiency measures.

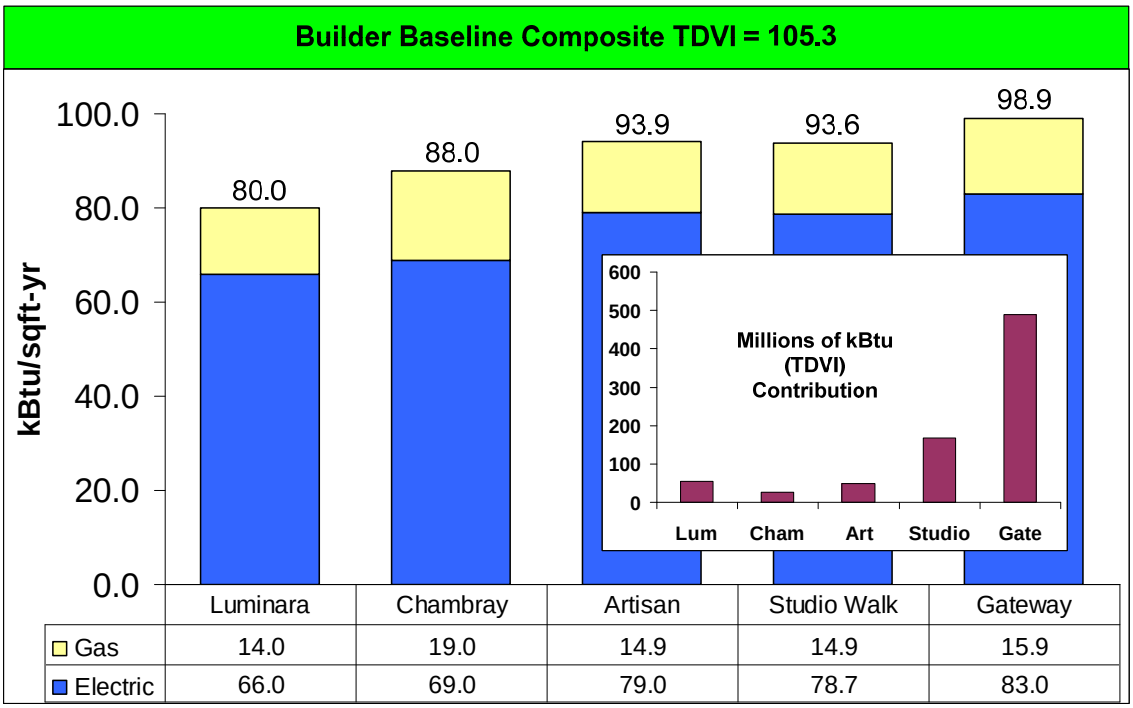


Figure 9. Builder Baseline - TDVI per Building Type

Table 2 – TDVI per Building Type (composite for prototype all end-use areas)

Baseline		Elec. TDVI as % of Total Elec. TDVI	Gas TDVI as % of Total Gas TDVI	Elec. TDVI as % of Total Site TDVI	Gas TDVI as % of Total Site TDVI
1	Luminara	6.6%	8.1%	5.7%	1.2%
2	Chambray	3.0%	4.8%	2.6%	0.7%
3	Artisan	6.3%	6.1%	5.4%	0.9%
4	Studio Walk	21.6%	20.3%	18.4%	3.0%
5	Gateway	62.5%	60.6%	53.3%	8.9%

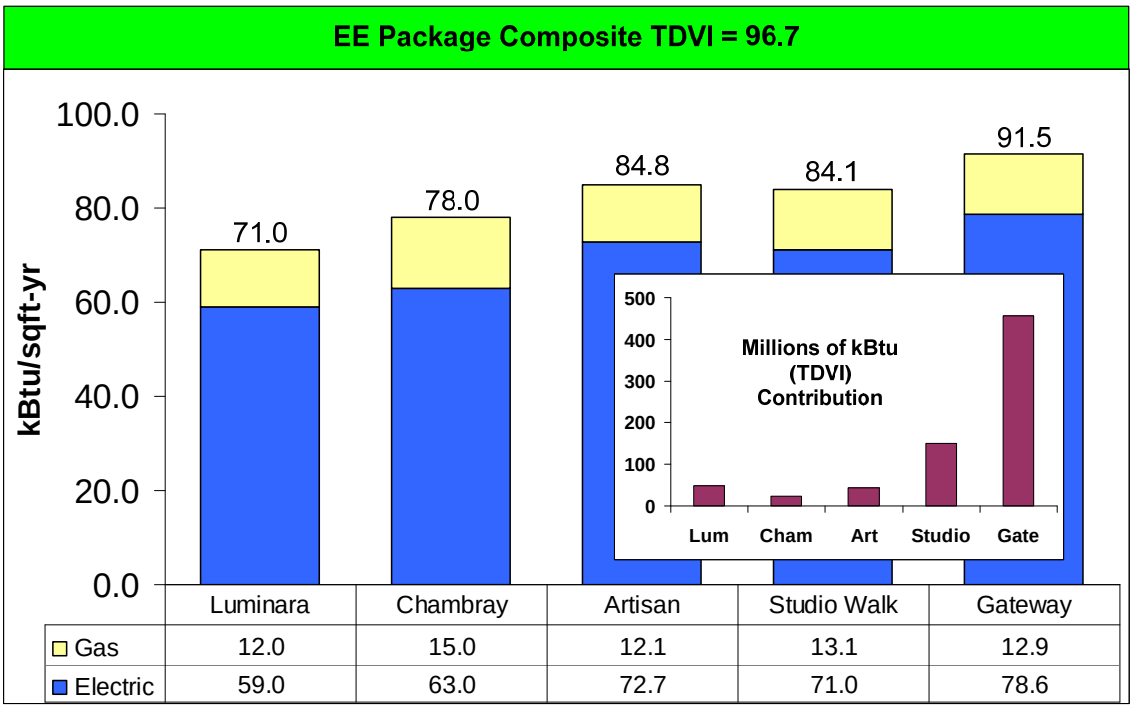


Figure 10. EE Packages Only Option - TDVI per Building Type

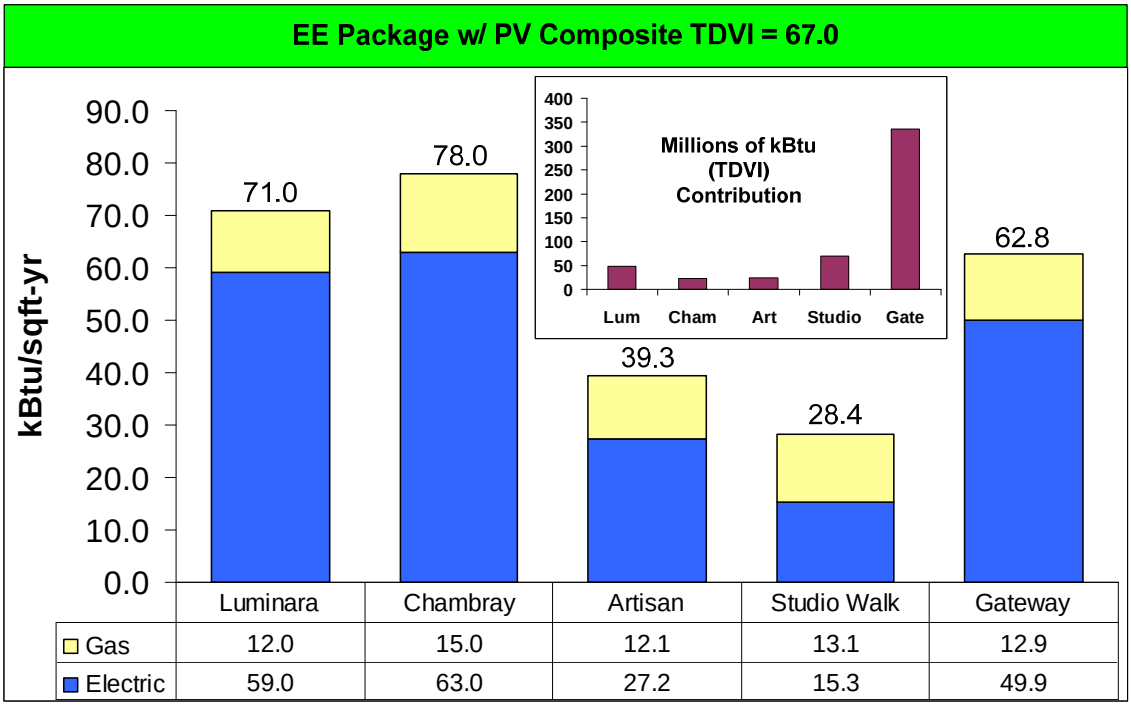


Figure 11. EE Package with PV Option - TDVI per Building Type

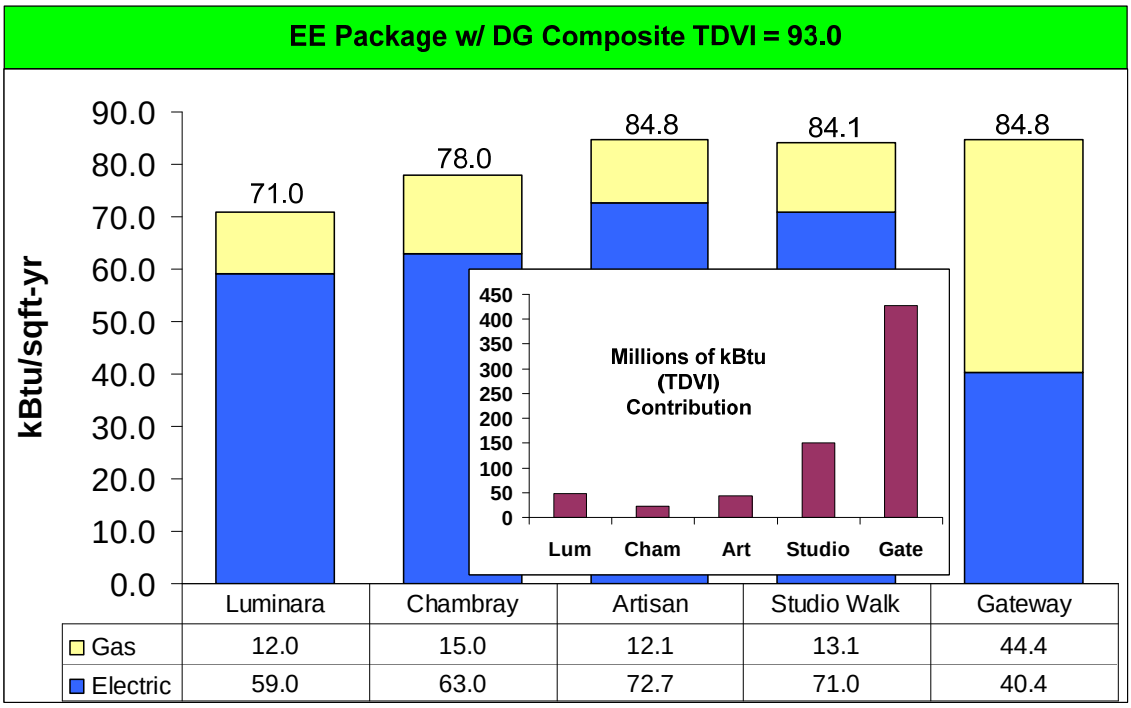


Figure 12. EE Package with DG Option - TDVI per Building Type

TDVI Impacts by Space-Use Type

To illustrate which of the building 2 major end-use spaces, residential or commercial, are the most energy intensive and to what degree the total square footage they represent contribute to the Site-B annual energy consumption charts shown in Figures 13 to 16 was prepared. The charts provide TDVI specific energy density for residential or commercial end-use spaces/floor plans as well as the total annual TDVI – based energy consumption for all the buildings end-use spaces of the same type (shown as a smaller chart insert).

Table 3 provides tabularized data showing percentage of each end-use space type TDVI as that of the Site-B total TDVI. The results are given as a utility specific percentage per total utility use(separate for electric and gas) as well as a utility specific percentage per site total TDVI.

As seen in Figure 9 (Builder Proposed Baseline) the commercial end-use floor plans have very high TDVI of 300.1 kBtu/sf-year as compared to 87.8 kBtu/sf-year for residential spaces. However because the Site-B will consist of 4270 residential units with total of 6,776,027 sf of living space and only 357 retail store/commercial units representing total of 296,259 sf of commercial space, residential spaces contribute to more than 74% of the Site-B TDVI (Table 3).

Figures 13 to 16 and Table 3 show that residential spaces / floor plans contribute most to the Site-B TDVI energy consumption, therefore residential spaces could be considered a good target when selecting end-use areas most attractive for uniform implementation of selected Energy Efficiency measures.

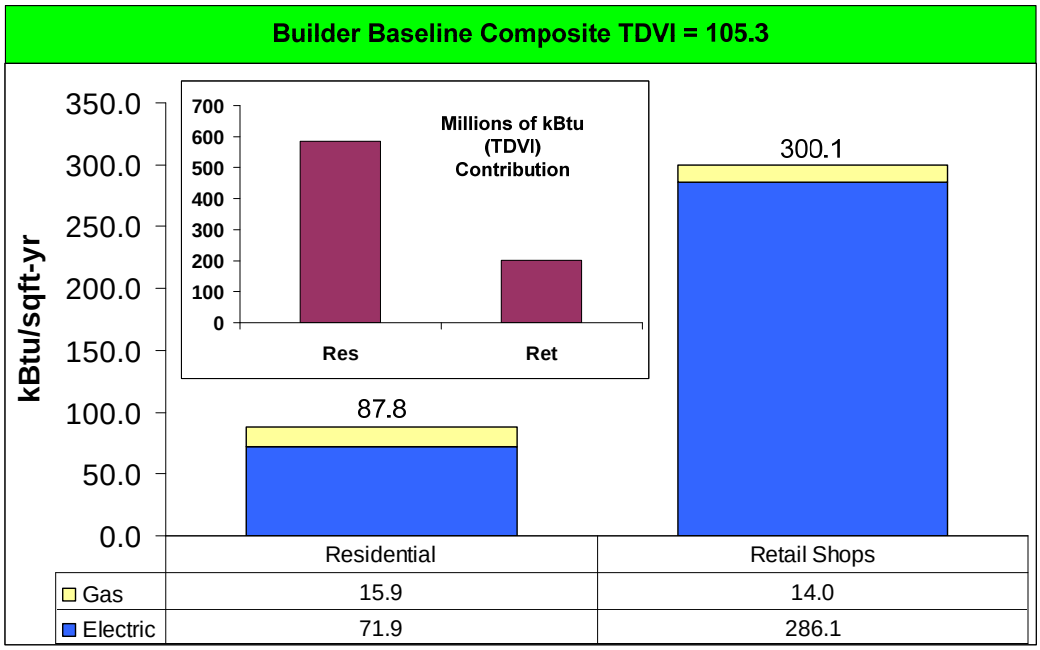


Figure 13. EE Builder Baseline - TDVI per Space-Use Type

Table 3 – TDVI per End-Use Area (composite for all buildings types)

Baseline	Elec. TDVI as % of Total Elec. TDVI	Gas TDVI as % of Total Gas TDVI	Elec. TDVI as % of Total Site TDVI	Gas TDVI as % of Total Site TDVI
Residential	71.6%	8.1%	61.0%	13.5%
Retail Shops	28.4%	4.8%	24.2%	1.2%

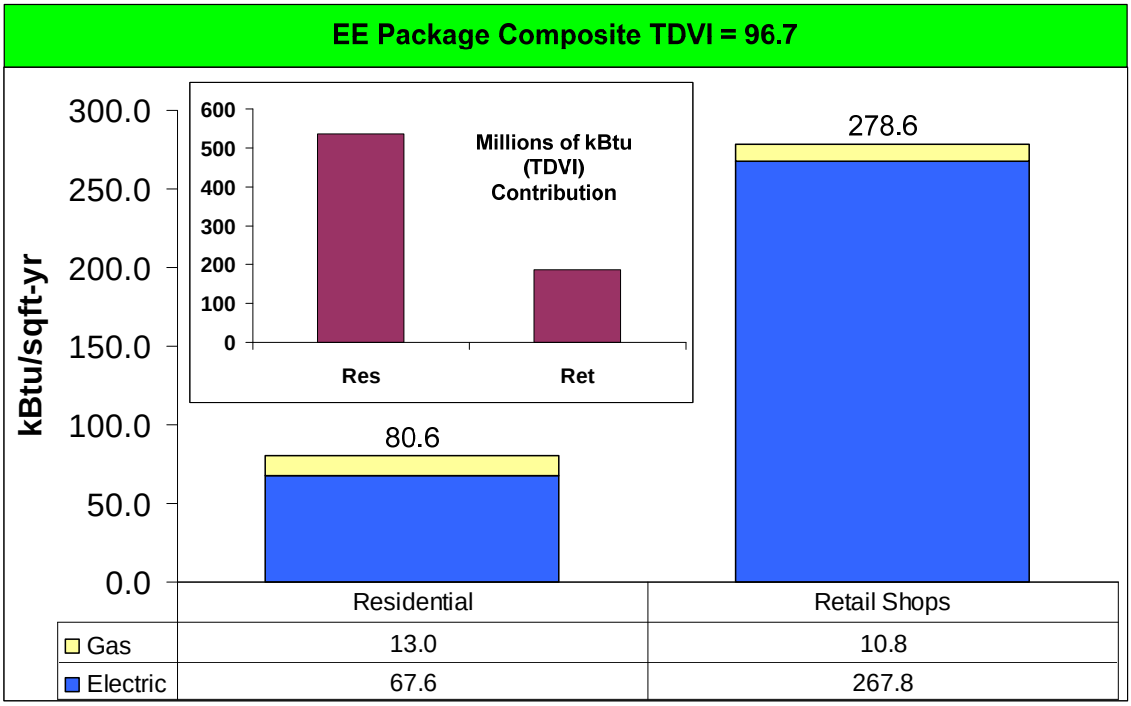


Figure 14. EE Package Option - TDVI per Space-Use Type

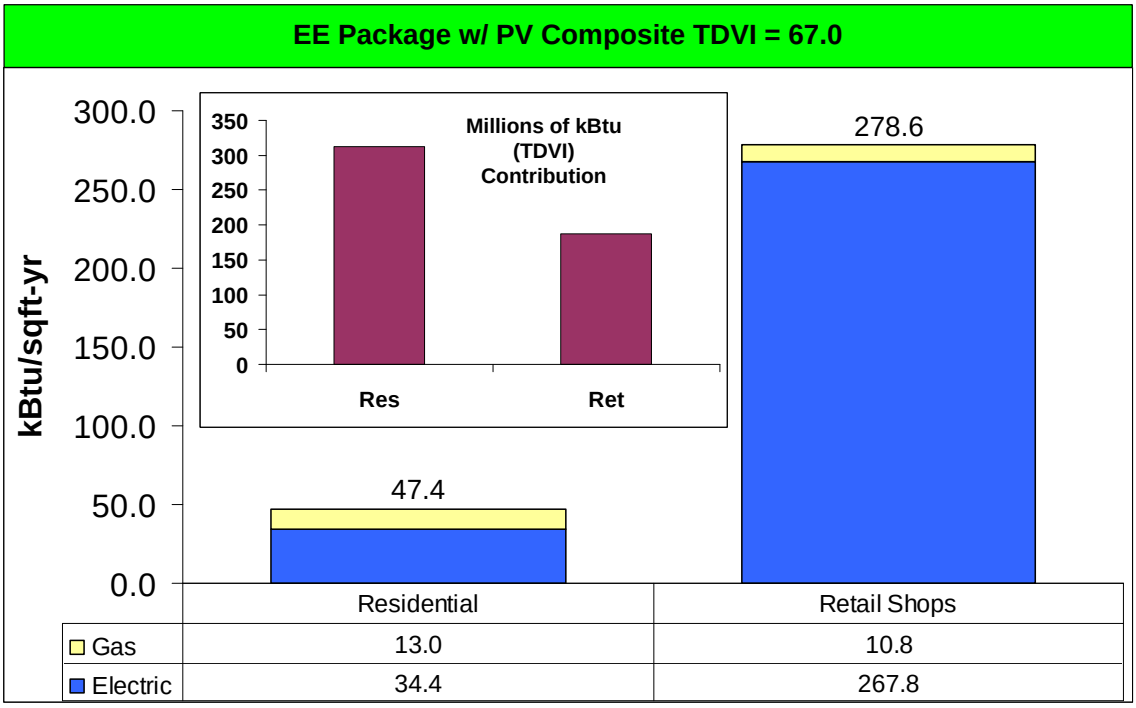


Figure 15. EE Package with PV Option - TDVI per Space-Use Type

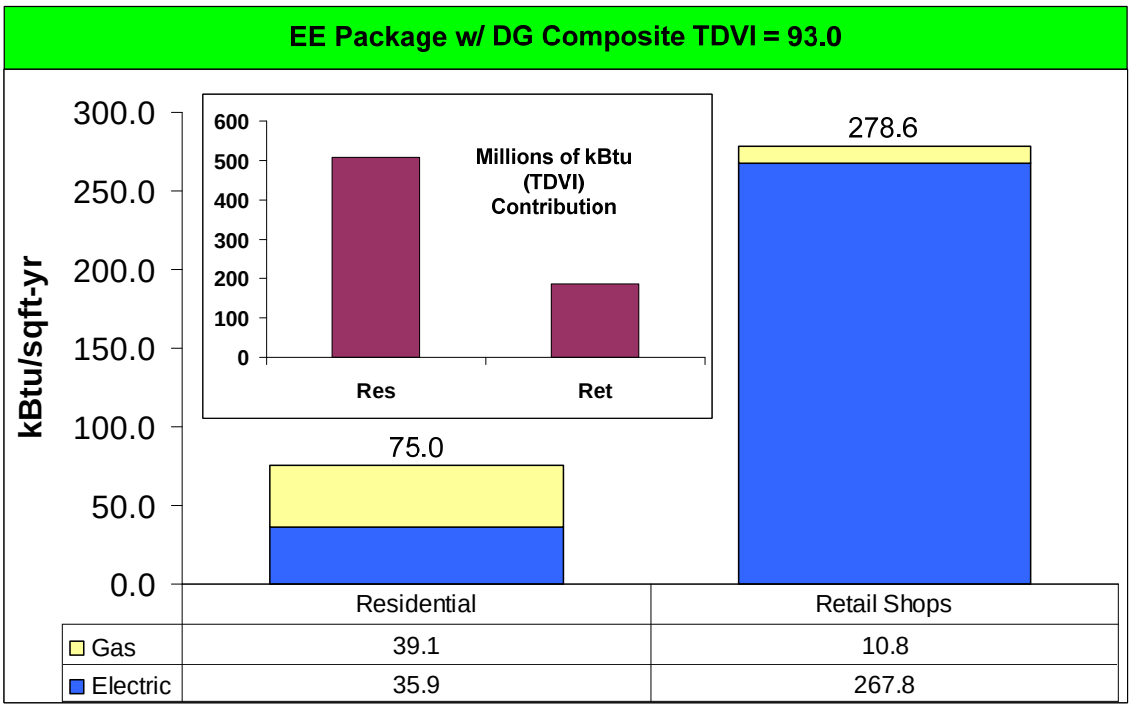


Figure 16. EE Package with DG Option - TDVI per Space-Use Type

Composite Results - Economics and Summary Tables

To help reader in direct comparison of the tree analyzed energy efficiency options with the builder proposed baseline a number of summary tables showing eleven different parameters related to the Site-B energy, emissions, and economics were complied and are provided below in Tables 4 to 6. The first nine of the listed parameters were already discussed in the previous sections of this report therefore only the economic aspects of the analysis will be highlighted in this section.

Table 4 – Impacts of EE Package vs. Builder Baseline

Parameter	Baseline	EE Package	% Savings
TDVI (kBtu/sqft-yr)	105.29	96.71	8.2%
Electricity (kWh/yr)	41,603,751	39,182,298	5.8%
Electric Demand (Max MW)	11.27	10.31	8.5%
Gas (MMBtu/yr)	110,164	90,968	17.4%
Total Energy (MMBtu/yr)	252,116	224,658	10.9%
Emissions - CO2 (tonnes/yr)	20,335.17	18,458.70	9.2%
Emissions - SOx (tonnes/yr)	2.66	2.50	6.0%
Emissions - NOx (tonnes/yr)	11.69	10.46	10.5%
Energy Cost ($/yr)	$11,983,344	$11,171,189	6.8%
Simple Payback (years)	n/a	9.8	n/a
ROI (%)	n/a	10.2	n/a

Table 4 shows that installing all recommended economically feasible EE options could lower Site-B annual utility costs by $812,155 or by 6.8%. The simple payback of the investment necessary to implement EE options would be 9.8 years with ROI of 10.2%.

Supplementing EE option with PV (see Table 5) could reduce Site-B electric and natural gas annual utility costs by $3,346,177 or by 27.9% compared to the BPB option. The simple payback of the EE-PV option would be 14.8 years with the ROI of 6.7%[9].

[9] Assumes that excess electricity generated PV qualifies for net metering based utility credits. PV installation incentive of $2.55/kW is applied.

Table 5 – Impacts of EE Package + PV vs. Builder Baseline

Parameter	Baseline	EE Package w/ PV	% Savings
TDVI (kBtu/sqft-yr)	105.29	66.99	36.4%
Electricity (kWh/yr)	41,603,751	23,889,289	42.6%
Electric Demand (Max MW)	11.27	9.44	16.2%
Gas (MMBtu/yr)	110,164	90,968	17.4%
Total Energy (MMBtu/yr)	252,116	180,010	28.6%
Emissions - CO2 (tonnes/yr)	20,335.17	13,178.60	35.2%
Emissions - SOx (tonnes/yr)	2.66	1.53	42.3%
Emissions - NOx (tonnes/yr)	11.69	7.88	32.5%
Energy Cost ($/yr)	$11,983,344	$8,637,167	27.9%
Simple Payback (years)	n/a	14.8	n/a
ROI (%)	n/a	6.7	n/a

Table 6 – Impacts of EE Package + DG vs. Builder Baseline

Parameter	Baseline	EE Package w/ DG	% Savings
TDVI (kBtu/sqft-yr)	105.29	92.95	11.7%
Electricity (kWh/yr)	41,603,751	28,920,574	30.5%
Electric Demand (Max MW)	11.27	9.80	13.1%
Gas (MMBtu/yr)	110,164	213,695	-94.0%
Total Energy (MMBtu/yr)	252,116	312,372	-23.9%
Emissions - CO2 (tonnes/yr)	20,335.17	21,393.10	-5.2%
Emissions - SOx (tonnes/yr)	2.66	1.88	29.1%
Emissions - NOx (tonnes/yr)	11.69	5.97	48.9%
Energy Cost ($/yr)	$11,983,344	$9,604,976	19.8%
Simple Payback (years)	n/a	6.7	n/a
ROI (%)	n/a	14.9	n/a

Finally, Table 6 shows that deploying EE-DG option could reduce Site-B combined electric and natural gas annual utility costs by $2,378,368 or by 19.8% as compared to the BPB option. The simple payback of the EE-DG option would be 6.7 years with the ROI of 14.9%. However, as previously noted on page 6 of this report, the economic calculations of the DG option were based on, applicable at the time the CVRP analysis was conducted, 2007 CA SGIP guidelines which provided rebate of $800/kW for microturbine-based systems with heat recovery. Unfortunately, the latest 2008 SGIP

eliminated all DG rebates except for the wind and fuel cell applications. That makes Site-B DG analysis presented in this report more a "what if" analytical case than a valid energy efficiency option as the DG technology becomes economically not feasible without the rebates. Nevertheless, the analysis of DG energy efficiency impacts on Site-B development remains valid while the economics could potentially become more favorable over time (lower cost, incentives.)

Due to a significant energy saving potential for PV technology a separate Table 7 was prepared to illustrate details of the Site-B PV system[10] economics. The evaluated PV installations would total ~10,760 kW (dc) of installed capacity which will require approximately 45% of the available roof areas for all prototype buildings 3, 4, and 5 to be used for PV cells installation. The simple payback for PV option alone (no other EE measures included) would be 13.8 years with the ROI of 7.3%.

Table 7 – Details of PV* Economic Calculation

Standalone PV Economics		
Excess PV generated electricity	Exported Electricity (kWh/yr)	4,979,410
exported to the utility grid	Net Metering Credits ($/yr)	$568,151
	Net Value of PV Generated Electricty ($/yr)	$3,102,173
Economics of PV system (net value)	PV Raw installed cost	$69,071,395
includes value of net metering utility	Incentive @ $2.55/watt	$27,452,004
credits and direct savings from	PV cost after Subsidy	$41,619,391
displacing grid supplied electricity	PV O&M ($/yr)	$82,886
	Simple Payback	13.8
	ROI	7.3%

* Total of ~10,760 kW (dc) of PV systems installed on 45% of the roof areas of prototypes 3 to 5.

[10] See page 94 of this report to review technical details / modeling assumption for PV based on-site power

Recommendation and Conclusions

Significant energy savings and reduction in environmental impacts can be achieved by selective application of specific Energy Efficiency measures in the Chula Vista Site-B development buildings.

The recommended Energy Efficiency measures include building envelope materials, high efficiency HVAC equipment and selective deployment of DG and PV technologies. However, as expected, each building and space-use type will have different combination and type of measures constituting a recommended/optimal Energy Efficiency package.

Details of the recommended space-use type specific EE packages are provided in the "Site-B Modeling - Detailed Results Tables" of this report. Tables 9 to 56 list recommended measures and shows their energy savings, environmental and economic impacts for each of the five Site-B prototypical buildings and their twelve analyzed space-use types.

The conducted study and detailed results listed on pages 24 to 58 of this report provide wealth of information that can be further used by the developer/builder for in-depth/ and building-specific analysis of implementing various economically feasible Energy Efficiency options in the Site-B development.

Potentially even more important may be the fact that the study also identifies Energy Efficiency measures commonly considered as valuable that in the Site-B application showed limited benefits and are not advised for implementation.

Site-B Buildings Modeling - Detailed Results, Tables

Table 8 - Prototype Buildings Detailed

Building Name	**Luminara**	**Chambray**	**Artisan**	**Artisan**	**Studio Walk**	**Studio Walk**	**Studio Walk**	**Gateway**	**Gateway**	**Gateway**	**Gateway**	**Gateway**
Space Usage	Residential	Residential	Residential	Retail	Residential	Retail	Retail	Residential	Retail	Retail	Retail	Retail
Building Prototype #	**01**	**02**	**03**	**03**	**04**	**04**	**04**	**05**	**05**	**05**	**05**	**05**
Model	RES	RES	RES	RSCSM	RES	RSCSM	RSISM	RES	RSCSM	RSISM	RSCLG	RSILG
Residential Units	1	2	5	0	10	0	0	84	0	0	0	0
Model Qty per Building	1	1	1	2	1	1	4	1	2	5	1	3
Model Length	42	49	72	19	172	19	19	198	39	39	44	44
Model Width	30	31	50	27	50	27	27	153	26	26	58	29
Stories	2	2	2.5	1	2	1	1	4	1	1	1	1
Floor-to-floor Ht.	11	11	11	14	11	14	14	11	14	14	14	14
Total sqft	2,540	2,982	9,091	510	17,215	510	510	121,309	1,003	1,003	2,528	1,242
Bedrooms	4	3	3	-	4	-	-	206	-	-	-	-
People per Unit	6	5	5	-	6	-	-	-	-	-	-	-
People Per Building	6	10	25	13	60	13	13	332	26	26	67	33
Sqft per Person	423	298	364	38	287	38	38	365	38	38	38	38
Roof Sqft	1,778	2,087	3,636	510	8,608	510	510	30,327	1,003	1,003	2,528	1,242
Roof Available %	0%	0%	45%	0%	45%	0%	0%	45%	0%	0%	0%	0%
Window %	18%	12%	7%	16%	11%	16%	10%	8%	10%	10%	16%	10%
Door % (3.5'x8')	3%	1%	6%	0%	4%	0%	0%	4%	0%	0%	0%	0%
Adiabatic Wall %	0%	0%	8%	50%	0%	50%	79%	0%	50%	70%	50%	70%
Average Orientation deg	212	178	201	201	206	206	206	171	171	171	171	171
Building Count	**265**	**99**	**47**	**47**	**80**	**80**	**80**	**33**	**33**	**33**	**33**	**33**

Detailed Modeling Results - Prototype 1 - Luminara Residential

Table 9 - Luminara Residential EE Package Composition

Measure	Baseline	Alternative 1	Alternative 2	Alternative 3	EE Package
Appliances	0.35193 w/sqft, 0.54043 Btu/hr/sqft	0.34694 w/sqft, 0.54043 Btu/hr/sqft	0.34663 w/sqft, 0.54043 Btu/hr/sqft	None	No Alternative
CHP	None	None	None	None	No Alternative
Roof Material	100% of roof at Abs=0.70	None	None	None	No Alternative
Water Heating	EF=0.594	EF=0.823	None	None	Alternative 1
Windows	U=0.56, SHGC=0.42	U=0.26, SHGC=0.37	U=0.22, SHGC=0.22	None	Alternative 2
Space Heating	Heat Pump (See Space Cooling)	AFUE=94%	None	None	No Alternative
Space Cooling	HSPF 8.1, EER 11.07, COP 3.28	SEER 14, EER 11.99	SEER 15, EER 12.72	SEER 18, EER 13.37	Alternative 2
Lighting	0.554 watts/sqft	0.508 watts/sqft	None	None	No Alternative
Photovoltaics	None	None	None	None	No Alternative
Roof Insulation	R30 batt	R38 batt	R49 batt	None	Alternative 1
Solar Thermal	None	42 Sqft of panels, 84 Gal tank	None	None	No Alternative
Thermal Storage	None	None	None	None	No Alternative
Wall Insulation	R13 batt	R19 batt	R21 batt	R21 batt + R5 rigid	Alternative 2

Table 10 - Luminara Residential EE Package and Single EE Measures Impacts on Utility Costs and Paybacks

Category and Measure	Elec Cost	Gas Cost	Total Cost	Alt Cost	Payback
Baseline	1689	$363	$2,052	$0	NA
Baseline + EE Package	1464	$315	$1,779	$3,406	12.5
Baseline + High Efficiency Appliances, 0.34694 w/sqft, 0.54043 Btu/hr/sqft	1672	$363	$2,035	$265	15.6
Baseline + High Efficiency Appliances, 0.34663 w/sqft, 0.54043 Btu/hr/sqft	1671	$363	$2,034	$359	19.9
Baseline + High Efficiency Domestic Hot Water, EF=0.823	1689	$304	$1,993	$371	6.3
Baseline + High Efficiency Glazing, U=0.26, SHGC=0.37	1692	$342	$2,034	$476	26.4
Baseline + High Efficiency Glazing, U=0.22, SHGC=0.22	1501	$392	$1,893	$1,421	8.9
Baseline + High Efficiency Heating, AFUE=94%	1689	$353	$2,042	$1,000	100.0
Baseline + High Efficiency Cooling, SEER 14, EER 11.99	1665	$363	$2,028	$329	13.7
Baseline + High Efficiency Cooling, SEER 15, EER 12.72	1647	$363	$2,010	$658	15.7
Baseline + High Efficiency Cooling, SEER 18, EER 13.37	1633	$363	$1,996	$1,645	29.4
Baseline + High Efficiency Lighting, 0.508 watts/sqft	1645	$364	$2,009	$2,070	48.1
Baseline + Envelope Insulation - Roof, R38 batt	1683	$360	$2,043	$213	23.7
Baseline + Envelope Insulation - Roof, R49 batt	1676	$359	$2,035	$978	57.5
Baseline + Solar Thermal, 42 Sqft of panels, 84 Gal tank	1689	$238	$1,927	$9,112	89.1
Baseline + Envelope Insulation - Walls, R19 batt	1682	$354	$2,036	$403	25.2
Baseline + Envelope Insulation - Walls, R21 batt	1681	$353	$2,034	$743	41.3
Baseline + Envelope Insulation - Walls, R21 batt + R5 rigid	1673	$342	$2,015	$4,707	127.2

Table 11 - Luminara Residential EE Package and Single EE Measures Impacts on Energy Consumption

Category and Measure	Elec kWh	Elec MMBtu	Gas MMBtu	Total MMBtu	MMBtu Diff
Baseline	11,091	38	33	71	0
Baseline + EE Package	10,078	34	29	63	8
Baseline + High Efficiency Appliances, 0.34694 w/sqft, 0.54043 Btu/hr/sqft	11,009	38	33	70	1
Baseline + High Efficiency Appliances, 0.34663 w/sqft, 0.54043 Btu/hr/sqft	11,004	38	33	70	1
Baseline + High Efficiency Domestic Hot Water, EF=0.823	11,091	38	28	65	6
Baseline + High Efficiency Glazing, U=0.26, SHGC=0.37	11,100	38	31	69	2
Baseline + High Efficiency Glazing, U=0.22, SHGC=0.22	10,242	35	36	70	1
Baseline + High Efficiency Heating, AFUE=94%	11,091	38	32	70	1
Baseline + High Efficiency Cooling, SEER 14, EER 11.99	10,986	37	33	70	1
Baseline + High Efficiency Cooling, SEER 15, EER 12.72	10,912	37	33	70	1
Baseline + High Efficiency Cooling, SEER 18, EER 13.37	10,853	37	33	70	1
Baseline + High Efficiency Lighting, 0.508 watts/sqft	10,891	37	33	70	1
Baseline + Envelope Insulation - Roof, R38 batt	11,071	38	33	70	1
Baseline + Envelope Insulation - Roof, R49 batt	11,044	38	33	70	1
Baseline + Solar Thermal, 42 Sqft of panels, 84 Gal tank	11,091	38	22	60	11
Baseline + Envelope Insulation - Walls, R19 batt	11,060	38	32	70	1
Baseline + Envelope Insulation - Walls, R21 batt	11,048	38	32	69	2
Baseline + Envelope Insulation - Walls, R21 batt + R5 rigid	11,012	38	31	68	3

Table 12 - Luminara Residential EE Package and Single EE Measures Impacts on TDVI

Category and Measure	Space Sqft	Elec TDV	Gas TDV	Total TDV	TDV Diff
Baseline	2,540	66	14	80	0
Baseline + EE Package	2,540	59	12	71	9
Baseline + High Efficiency Appliances, 0.34694 w/sqft, 0.54043 Btu/hr/sqft	2,540	66	14	80	0
Baseline + High Efficiency Appliances, 0.34663 w/sqft, 0.54043 Btu/hr/sqft	2,540	66	14	79	1
Baseline + High Efficiency Domestic Hot Water, EF=0.823	2,540	66	11	78	2
Baseline + High Efficiency Glazing, U=0.26, SHGC=0.37	2,540	66	13	79	1
Baseline + High Efficiency Glazing, U=0.22, SHGC=0.22	2,540	61	15	75	5
Baseline + High Efficiency Heating, AFUE=94%	2,540	66	13	80	0
Baseline + High Efficiency Cooling, SEER 14, EER 11.99	2,540	66	14	79	1
Baseline + High Efficiency Cooling, SEER 15, EER 12.72	2,540	65	14	78	2
Baseline + High Efficiency Cooling, SEER 18, EER 13.37	2,540	64	14	78	2
Baseline + High Efficiency Lighting, 0.508 watts/sqft	2,540	65	14	79	1
Baseline + Envelope Insulation - Roof, R38 batt	2,540	66	14	80	0
Baseline + Envelope Insulation - Roof, R49 batt	2,540	66	13	80	0
Baseline + Solar Thermal, 42 Sqft of panels, 84 Gal tank	2,540	66	9	75	5
Baseline + Envelope Insulation - Walls, R19 batt	2,540	66	13	79	1
Baseline + Envelope Insulation - Walls, R21 batt	2,540	66	13	79	1
Baseline + Envelope Insulation - Walls, R21 batt + R5 rigid	2,540	66	13	78	2

Detailed Modeling Results - Prototype 2 - Chambray Residential

Table 13 - Chambray Residential EE Package Composition

Measure	Baseline	Alternative 1	Alternative 2	Alternative 3	EE Package
Appliances	0.39347 w/sqft, 0.93 Btu/hr/sqft	0.38497 w/sqft, 0.93 Btu/hr/sqft	0.38444 w/sqft, 0.93 Btu/hr/sqft	None	No Alternative
CHP	None	None	None	None	No Alternative
Roof Material	100% of roof at Abs=0.70	None	None	None	No Alternative
Water Heating	EF=0.594	EF=0.823	None	None	Alternative 1
Windows	U=0.56, SHGC=0.42	U=0.26, SHGC=0.37	U=0.22, SHGC=0.22	None	Alternative 2
Space Heating	Heat Pump (See Space Cooling)	AFUE=94%	None	None	No Alternative
Space Cooling	HSPF 8.1, EER 11.07, COP 3.28	SEER 14, EER 11.99	SEER 15, EER 12.72	SEER 18, EER 13.37	Alternative 1
Lighting	0.592 watts/sqft	0.542 watts/sqft	None	None	No Alternative
Photovoltaics	None	None	None	None	No Alternative
Roof Insulation	R30 batt	R38 batt	R49 batt	None	Alternative 1
Solar Thermal	None	42 Sqft of panels, 84 Gal tank	None	None	No Alternative
Thermal Storage	None	None	None	None	No Alternative
Wall Insulation	R13 batt	R19 batt	R21 batt	R21 batt + R5 rigid	Alternative 2

Table 14 - Chambray Residential EE Package and Single EE Measures Impacts on Utility Costs and Paybacks

Category and Measure	Elec Cost	Gas Cost	Total Cost	Alt Cost	Payback
Baseline	2238	$601	$2,839	$0	NA
Baseline + EE Package	2036	$484	$2,520	$3,213	10.1
Baseline + High Efficiency Appliances, 0.38497 w/sqft, 0.93 Btu/hr/sqft	2204	$602	$2,806	$529	16.0
Baseline + High Efficiency Appliances, 0.38444 w/sqft, 0.93 Btu/hr/sqft	2201	$602	$2,803	$717	19.9
Baseline + High Efficiency Domestic Hot Water, EF=0.823	2238	$493	$2,731	$741	6.9
Baseline + High Efficiency Glazing, U=0.26, SHGC=0.37	2244	$586	$2,830	$331	36.8
Baseline + High Efficiency Glazing, U=0.22, SHGC=0.22	2091	$625	$2,716	$990	8.0
Baseline + High Efficiency Heating, AFUE=94%	2238	$590	$2,828	$2,000	181.8
Baseline + High Efficiency Cooling, SEER 14, EER 11.99	2215	$601	$2,816	$400	17.4
Baseline + High Efficiency Cooling, SEER 15, EER 12.72	2197	$601	$2,798	$800	19.5
Baseline + High Efficiency Cooling, SEER 18, EER 13.37	2185	$601	$2,786	$2,001	37.7
Baseline + High Efficiency Lighting, 0.542 watts/sqft	2182	$602	$2,784	$2,700	49.1
Baseline + Envelope Insulation - Roof, R38 batt	2231	$598	$2,829	$250	25.0
Baseline + Envelope Insulation - Roof, R49 batt	2225	$598	$2,823	$1,148	71.8
Baseline + Solar Thermal, 42 Sqft of panels, 84 Gal tank	2238	$371	$2,609	$18,224	98.8
Baseline + Envelope Insulation - Walls, R19 batt	2233	$592	$2,825	$450	32.2
Baseline + Envelope Insulation - Walls, R21 batt	2231	$588	$2,819	$831	41.6
Baseline + Envelope Insulation - Walls, R21 batt + R5 rigid	2223	$577	$2,800	$5,266	135.0

Table 15 - Chambray Residential EE Package and Single EE Measures Impacts on Energy Consumption

Category and Measure	Elec kWh	Elec MMBtu	Gas MMBtu	Total MMBtu	MMBtu Diff
Baseline	13,612	46	53	99	0
Baseline + EE Package	12,710	43	43	86	13
Baseline + High Efficiency Appliances, 0.38497 w/sqft, 0.93 Btu/hr/sqft	13,450	46	53	99	0
Baseline + High Efficiency Appliances, 0.38444 w/sqft, 0.93 Btu/hr/sqft	13,440	46	53	99	0
Baseline + High Efficiency Domestic Hot Water, EF=0.823	13,612	46	44	90	9
Baseline + High Efficiency Glazing, U=0.26, SHGC=0.37	13,634	47	52	98	1
Baseline + High Efficiency Glazing, U=0.22, SHGC=0.22	12,954	44	55	99	0
Baseline + High Efficiency Heating, AFUE=94%	13,612	46	52	99	0
Baseline + High Efficiency Cooling, SEER 14, EER 11.99	13,511	46	53	99	0
Baseline + High Efficiency Cooling, SEER 15, EER 12.72	13,439	46	53	99	0
Baseline + High Efficiency Cooling, SEER 18, EER 13.37	13,381	46	53	98	1
Baseline + High Efficiency Lighting, 0.542 watts/sqft	13,359	46	53	99	0
Baseline + Envelope Insulation - Roof, R38 batt	13,587	46	53	99	0
Baseline + Envelope Insulation - Roof, R49 batt	13,553	46	52	99	0
Baseline + Solar Thermal, 42 Sqft of panels, 84 Gal tank	13,612	46	33	80	19
Baseline + Envelope Insulation - Walls, R19 batt	13,584	46	52	98	1
Baseline + Envelope Insulation - Walls, R21 batt	13,576	46	52	98	1
Baseline + Envelope Insulation - Walls, R21 batt + R5 rigid	13,539	46	51	97	2

Table 16 - Chambray Residential EE Package and Single EE Measures Impacts on TDVI

Category and Measure	Space Sqft	Elec TDV	Gas TDV	Total TDV	TDV Diff
Baseline	2,982	69	19	87	0
Baseline + EE Package	2,982	63	15	79	8
Baseline + High Efficiency Appliances, 0.38497 w/sqft, 0.93 Btu/hr/sqft	2,982	68	19	87	0
Baseline + High Efficiency Appliances, 0.38444 w/sqft, 0.93 Btu/hr/sqft	2,982	68	19	87	0
Baseline + High Efficiency Domestic Hot Water, EF=0.823	2,982	69	16	84	3
Baseline + High Efficiency Glazing, U=0.26, SHGC=0.37	2,982	69	18	87	0
Baseline + High Efficiency Glazing, U=0.22, SHGC=0.22	2,982	65	19	84	3
Baseline + High Efficiency Heating, AFUE=94%	2,982	69	19	87	0
Baseline + High Efficiency Cooling, SEER 14, EER 11.99	2,982	68	19	87	0
Baseline + High Efficiency Cooling, SEER 15, EER 12.72	2,982	68	19	86	1
Baseline + High Efficiency Cooling, SEER 18, EER 13.37	2,982	67	19	86	1
Baseline + High Efficiency Lighting, 0.542 watts/sqft	2,982	67	19	86	1
Baseline + Envelope Insulation - Roof, R38 batt	2,982	69	19	87	0
Baseline + Envelope Insulation - Roof, R49 batt	2,982	68	19	87	0
Baseline + Solar Thermal, 42 Sqft of panels, 84 Gal tank	2,982	69	12	80	7
Baseline + Envelope Insulation - Walls, R19 batt	2,982	68	18	87	0
Baseline + Envelope Insulation - Walls, R21 batt	2,982	68	18	87	0
Baseline + Envelope Insulation - Walls, R21 batt + R5 rigid	2,982	68	18	86	1

Detailed Modeling Results - Prototype 3 - Artisan Residential

Table 17- Artisan Residential EE Package Composition

Measure	Baseline	Alternative 1	Alternative 2	Alternative 3	EE Package
Appliances	0.37556 w/sqft, 0.75563 Btu/hr/sqft	0.36858 w/sqft, 0.75563 Btu/hr/sqft	0.36815 w/sqft, 0.75563 Btu/hr/sqft	None	Alternative 1
CHP	None	None	None	None	No Alternative
Roof Material	75% of roof at Abs=0.70	75% of roof at Abs=0.25	None	None	Alternative 1
Water Heating	EF=0.594	EF=0.823	None	None	Alternative 1
Windows	U=0.56, SHGC=0.42	U=0.26, SHGC=0.37	U=0.22, SHGC=0.22	None	Alternative 2
Space Heating	Heat Pump (See Space Cooling)	AFUE=94%	None	None	No Alternative
Space Cooling	HSPF 8.1, EER 11.07, COP 3.28	SEER 14, EER 11.99	SEER 15, EER 12.72	SEER 18, EER 13.37	Alternative 2
Lighting	0.643 watts/sqft	0.587 watts/sqft	None	None	No Alternative
Photovoltaics	None	1640 Sqft @ 0 deg pitch	None	None	Alternative 1
Roof Insulation	R30 batt	R38 batt	R49 batt	None	Alternative 2
Solar Thermal	None	42 Sqft of panels, 84 Gal tank	None	None	No Alternative
Thermal Storage	None	None	None	None	No Alternative
Wall Insulation	R13 batt	R19 batt	R21 batt	R21 batt + R5 rigid	No Alternative

Table 18- Artisan Residential EE Package and Single EE Measures Impacts on Utility Costs and Paybacks

Baseline	8712	$1,556	$10,268	$0	NA
Baseline + EE Package	8127	$1,273	$9,400	$8,144	9.4
Baseline + EE Package + Photovoltaics	4701	$1,273	$5,974	$89,680	16.2
Baseline + High Efficiency Appliances, 0.36858 w/sqft, 0.75563 Btu/hr/sqft	8609	$1,558	$10,167	$1,323	13.1
Baseline + High Efficiency Appliances, 0.36815 w/sqft, 0.75563 Btu/hr/sqft	8604	$1,558	$10,162	$1,793	16.9
Baseline + Cool Roof, 75% of roof at Abs=0.25	8574	$1,563	$10,137	$900	6.9
Baseline + High Efficiency Domestic Hot Water, EF=0.823	8712	$1,269	$9,981	$1,853	6.5
Baseline + High Efficiency Glazing, U=0.26, SHGC=0.37	8724	$1,550	$10,274	$400	never
Baseline + High Efficiency Glazing, U=0.22, SHGC=0.22	8486	$1,563	$10,049	$1,196	5.5
Baseline + High Efficiency Heating, AFUE=94%	8712	$1,541	$10,253	$5,000	333.3
Baseline + High Efficiency Cooling, SEER 14, EER 11.99	8631	$1,556	$10,187	$891	11.0
Baseline + High Efficiency Cooling, SEER 15, EER 12.72	8574	$1,556	$10,130	$1,781	12.9
Baseline + High Efficiency Cooling, SEER 18, EER 13.37	8527	$1,556	$10,083	$4,453	24.1
Baseline + High Efficiency Lighting, 0.587 watts/sqft	8478	$1,559	$10,037	$8,910	38.6
Baseline + Photovoltaics, 1640 Sqft @ 0 deg pitch	5028	$1,556	$6,584	$81,535	16.9
Baseline + Envelope Insulation - Roof, R38 batt	8677	$1,550	$10,227	$655	16.0
Baseline + Envelope Insulation - Roof, R49 batt	8670	$1,547	$10,217	$1,091	21.4
Baseline + Solar Thermal, 42 Sqft of panels, 84 Gal tank	8712	$917	$9,629	$45,560	86.8
Baseline + Envelope Insulation - Walls, R19 batt	8708	$1,550	$10,258	$754	75.4
Baseline + Envelope Insulation - Walls, R21 batt	8709	$1,547	$10,256	$1,392	116.0
Baseline + Envelope Insulation - Walls, R21 batt + R5 rigid	8704	$1,543	$10,247	$8,819	419.9

Table 19- Artisan Residential EE Package and Single EE Measures Impacts on Energy Consumption

Category and Measure	Elec kWh	Elec MMBtu	Gas MMBtu	Total MMBtu	MMBtu Diff
Baseline	41,274	141	126	267	0
Baseline + EE Package	38,948	133	104	237	30
Baseline + EE Package + Photovoltaics	24,612	84	104	188	79
Baseline + High Efficiency Appliances, 0.36858 w/sqft, 0.75563 Btu/hr/sqft	40,865	139	126	265	2
Baseline + High Efficiency Appliances, 0.36815 w/sqft, 0.75563 Btu/hr/sqft	40,840	139	126	265	2
Baseline + Cool Roof, 75% of roof at Abs=0.25	40,730	139	126	265	2
Baseline + High Efficiency Domestic Hot Water, EF=0.823	41,274	141	104	245	22
Baseline + High Efficiency Glazing, U=0.26, SHGC=0.37	41,335	141	125	267	0
Baseline + High Efficiency Glazing, U=0.22, SHGC=0.22	40,383	138	127	264	3
Baseline + High Efficiency Heating, AFUE=94%	41,274	141	125	266	1
Baseline + High Efficiency Cooling, SEER 14, EER 11.99	40,955	140	126	266	1
Baseline + High Efficiency Cooling, SEER 15, EER 12.72	40,729	139	126	265	2
Baseline + High Efficiency Cooling, SEER 18, EER 13.37	40,548	138	126	264	3
Baseline + High Efficiency Lighting, 0.587 watts/sqft	40,332	138	126	264	3
Baseline + Photovoltaics, 1640 Sqft @ 0 deg pitch	26,021	89	126	215	52
Baseline + Envelope Insulation - Roof, R38 batt	41,148	140	125	266	1
Baseline + Envelope Insulation - Roof, R49 batt	41,112	140	125	266	1
Baseline + Solar Thermal, 42 Sqft of panels, 84 Gal tank	41,274	141	77	218	49
Baseline + Envelope Insulation - Walls, R19 batt	41,258	141	126	266	1
Baseline + Envelope Insulation - Walls, R21 batt	41,272	141	125	266	1
Baseline + Envelope Insulation - Walls, R21 batt + R5 rigid	41,258	141	125	266	1

Table 20- Artisan Residential EE Package and Single EE Measures Impacts on TDVI

Category and Measure	Space Sqft	Elec TDV	Gas TDV	Total TDV	TDV Diff
Baseline	9,091	68	15	83	0
Baseline + EE Package	9,091	64	12	76	7
Baseline + EE Package + Photovoltaics	9,091	16	12	28	55
Baseline + High Efficiency Appliances, 0.36858 w/sqft, 0.75563 Btu/hr/sqft	9,091	67	15	82	1
Baseline + High Efficiency Appliances, 0.36815 w/sqft, 0.75563 Btu/hr/sqft	9,091	67	15	82	1
Baseline + Cool Roof, 75% of roof at Abs=0.25	9,091	67	15	82	1
Baseline + High Efficiency Domestic Hot Water, EF=0.823	9,091	68	12	80	3
Baseline + High Efficiency Glazing, U=0.26, SHGC=0.37	9,091	68	15	83	0
Baseline + High Efficiency Glazing, U=0.22, SHGC=0.22	9,091	66	15	81	2
Baseline + High Efficiency Heating, AFUE=94%	9,091	68	15	82	1
Baseline + High Efficiency Cooling, SEER 14, EER 11.99	9,091	67	15	82	1
Baseline + High Efficiency Cooling, SEER 15, EER 12.72	9,091	67	15	81	2
Baseline + High Efficiency Cooling, SEER 18, EER 13.37	9,091	66	15	81	2
Baseline + High Efficiency Lighting, 0.587 watts/sqft	9,091	66	15	81	2
Baseline + Photovoltaics, 1640 Sqft @ 0 deg pitch	9,091	20	15	35	48
Baseline + Envelope Insulation - Roof, R38 batt	9,091	68	15	82	1
Baseline + Envelope Insulation - Roof, R49 batt	9,091	68	15	82	1
Baseline + Solar Thermal, 42 Sqft of panels, 84 Gal tank	9,091	68	9	77	6
Baseline + Envelope Insulation - Walls, R19 batt	9,091	68	15	83	0
Baseline + Envelope Insulation - Walls, R21 batt	9,091	68	15	82	1
Baseline + Envelope Insulation - Walls, R21 batt + R5 rigid	9,091	68	15	82	1

Detailed Modeling Results - Prototype 3 - Artisan Retail Shop (Corner, Small)

Table 21 - Artisan Retail Shop (Corner, Small) EE Package Composition

Measure	Baseline	Alternative 1	Alternative 2	Alternative 3	EE Package
Appliances	Not Applicable	None	None	None	No Alternative
CHP	Not Applicable	None	None	None	No Alternative
Roof Material	Not Applicable	None	None	None	No Alternative
Water Heating	EF=0.594	EF=0.823	None	None	No Alternative
Windows	U=0.57, SHGC=0.61	U=0.26, SHGC=0.37	U=0.22, SHGC=0.22	None	Alternative 2
Space Heating	Heat Pump (See Space Cooling)	None	None	None	No Alternative
Space Cooling	HSPF 8.1, EER 11.07, COP 3.28	HSPF 8.6, EER 12.19, COP 3.52	HSPF 8.8 ,EER 12.70, COP 3.74	HSPF 9.2 ,EER 12.88, COP 3.66	Alternative 3
Lighting	1.5 watts/sqft	None	None	None	No Alternative
Photovoltaics	Not Applicable	None	None	None	No Alternative
Roof Insulation	Not Applicable	None	None	None	No Alternative
Solar Thermal	Not Applicable	None	None	None	No Alternative
Thermal Storage	Not Applicable	None	None	None	No Alternative
Wall Insulation	R11 batt	R19 batt	R21 batt	R21 batt + R5 rigid	Alternative 3

Table 22- Artisan Retail Shop (Corner, Small) EE Package and Single EE Measures Impacts on Utility Costs and Paybacks

Category and Measure	Elec Cost	Gas Cost	Total Cost	Alt Cost	Payback
Baseline	1812	$1,536	$3,348	$0	NA
Baseline + EE Package	1593	$1,536	$3,129	$2,525	11.5
Baseline + High Efficiency Domestic Hot Water, EF=0.823	1812	$1,512	$3,324	$371	15.4
Baseline + High Efficiency Glazing, U=0.26, SHGC=0.37	1769	$1,536	$3,305	$168	3.9
Baseline + High Efficiency Glazing, U=0.22, SHGC=0.22	1700	$1,536	$3,236	$503	4.5
Baseline + High Efficiency Cooling, HSPF 8.6, EER 12.19, COP 3.52	1766	$1,536	$3,302	$209	4.6
Baseline + High Efficiency Cooling, HSPF 8.8 ,EER 12.70, COP 3.74	1743	$1,536	$3,279	$419	6.1
Baseline + High Efficiency Cooling, HSPF 9.2 ,EER 12.88, COP 3.66	1732	$1,536	$3,268	$1,047	13.1
Baseline + Envelope Insulation - Walls, R19 batt	1790	$1,536	$3,326	$83	3.8
Baseline + Envelope Insulation - Walls, R21 batt	1789	$1,536	$3,325	$154	6.7
Baseline + Envelope Insulation - Walls, R21 batt + R5 rigid	1776	$1,536	$3,312	$975	27.1

Table 23 - Artisan Retail Shop (Corner, Small) EE Package and Single EE Measures Impacts on Energy Consumption

Category and Measure	Elec kWh	Elec MMBtu	Gas MMBtu	Total MMBtu	MMBtu Diff
Baseline	7,044	24	7	31	0
Baseline + EE Package	5,927	20	7	27	4
Baseline + High Efficiency Domestic Hot Water, EF=0.823	7,044	24	5	29	2
Baseline + High Efficiency Glazing, U=0.26, SHGC=0.37	6,929	24	7	30	1
Baseline + High Efficiency Glazing, U=0.22, SHGC=0.22	6,379	22	7	28	3
Baseline + High Efficiency Cooling, HSPF 8.6, EER 12.19, COP 3.52	6,815	23	7	30	1
Baseline + High Efficiency Cooling, HSPF 8.8 ,EER 12.70, COP 3.74	6,698	23	7	29	2
Baseline + High Efficiency Cooling, HSPF 9.2 ,EER 12.88, COP 3.66	6,633	23	7	29	2
Baseline + Envelope Insulation - Walls, R19 batt	7,008	24	7	31	0
Baseline + Envelope Insulation - Walls, R21 batt	7,000	24	7	30	1
Baseline + Envelope Insulation - Walls, R21 batt + R5 rigid	6,927	24	7	30	1

Table 24 - Artisan Retail Shop (Corner, Small) EE Package and Single EE Measures Impacts on TDVI

Category and Measure	Space Sqft	Elec TDV	Gas TDV	Total TDV	TDV Diff
Baseline	510	275	14	289	0
Baseline + EE Package	510	227	14	241	48
Baseline + High Efficiency Domestic Hot Water, EF=0.823	510	275	11	285	4
Baseline + High Efficiency Glazing, U=0.26, SHGC=0.37	510	271	14	285	4
Baseline + High Efficiency Glazing, U=0.22, SHGC=0.22	510	250	14	264	25
Baseline + High Efficiency Cooling, HSPF 8.6, EER 12.19, COP 3.52	510	264	14	279	10
Baseline + High Efficiency Cooling, HSPF 8.8 ,EER 12.70, COP 3.74	510	259	14	273	16
Baseline + High Efficiency Cooling, HSPF 9.2 ,EER 12.88, COP 3.66	510	256	14	270	19
Baseline + Envelope Insulation - Walls, R19 batt	510	273	14	287	2
Baseline + Envelope Insulation - Walls, R21 batt	510	273	14	287	2
Baseline + Envelope Insulation - Walls, R21 batt + R5 rigid	510	270	14	284	5

Detailed Modeling Results - Prototype 4 – Studio Walk Residential

Table 25 - Studio Walk Residential EE Package Composition

Measure	Baseline	Alternative 1	Alternative 2	Alternative 3	EE Package
Appliances	0.3801 w/sqft, 0.79647 Btu/hr/sqft	0.37273 w/sqft, 0.79647 Btu/hr/sqft	0.37228 w/sqft, 0.79647 Btu/hr/sqft	None	Alternative 1
CHP	None	30 kW, 0 Tons Abs	None	None	No Alternative
Roof Material	100% of roof at Abs=0.70	100% of roof at Abs=0.25	None	None	Alternative 1
Water Heating	EF=0.594	EF=0.823	None	None	Alternative 1
Windows	U=0.56, SHGC=0.42	U=0.26, SHGC=0.37	U=0.22, SHGC=0.22	None	Alternative 2
Space Heating	Heat Pump (See Space Cooling)	AFUE=94%	None	None	No Alternative
Space Cooling	HSPF 8.1, EER 11.07, COP 3.28	SEER 14, EER 11.99	SEER 15, EER 12.72	SEER 18, EER 13.37	Alternative 2
Lighting	0.576 watts/sqft	0.532 watts/sqft	None	None	No Alternative
Photovoltaics	None	3870 Sqft @ 0 deg pitch	None	None	Alternative 1
Roof Insulation	R30 batt	R38 batt	R49 batt	None	Alternative 2
Solar Thermal	None	42 Sqft of panels, 84 Gal tank	None	None	No Alternative
Thermal Storage	None	None	None	None	No Alternative
Wall Insulation	R13 batt	R19 batt	R21 batt	R21 batt + R5 rigid	No Alternative

Table 26 - Studio Walk Residential EE Package and Single EE Measures Impacts on Utility Costs and Paybacks

Baseline	17693	$3,185	$20,878	$0	NA
Baseline + EE Package	16256	$2,623	$18,879	$18,225	9.1
Baseline + EE Package + Photovoltaics	9215	$2,623	$11,838	$210,629	16.7
Baseline + High Efficiency Appliances, 0.37273 w/sqft, 0.79647 Btu/hr/sqft	17484	$3,186	$20,670	$2,646	12.7
Baseline + High Efficiency Appliances, 0.37228 w/sqft, 0.79647 Btu/hr/sqft	17470	$3,186	$20,656	$3,586	16.2
Baseline + Combined Heat and Power, 30 kW, 0 Tons Abs	8191	$11,066	$19,257	$88,693	97.4
Baseline + Cool Roof, 100% of roof at Abs=0.25	17156	$3,210	$20,366	$2,840	5.5
Baseline + High Efficiency Domestic Hot Water, EF=0.823	17693	$2,615	$20,308	$3,706	6.5
Baseline + High Efficiency Glazing, U=0.26, SHGC=0.37	17744	$3,171	$20,915	$882	never
Baseline + High Efficiency Glazing, U=0.22, SHGC=0.22	17080	$3,203	$20,283	$2,634	4.4
Baseline + High Efficiency Heating, AFUE=94%	17693	$3,153	$20,846	$10,000	312.5
Baseline + High Efficiency Cooling, SEER 14, EER 11.99	17502	$3,185	$20,687	$1,908	10.0
Baseline + High Efficiency Cooling, SEER 15, EER 12.72	17370	$3,185	$20,555	$3,815	11.8
Baseline + High Efficiency Cooling, SEER 18, EER 13.37	17261	$3,185	$20,446	$9,537	22.1
Baseline + High Efficiency Lighting, 0.532 watts/sqft	17339	$3,187	$20,526	$17,100	48.6
Baseline + Photovoltaics, 3870 Sqft @ 0 deg pitch	10029	$3,185	$13,214	$192,404	17.6
Baseline + Envelope Insulation - Roof, R38 batt	17626	$3,171	$20,797	$1,549	19.1
Baseline + Envelope Insulation - Roof, R49 batt	17596	$3,167	$20,763	$2,582	22.5
Baseline + Solar Thermal, 42 Sqft of panels, 84 Gal tank	17693	$1,917	$19,610	$91,120	87.6
Baseline + Envelope Insulation - Walls, R19 batt	17695	$3,173	$20,868	$1,220	122.0
Baseline + Envelope Insulation - Walls, R21 batt	17692	$3,171	$20,863	$2,252	150.1
Baseline + Envelope Insulation - Walls, R21 batt + R5 rigid	17682	$3,161	$20,843	$14,263	407.5

Table 27 - Studio Walk Residential EE Package and Single EE Measures Impacts on Energy Consumption

Category and Measure	Elec kWh	Elec MMBtu	Gas MMBtu	Total MMBtu	MMBtu Diff
Baseline	77,738	265	250	515	0
Baseline + EE Package	71,984	246	207	453	62
Baseline + EE Package + Photovoltaics	43,454	148	207	355	160
Baseline + High Efficiency Appliances, 0.37273 w/sqft, 0.79647 Btu/hr/sqft	76,885	262	250	512	3
Baseline + High Efficiency Appliances, 0.37228 w/sqft, 0.79647 Btu/hr/sqft	76,831	262	250	512	3
Baseline + Combined Heat and Power, 30 kW, 0 Tons Abs	33,414	114	849	963	-448
Baseline + Cool Roof, 100% of roof at Abs=0.25	75,592	258	252	510	5
Baseline + High Efficiency Domestic Hot Water, EF=0.823	77,738	265	207	472	43
Baseline + High Efficiency Glazing, U=0.26, SHGC=0.37	77,941	266	249	515	0
Baseline + High Efficiency Glazing, U=0.22, SHGC=0.22	75,282	257	251	508	7
Baseline + High Efficiency Heating, AFUE=94%	77,738	265	247	513	2
Baseline + High Efficiency Cooling, SEER 14, EER 11.99	76,983	263	250	513	2
Baseline + High Efficiency Cooling, SEER 15, EER 12.72	76,449	261	250	511	4
Baseline + High Efficiency Cooling, SEER 18, EER 13.37	76,023	259	250	509	6
Baseline + High Efficiency Lighting, 0.532 watts/sqft	76,302	260	250	510	5
Baseline + Photovoltaics, 3870 Sqft @ 0 deg pitch	46,727	159	250	409	106
Baseline + Envelope Insulation - Roof, R38 batt	77,468	264	249	513	2
Baseline + Envelope Insulation - Roof, R49 batt	77,352	264	249	513	2
Baseline + Solar Thermal, 42 Sqft of panels, 84 Gal tank	77,738	265	154	419	96
Baseline + Envelope Insulation - Walls, R19 batt	77,742	265	249	514	1
Baseline + Envelope Insulation - Walls, R21 batt	77,726	265	249	514	1
Baseline + Envelope Insulation - Walls, R21 batt + R5 rigid	77,693	265	248	513	2

Table 28 - Studio Walk Residential EE Package and Single EE Measures Impacts on TDVI

Category and Measure	Space Sqft	Elec TDV	Gas TDV	Total TDV	TDV Diff
Baseline	17,215	68	15	83	0
Baseline + EE Package	17,215	62	13	75	8
Baseline + EE Package + Photovoltaics	17,215	3	13	15	68
Baseline + High Efficiency Appliances, 0.37273 w/sqft, 0.79647 Btu/hr/sqft	17,215	67	15	82	1
Baseline + High Efficiency Appliances, 0.37228 w/sqft, 0.79647 Btu/hr/sqft	17,215	67	15	82	1
Baseline + Combined Heat and Power, 30 kW, 0 Tons Abs	17,215	28	52	81	2
Baseline + Cool Roof, 100% of roof at Abs=0.25	17,215	66	15	81	2
Baseline + High Efficiency Domestic Hot Water, EF=0.823	17,215	68	13	80	3
Baseline + High Efficiency Glazing, U=0.26, SHGC=0.37	17,215	68	15	83	0
Baseline + High Efficiency Glazing, U=0.22, SHGC=0.22	17,215	65	15	81	2
Baseline + High Efficiency Heating, AFUE=94%	17,215	68	15	83	0
Baseline + High Efficiency Cooling, SEER 14, EER 11.99	17,215	67	15	82	1
Baseline + High Efficiency Cooling, SEER 15, EER 12.72	17,215	66	15	82	1
Baseline + High Efficiency Cooling, SEER 18, EER 13.37	17,215	66	15	81	2
Baseline + High Efficiency Lighting, 0.532 watts/sqft	17,215	66	15	82	1
Baseline + Photovoltaics, 3870 Sqft @ 0 deg pitch	17,215	8	15	24	59
Baseline + Envelope Insulation - Roof, R38 batt	17,215	67	15	83	0
Baseline + Envelope Insulation - Roof, R49 batt	17,215	67	15	82	1
Baseline + Solar Thermal, 42 Sqft of panels, 84 Gal tank	17,215	68	9	77	6
Baseline + Envelope Insulation - Walls, R19 batt	17,215	68	15	83	0
Baseline + Envelope Insulation - Walls, R21 batt	17,215	68	15	83	0
Baseline + Envelope Insulation - Walls, R21 batt + R5 rigid	17,215	67	15	83	0

Detailed Modeling Results - Prototype 4 – Studio Walk Retail Shop (Corner, Small)

Table 29 - Studio Walk Retail Shop (Corner, Small) EE Package Composition

Measure	Baseline	Alternative 1	Alternative 2	Alternative 3	EE Package
Appliances	Not Applicable	None	None	None	No Alternative
CHP	Not Applicable	None	None	None	No Alternative
Roof Material	Not Applicable	None	None	None	No Alternative
Water Heating	EF=0.594	EF=0.823	None	None	No Alternative
Windows	U=0.57, SHGC=0.61	U=0.26, SHGC=0.37	U=0.22, SHGC=0.22	None	Alternative 2
Space Heating	Heat Pump (See Space Cooling)	None	None	None	No Alternative
Space Cooling	HSPF 8.1, EER 11.07, COP 3.28	HSPF 8.6, EER 12.19, COP 3.52	HSPF 8.8 ,EER 12.70, COP 3.74	HSPF 9.2 ,EER 12.88, COP 3.66	Alternative 3
Lighting	1.5 watts/sqft	None	None	None	No Alternative
Photovoltaics	Not Applicable	None	None	None	No Alternative
Roof Insulation	Not Applicable	None	None	None	No Alternative
Solar Thermal	Not Applicable	None	None	None	No Alternative
Thermal Storage	Not Applicable	None	None	None	No Alternative
Wall Insulation	R11 batt	R19 batt	R21 batt	R21 batt + R5 rigid	Alternative 3

Table 30 - Studio Walk Retail Shop (Corner, Small) EE Package and Single EE Measures Impacts on Utility Costs and Paybacks

Category and Measure	Elec Cost	Gas Cost	Total Cost	Alt Cost	Payback
Baseline	1792	$1,536	$3,328	$0	NA
Baseline + EE Package	1595	$1,536	$3,131	$2,493	12.7
Baseline + High Efficiency Domestic Hot Water, EF=0.823	1792	$1,512	$3,304	$371	15.4
Baseline + High Efficiency Glazing, U=0.26, SHGC=0.37	1764	$1,536	$3,300	$168	6.0
Baseline + High Efficiency Glazing, U=0.22, SHGC=0.22	1697	$1,536	$3,233	$503	5.3
Baseline + High Efficiency Cooling, HSPF 8.6, EER 12.19, COP 3.52	1757	$1,536	$3,293	$203	5.8
Baseline + High Efficiency Cooling, HSPF 8.8 ,EER 12.70, COP 3.74	1738	$1,536	$3,274	$406	7.5
Baseline + High Efficiency Cooling, HSPF 9.2 ,EER 12.88, COP 3.66	1729	$1,536	$3,265	$1,015	16.1
Baseline + Envelope Insulation - Walls, R19 batt	1784	$1,536	$3,320	$83	10.4
Baseline + Envelope Insulation - Walls, R21 batt	1784	$1,536	$3,320	$154	19.2
Baseline + Envelope Insulation - Walls, R21 batt + R5 rigid	1773	$1,536	$3,309	$975	51.3

Table 31 - Studio Walk Retail Shop (Corner, Small) EE Package and Single EE Measures Impacts on Energy Consumption

Category and Measure	Elec kWh	Elec MMBtu	Gas MMBtu	Total MMBtu	MMBtu Diff
Baseline	6,996	24	7	30	0
Baseline + EE Package	5,922	20	7	27	3
Baseline + High Efficiency Domestic Hot Water, EF=0.823	6,996	24	5	29	1
Baseline + High Efficiency Glazing, U=0.26, SHGC=0.37	6,878	23	7	30	0
Baseline + High Efficiency Glazing, U=0.22, SHGC=0.22	6,352	22	7	28	2
Baseline + High Efficiency Cooling, HSPF 8.6, EER 12.19, COP 3.52	6,774	23	7	30	0
Baseline + High Efficiency Cooling, HSPF 8.8 ,EER 12.70, COP 3.74	6,654	23	7	29	1
Baseline + High Efficiency Cooling, HSPF 9.2 ,EER 12.88, COP 3.66	6,589	22	7	29	1
Baseline + Envelope Insulation - Walls, R19 batt	6,960	24	7	30	0
Baseline + Envelope Insulation - Walls, R21 batt	6,955	24	7	30	0
Baseline + Envelope Insulation - Walls, R21 batt + R5 rigid	6,883	23	7	30	0

Table 32 - Studio Walk Retail Shop (Corner, Small) EE Package and Single EE Measures Impacts on TDVI

Category and Measure	Space Sqft	Elec TDV	Gas TDV	Total TDV	TDV Diff
Baseline	510	273	14	287	0
Baseline + EE Package	510	226	14	241	46
Baseline + High Efficiency Domestic Hot Water, EF=0.823	510	273	11	283	4
Baseline + High Efficiency Glazing, U=0.26, SHGC=0.37	510	269	14	283	4
Baseline + High Efficiency Glazing, U=0.22, SHGC=0.22	510	248	14	263	24
Baseline + High Efficiency Cooling, HSPF 8.6, EER 12.19, COP 3.52	510	262	14	277	10
Baseline + High Efficiency Cooling, HSPF 8.8 ,EER 12.70, COP 3.74	510	257	14	271	16
Baseline + High Efficiency Cooling, HSPF 9.2 ,EER 12.88, COP 3.66	510	254	14	268	19
Baseline + Envelope Insulation - Walls, R19 batt	510	271	14	285	2
Baseline + Envelope Insulation - Walls, R21 batt	510	271	14	285	2
Baseline + Envelope Insulation - Walls, R21 batt + R5 rigid	510	268	14	282	5

Detailed Modeling Results - Prototype 4 – Studio Walk Retail Shop (Internal, Small)

Table 33 - Studio Walk Retail Shop (Internal, Small) EE Package Composition

Measure	Baseline	Alternative 1	Alternative 2	Alternative 3	EE Package
Appliances	Not Applicable	None	None	None	No Alternative
CHP	Not Applicable	None	None	None	No Alternative
Roof Material	Not Applicable	None	None	None	No Alternative
Water Heating	EF=0.594	EF=0.823	None	None	No Alternative
Windows	U=0.57, SHGC=0.61	U=0.26, SHGC=0.37	U=0.22, SHGC=0.22	None	Alternative 2
Space Heating	Heat Pump (See Space Cooling)	None	None	None	No Alternative
Space Cooling	HSPF 8.1, EER 11.07, COP 3.28	HSPF 8.6, EER 12.19, COP 3.52	HSPF 8.8 ,EER 12.70, COP 3.74	HSPF 9.2 ,EER 12.88, COP 3.66	Alternative 3
Lighting	1.5 watts/sqft	None	None	None	No Alternative
Photovoltaics	Not Applicable	None	None	None	No Alternative
Roof Insulation	Not Applicable	None	None	None	No Alternative
Solar Thermal	Not Applicable	None	None	None	No Alternative
Thermal Storage	Not Applicable	None	None	None	No Alternative
Wall Insulation	R11 batt	R19 batt	R21 batt	R21 batt + R5 rigid	Alternative 3

Table 34 - Studio Walk Retail Shop (Internal, Small) EE Package and Single EE Measures Impacts on Utility Costs and Paybacks

Category and Measure	Elec Cost	Gas Cost	Total Cost	Alt Cost	Payback
Baseline	1667	$1,536	$3,203	$0	NA
Baseline + EE Package	1564	$1,536	$3,100	$1,524	14.8
Baseline + High Efficiency Domestic Hot Water, EF=0.823	1667	$1,512	$3,179	$371	15.4
Baseline + High Efficiency Glazing, U=0.26, SHGC=0.37	1653	$1,536	$3,189	$105	7.5
Baseline + High Efficiency Glazing, U=0.22, SHGC=0.22	1603	$1,536	$3,139	$314	4.9
Baseline + High Efficiency Cooling, HSPF 8.6, EER 12.19, COP 3.52	1623	$1,536	$3,159	$161	3.6
Baseline + High Efficiency Cooling, HSPF 8.8 ,EER 12.70, COP 3.74	1595	$1,536	$3,131	$321	4.5
Baseline + High Efficiency Cooling, HSPF 9.2 ,EER 12.88, COP 3.66	1588	$1,536	$3,124	$803	10.2
Baseline + Envelope Insulation - Walls, R19 batt	1661	$1,536	$3,197	$35	5.8
Baseline + Envelope Insulation - Walls, R21 batt	1660	$1,536	$3,196	$64	9.2
Baseline + Envelope Insulation - Walls, R21 batt + R5 rigid	1655	$1,536	$3,191	$406	33.9

Table 35 - Studio Walk Retail Shop (Internal, Small) EE Package and Single EE Measures Impacts on Energy Consumption

Category and Measure	Elec kWh	Elec MMBtu	Gas MMBtu	Total MMBtu	MMBtu Diff
Baseline	6,233	21	7	28	0
Baseline + EE Package	5,794	20	7	26	2
Baseline + High Efficiency Domestic Hot Water, EF=0.823	6,233	21	5	26	2
Baseline + High Efficiency Glazing, U=0.26, SHGC=0.37	6,178	21	7	28	0
Baseline + High Efficiency Glazing, U=0.22, SHGC=0.22	6,024	21	7	27	1
Baseline + High Efficiency Cooling, HSPF 8.6, EER 12.19, COP 3.52	6,017	21	7	27	1
Baseline + High Efficiency Cooling, HSPF 8.8 ,EER 12.70, COP 3.74	5,942	20	7	27	1
Baseline + High Efficiency Cooling, HSPF 9.2 ,EER 12.88, COP 3.66	5,912	20	7	27	1
Baseline + Envelope Insulation - Walls, R19 batt	6,213	21	7	28	0
Baseline + Envelope Insulation - Walls, R21 batt	6,203	21	7	28	0
Baseline + Envelope Insulation - Walls, R21 batt + R5 rigid	6,175	21	7	28	0

Table 36 - Studio Walk Retail Shop (Internal, Small) EE Package and Single EE Measures Impacts on TDVI

Category and Measure	Space Sqft	Elec TDV	Gas TDV	Total TDV	TDV Diff
Baseline	510	244	14	258	0
Baseline + EE Package	510	219	14	234	24
Baseline + High Efficiency Domestic Hot Water, EF=0.823	510	244	11	254	4
Baseline + High Efficiency Glazing, U=0.26, SHGC=0.37	510	242	14	256	2
Baseline + High Efficiency Glazing, U=0.22, SHGC=0.22	510	233	14	247	11
Baseline + High Efficiency Cooling, HSPF 8.6, EER 12.19, COP 3.52	510	232	14	246	12
Baseline + High Efficiency Cooling, HSPF 8.8 ,EER 12.70, COP 3.74	510	228	14	242	16
Baseline + High Efficiency Cooling, HSPF 9.2 ,EER 12.88, COP 3.66	510	226	14	240	18
Baseline + Envelope Insulation - Walls, R19 batt	510	243	14	257	1
Baseline + Envelope Insulation - Walls, R21 batt	510	242	14	257	1
Baseline + Envelope Insulation - Walls, R21 batt + R5 rigid	510	241	14	256	2

Detailed Modeling Results - Prototype 5 – Gateway Residential

Table 37 - Gateway Residential EE Package Composition

Measure	Baseline	Alternative 1	Alternative 2	Alternative 3	EE Package
Appliances	0.39693 w/sqft, 0.94594 Btu/hr/sqft	0.38815 w/sqft, 0.94594 Btu/hr/sqft	0.3876 w/sqft, 0.94594 Btu/hr/sqft	None	Alternative 1
CHP	None	120 kW, 0 Tons Abs	None	None	Alternative 1
Roof Material	100% of roof at Abs=0.70	100% of roof at Abs=0.25	None	None	Alternative 1
Water Heating	EF=0.594	EF=0.823	None	None	Alternative 1
Windows	U=0.56, SHGC=0.42	U=0.26, SHGC=0.37	U=0.22, SHGC=0.22	None	Alternative 2
Space Heating	AFUE=75%	None	None	None	No Alternative
Space Cooling	HSPF 8.1, EER 11.07, COP 3.28	HSPF 8.6, EER 12.19, COP 3.52	HSPF 8.8 ,EER 12.70, COP 3.74	HSPF 9.2 ,EER 12.88, COP 3.66	Alternative 3
Lighting	0.623 watts/sqft	0.573 watts/sqft	None	None	No Alternative
Photovoltaics	None	13650 Sqft @ 0 deg pitch	None	None	Alternative 1
Roof Insulation	R30 batt	R38 batt	R49 batt	None	No Alternative
Solar Thermal	None	42 Sqft of panels, 84 Gal tank	None	None	No Alternative
Thermal Storage	None	None	None	None	No Alternative
Wall Insulation	R11 batt	R19 batt	R21 batt	R21 batt + R5 rigid	No Alternative

Table 38 - Gateway Residential EE Package and Single EE Measures Impacts on Utility Costs and Paybacks

Baseline	146255	$24,397	$170,652	$0	NA
Baseline + EE Package	138714	$19,977	$158,691	$112,274	9.4
Baseline + EE Package + Distributed Generation	42303	$68,927	$111,230	$350,098	6.2
Baseline + EE Package + Photovoltaics	83874	$19,977	$103,851	$790,908	11.1
Baseline + High Efficiency Appliances, 0.38815 w/sqft, 0.94594 Btu/hr/sqft	144509	$24,397	$168,906	$22,230	12.7
Baseline + High Efficiency Appliances, 0.3876 w/sqft, 0.94594 Btu/hr/sqft	144354	$24,397	$168,751	$30,126	15.8
Baseline + Combined Heat and Power, 120 kW, 0 Tons Abs	45289	$72,634	$117,923	$237,824	4.8
Baseline + Cool Roof, 100% of roof at Abs=0.25	145522	$24,397	$169,919	$10,008	13.7
Baseline + High Efficiency Domestic Hot Water, EF=0.823	146255	$19,977	$166,232	$31,134	7.0
Baseline + High Efficiency Glazing, U=0.26, SHGC=0.37	146678	$24,397	$171,075	$2,027	never
Baseline + High Efficiency Glazing, U=0.22, SHGC=0.22	144724	$24,397	$169,121	$6,056	4.0
Baseline + High Efficiency Cooling, HSPF 8.6, EER 12.19, COP 3.52	143871	$24,397	$168,268	$8,570	3.6
Baseline + High Efficiency Cooling, HSPF 8.8 ,EER 12.70, COP 3.74	143052	$24,397	$167,449	$17,139	5.4
Baseline + High Efficiency Cooling, HSPF 9.2 ,EER 12.88, COP 3.66	142604	$24,397	$167,001	$42,847	11.7
Baseline + High Efficiency Lighting, 0.573 watts/sqft	143217	$24,397	$167,614	$111,420	36.7
Baseline + Photovoltaics, 13650 Sqft @ 0 deg pitch	91451	$24,397	$115,848	$678,634	11.7
Baseline + Envelope Insulation - Roof, R38 batt	147006	$24,397	$171,403	$5,459	never
Baseline + Envelope Insulation - Roof, R49 batt	147246	$24,397	$171,643	$9,098	never
Baseline + Solar Thermal, 42 Sqft of panels, 84 Gal tank	146255	$14,313	$160,568	$765,408	93.7
Baseline + Envelope Insulation - Walls, R19 batt	146514	$24,397	$170,911	$3,856	never
Baseline + Envelope Insulation - Walls, R21 batt	146672	$24,397	$171,069	$7,118	never
Baseline + Envelope Insulation - Walls, R21 batt + R5 rigid	146665	$24,397	$171,062	$45,083	never

Table 39 - Gateway Residential EE Package and Single EE Measures Impacts on Energy Consumption

Category and Measure	Elec kWh	Elec MMBtu	Gas MMBtu	Total MMBtu	MMBtu Diff
Baseline	597,864	2,040	1,861	3,901	0
Baseline + EE Package	567,363	1,936	1,526	3,461	440
Baseline + EE Package + Distributed Generation	256,594	875	5,245	6,120	-2,219
Baseline + EE Package + Photovoltaics	345,055	1,177	1,526	2,703	1,198
Baseline + High Efficiency Appliances, 0.38815 w/sqft, 0.94594 Btu/hr/sqft	590,752	2,016	1,861	3,877	24
Baseline + High Efficiency Appliances, 0.3876 w/sqft, 0.94594 Btu/hr/sqft	590,121	2,013	1,861	3,875	26
Baseline + Combined Heat and Power, 120 kW, 0 Tons Abs	275,030	938	5,527	6,465	-2,564
Baseline + Cool Roof, 100% of roof at Abs=0.25	594,892	2,030	1,861	3,891	10
Baseline + High Efficiency Domestic Hot Water, EF=0.823	597,864	2,040	1,526	3,566	335
Baseline + High Efficiency Glazing, U=0.26, SHGC=0.37	599,637	2,046	1,861	3,907	-6
Baseline + High Efficiency Glazing, U=0.22, SHGC=0.22	591,661	2,019	1,861	3,880	21
Baseline + High Efficiency Cooling, HSPF 8.6, EER 12.19, COP 3.52	588,273	2,007	1,861	3,869	32
Baseline + High Efficiency Cooling, HSPF 8.8 ,EER 12.70, COP 3.74	584,977	1,996	1,861	3,857	44
Baseline + High Efficiency Cooling, HSPF 9.2 ,EER 12.88, COP 3.66	583,152	1,990	1,861	3,851	50
Baseline + High Efficiency Lighting, 0.573 watts/sqft	585,493	1,998	1,861	3,859	42
Baseline + Photovoltaics, 13650 Sqft @ 0 deg pitch	375,715	1,282	1,861	3,143	758
Baseline + Envelope Insulation - Roof, R38 batt	601,009	2,051	1,861	3,912	-11
Baseline + Envelope Insulation - Roof, R49 batt	602,017	2,054	1,861	3,915	-14
Baseline + Solar Thermal, 42 Sqft of panels, 84 Gal tank	597,864	2,040	1,095	3,135	766
Baseline + Envelope Insulation - Walls, R19 batt	598,956	2,044	1,861	3,905	-4
Baseline + Envelope Insulation - Walls, R21 batt	599,618	2,046	1,861	3,907	-6
Baseline + Envelope Insulation - Walls, R21 batt + R5 rigid	599,629	2,046	1,861	3,907	-6

Table 40 - Gateway Residential EE Package and Single EE Measures Impacts on TDVI

Category and Measure	Space Sqft	Elec TDV	Gas TDV	Total TDV	TDV Diff
Baseline	30,327	73	16	89	0
Baseline + EE Package	30,327	69	13	82	7
Baseline + EE Package + Distributed Generation	30,327	29	46	75	14
Baseline + EE Package + Photovoltaics	30,327	39	13	52	37
Baseline + High Efficiency Appliances, 0.38815 w/sqft, 0.94594 Btu/hr/sqft	30,327	72	16	88	1
Baseline + High Efficiency Appliances, 0.3876 w/sqft, 0.94594 Btu/hr/sqft	30,327	72	16	88	1
Baseline + Combined Heat and Power, 120 kW, 0 Tons Abs	30,327	31	48	80	9
Baseline + Cool Roof, 100% of roof at Abs=0.25	30,327	72	16	88	1
Baseline + High Efficiency Domestic Hot Water, EF=0.823	30,327	73	13	86	3
Baseline + High Efficiency Glazing, U=0.26, SHGC=0.37	30,327	73	16	89	0
Baseline + High Efficiency Glazing, U=0.22, SHGC=0.22	30,327	72	16	88	1
Baseline + High Efficiency Cooling, HSPF 8.6, EER 12.19, COP 3.52	30,327	71	16	88	1
Baseline + High Efficiency Cooling, HSPF 8.8 ,EER 12.70, COP 3.74	30,327	71	16	87	2
Baseline + High Efficiency Cooling, HSPF 9.2 ,EER 12.88, COP 3.66	30,327	71	16	87	2
Baseline + High Efficiency Lighting, 0.573 watts/sqft	30,327	71	16	87	2
Baseline + Photovoltaics, 13650 Sqft @ 0 deg pitch	30,327	43	16	59	30
Baseline + Envelope Insulation - Roof, R38 batt	30,327	73	16	89	0
Baseline + Envelope Insulation - Roof, R49 batt	30,327	73	16	89	0
Baseline + Solar Thermal, 42 Sqft of panels, 84 Gal tank	30,327	73	10	82	7
Baseline + Envelope Insulation - Walls, R19 batt	30,327	73	16	89	0
Baseline + Envelope Insulation - Walls, R21 batt	30,327	73	16	89	0
Baseline + Envelope Insulation - Walls, R21 batt + R5 rigid	30,327	73	16	89	0

Detailed Modeling Results - Prototype 5 – Gateway Retail Shop (Corner, Large)

Table 41 - Gateway Retail Shop (Corner, Large) EE Package Composition

Measure	Baseline	Alternative 1	Alternative 2	Alternative 3	EE Package
Appliances	Not Applicable	None	None	None	No Alternative
CHP	Not Applicable	None	None	None	No Alternative
Roof Material	Not Applicable	None	None	None	No Alternative
Water Heating	EF=0.594	EF=0.823	None	None	Alternative 1
Windows	U=0.57, SHGC=0.61	U=0.26, SHGC=0.37	U=0.22, SHGC=0.22	None	Alternative 2
Space Heating	Heat Pump (See Space Cooling)	None	None	None	No Alternative
Space Cooling	HSPF 8.1, EER 11.07, COP 3.28	HSPF 8.6, EER 12.19, COP 3.52	HSPF 8.8 ,EER 12.70, COP 3.74	HSPF 9.2 ,EER 12.88, COP 3.66	Alternative 3
Lighting	1.5 watts/sqft	None	None	None	No Alternative
Photovoltaics	Not Applicable	None	None	None	No Alternative
Roof Insulation	Not Applicable	None	None	None	No Alternative
Solar Thermal	Not Applicable	None	None	None	No Alternative
Thermal Storage	Not Applicable	None	None	None	No Alternative
Wall Insulation	R11 batt	R19 batt	R21 batt	R21 batt + R5 rigid	No Alternative

Table 42 - Gateway Retail Shop (Corner, Large) EE Package and Single EE Measures Impacts on Utility Costs and Paybacks

Baseline	6518	$1,898	$8,416	$0	NA
Baseline + EE Package	6120	$1,774	$7,894	$3,982	7.6
Baseline + High Efficiency Domestic Hot Water, EF=0.823	6518	$1,774	$8,292	$371	3.0
Baseline + High Efficiency Glazing, U=0.26, SHGC=0.37	6540	$1,898	$8,438	$373	never
Baseline + High Efficiency Glazing, U=0.22, SHGC=0.22	6357	$1,898	$8,255	$1,115	6.9
Baseline + High Efficiency Cooling, HSPF 8.6, EER 12.19, COP 3.52	6276	$1,898	$8,174	$499	2.1
Baseline + High Efficiency Cooling, HSPF 8.8 ,EER 12.70, COP 3.74	6214	$1,898	$8,112	$998	3.3
Baseline + High Efficiency Cooling, HSPF 9.2 ,EER 12.88, COP 3.66	6201	$1,898	$8,099	$2,496	7.9
Baseline + Envelope Insulation - Walls, R19 batt	6519	$1,898	$8,417	$185	never
Baseline + Envelope Insulation - Walls, R21 batt	6521	$1,898	$8,419	$341	never
Baseline + Envelope Insulation - Walls, R21 batt + R5 rigid	6529	$1,898	$8,427	$2,162	never

Table 43 - Gateway Retail Shop (Corner, Large) EE Package and Single EE Measures Impacts on Energy Consumption

Category and Measure	Elec kWh	Elec MMBtu	Gas MMBtu	Total MMBtu	MMBtu Diff
Baseline	39,644	135	33	168	0
Baseline + EE Package	36,884	126	24	150	18
Baseline + High Efficiency Domestic Hot Water, EF=0.823	39,644	135	24	159	9
Baseline + High Efficiency Glazing, U=0.26, SHGC=0.37	39,865	136	33	169	-1
Baseline + High Efficiency Glazing, U=0.22, SHGC=0.22	38,223	130	33	163	5
Baseline + High Efficiency Cooling, HSPF 8.6, EER 12.19, COP 3.52	37,871	129	33	162	6
Baseline + High Efficiency Cooling, HSPF 8.8 ,EER 12.70, COP 3.74	37,541	128	33	161	7
Baseline + High Efficiency Cooling, HSPF 9.2 ,EER 12.88, COP 3.66	37,420	128	33	161	7
Baseline + Envelope Insulation - Walls, R19 batt	39,672	135	33	168	0
Baseline + Envelope Insulation - Walls, R21 batt	39,679	135	33	168	0
Baseline + Envelope Insulation - Walls, R21 batt + R5 rigid	39,735	136	33	168	0

Table 44 - Gateway Retail Shop (Corner, Large) EE Package and Single EE Measures Impacts on TDVI

Category and Measure	Space Sqft	Elec TDV	Gas TDV	Total TDV	TDV Diff
Baseline	2,528	300	14	314	0
Baseline + EE Package	2,528	279	10	289	25
Baseline + High Efficiency Domestic Hot Water, EF=0.823	2,528	300	10	310	4
Baseline + High Efficiency Glazing, U=0.26, SHGC=0.37	2,528	301	14	316	-2
Baseline + High Efficiency Glazing, U=0.22, SHGC=0.22	2,528	290	14	304	10
Baseline + High Efficiency Cooling, HSPF 8.6, EER 12.19, COP 3.52	2,528	287	14	301	13
Baseline + High Efficiency Cooling, HSPF 8.8 ,EER 12.70, COP 3.74	2,528	284	14	298	16
Baseline + High Efficiency Cooling, HSPF 9.2 ,EER 12.88, COP 3.66	2,528	283	14	297	17
Baseline + Envelope Insulation - Walls, R19 batt	2,528	300	14	314	0
Baseline + Envelope Insulation - Walls, R21 batt	2,528	300	14	314	0
Baseline + Envelope Insulation - Walls, R21 batt + R5 rigid	2,528	300	14	315	-1

Detailed Modeling Results - Prototype 5 – Gateway Retail Shop (Corner, Small)

Table 45 - Gateway Retail Shop (Corner, Small) EE Package Composition

Measure	Baseline	Alternative 1	Alternative 2	Alternative 3	EE Package
Appliances	Not Applicable	None	None	None	No Alternative
CHP	Not Applicable	None	None	None	No Alternative
Roof Material	Not Applicable	None	None	None	No Alternative
Water Heating	EF=0.594	EF=0.823	None	None	Alternative 1
Windows	U=0.57, SHGC=0.61	U=0.26, SHGC=0.37	U=0.22, SHGC=0.22	None	Alternative 2
Space Heating	Heat Pump (See Space Cooling)	None	None	None	No Alternative
Space Cooling	HSPF 8.1, EER 11.07, COP 3.28	HSPF 8.6, EER 12.19, COP 3.52	HSPF 8.8 ,EER 12.70, COP 3.74	HSPF 9.2 ,EER 12.88, COP 3.66	Alternative 1
Lighting	1.5 watts/sqft	None	None	None	No Alternative
Photovoltaics	Not Applicable	None	None	None	No Alternative
Roof Insulation	Not Applicable	None	None	None	No Alternative
Solar Thermal	Not Applicable	None	None	None	No Alternative
Thermal Storage	Not Applicable	None	None	None	No Alternative
Wall Insulation	R11 batt	R19 batt	R21 batt	R21 batt + R5 rigid	No Alternative

Table 46 - Gateway Retail Shop (Corner, Small) EE Package and Single EE Measures Impacts on Utility Costs and Paybacks

Baseline	2897	$1,625	$4,522	$0	NA
Baseline + EE Package	2749	$1,575	$4,324	$1,148	5.8
Baseline + High Efficiency Domestic Hot Water, EF=0.823	2897	$1,575	$4,472	$371	7.4
Baseline + High Efficiency Glazing, U=0.26, SHGC=0.37	2891	$1,625	$4,516	$148	24.7
Baseline + High Efficiency Glazing, U=0.22, SHGC=0.22	2874	$1,625	$4,499	$443	19.3
Baseline + High Efficiency Cooling, HSPF 8.6, EER 12.19, COP 3.52	2869	$1,625	$4,494	$334	11.9
Baseline + High Efficiency Cooling, HSPF 8.8 ,EER 12.70, COP 3.74	2865	$1,625	$4,490	$668	20.9
Baseline + High Efficiency Cooling, HSPF 9.2 ,EER 12.88, COP 3.66	2864	$1,625	$4,489	$1,670	50.6
Baseline + Envelope Insulation - Walls, R19 batt	2900	$1,625	$4,525	$118	never
Baseline + Envelope Insulation - Walls, R21 batt	2899	$1,625	$4,524	$217	never
Baseline + Envelope Insulation - Walls, R21 batt + R5 rigid	2893	$1,625	$4,518	$1,374	never

Table 47 - Gateway Retail Shop (Corner, Small) EE Package and Single EE Measures Impacts on Energy Consumption

Category and Measure	Elec kWh	Elec MMBtu	Gas MMBtu	Total MMBtu	MMBtu Diff
Baseline	14,831	51	13	64	0
Baseline + EE Package	13,733	47	9	56	8
Baseline + High Efficiency Domestic Hot Water, EF=0.823	14,831	51	9	60	4
Baseline + High Efficiency Glazing, U=0.26, SHGC=0.37	14,929	51	13	64	0
Baseline + High Efficiency Glazing, U=0.22, SHGC=0.22	14,768	50	13	63	1
Baseline + High Efficiency Cooling, HSPF 8.6, EER 12.19, COP 3.52	14,731	50	13	63	1
Baseline + High Efficiency Cooling, HSPF 8.8 ,EER 12.70, COP 3.74	14,706	50	13	63	1
Baseline + High Efficiency Cooling, HSPF 9.2 ,EER 12.88, COP 3.66	14,688	50	13	63	1
Baseline + Envelope Insulation - Walls, R19 batt	14,863	51	13	64	0
Baseline + Envelope Insulation - Walls, R21 batt	14,869	51	13	64	0
Baseline + Envelope Insulation - Walls, R21 batt + R5 rigid	14,957	51	13	64	0

Table 48 - Gateway Retail Shop (Corner, Small) EE Package and Single EE Measures Impacts on TDVI

Category and Measure	Space Sqft	Elec TDV	Gas TDV	Total TDV	TDV Diff
Baseline	1,003	285	14	299	0
Baseline + EE Package	1,003	266	10	276	23
Baseline + High Efficiency Domestic Hot Water, EF=0.823	1,003	285	10	295	4
Baseline + High Efficiency Glazing, U=0.26, SHGC=0.37	1,003	286	14	301	-2
Baseline + High Efficiency Glazing, U=0.22, SHGC=0.22	1,003	283	14	298	1
Baseline + High Efficiency Cooling, HSPF 8.6, EER 12.19, COP 3.52	1,003	282	14	297	2
Baseline + High Efficiency Cooling, HSPF 8.8 ,EER 12.70, COP 3.74	1,003	282	14	296	3
Baseline + High Efficiency Cooling, HSPF 9.2 ,EER 12.88, COP 3.66	1,003	282	14	296	3
Baseline + Envelope Insulation - Walls, R19 batt	1,003	285	14	299	0
Baseline + Envelope Insulation - Walls, R21 batt	1,003	285	14	300	-1
Baseline + Envelope Insulation - Walls, R21 batt + R5 rigid	1,003	287	14	301	-2

Detailed Modeling Results - Prototype 5 – Gateway Retail Shop (Internal, Large)

Table 49 - Gateway Retail Shop (Internal, Large) EE Package Composition

Measure	Baseline	Alternative 1	Alternative 2	Alternative 3	EE Package
Appliances	Not Applicable	None	None	None	No Alternative
CHP	Not Applicable	None	None	None	No Alternative
Roof Material	Not Applicable	None	None	None	No Alternative
Water Heating	EF=0.594	EF=0.823	None	None	Alternative 1
Windows	U=0.57, SHGC=0.61	U=0.26, SHGC=0.37	U=0.22, SHGC=0.22	None	No Alternative
Space Heating	Heat Pump (See Space Cooling)	None	None	None	No Alternative
Space Cooling	HSPF 8.1, EER 11.07, COP 3.28	HSPF 8.6, EER 12.19, COP 3.52	HSPF 8.8 ,EER 12.70, COP 3.74	HSPF 9.2 ,EER 12.88, COP 3.66	No Alternative
Lighting	1.5 watts/sqft	None	None	None	No Alternative
Photovoltaics	Not Applicable	None	None	None	No Alternative
Roof Insulation	Not Applicable	None	None	None	No Alternative
Solar Thermal	Not Applicable	None	None	None	No Alternative
Thermal Storage	Not Applicable	None	None	None	No Alternative
Wall Insulation	R11 batt	R19 batt	R21 batt	R21 batt + R5 rigid	No Alternative

Table 50 - Gateway Retail Shop (Internal, Large) EE Package and Single EE Measures Impacts on Utility Costs and Paybacks

Baseline	2891	$1,625	$4,516	$0	NA
Baseline + EE Package	2891	$1,575	$4,466	$371	7.4
Baseline + High Efficiency Domestic Hot Water, EF=0.823	2891	$1,575	$4,466	$371	7.4
Baseline + High Efficiency Glazing, U=0.26, SHGC=0.37	2900	$1,625	$4,525	$166	never
Baseline + High Efficiency Glazing, U=0.22, SHGC=0.22	2886	$1,625	$4,511	$494	98.9
Baseline + High Efficiency Cooling, HSPF 8.6, EER 12.19, COP 3.52	2882	$1,625	$4,507	$319	35.4
Baseline + High Efficiency Cooling, HSPF 8.8 ,EER 12.70, COP 3.74	2877	$1,625	$4,502	$637	45.5
Baseline + High Efficiency Cooling, HSPF 9.2 ,EER 12.88, COP 3.66	2875	$1,625	$4,500	$1,593	99.6
Baseline + Envelope Insulation - Walls, R19 batt	2894	$1,625	$4,519	$79	never
Baseline + Envelope Insulation - Walls, R21 batt	2895	$1,625	$4,520	$146	never
Baseline + Envelope Insulation - Walls, R21 batt + R5 rigid	2898	$1,625	$4,523	$927	never

Table 51 - Gateway Retail Shop (Internal, Large) EE Package and Single EE Measures Impacts on Energy Consumption

Category and Measure	Elec kWh	Elec MMBtu	Gas MMBtu	Total MMBtu	MMBtu Diff
Baseline	14,944	51	13	64	0
Baseline + EE Package	14,944	51	9	60	4
Baseline + High Efficiency Domestic Hot Water, EF=0.823	14,944	51	9	60	4
Baseline + High Efficiency Glazing, U=0.26, SHGC=0.37	15,027	51	13	64	0
Baseline + High Efficiency Glazing, U=0.22, SHGC=0.22	14,898	51	13	64	0
Baseline + High Efficiency Cooling, HSPF 8.6, EER 12.19, COP 3.52	14,855	51	13	64	0
Baseline + High Efficiency Cooling, HSPF 8.8 ,EER 12.70, COP 3.74	14,833	51	13	64	0
Baseline + High Efficiency Cooling, HSPF 9.2 ,EER 12.88, COP 3.66	14,822	51	13	64	0
Baseline + Envelope Insulation - Walls, R19 batt	14,968	51	13	64	0
Baseline + Envelope Insulation - Walls, R21 batt	14,981	51	13	64	0
Baseline + Envelope Insulation - Walls, R21 batt + R5 rigid	15,008	51	13	64	0

Table 52 - Gateway Retail Shop (Internal, Large) EE Package and Single EE Measures Impacts on TDVI

Category and Measure	Space Sqft	Elec TDV	Gas TDV	Total TDV	TDV Diff
Baseline	1,242	286	14	301	0
Baseline + EE Package	1,242	286	10	297	4
Baseline + High Efficiency Domestic Hot Water, EF=0.823	1,242	286	10	297	4
Baseline + High Efficiency Glazing, U=0.26, SHGC=0.37	1,242	288	14	302	-1
Baseline + High Efficiency Glazing, U=0.22, SHGC=0.22	1,242	285	14	300	1
Baseline + High Efficiency Cooling, HSPF 8.6, EER 12.19, COP 3.52	1,242	284	14	299	2
Baseline + High Efficiency Cooling, HSPF 8.8 ,EER 12.70, COP 3.74	1,242	284	14	298	3
Baseline + High Efficiency Cooling, HSPF 9.2 ,EER 12.88, COP 3.66	1,242	284	14	298	3
Baseline + Envelope Insulation - Walls, R19 batt	1,242	287	14	301	0
Baseline + Envelope Insulation - Walls, R21 batt	1,242	287	14	301	0
Baseline + Envelope Insulation - Walls, R21 batt + R5 rigid	1,242	287	14	302	-1

Detailed Modeling Results - Prototype 5 – Gateway Retail Shop (Internal, Small)

Table 53 - Gateway Retail Shop (Internal, Small) EE Package Composition

Measure	Baseline	Alternative 1	Alternative 2	Alternative 3	EE Package
Appliances	Not Applicable	None	None	None	No Alternative
CHP	Not Applicable	None	None	None	No Alternative
Roof Material	Not Applicable	None	None	None	No Alternative
Water Heating	EF=0.594	EF=0.823	None	None	Alternative 1
Windows	U=0.57, SHGC=0.61	U=0.26, SHGC=0.37	U=0.22, SHGC=0.22	None	No Alternative
Space Heating	Heat Pump (See Space Cooling)	None	None	None	No Alternative
Space Cooling	HSPF 8.1, EER 11.07, COP 3.28	HSPF 8.6, EER 12.19, COP 3.52	HSPF 8.8 ,EER 12.70, COP 3.74	HSPF 9.2 ,EER 12.88, COP 3.66	No Alternative
Lighting	1.5 watts/sqft	None	None	None	No Alternative
Photovoltaics	Not Applicable	None	None	None	No Alternative
Roof Insulation	Not Applicable	None	None	None	No Alternative
Solar Thermal	Not Applicable	None	None	None	No Alternative
Thermal Storage	Not Applicable	None	None	None	No Alternative
Wall Insulation	R11 batt	R19 batt	R21 batt	R21 batt + R5 rigid	No Alternative

Table 54 - Gateway Retail Shop (Internal, Small) EE Package and Single EE Measures Impacts on Utility Costs and Paybacks

Baseline	2890	$1,625	$4,515	$0	NA
Baseline + EE Package	2890	$1,575	$4,465	$371	7.4
Baseline + High Efficiency Domestic Hot Water, EF=0.823	2890	$1,575	$4,465	$371	7.4
Baseline + High Efficiency Glazing, U=0.26, SHGC=0.37	2899	$1,625	$4,524	$148	never
Baseline + High Efficiency Glazing, U=0.22, SHGC=0.22	2884	$1,625	$4,509	$443	73.8
Baseline + High Efficiency Cooling, HSPF 8.6, EER 12.19, COP 3.52	2878	$1,625	$4,503	$320	26.7
Baseline + High Efficiency Cooling, HSPF 8.8 ,EER 12.70, COP 3.74	2874	$1,625	$4,499	$640	40.0
Baseline + High Efficiency Cooling, HSPF 9.2 ,EER 12.88, COP 3.66	2874	$1,625	$4,499	$1,599	100.0
Baseline + Envelope Insulation - Walls, R19 batt	2892	$1,625	$4,517	$70	never
Baseline + Envelope Insulation - Walls, R21 batt	2894	$1,625	$4,519	$130	never
Baseline + Envelope Insulation - Walls, R21 batt + R5 rigid	2897	$1,625	$4,522	$821	never

Table 55 - Gateway Retail Shop (Internal, Small) EE Package and Single EE Measures Impacts on Energy Consumption

Category and Measure	Elec kWh	Elec MMBtu	Gas MMBtu	Total MMBtu	MMBtu Diff
Baseline	14,931	51	13	64	0
Baseline + EE Package	14,931	51	9	60	4
Baseline + High Efficiency Domestic Hot Water, EF=0.823	14,931	51	9	60	4
Baseline + High Efficiency Glazing, U=0.26, SHGC=0.37	15,024	51	13	64	0
Baseline + High Efficiency Glazing, U=0.22, SHGC=0.22	14,881	51	13	64	0
Baseline + High Efficiency Cooling, HSPF 8.6, EER 12.19, COP 3.52	14,845	51	13	64	0
Baseline + High Efficiency Cooling, HSPF 8.8 ,EER 12.70, COP 3.74	14,821	51	13	64	0
Baseline + High Efficiency Cooling, HSPF 9.2 ,EER 12.88, COP 3.66	14,810	51	13	64	0
Baseline + Envelope Insulation - Walls, R19 batt	14,955	51	13	64	0
Baseline + Envelope Insulation - Walls, R21 batt	14,969	51	13	64	0
Baseline + Envelope Insulation - Walls, R21 batt + R5 rigid	14,998	51	13	64	0

Table 56 - Gateway Retail Shop (Internal, Small) EE Package and Single EE Measures Impacts on TDVI

Category and Measure	Space Sqft	Elec TDV	Gas TDV	Total TDV	TDV Diff
Baseline	1,003	286	14	300	0
Baseline + EE Package	1,003	286	10	297	3
Baseline + High Efficiency Domestic Hot Water, EF=0.823	1,003	286	10	297	3
Baseline + High Efficiency Glazing, U=0.26, SHGC=0.37	1,003	288	14	302	-2
Baseline + High Efficiency Glazing, U=0.22, SHGC=0.22	1,003	285	14	299	1
Baseline + High Efficiency Cooling, HSPF 8.6, EER 12.19, COP 3.52	1,003	284	14	299	1
Baseline + High Efficiency Cooling, HSPF 8.8 ,EER 12.70, COP 3.74	1,003	284	14	298	2
Baseline + High Efficiency Cooling, HSPF 9.2 ,EER 12.88, COP 3.66	1,003	284	14	298	2
Baseline + Envelope Insulation - Walls, R19 batt	1,003	287	14	301	-1
Baseline + Envelope Insulation - Walls, R21 batt	1,003	287	14	301	-1
Baseline + Envelope Insulation - Walls, R21 batt + R5 rigid	1,003	287	14	302	-2

APPENDIX A

Site-B Modeling Assumptions

Construction Types

For the purposes of this study, the following construction types apply unless otherwise noted.

Type I: Not Applicable

Type II: Reinforced "poured-in-place" concrete exterior walls with plaster exterior finish. Steel framing is attached to the inside of the concrete walls with mineral fiber batts between the studs and Gypsum board on the interior. Roofs are flat 3-ply BUR over 2" rigid insulation boards over metal decking.

Type III: Wood framed walls with lath/plaster and brick veneer exterior. The walls are filled with mineral fiber batts between the studs and Gypsum board will be on the interior. Roofs are flat wood trusses with rigid insulation over plywood decking or mineral batt under decking. A 3-ply built-up-roof covers the rigid insulation.

Type V: Wood framed with plaster exterior finish, fiberglass batts within the framing, and Gypsum interior. Roofs are flat wood trusses with fiberglass batt insulation below the wood decking. A 3-ply built-up-roof covers the wood decking. If the roofs are pitched with an attic, fiberglass batt insulation is placed at the attic floor and flat concrete tiles cover the roof exterior.

Building Prototypes

Note: For classification purposes, although in some cases more than one type of construction may be used, a single construction type for each prototype was selected. The construction types are intended to meet the code but be specific to this study.

Residential Buildings – Prototypes 1 and 2

1. Residential Single-Family Detached Home (6.0 DU/AC); Type V construction, Colonial style approximately 2,540 sf. 2-story structure with 2-car attached direct-access garage parking. Interior floor space demised to accommodate 4 BR and 3 BA. The floor-to-floor height is 11'-0" and 45% of the roof area is available for solar cells.

Sample Picture

2. Residential Multi-Family/Town Home (15+ DU/AC); Type V construction, approximately 2,980 sf total. 2-story structure with 2-car attached direct-access garage parking per unit. Interior floor space demised to accommodate 2 individual units at approximately 1490 sf each, 3 BR and 2.5 BA. The floor-to-floor height is 11'-0" and 45% of the roof area is available for solar cells.

Sample Picture

Mixed Use Buildings – Prototypes 3 to 5

3. Retail/Residential Mixed Use Low-Rise Building (20 DU/AC); Type V construction for retail and residential space, approximately 10,110 sf three-story mixed use slab on grade building. Interior floor space demised to accommodate 2 individual retail tenants at street level averaging 510 sf each. Two and a half floor levels of residential apartments on or above the first floor totaling approximately 9,090 sf. Residential floor space demised to accommodate 5 individual 2BR, 2BA units ranging from approximately 1220 to 1,970 sf each. The floor-to-floor height for the first floor retail is 14'-0" and 11'-0" for the residential levels above. 45% of the roof area is available for solar cells.

Sample Picture

4. Retail/Residential Mixed Use Low-Rise Building (30 DU/AC); Type II construction for the ground floor and Type V construction for the residential space above. Approximately 19,800 sf three-story mixed use slab on grade building. Interior floor space demised to accommodate 5 individual retail tenants at street level averaging 510 sf each. Two floor levels of residential apartments above the first floor totaling approximately 17,250 sf. Residential floor space demised to accommodate five 3BR, 3BA and five 4BR, 3BA units ranging from approximately 1600 to 1,850 sf each. The floor-to-floor height for the first floor retail is 14'-0" and 11'-0" for the residential levels above. 45% of the roof area is available for solar cells.

Sample Picture

5. Retail/Residential Mixed Use Mid-Rise Building (85 DU/AC); Type III construction, approximately 134,000 sf five-story mixed use slab on grade building. Interior floor space demised to accommodate 12 individual retail tenants at street level averaging 1,050 sf each. Four floor levels of residential apartments above the first floor totaling approximately 121,300 sf. Residential floor space demised to accommodate 84 individual units; 12 @ 850 sqft, 8 @ 1,115 sqft, 14 @ 1450 sqft, 4 @ 1,580 sqft, 16 @ 1,545, 20 @ 1,645, and 10 @ 1,795. The floor-to-floor height for the first floor retail is 14'-0" and 11'-0" for the residential levels above. 50% of the roof area is available for solar cells.

Sample Picture

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)

Applicable to the following Type III residential prototypes:	Prototype #
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**	
2-pane, LowE	2-pane, LowE	2-pane, LowE	
Max Air leakage = 0.30 cfm/sf	←	←	NA
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

Applicable to the following prototypes:	Prototype #
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 Max air leakage = 0.30 cfm/sf U = 0.18	Not Applicable	Not Applicable	Not Applicable

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 No slab insulation	Not Applicable	Not Applicable	Not Applicable

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 No slab insulation	Not Applicable	Not Applicable	Not Applicable

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

Raised Floors

Raised Floors – Prototype 5

Applicable to the following prototypes:	Prototype #
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 R19 insulation	Not Applicable	Not Applicable	Not Applicable

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/apppliance	Not Applicable	Not Applicable

Clothes Washer – 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
MMEF = 1.26	

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

Alternative Incremental Costs (Alt X – Baseline)		
Alternative 1	**Alternative 2**	**Alternative 3**
$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 x freezer + refrig vol	

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

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

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

Title 24	
T24 Mandatory	**T24 Prescriptive**
Not Applicable	1.0 watts/sqft Residential

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
0.600 watts/sqft	0.573 watts/sqft		

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

Lighting – Prototypes 3 to 5 (Retail)

Applicable to the following prototypes:	Prototype #
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

Title 24	
T24 Mandatory	**T24 Prescriptive**
None	1.5 watts/sf

Modeling Scenarios			
Proposed Baseline	**Alternative 1**	**Alternative 2**	**Alternative 3**
Typical T8 fluorescent 1.50 watts/sf	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 – Prototype 1 Floor Plan

PLAN TWO
French Country
2540 Sq.Ft. Total
4 Bdrm, 3 Ba, Opt. Bdrm. 5
2 Car Garage

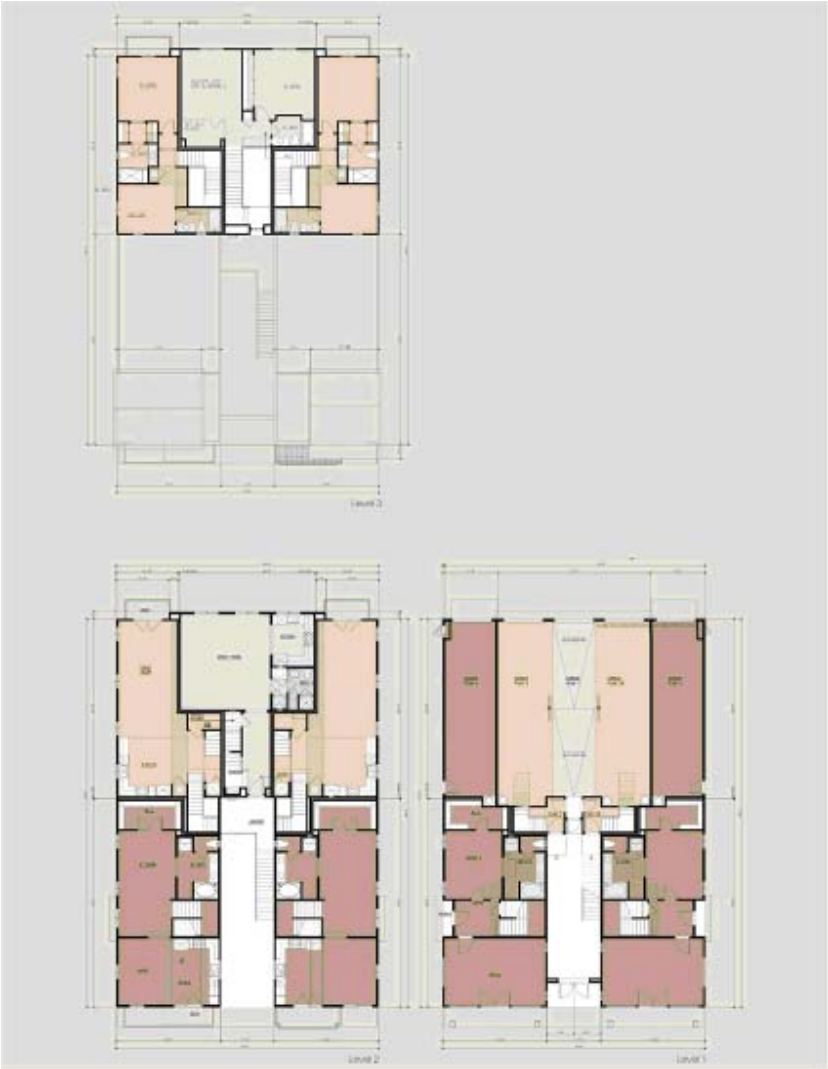
50' x 70' Lots

Luminara	1					Proposed Baseline					Alternative 1	
Plan 1 x 1	Lum/sf	SF	%	Lumens	Wattage	Lum/watt	Watts	Equiv Inc	Watts/SF	Weighted	Lum/watt	Weighted
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	457	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	480	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	45	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%	8434	>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	
Plan2 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	
Plan1 x 5	Lum/sf	SF	%	Lumens	Wattage	Lum/watt	Watts	Equiv hc	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	0.084
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	
Plan2 x 5	Lum/sf	SF	%	Lumens	Wattage	Lum/watt	Watts	Equiv hc	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 4th.

Gateway		12				Proposed Baseline					Alternative 1	
PlanA x 12	Lum/sf	SF	%	Lumens	Wattage	Lum/watt	Watts	Equiv hc	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 hc	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	
Plan C 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	
Plan D 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	
Plan E 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	0.045
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		0.558		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	60	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	3850		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, 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.

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	
	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																								

Weekday Rate Schedule																								
Winter	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																								

Weekend Rate Schedule																								
Summer/ Winter	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																								

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
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