# HomeTown Ford

## MyTown, USA

# Business Case for Energy Efficiency


Ford Marketing & Sales

November 1, 2011

**Produced by:**

Ford Land Energy Efficiency Team
Go Green Dealership Program

**Produced For:**

HomeTown Ford
MyTown, USA

# Contents

**APPENDICES**

# 1. Executive Summary

This document presents efficiency measures for improving the energy and environmental performance of the HomeTown Ford Dealership.

- The dealership can save an estimated $28,009 annually in energy costs by incorporating the efficiency measures. The capital costs for these measures are expected to have a simple payback of 4 years, with available utility incentives of $13,320.

- An additional estimated $8,804 per year can be saved by the installation of renewable energy measures. It is estimated that $93,678 of utility incentives and government tax credits could be available to help defray the $261,100 cost of installing these measures.

The recommendations in this report are based on an on-site energy audit conducted on September 1, 2011. The principle contact for the audit was Mary Dealer.

## 1.1 Savings Summary

The energy survey on which this report is based showed that annual energy costs for the facility now total:

| | |
|---|---|
| Electricity | $72,591 |
| Natural gas | $8,107 |
| Annual energy cost | $80,698 |

The on-site energy evaluation found opportunities to obtain the following savings:

Estimated Annual Energy Savings (total): $28009 = 35% of total energy bill

Estimated Annual Renewable Generation Opportunity (total): $8,804 = 11% of total energy bill

Chapter 4 provides a discussion of the recommended energy-efficiency measures and Chapter 5 describes recommended renewable generation opportunities.

## 1.2 Next Steps

It is now up to the dealership to evaluate the information and opportunities presented in this report and determine how to move forward.  If you have questions about the report, the key contacts are listed in the table.

**Team Contacts**

| Contact | Title | E-Mail | Telephone |
|---|---|---|---|
| James Manager | Ford Regional Manager | | (123) 000-0000 |
| Mary Dealer | Dealer Designated EV Team Leader | | (123) 000-0000 |
| Patrick Smithbauer | Ford Green Dealership Program Manager | psmithba@ford.com | (313) 337-8362 |

# 2. Introduction

## 2.1 Go Green Program Background

Improving facility energy efficiency is a vital component of Ford Motor Company's commitment to energy and natural resource conservation. The Go Green Program extends this commitment to the dealer body by including the Go Green Assessment as a requirement for the Focus Electric Vehicle program.

Ford Motor Company elected to utilize the expertise of leaders within the environmental community to create a world class environmental assessment program. Go Green is the combined expertise of our Ford Energy Team and several national firms that are experts in energy consulting, facility evaluation, green technologies, and environmental efficiency.

The Go Green Program Manager is Patrick Smithbauer, P.E., LEED AP. Mr. Smithbauer will be the primary liaison for dealerships going through the Go Green program. He will manage the process of scheduling assessments and follow up for the Go Green Program. In addition he will be available to address questions from dealers electing to implement Go Green recommendations. Mr. Smithbauer has over 40 years of engineering and management experience in the design of new facilities and renovations for automotive, commercial and institutional clients. He is a co-founder and past chair of the Detroit Chapter of the US Green Building Council. He is also an adjunct professor at Wayne State University, in Detroit, teaching a graduate level class in environmental management and sustainable development. Thus, Ford put in place the appropriate expertise to successfully define, implement, and manage the Go Green Dealership Program.

Go Green is an independent, unbiased and in-depth energy systems analysis of a dealership's existing facility and energy operations. Go Green brings the expertise of Ford's energy team and industry experts to Ford and Lincoln dealerships. It provides guidance for energy system upgrades that can reduce energy consumption and operating costs. The Go Green assessment for each dealership includes the identification of energy savings opportunities, the potential application of new technologies, and the possibility of using renewable energy. The end deliverable of the assessment is a report with initial findings, proposed opportunities for improvements, estimated expenditures, and energy cost savings with a payback analysis. Based on the results of the assessment, the individual dealerships can make a business decision relative to the implementation of all, some or none of the recommendations.

## 2.2 Benefits of Green Dealerships

A Green Dealership mirrors Ford's corporate commitment to energy efficiency and sustainability. Green Dealerships have reduced energy costs, improved indoor environmental conditions, and reduced impacts on the environment. The marketing and public relations benefits to being green include the potential recognition of the dealership for exemplary energy performance by the U.S. Department of Energy and Ford Motor Company. A green dealership also offers the opportunity for marketing exposure through community outreach and education programs that highlight the green nature of the dealership.

| | | | | | |
|---|---|---|---|---|---|
| **Reduced energy consumption and operating expenses** | **Reduced environmental impact of selling and maintaining vehicles** | **Marketing and outreach opportunity** | **Mirrors Ford's corporate commitment to sustainability** | **Potential LEED, Ford or Energy Star recognition** | **Improved indoor environment** |

### 2.2.1 Resource Efficient Operations and Maintenance

The business-as-usual approach to building operations and maintenance does not typically consider energy efficiency, and therefore leads to higher energy bills. The opportunity for energy savings is missed if facilities' upkeep does not include preventative measures and maintenance of equipment are addressed only at the time of equipment failure.

In contrast, investing in energy efficiency upgrades and ongoing maintenance can reduce long-term operating costs significantly and simultaneously provide other environmental and retail benefits, making a financially attractive business case. Efficiency retrofits are especially cost-effective when equipment or envelope upgrades are scheduled to coincide with replacement cycles of existing equipment or systems, or with other retrofits to reduce total costs for construction, repair, and interruption to business.

## 2.3 Dealership Background

HomeTown Ford owns and manages a group of buildings constructed in the early 1960's located at Main Street and First Street. The dealership provides full sales and car repair services at both locations and does not include a body repair shop. Total enclosed floor space is about 33,113 sq. ft. All buildings are single story except for the 2-story Parts Building and a small second story office at the north end of the Truck Service building.

## 2.4 Building and Site Description

The HomeTown Ford campus is located on Main Street in MyTown, CA. The buildings and associated lots cover approximately 230,000 square feet, or five acres. Most of the lot area is asphalt, with some grass and trees in boundary areas. An aerial photo of the campus is shown below.

All buildings are constructed from concrete blocks. A portion of the exterior facade of the show room is also clad with a decorative medal siding. All roofs are wood frame. The showroom and business office area roofs are insulated to approximately R19. The walls of the office and showroom areas are also insulated while the walls and roofs of the parts and shop service areas are not. All windows are single pane clear glass. Building details and operating schedules are shown below.

| Bulding Name | Foor Area, sq. ft. | Operating Hours | Occupancy |
|---|---|---|---|
| SALES DEPARTMENT: | 22,218 | 8:30 a.m. - 8 p.m., M-F;<br>8:30 a.m. - 6 p.m., Sat;<br>10 a.m. - 6 p.m., Sun | 40 |
| Show Room & Sales | 4,560 | Same | |
| Business Offices | 3,444 | Same | |
| Sales Services Shop | 6,536 | Same | |
| Service Maintenance | 7,678 | Same | |
| SERVICE DEPARTMENT: | 10,895 | | 30 |
| Parts & Customer Lounge | 2,933 | 7:30 a.m. - 5:30 p.m. | |
| Service Shop | 3,938 | 7:00 a.m. - 6 p.m. | |
| Truck Service | 4,024 | 7:00 a.m. - 6 p.m. | |

**Aerial View of HomeTown Ford**


For any building, the road to efficient energy management begins with a thorough understanding of the current systems and how they affect the operation and cost of the facility. In order to determine energy efficiency upgrade opportunities, an on-site energy audit was completed in which energy-using systems were identified and documented. These equipment and operating schedules are identified below. The engineers also documented the age and approximate size of the buildings, and inspected the building shell.

The following section lists the lighting equipment in use at HomeTown Ford. The type of lighting is shown along with the operating hours and number of fixtures. The connected kW is the total power requirement of the fixtures listed.

### 2.4.1 Exterior Lighting

An inventory of exterior lighting is shown in the table below. The north and south lots are lighted by a total of thirty two 400-watt metal halide lamps. These fixtures are estimated to be on approximately 82 hours per week.

| ***Exterior Lighting Systems*** | | | | |
|---|---|---|---|---|
| *Lighting Area* | *Hours/ Week* | *Fixture Type* | *Number of Fixtures* | *Connected kW* |
| South Sales Lot | 82 | 400 Watt Metal Halide | 24 | 10.9 |
| North Sales Lot. | 82 | 400 Watt Metal Halide | 6 | 2.7 |
| Sales Building Facade | 82 | 400 Watt Metal Halide | 2 | 0.9 |

## 2.4.2 Interior Lighting

An inventory of interior lighting is shown in the table below. Most of the buildings are lighted with T12 fluorescent lamps with magnetic ballasts. The showroom and service areas also use metal halide lighting. Most fixtures are estimated to be on 87 hours per week.

| *Interior Lighting Systems* | | | | |
|---|---|---|---|---|
| *Lighting Area* | *Hours/ Week* | *Fixture Type* | *Number of Fixtures* | *Connected kW* |
| **Sales Department Buildings** | | | | |
| Business Office | 87 | 4-4' 40W T12 Lamp, Standard Ballast (2) | 15 | 2.9 |
| Car Wash | 87 | 2-8' 60W T12 Lamp, Standard Ballast (1) | 1 | 0.1 |
| Car Wash. | 87 | 4-4' 40W T12 Lamp, Standard Ballast (2) | 1 | 0.2 |
| Corporate Office | 87 | 2-4' 40W T12 Lamp, Standard Ballast (1) | 2 | 0.2 |
| Finance | 87 | 4-4' 40W T12 Lamp, Standard Ballast (2) | 4 | 0.8 |
| Finance. | 87 | 2-4' 40W T12 Lamp, Standard Ballast (1) | 1 | 0.1 |
| Fleet Department | 87 | 4-4' 40W T12 Lamp, Standard Ballast (2) | 2 | 0.4 |
| Fleet Department. | 87 | 2-4' 40W T12 Lamp, Standard Ballast (1) | 1 | 0.1 |
| Interior Dept. | 87 | 4-4' 40W T12 Lamp, Standard Ballast (2) | 4 | 0.8 |
| Lobby | 87 | 4-4' 40W T12 Lamp, Standard Ballast (2) | 4 | 0.8 |
| Restroom | 87 | 13W Comp Fluor / Integral | 8 | 0.1 |
| Restroom Mirror | 87 | 60 Watt A-Line Incandescent | 12 | 0.7 |
| Sales Office | 87 | 4-4' 40W T12 Lamp, Standard Ballast (2) | 6 | 1.2 |
| Sales Office. | 87 | 2-4' 40W T12 Lamp, Standard Ballast (1) | 4 | 0.4 |
| Showroom | 87 | 250 Watt Metal Halide | 15 | 4.4 |
| Stefanie's Office | 87 | 2-8' 60W T12 Lamp, Standard Ballast (1) | 1 | 0.1 |
| Stefanie's Office. | 87 | 2-4' 40W T12 Lamp, Standard Ballast (1) | 2 | 0.2 |
| Tire Shop Service | 87 | 4-4' 40W T12 Lamp, Standard Ballast (2) | 4 | 0.8 |
| Tire Shop Service. | 87 | 100 Watt A-Line Incandescent | 10 | 1.0 |
| Tire Shop Service.. | 87 | 2-8' 60W T12 Lamp, Standard Ballast (1) | 31 | 4.3 |
| Tire Shop Service... | 87 | 400 Watt Metal Halide | 11 | 5.0 |
| **Service Department Buildings** | | | | |
| Customers Office | 63 | 2-8' 60W T12 Lamp, Standard Ballast (1) | 5 | 0.7 |
| Customers Office. | 63 | 2-4' 40W T12 Lamp, Standard Ballast (1) | 4 | 0.4 |
| File Room | 63 | 2-8' 60W T12 Lamp, Standard Ballast (1) | 2 | 0.3 |
| File Room. | 87 | 4-4' 40W T12 Lamp, Standard Ballast (2) | 4 | 0.8 |
| Office In Shop | 87 | 4-4' 40W T12 Lamp, Standard Ballast (2) | 2 | 0.4 |
| Office In Shop. | 87 | 250 Watt Metal Halide | 2 | 0.6 |
| Parts Office/Storage | 63 | 2-8' 60W T12 Lamp, Standard Ballast (1) | 57 | 7.9 |
| Parts Office/Storage. | 87 | 2-4' 40W T12 Lamp, Standard Ballast (1) | 4 | 0.4 |
| Parts Office/Storage.. | 63 | 100 Watt A-Line Incandescent | 1 | 0.1 |
| Service | 87 | 2-8' 60W T12 Lamp, Standard Ballast (1) | 40 | 5.5 |
| Service Offices | 87 | 2-4' 40W T12 Lamp, Standard Ballast (1) | 3 | 0.3 |
| Service Offices. | 87 | 4-4' 40W T12 Lamp, Standard Ballast (2) | 7 | 1.3 |
| Service Shop | 87 | 2-8' 60W T12 Lamp, Standard Ballast (1) | 33 | 4.6 |
| Service Write Up | 87 | 2-8' 60W T12 Lamp, Standard Ballast (1) | 8 | 1.1 |
| Service. | 87 | 4-4' 40W T12 Lamp, Standard Ballast (2) | 5 | 1.0 |

### 2.4.3 Heating, Ventilating, and Cooling Equipment

Heating, ventilating and air conditioning equipment (HVAC) can account for a significant portion of energy costs in a typical facility. Because HVAC contributes so much to a facility's operating cost, building supervisors should be familiar with all pieces of this equipment. An inventory of HVAC equipment is provided below.

For safety and efficiency, we recommend implementing a regular maintenance program for all fuel-burning HVAC equipment. The efficiencies given in the table below take into account the unit size, type, age, and condition.

Office and showroom areas are heated and cooled with rooftop package units. The heating only service and parts areas are heated with unit radiant heaters.

| Description of HVAC Equipment | | | | | | | |
|---|---|---|---|---|---|---|---|
| *Equipment Name* | *System Type* | *Qty* | *Year* | *Capacity* | | *Fuel* | *Efficiency* |
| Business Office Package Unit | Rooftop package unit | 1 | 2001 | Heating | 200 KBtuh | Natural gas | 0.83 AFUE |
| | | | | Cooling | 20 ton | Electricity | 7.84 EER |
| Carwash Heater | Unit heater | 1 | 2001 | Heating | 85 KBtuh | Natural gas | 0.73 AFUE |
| Parts Department Heater | Unit heater | 1 | 2001 | Heating | 140 KBtuh | Natural gas | 0.73 AFUE |
| Sales Office Package Unit | Rooftop package unit | 1 | 2001 | Heating | 200 KBtuh | Natural gas | 0.83 AFUE |
| | | | | Cooling | 20 ton | Electricity | 7.84 EER |
| Service Area Shop Heaters | Unit heater | 14 | 2001 | Heating | 75 KBtuh | Natural gas | 0.73 AFUE |
| Service Lobby Office Heat Pump | Packaged terminal unit | 1 | 2001 | Heating | 12 KBtuh | Electricity | 5.76 HSPF |
| | | | | Cooling | 1 ton | Electricity | 8.79 SEER |
| Service Lounge Rooftop Unit | Rooftop package unit | 1 | 2001 | Heating | 50 KBtuh | Natural gas | 0.83 AFUE |
| | | | | Cooling | 4 ton | Electricity | 7.84 EER |
| Service Office Split System | Split system | 1 | 2001 | Cooling | 12 KBtuh | Electricity | 11.21 SEER |
| Service Office Package Unit | Rooftop package unit | 1 | 2001 | Heating | 50 KBtuh | Natural gas | 0.83 AFUE |
| | | | | Cooling | 4 ton | Electricity | 7.84 EER |

### 2.4.4 Building Occupancy - Heating and Cooling Schedule

For heating and cooling, the facility is subdivided into distinct zones based on operating schedule. The following tables show the operation of each zone as reported by the dealership. The operating temperature corresponds to the setting during occupied hours.

Currently, thermostat setpoints at HomeTown Ford are not changed during unoccupied times; they are kept constant.

| ***Heating Season Occupancy and Temperature Profile*** | | | | |
|---|---|---|---|---|
| *Building Climate Zone* | *Average Occupants* | *Temperature Schedule* | *Operating Temperatures* | *Days of Week* |
| Business Office | 20 | Heat-68, M-Su | 68<br>68<br>68 | Mon-Fri<br>Sat<br>Sun/Hol |
| Parts Department | 10 | Heat-68, M-Su | 68<br>68<br>68 | Mon-Fri<br>Sat<br>Sun/Hol |
| Showroom | 40 | Heat-72, M-Su | 72<br>72<br>72 | Mon-Fri<br>Sat<br>Sun/Hol |

All other heated areas are served by radiant unit heaters. These are individually controlled manually by each service technician. As such, there is no set operating schedule or temperature set point control. These units are shut off during unoccupied hours.

| ***Cooling Season Occupancy and Temperature Profile*** | | | | |
|---|---|---|---|---|
| *Building Climate Zone* | *Average Occupants* | *Temperature Schedule* | *Operating Temperatures* | *Days of Week* |
| Business Office | 20 | Cool-76 M-Su | 76<br>76<br>76 | Mon-Fri<br>Sat<br>Sun/Hol |
| Showroom | 40 | Cool-74 M-Su | 74<br>74<br>74 | Mon-Fri<br>Sat<br>Sun/Hol |

No other areas are air conditioned.

### 2.4.5 Domestic Hot Water Equipment

The following table lists the equipment used for the domestic hot water system in your facility. The domestic hot water load has been estimated based on information gathered during the evaluation and is given below in gallons per day (GPD). The estimated load includes restroom lavatories and other miscellaneous uses where applicable. The Energy Factor is an indicator of the overall efficiency of the water heater. The temperature is the measured or estimated temperature at the tap.

| ***Description of Domestic Hot Water Equipment*** | | | | | | | |
|---|---|---|---|---|---|---|---|
| *Equipment Name* | *System Type* | *Qty* | *Tank Volume (Gal)* | *Fuel* | *Energy Factor* | *DHW Temp* | *Load (GPD)* |
| Water Heater | Self-contained | 1 | 30 | Natural gas | 0.70 | 130°F | 15 |

### 2.4.6 Other Equipment

Equipment that does not correspond to one of the other inventory sections is listed in the following figure. The capacity is in units that are common for the type of equipment being described. The operating hours are estimated based on data collected during the evaluation. These items are used intermittently so the energy use is difficult to estimate, therefore we show them separately.

| ***Description of Other Equipment*** | | | | | |
|---|---|---|---|---|---|
| *Equipment Name* | *System Type* | *Qty* | *Capacity* | *Fuel* | *Operating Hours/Wk* |
| Air Compressor | Air compressor | 2 | 7.5 kW | Electricity | 29 |
| Car Wash Pump | Other | 1 | 2 hp | Electricity | 43 |
| Cold Beverage Vending Machines | Other | 2 | 3 kW | Electricity | 24 |
| Exhaust Fans | Other | 5 | 5 hp | Electricity | 5 |
| HVAC Fans | Other | 10 | 0.5 hp | Electricity | 14 |
| Hydraulic Lift Motors | Other | 39 | 2 hp | Electricity | 1 |
| Office Equipment* | Office equipment | 1 | 9 kW | Electricity | 87 |

*Office Equipment includes printers, copiers, fax machines, servers and computers.

# 3. Current Energy Profile

This section profiles current energy costs and usage for HomeTown Ford. It presents information that serves as a basis for quantifying and evaluating energy and cost-savings opportunities presented elsewhere in this report.

## 3.1 Cost of Energy

The cost of energy is an important factor in any energy appraisal. In the table below, entitled "Annual Energy Costs and Usage", the annual cost is given for each type of energy used in the facility.

***Annual Energy Costs and Usage***

| Source | Annual Use | Annual Cost | $ per ft² | % of Cost | Energy in MBtu | Kbtu/ft² | % of Energy |
|---|---|---|---|---|---|---|---|
| Electricity | 455,442 kWh | $72,590 | $2.19 | 90% | 1,554 | 47 | 66% |
| Natural gas | 802 DKT | $8,106 | $0.25 | 10% | 802 | 24 | 34% |
| Total: | | $80,696 | $2.44 | 100% | 2,356 | 71 | 100% |

Floor space used in analysis: 33,113 ft²

Total site footprint: 230,000 ft²

### 3.1.1 Common Energy Conversion Factors

| | | | | | |
|---|---|---|---|---|---|
| Electricity: | 3.413 | Mbtu/kWh | Natural Gas: | 100.0 | Mbtu/Therm |
| Fuel Oil: | 138.7 | Mbtu/Gal | Natural Gas: | 10.0 | Therms/DKT |
| Coal: | 27,000 | Mbtu/Ton | Propane: | 92.0 | Mbtu/Gal |

A common measure of energy is the British Thermal Unit or Btu, defined as the quantity of heat required to raise the temperature of one pound of water one degree Fahrenheit (see the glossary in the appendix of this report), and its multiples, the Kbtu and the Mbtu, i.e.

1 Kbtu = 1,000 Btu and 1 Mbtu = 1,000,000 Btu = 1,000 Kbtu

One cooling ton = 12,000 Btu

### 3.1.2 Energy Costs Per Unit

Electric and gas rates for the dealership are indicated in the tables below. For cost and savings estimates in this report, the cost of electricity was calculated to be $0.1594/kWh from consumption and billing charges in calendar year 2010. The rate structures are:

Electric Rate for Electric Service:

| Season | $/kWh | $/kW |
|---|---|---|
| November 01 to April 30 | 0.10643 | 7.02 |
| May 01 to October 31 | 0.13666 | 11.05 |

Natural Gas Rate for Natural Gas:

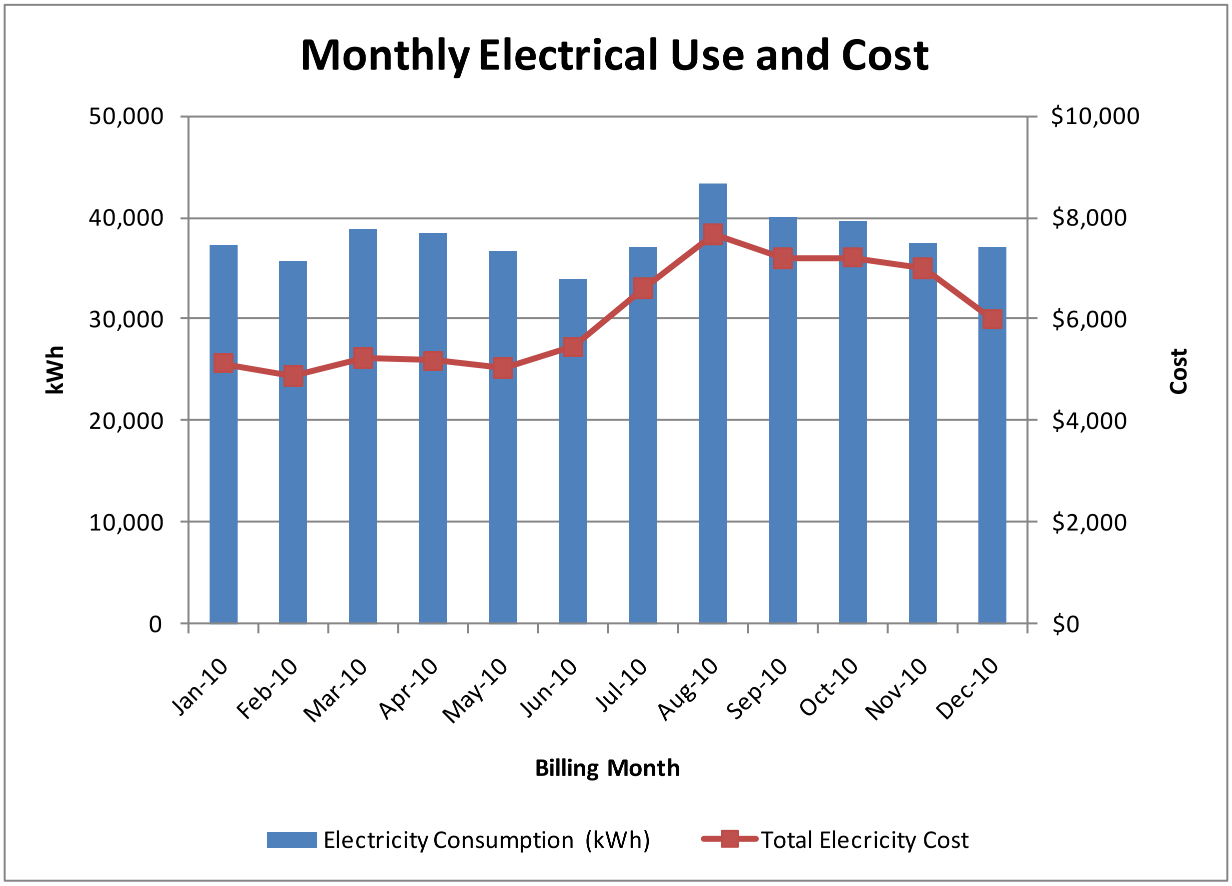
| Season | $/therm |
|---|---|
| April 01 to October 31 | 0.86890 |
| November 01 to March 31 | 0.93585 |

## 3.2 Estimated Annual Utility Costs and Usage

Monthly electric consumption and charges to HomeTown Ford for calendar year 2010 are shown below.

| Month | Electricity Consumption (kWh) | Total Electricity Cost |
|---|---|---|
| Jan-10 | 37,302 | 5,134.96 |
| Feb-10 | 35,771 | 4,884.53 |
| Mar-10 | 38,840 | 5,229.11 |
| Apr-10 | 38,409 | 5,176.77 |
| May-10 | 36,713 | 5,041.89 |
| Jun-10 | 33,868 | 5,450.32 |
| Jul-10 | 37,084 | 6,603.24 |
| Aug-10 | 43,258 | 7,661.82 |
| Sep-10 | 40,017 | 7,201.74 |
| Oct-10 | 39,594 | 7,212.70 |
| Nov-10 | 37,468 | 6,997.66 |
| Dec-10 | 37,118 | 5,995.89 |
| **Totals** | **455,442** | **72,590.63** |
| Average Total Cost of Electricity $/kWh | | **$0.1594** |

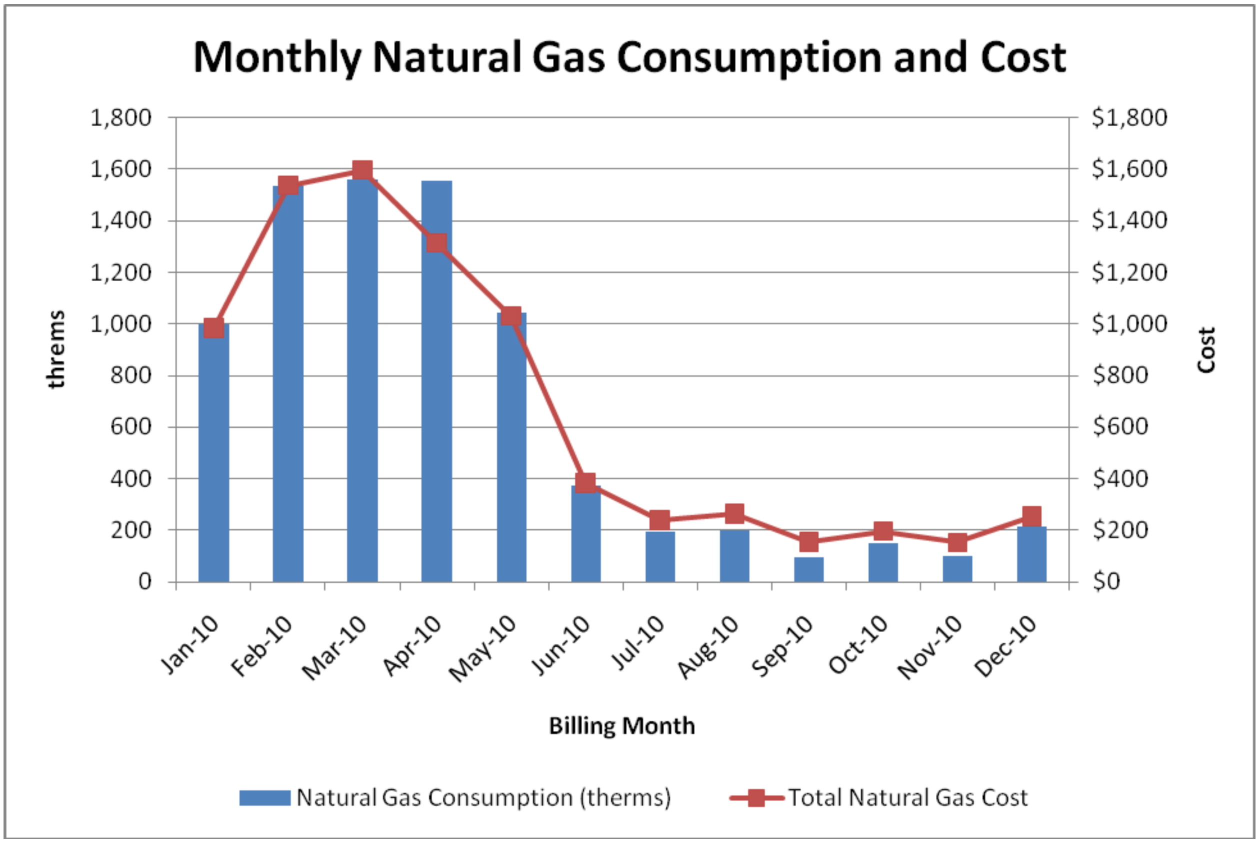
From the table, it can be seen that over the 12-month period ending in December 2010 is delivered 455,442 kWh at an average cost of about $0.16 per kWh.



Monthly natural gas consumption and charges to HomeTown Ford for calendar year 2010 are shown below.

| Month | Natural Gas Consumption (therms) | Total Natural Gas Cost |
|---|---|---|
| Jan-10 | 1,001 | 984.64 |
| Feb-10 | 1,537 | 1,536.68 |
| Mar-10 | 1,560 | 1,597.12 |
| Apr-10 | 1,555 | 1,313.63 |
| May-10 | 1,042 | 1,030.78 |
| Jun-10 | 371 | 384.20 |
| Jul-10 | 196 | 238.37 |
| Aug-10 | 202 | 264.07 |
| Sep-10 | 94 | 153.60 |
| Oct-10 | 149 | 196.14 |
| Nov-10 | 99 | 152.63 |
| Dec-10 | 212 | 254.14 |
| **Totals** | **8,018** | **8,106.00** |
| Average Total Cost of Natural Gas $/therm | | **$1.0110** |

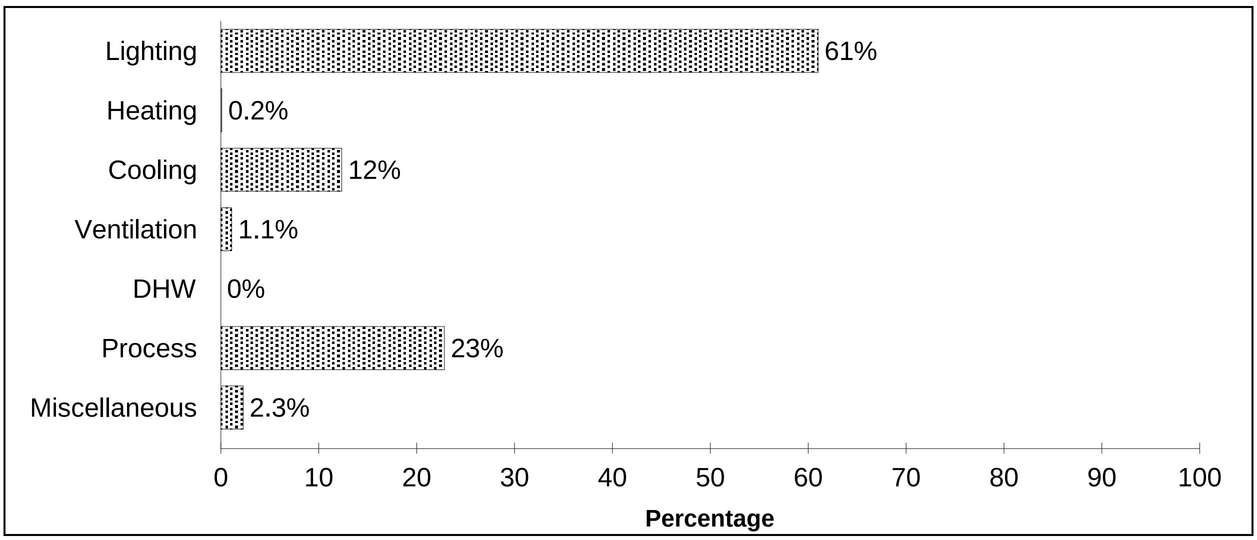
From the table, it can be seen that over the 12-month period ending in December 2010, the utility company delivered 8,018 therms at an average cost of about $1.01 per therm.



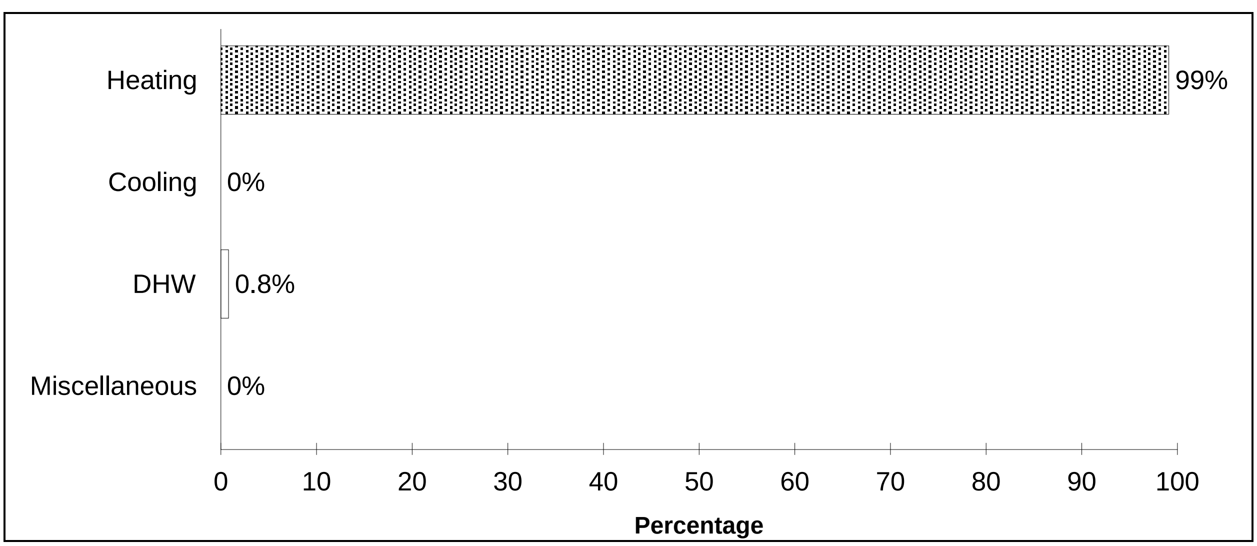
## 3.3 Energy Use Analysis

In order to properly evaluate energy management opportunities, it is first necessary to analyze current energy usage. We have analyzed how energy use is distributed among the many end-uses in your facility. The resulting energy profile serves as a basis for identifying and quantifying recommendations. The following graph(s) are profiles of energy use for HomeTown Ford.

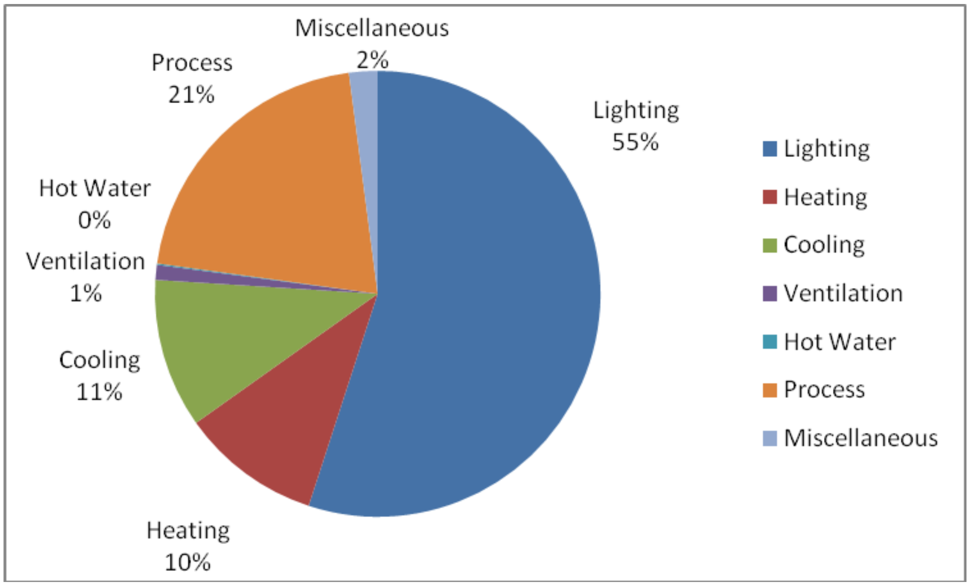
Electricity Consumption by End Use




Natural Gas Consumption by End Use



Energy Cost by End Use



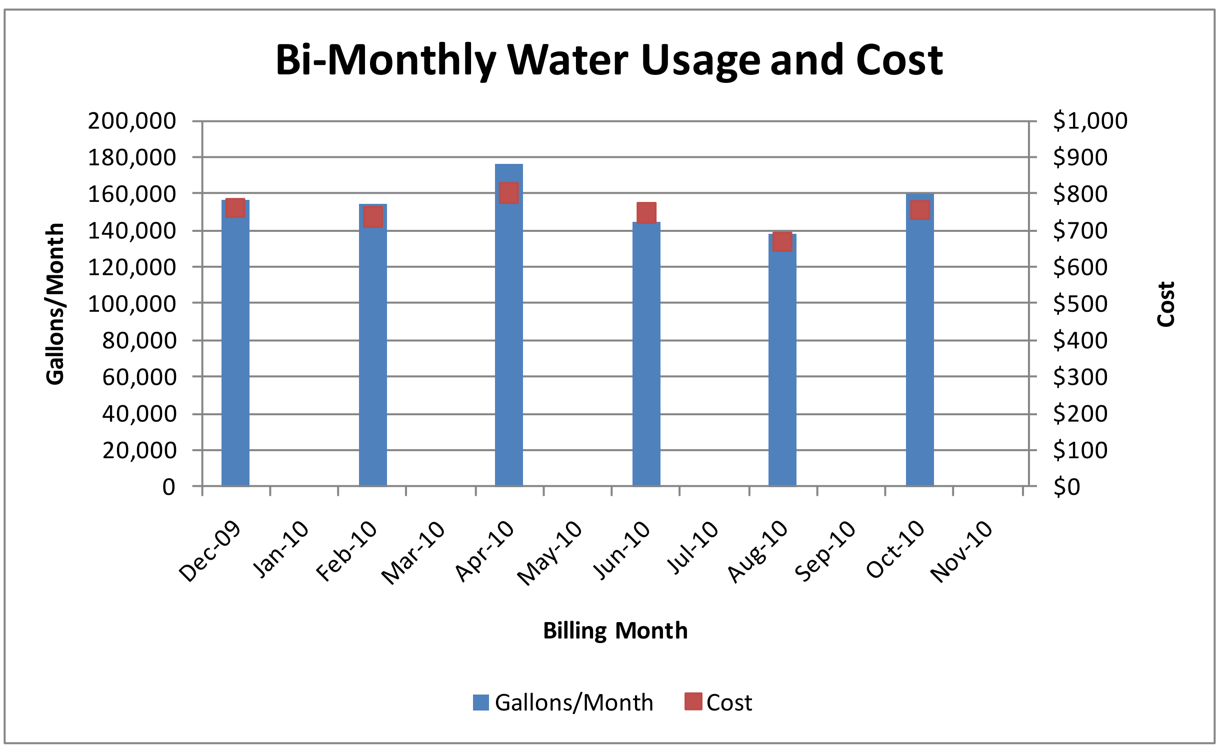

Process uses include items such as air compressors, shop tools, rotary and hydraulic lifts and car wash pumps.

## 3.4 Water Use Analysis

Total water consumption in calendar year 2010 was 928,663 gallons. Individual uses were not metered on site. It is estimated that approximately 10% of total annual consumption was used for domestic water needs. It is estimated that the balance of water was consumed washing cars and trucks. There is no irrigated landscaping.

Bi-monthly water consumption and charges from the water utility company to HomeTown Ford for calendar year 2010 are shown below.

| Month | Water Consumption Gallons/Month | Total Water Cost |
|---|---|---|
| Jan-10 | 156,332 | $762.55 |
| Feb-10 | | |
| Mar-10 | 154,483 | $737.09 |
| Apr-10 | | |
| May-10 | 176,528 | $802.47 |
| Jun-10 | | |
| Jul-10 | 144,364 | $747.07 |
| Aug-10 | | |
| Sep-10 | 137,632 | $669.70 |
| Oct-10 | | |
| Nov-10 | 159,324 | $754.67 |
| Dec-10 | | |
| Total | 928,663 | $4,473.55 |
| Average Total Cost of Water $/Thousand Gallons | | $4.82 |



# 4. Summary of Recommendations and Results

This section presents a summary of the energy measures recommended for the dealership. The measures were developed based on findings made during the energy assessment audits and the analysis of capital costs and energy savings potential.

## Summary of Energy Appraisal Recommendations

| Report Section | Description | Annual Cost Savings | Cost | Incentive | Payback with Incentives | Annual Energy Savings | |
|---|---|---|---|---|---|---|---|
| **4.1** | **Lighting** | | | | | | |
| 4.1.1 | Replace incandescent and CFL w/LED | $873 | $658 | $0 | 0.75 | 7,279 | kWh |
| 4.1.2 | Replace 135W 8 ft Fluor. with 80W LED | $7,064 | $62,696 | $7,120 | 7.9 | 58,864 | kWh |
| 4.1.3 | Replace 95W 4 ft Fluor. with 40W LED | $853 | $4,947 | $840 | 4.1 | 7,111 | kWh |
| 4.1.4 | Replace 190W 4 ft Fluor. with 75W LED | $4,696 | $17,207 | $2,320 | 3.2 | 39,133 | kWh |
| 4.1.5 | Replace Interior Metal Halide With LED | $3,331 | $11,731 | $1,400 | 3.1 | 27,755 | kWh |
| 4.1.6 | Replace Ext. 400W MH with 168W LED | $4,699 | $27,413 | $1,440 | 5.5 | 39,161 | kWh |
| | Subtotal Lighting | $21,516 | $124,651 | $13,120 | 5.2 | 179,302 | kWh |
| **4.2** | **HVAC** | | | | | | |
| 4.2.1 | HVAC system tune up | $721 | $1,095 | $0 | 1.5 | 4,130 | kWh |
| 4.2.2 | Change HVAC setpoint temperature | $5,151 | $0 | $0 | 0.0 | 15,916 | kWh |
| **4.3** | **Other Recommendations** | | | | | | |
| 4.3.1 | Cold Beverage Vending Machines: Install 2 VendingMisers | $621 | $350 | $200 | 0.2 | 3,539 | kWh |
| | **BUILDING TOTAL** | $28,009 | $126,096 | $13,320 | 4.0 | 202,887 | kWh |

Each of these recommendations is discussed below. The following format is employed:

1. A short description of the recommendation.
2. A summary of savings and costs.
3. An explanation that clarifies the nature of the recommendation and discusses why and how the recommendation should be pursued.
4. A list of specific opportunities for each recommendation. For each, we indicate the location involved, the precise action to be taken, and the implementation cost estimates and annual cost savings resulting from following the recommendations.

Each recommendation presented in this chapter is analyzed as a stand-alone recommendation. Exact impacts will depend on other recommendations implemented and the specific conditions following implementation. Since some recommendations may overlap, the total savings given may not be realized.

The costs to implement the recommendations are estimates and are intended to be conservative. Although every reasonable effort is made to be accurate, exact conditions may vary. We suggest obtaining qualified, firm quotes from a consulting engineer/architect, equipment supplier, or contractor prior to actual implementation, particularly for high-cost recommendations.

In an attempt to be conservative and avoid unsubstantiated estimates, the cost savings due to the following items have not been included in our analysis:

1. Federal, State, of Local Tax Credits
2. Savings due to reduced maintenance.
3. Higher future cost savings due to inflation.

Although the these items may result in actual cost savings, they may be subject to speculation and will vary widely depending on the specific financial and operating parameters of each dealership.

## 4.1 LIGHTING

### 4.1.1 Replace interior incandescent and CFL lamps with LED bulbs

Newer LED lighting systems can provide the same light using less electricity. We recommend the replacement of the incandescent lamps in the restroom mirror, parts office and tire shop with LED bulbs. We also recommend replacing the compact fluorescent lamps in the sales restroom with LED bulbs for consistency even though the savings of LED over CFL lamps is not as great as it is for incandescent lamps.

**Recommendation Impacts**

| | |
|---|---|
| Annual cost savings | $873 |
| Cost | $658 |
| Payback years | 0.75 |
| Incentive | $0 |
| Payback years with incentive | 0.75 |

**Discussion**

We are recommending replacing the existing 100W Incandescent lamps in the Tire Shop Service (10 lamps), and the Parts Office (1) with 10W LED Bulbs. We recommend replacement of the existing 60W incandescent lamps in the Sales Restroom Mirror (12) with 7W LEDs. We further recommend replacement of the CFLs in the Sales Restroom with 10W LED Bulbs.

Incandescent lighting is relatively inexpensive to install, but is only about one-eighth as efficient as LED lighting. Of course, the efficiency of the lamps is only one part of the overall effectiveness of a lighting system. The quality of the light in terms of color is discussed below. Although incandescent provides the best color quality, the color quality of LED is very good and is equivalent to or better than fluorescent while achieving an efficiency much greater than incandescent. Also, since LEDs have a life expectancy of 6 times that of CFLs and 35-50 times that of incandescent lamps, the maintenance cost of replacement is reduced. In addition, LEDs are not subject to the lighting level degradation over time that is inherent to other lighting systems, thus providing a higher level of lighting throughout the life of the fixture.

- Color: Two factors influence how well we see under a given light source: Color temperature, and color rendering index (CRI). CRI is a measure of how well a given light source renders colors at the source's color temperature. The color temperature of a light source is expressed in Kelvin (K). The higher the color temperature the bluer or "cooler" the light, the lower the number, the redder or "warmer" the light. Most incandescent lamps are "warm" red or yellow. Older fluorescent lamps are said to be warm-white lamps, producing light similar to an incandescent. Cool-white lamps are most commonly used in retail spaces and offices and produce a blue or cool light. These lamps do not do a good job of bringing out warmer skin colors. Modern LED bulbs provide high CRI at three color temperatures, thus avoiding the poor color rendering characteristics of older "warm white" or "cool white" lamps.

### 4.1.2 Install 80W LED fixtures to Replace 8 foot long 135W T12 fluorescent fixtures

New LED fixtures are available that are more efficient than fluorescent T12 or even T8 lamps. The LED units are available as direct replacements for existing fixtures. Replace existing fluorescent units in specified areas with new 80W LED fixtures (Cree CS18 is indicated).

**Recommendation Impacts**

| | |
|---|---|
| Annual cost savings | $7,064 |
| Cost | $62,696 |
| Incentive | $7,120 |
| Net Cost | $55,576 |
| Payback years with incentive | 7.9 |

**Discussion**

Recent development of LED fixtures has provided an opportunity to save significant energy and improve the lighting quality as compared to the existing T12 fluorescent fixtures currently in use. The use of fixtures such as the Cree CS18 80W will offer significant lighting upgrades. We are recommending replacing the existing 135W T12 fluorescent fixtures in the Car wash (1 fixture), Stefanie's office (1), Tire Shop Service (31), Customer Office (5), File Room (2), Parts Office Storage (57), Service (40), Service Shop (33), and Service Write Up (8). The replacement suggested is based on the use of a fixture equivalent to an 80W Cree CS18 unit.

The efficiency of the lamp is only one part of the overall effectiveness of a light fixture. The quality of the light in terms of color will be improved as discussed in the section 4.1.1 above. The lighting distribution will be significantly improved thus reducing the bright spots and dim spots typical for most non-LED systems. LED will provide a much more even distribution of light within the area served. Also, since LEDs have a life expectancy of 2-3 times that of fluorescent tubes, the maintenance cost of replacement is reduced. In addition, LEDs are not subject to the lighting level degradation over time that is inherent to other lighting systems, thus providing a higher level of lighting throughout the life of the fixture.

### 4.1.3 Install 40W LED fixtures to Replace 4 foot long 95W T12 fluorescent fixtures

New LED fixtures are available that are more efficient than fluorescent T12 or even T8 lamps. LED units are available as direct replacements for existing fixtures. Replace existing fluorescent units in specified areas with new 40W LED fixtures (Phillips Dayline).

**Recommendation Impacts**

| | |
|---|---|
| Annual cost savings | $853 |
| Cost | $4,947 |

| | |
|---|---|
| Incentive | $840 |
| Net Cost | $4,107 |
| Payback years with incentive | 4.1 |

**Discussion**

Recent development of LED fixtures has provided to opportunity so save significant energy and improve the lighting quality as compared to the existing T12 fluorescent fixtures currently in use. The use of fixtures such as the Phillips Dayline 40W will offer significant lighting upgrades. We are recommending replacing the existing 95W T12 fluorescent fixtures in the Corporate Office (2), Finance (1), Fleet Department (1), Sales Office (4), Stefanie's Office (2), Customer's Office (4), Parts Office/Storage (4), and Service Office (3). The replacement suggested is based on the use of a fixture equivalent to a Phillips Dayline 40W unit.

The efficiency of the lamp is only one part of the overall effectiveness of a light fixture. The quality of the light in terms of color will be improved as discussed in the section 4.1.1 above. The lighting distribution will be significantly improved thus reducing the bright spots and dim spots typical for most non LED systems. LED will provide a much more even distribution of light within the area served. Also, since LEDs have a life expectancy of 2-3 times that of fluorescent tubes, the maintenance cost of replacement is reduced. In addition, LEDs are not subject to the lighting level degradation over time that is inherent to other lighting systems, thus providing a higher level of lighting throughout the life of the fixture.

### 4.1.4 Install 75W LED fixtures to Replace 4 foot long 190W T12 fluorescent fixtures

New LED fixtures are available that are more efficient than fluorescent T12 or even T8 lamps. The LED units are available as direct replacements for existing fixtures. Replace existing fluorescent units in specified areas with new 75W LED fixtures (Phillips Dayline).

**Recommendation Impacts**

| | |
|---|---|
| Annual cost savings | $4,696 |
| Cost | $17,207 |
| Incentive | $2,320 |
| Net Cost | $14,887 |
| Payback years with incentive | 3.2 |

**Discussion**

Recent development of LED fixtures has provided to opportunity so save significant energy and improve the lighting quality as compared to the existing T12 fluorescent fixtures currently in use. The use of fixtures such as the Phillips Dayline 75W will offer significant lighting upgrades. We are recommending replacing the existing 190W T12 fluorescent fixtures in the Business Office (15), Car Wash (1), Finance

(4), Fleet Management (2), Interior Dept. (4), Lobby (4), Sales Office (6), Tire Shop Service (4), File Room (4), Office in Shop (2), Service Office (7), and Service (5). The replacement suggested is based on the use of a fixture equivalent to a Phillips Dayline 75W unit.

The efficiency of the lamp is only one part of the overall effectiveness of a light fixture. The quality of the light in terms of color will be improved as discussed in the section 4.1.1 above. The lighting distribution will be significantly improved thus reducing the bright spots and dim spots typical for most non LED systems. LED will provide a much more even distribution of light within the area served. Also, since LEDs have a life expectancy of 2-3 times that of fluorescent tubes, the maintenance cost of replacement is reduced. In addition, LEDs are not subject to the lighting level degradation over time that is inherent to other lighting systems, thus providing a higher level of lighting throughout the life of the fixture.

### 4.1.5 Install 110W LED Fixtures to Replace 250W Metal Halide Fixtures. Also Install 172W Fixtures to Replace 400W Metal Halide Fixture

New LED fixtures are available that are more efficient than Metal Halide. The LED units are available as direct replacements for existing fixtures. Replace existing 250W and 400W metal halide units in specified areas with new 110W and 172W LED fixtures respectively (Lusio 4ms & 6ms 6ms units).

**Recommendation Impacts**

| | |
|---|---|
| Annual cost savings | $3,331 |
| Cost | $11,731 |
| Incentive | $1,400 |
| Net Cost | $10,331 |
| Payback years with incentive | 3.1 |

**Discussion**

Recent development of LED fixtures has provided an opportunity to save significant energy and improve the lighting quality as compared to the existing metal halide units currently in use. The use of fixtures such as the Lusio 110W and 172W will offer significant lighting upgrades. We are recommending replacing the existing 110W metal halide fixtures in the Showroom (15), Shop Office (2), and Tire Shop (11). The replacement suggested is based on the use of a fixture equivalent to a Lusio 4ms (110W) & 6ms (172W) units.

The efficiency of the lamp is only one part of the overall effectiveness of a light fixture. The quality of the light in terms of color will be improved as discussed in the section 4.1.1 above. The lighting distribution will be significantly improved thus reducing the bright spots and dim spots typical for most non LED systems.  LED will provide a much more even distribution of light within the area served.  Also, since LEDs have a life expectancy of metal halide, the maintenance cost of replacement is reduced.  In addition, LEDs are not subject to the lighting level degradation over time that is inherent to other lighting systems, thus providing a higher level of lighting throughout the life of the fixture.

### 4.1.6 Exterior Lighting – Install168W LED Fixtures to Replace the Existing 400 W Metal Halide Luminaires

Recent development of LED fixtures has provided to opportunity so save significant energy and improve the lighting quality as compared to the existing metal halide units currently in use.  The use of fixtures such as the Cree OSO Medium fixtures will offer significant lighting upgrades over the existing metal halide units.  We are recommending replacing the existing 400W metal halide fixtures in exterior parking lot areas.  The replacement suggested is based on the use of a fixture equivalent to Cree OSO Medium 168W units.

**Recommendation Impacts**

| | |
|---|---|
| Annual cost savings | $4,699 |
| Cost | $27,413 |
| Incentive | $1,440 |
| Net cost | $26,013 |
| Payback years with incentive | 5.5 |

**Discussion**

Recent development of LED fixtures has provided to opportunity so save significant energy and improve the lighting quality as compared to the existing metal halide units currently in use.  The use of fixtures such as the Cree OSO Medium will offer significant lighting upgrades.  We are recommending replacing the existing 400W metal halide fixtures.  The replacement suggested is based on the use of a fixture equivalent to a Cree OSO Medium unit.

The efficiency of the lamp is only one part of the overall effectiveness of a light fixture.  The quality of the light in terms of color will be improved as discussed in the section 4.1.1 above.  The lighting distribution will be significantly improved thus reducing the bright spots and dim spots typical for most non LED systems.  LED will provide a much more even distribution of light within the area served.  Also, since LEDs have a life expectancy of 5 to 6 times that of metal halide, the maintenance cost of replacement is reduced.  In addition, LEDs are not subject to the lighting level degradation over time that is inherent to other lighting systems, thus providing a higher level of lighting throughout the life of the fixture.  The net result is an exterior vehicle display area that enhances the appearance of the vehicles while promoting security.

In addition, LED fixtures allow for the use of on-off and dimming controls that can further decrease operating costs. Examples include the ability to dim lot lights during late night hours, shut off lights or a percentage of lights in specific areas, provide motion sensors to instantaneously re-light an area upon the detection of movement, and customize specific lot lighting levels on an area-by-area basis.

## 4.2 Heating, Ventilation, and Air Conditioning Recommendations

HVAC equipment was observed to be in good condition. Replacement of HVAC Equipment with more efficient units is an enhanced energy efficiency opportunity discussed in Section 4.4.2.

### 4.2.1 Tune Up HVAC Equipment

Maintain HVAC equipment as specified. Heating and cooling equipment should be cleaned and tuned for maximum efficiency.

**Recommendation Impacts**

| | |
|---|---|
| Annual cost savings | $721 |
| Cost | $1,095 |
| Payback years | 1.5 |
| Incentive | $0 |
| Net cost | $1,095 |
| Payback years with incentive | 1.5 |

**Discussion**

Cooling equipment requires periodic maintenance to ensure its efficient operation by preventing the following conditions:

- Dirty heat transfer coils, either the exterior heat rejection equipment (condenser) or the cooling coil, reduce the cooling capacity of a system, requiring it to work harder to adequately cool the building. Coils may foul with dust, dirt or other matter. Exterior coils may be cleaned by hosing off. Interior coils can usually be blown off with compressed air or vacuum equipment.

- Belts which connect motors to fans or refrigeration equipment frequently become loose due to wear over a period of time. Belt slippage makes motors work harder than necessary to perform their task. Replace all worn, loose, or broken drive belts.

- Dirty filters require fans to work harder to deliver sufficient air. Inspect filters periodically and clean or replace as necessary.

- Air conditioning equipment which operates continuously, even when cooling loads are small, may be low on refrigerant. A refrigeration technician should be called in to check on refrigerant levels.

- When cooling equipment cycles (turns on and off excessively), runs continuously, or continually trips circuit breakers, it is likely that an element of the control system has malfunctioned.

Heating equipment should be serviced periodically to assure its continued operation at peak efficiency. This work can be carried out by maintenance personnel or a local heating contractor. The following actions are recommended:

- Filters, where installed, should be inspected and cleaned or replaced as required.

- Heat exchangers or coils should be cleaned.

- The fire-side of combustion units should be inspected at least yearly and mechanically cleaned if scale or soot build-up is observed. If excessive soot and scale have built up, consult a professional since this may indicate a problem with combustion.

- When equipment is serviced, have a complete combustion analysis performed and air/fuel settings adjusted for peak efficiency.

Costs for this measure are presented as a one-time cost, over and above normal annual maintenance costs. Of course, these costs could vary, depending on specific equipment and problems encountered during service. As part of your normal service, these items should be regularly checked.

As shown in the table below, tuning up package units will save approximately $721 per year.

| Location/Name | Description | Cost | Annual Savings | Payback (years) |
|---|---|---|---|---|
| Business Office Package Unit | Tune up system | $52 Matl<br>$222 Labor<br>$274 Total | $357 Energy | 0.8 |
| Sales Office Package Unit | Tune up system | $52 Matl<br>$222 Labor<br>$274 Total | $281 Energy | 1.0 |
| Service Office Package Unit | Tune up system | $52 Matl<br>$222 Labor<br>$274 Total | $42 Energy<br>$42 Total | 6.5 |
| Service Lounge Rooftop Unit | Tune up system | $52 Matl<br>$222 Labor<br>$274 Total | $41 Energy<br>$41 Total | 6.6 |
| | TOTAL | $206 Matl<br>$889 Labor<br>$1,095 Total | $721 Total | 1.5 |

### 4.2.2 Change HVAC Setpoint Temperature

Adjusting the thermostat setting as recommended will create worthwhile savings while maintaining adequate occupant comfort levels.

**Recommendation Impacts**

| | |
|---|---|
| Annual cost savings | $5,151 |
| Cost | $0 |
| Payback years | 0 |
| Incentive | $0 |
| Net cost | $0 |
| Payback years with incentive | 0 |

**Discussion**

Energy is required to bring the interior temperature to comfortable occupancy conditions during cold weather. In general, the higher the inside temperature, the more energy is expended. Energy can be saved by reducing heating temperatures to lower, more economical levels. Standards for most areas are 65-68 degrees Fahrenheit. Areas in which people are more active could be maintained at a lower level, i.e., 60-65 degrees Fahrenheit. Temperatures as low as 50 degrees Fahrenheit may be acceptable in areas where little time is spent, such as storage space. Potential savings resulting from temperature reduction are considerable, as they occur on a twenty-four hour basis.

Air conditioning involves expending energy to remove heat from air to bring a room from a high temperature to a lower temperature for comfort of occupants. The lower the room temperature, the more cooling energy is required. Conversely, the higher the temperature of the room, the less energy required. For normal levels of activity, 78 degrees Fahrenheit can provide reasonable comfort. When thermostats are set at lower or higher levels than those to which people are accustomed, there is the risk of constant tampering and adjusting. Any one of a variety of thermostat guards and covers, available from a heating and air or controls contractor, can be installed with little time or trouble, and can be locked with a key. Occupants may object to lower or higher temperatures. It is recommended that when such an action is proposed, the situation is explained so that they understand what is happening and why, and that the reduction is reasonable. Appropriate dress should be advised.

As shown in the table below, adjusting the temperature setpoints in the showroom, business office, and parts department will save approximately $5,151 per year.

| Location/Name | Description | Cost | Annual Savings | Payback (years) |
|---|---|---|---|---|
| Showroom | Change the heating temperature schedule to Heat-68 8:00A-8:00P, M-Sa and change the cooling temperature schedule to Cool-78, 8:00A-8:00P,M-Sa | $0 Matl<br>$0 Total | $2,282 Energy<br>$2,282 Total | 0.0 |
| Business Office | Change the heating temperature schedule to Heat-68, setback 55 and change the cooling temperature schedule to Cool-78 M-F, 85 Sa-Su | $0 Matl<br>$0 Total | $1,531 Energy<br>$1,531 Total | 0.0 |
| Parts Department | Change the heating temperature schedule to Heat-68 8:00A-8:00P, M-Sa | $0 Matl<br>$0 Total | $1,338 Energy<br>$1,338 Total | 0.0 |
| | TOTAL | $0 Matl<br>$0 Total | $5,151 Total | 0.0 |

## 4.3 Other Recommendations

### 4.3.1 Install 2 VendingMisers

**Recommendation Impacts**

| | |
|---|---|
| Annual cost savings | $621 |
| Cost | $350 |
| Payback years | 0.6 |
| Incentive | $200 |
| Net cost | $150 |
| Payback years with incentive | 0.2 |

**Discussion**

We recommend installing a VendingMiser control on each of the refrigerated vending machines. VendingMisers are a simple, cost-effective way to reduce energy costs while still providing employees and customers with the convenience of vending machines on site. VendingMisers are control devices that are installed on vending machines that use a passive infrared occupancy sensor to power down a vending machine when the area around it is vacant. VendingMisers also monitor the surrounding temperature and automatically re-power the vending machine as needed to keep the product refrigerated. Visit www.vendingmiserstore.com for details and more information.

As shown in the table below, installing VendingMisers will save approximately $621 per year.

| Location/Name | Description | Cost | Annual Savings | Payback (years) |
|---|---|---|---|---|
| Cold Beverage Vending Machines | Install 2 VendingMisers | $350 Matl<br>($200) Incentive<br>$150 Total | $621 Energy | 0.2 |

Incentive calculation based on $100.00/Unit.

More information on energy efficient vending machine controls is available at *http://www.pge.com/includes/docs/pdfs/mybusiness/energysavingsrebates/incentivesbyindustry/refrigeration_catalog_final.pdf*

### 4.3.2 Water Conservation

**Domestic flow and flush fixtures**

Toilets, urinals, lavatories and showers are all considered domestic flow and flush fixtures. These units currently consume water at a rate estimated at 3.5 gpf for toilets, 2 gpf for urinals and 2 gpm for lavatories. Consumption by these units can be cut considerably by retrofitting with code standard toilets and aerators (1.6 gallons per flush (gpf) for the toilets, 1 gpf for the urinals and 0.5 gallons per minute (gpm) for the lavatories).

The number of toilets, urinals and lavatories were not counted during the site visit. To calculate the daily uses of these devices and the savings achieved by retrofitting with low flow devices, one can assume that the occupancy of the buildings is 50% female and 50% male, with females using the toilets 3 times a day and men using urinals 2 times a day and the toilet 1 time each day. There are also an estimated 100 customers per day (50% male and 50% female) using these facilities.

Note that the cost of replacing toilets and urinals is high compared to the cost savings from reduced water usage. Consequently these conservation measures are not cost effective retrofits. However, they will be required by code for new installations or when replacing these fixtures for other reasons.

## 4.4 ENHANCED EFFICIENCY OPTIONS

### 4.4.1 Lighting

**Incorporating Enhanced Lighting Controls with Light Emitting Diode fixtures**

Light emitting diode (LED) fixtures are much more efficient are much longer lived than most other fixtures. LEDs also can be shut off, restarted, and dimmed very easily through wireless control systems. LED's do not require the longer start-up time required by metal halide or fluorescent lighting systems. Through recent advances, LEDs can be dimmed during late night hours or even shut off. The dimming and shut off can be accomplished on an area-by-area basis based on the needs and preferences of the dealership. Motion sensors can be provided to instantaneously reactivate the LED fixtures in the areas where motion is detected. Thus security can be enhanced while reducing energy.

### 4.4.2 HVAC

**Replace package units with high SEER units on burnout**

A new, properly designed HVAC unit can achieve a significant efficiency improvement over the old unit, and can save a substantial percentage of current cooling costs.

Currently, HomeTown Ford has package units that have been in service for over 10 years. When it comes time to replace this equipment due to equipment failure or excessive maintenance, we recommend the purchase of high efficiency package units. The use of new, high efficiency package units will significantly reduce air conditioning electricity costs by as much as 10% over standard replacement units and about 20% over the units you currently have. The energy cost savings from a high efficiency unit would payback its incremental cost in just two or three cooling seasons over the cost of replacement with standard units. It will be worthwhile to review the HVAC units on an annual basis. As the energy efficiency rating of new available units improves, the ROI of replacing HVAC units may become financially advantageous even if the existing units are functioning relatively well.

### 4.4.3 Water Conservation

Possible enhanced water conservation measures would be to replace the existing urinals with waterless urinals and the existing toilets with low flow toilets with dual flush valves. Dual flush valves can be installed on each new low flow toilet that will produce a 1.1 gallon flush when low flow is needed and a 1.6 gallon flush when a heavier flush is needed. Waterless urinals eliminate the use of water entirely. These devices use a trap insert filled with a sealant liquid instead of water. The lighter-than-water sealant floats on top of the urine collected in the U-bend, preventing odors from being released into the air.

# 5. RENEWABLE ENERGY ASSESSMENT

As part of the audit, the HomeTown Ford Dealership was also assessed for the use of renewable energy sources. The overall results of the analysis are shown in the sections below along with a discussion of conceptual design assumptions, costs, and design factors.

## 5.1 Solar Assessment

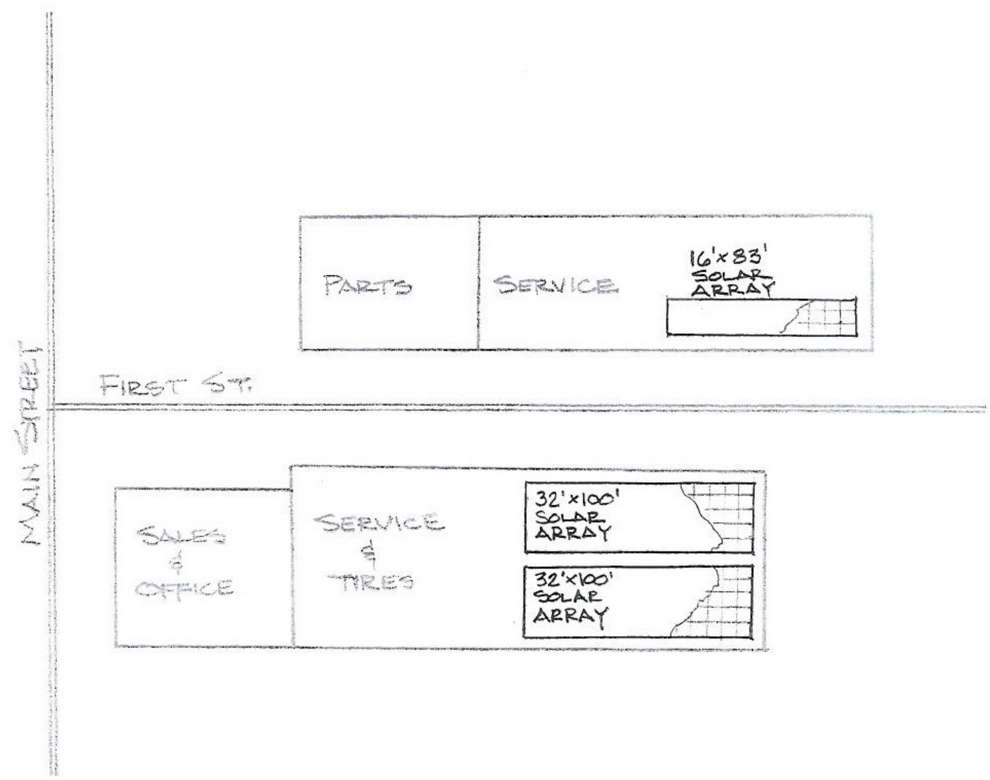
This section presents the best available options for solar power generation at the HomeTown Ford Dealership in MyTown, CA. There are feasible options for photovoltaic (PV) arrays on the Service Department (SERVICE MAINTENANCE) building roof on Main Street and the Service Department (SERVICE) building roof at First Avenue. The tables below show that the simple payback when incentives are included is 19.0 years. The conceptual design assumptions and other details are provided in Sections 5.2 through 5.4.

**Solar Generation Savings Summary**

| Building Area | Savings kWh/yr | Annual cost savings | Installed cost | Simple Payback (years) | Incentives | Net cost | Simple Payback with Incentives |
|---|---|---|---|---|---|---|---|
| SERVICE MAINTENANCE Roof | 48,789 | $6,988 | $207,200 | 29.7 | $74,537 | $132,843 | 19.0 |
| SERVICE Roof | 12,685 | $1,817 | $53,900 | 29.7 | $19,321 | $34,579 | 19.0 |
| Site Total | 61,474 | $8,804 | $261,100 | 29.7 | $93,678 | $167,422 | 19.0 |

The installed cost estimates for the arrays shown above are based on an installed cost of $7.00 per watt. Incentives are based on currently available California Solar Initiative incentives (CSI) plus the current Federal tax credit of 30%. Note that CSI incentives are scheduled to change over time and could vary and that the Federal tax credit expires in 2016. The preferred locations of solar arrays are shown in the figures below.

**Sales & Service Building Solar Array Location**




The solar generation estimated above assumes fairly standard modules with an output of 230 watts. Higher output modules are available, but are manufactured by a limited number of companies. Specifying higher output modules could limit the potential bidders for the project. Modules by a single manufacturer have output as high as 320 watts. Using these panels could increase the total generation to 85,670 kWh/yr with the same number of panels and area.

### 5.1.1 Available PV Capacity

PV locations that make the best use of space and performance at the site include the SERVICE MAINTENANCE Building Roof, and the SERVICE building roof. Other building roof areas were found to be unsuited for PV panels. The SHOW ROOM and PARTS building roofs are too crowded with existing equipment to make a PV array practical. The TRACK SERVICE roof is constructed from wood, and due to its age and condition is not capable of supporting the added load from solar panels. The wooden Business Office/Sales Service building roof is arched. This shape and construction is not conducive for solar panel installation.

Based on standard PV components the following available capacity estimates are:

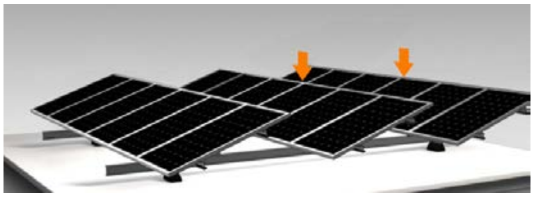
**Solar Capacity Summary**

| Location | Total Capacity | Number of Modules |
|---|---|---|
| Sales Department Roof | 29.6 kW | 150 |
| Service Department Roof | 7.7 kW | 39 |

Capacity and savings values in Tables 1-1 and 2-1 were calculated using the California Solar Initiative (CSI) EPBB incentive calculator. The CSI-EPBB calculator1 is a tool that determines the EPBB Design Factor and calculates annual kWh output for an individual system based on the orientation and tilt of the panels, the square footage of the panels, and the ZIP code of the site location.

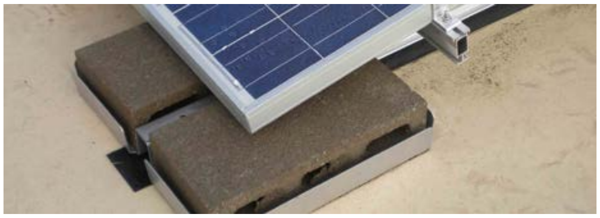
Alternatives for panel installation are shown below.

**Panel Installation Alternatives**



*Source: Uni-rac*

*Source: Sunpower*



*Source: JacRack*

Conceptual roof panel layouts are provided in herein.

### 5.1.2 System Costs

Cost data was collected for various solar integrators, contractors and distributors. Cost data provided is considered conservative. System cost per watt is very dependent on the size of system. Standard roof

[1] The CSI-EPBB calculator is available at http://www.csi-epbb.com/default.aspx. The CSI-EPBB calculator Users Guide can be found at http://www.csi-epbb.com/CSICalculatorV5UserGuide.pdf

mount systems like the Sales Department and Service Department roofs can cost between $4 and $7 per DC watt in today's market. Assuming at least 30 kW will be put out to bid, the price point used for this conceptual estimate was $7.00 per DC watt.

### 5.1.3 HomeTown Ford Dealership Conceptual Design Components

Two areas on HomeTown Dealership were assessed for PV feasibility- the SERVICE MAINTENANCE roof and the SERVICE roof as shown in herein. Standard crystalline PV modules mounted with racking attached to the structure were assumed for each location.

### 5.1.4 Modules

PV modules are available in many sizes and outputs depending on the manufacturer and model. For purposes of this study, sizing and available capacity estimates at the HomeTown Ford Dealership a standard PV module size of 40" x 66" was assumed. Sizing and module outputs will vary depending on the exact specifications of the equipment used. A common output of this size module is 230 watts and was used as the basis for this capacity estimate. However, higher and lower performance modules are available (~180 to 320 watts) and will likely be proposed. Higher performance modules may reduce the number of modules or increase the capacity of the system, but will also come at a higher cost. For purposes of this conceptual estimate a 230 watt module was assumed for all areas. Panel details are pictured herein.

### 5.1.5 Inverters

As with PV modules there are a variety of options for inverter technology. The most common configuration is to minimize the number of components by installing larger inverters sized to the configuration of the modules.

An optional approach is micro-inverters. This is a distributed architecture, in which Maximum Power Point Tracking (MPPT) is done in a panel level. In this architecture an MPP tracker is connected to each PV panel and tracks its individual maximum power point, independently of other panels. Then, it is only responsible for DC-AC conversion, which makes it more efficient and reliable than traditional one. The panel-level MPP tracker may also act as an inverter, or more precisely - micro-inverter, performing both the MPPT and DC-AC conversion at the panel level.

Standard inverters were assumed in the calculation of the system output for the HomeTown Dealership. Micro-inverters, just like high performance modules, will increase output but also increase costs. The HomeTown Ford Dealership will need to evaluate the cost-benefit of all proposals. Given the purpose of this analysis was to evaluate the total available PV capacity of the site it is not possible to say which components are the best option.  When HomeTown Ford Dealership determines the funding and actual size of the system desired a better cost-benefit analysis of options should be completed.

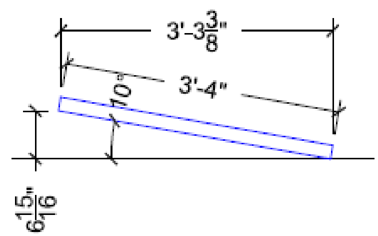
### 5.1.6 Design Factors

As described above, orientation, tilt, and shading each have a large effect on the output of a PV system. The design assumptions we used are described below.

**Orientation:** The orientation to true south affects the amount of sunlight that will hit the solar panels. The further the panels are oriented away from true south the worse they will perform. The impact is not linear and higher tilt systems are more impacted by deviations on southern orientation. Arrays are typically aligned with the building orientation for aesthetic (and some cost) reasons.  We analyzed the panel layout at 180 degrees (south) and the ANGLE degree (COMPASS DIRECTION) orientations that align with the buildings.  The south orientation provides slightly higher output but not significantly enough to outweigh the aesthetics of the layout.

**Tilt:** The tilt of a system also has an impact on system performance.  Panels are typically mounted flat onto the roof for roofs with some pitch (> 4:12). For flat roof installation, panels are put on 'tilt up' mounting kits that hold the panels at anywhere from 5-25+ degrees; the amount of tilt depends on several mounting and structural variables. This conceptual analysis was calculated with the modules on the SERVICE MAINTENANCE roof tilted at a 10 degree rise roof.  The SERVICE building roof panels are on the same slope as the roof- 10 degrees.

**Module Tilt Detail**




**Shading:** Solar Photovoltaics are particularly sensitive to shading. This is due in part to the way they are wired in series to boost the voltage to achieve acceptable performance in a normal electrical service. Siting away from elements that cast shadows is extremely important.  There are no shading objects at the site.

## 5.2 Wind Energy Assessment

Small wind turbines (defined as turbines <30 kW) operate optimally at a limited range of wind speeds. Therefore, it is important to site a small wind system where there is adequate wind. In addition, available wind maps only provide a general picture of annual wind resources. They do not provide seasonal, monthly, or daily variables, nor do they evaluate wind resources at a specific site.

The Department of Energy's Wind Program and the National Renewable Energy Laboratory (NREL) has published a wind resource map for the state of California. The wind resource map shows the predicted mean annual wind speeds at a height of 80-meters. Areas with annual average wind speeds around 6.5 meters/second and greater at 80-meter height are generally considered to have suitable wind resource for wind development. According to the wind resource map of California, HomeTown is not suited for wind power as it has an annual average wind speed of only about 5.0 meters/second at a height of 80 meters.

The NREL wind resource map for the state of California can be viewed at http://www.windpoweringamerica.gov/images/windmaps/ca_80m.jpg

The actual wind speed at a site is also greatly influenced by the local topography and nearby obstacles such as trees or other building structures. Not only do these obstacles reduce wind speed and its consistency, they may cause wind direction to shift erratically. All these factors make the task of estimating wind resources difficult. Inaccurate estimates of wind speed ultimately lead to false performance expectations.

The capacity factor for a wind turbine is the amount of energy produced as a percentage of its rated output. In a recent California study, it was found that the mean capacity factor of all the small turbines installed in the state was only 11%. So for a 30 kW turbine, the expected average output would be just 3.3 kW. Moreover, the study found that there was a large spread of performance characteristics between those turbines with excellent performance factors (18 percent or above) and those with dismal performance factors (4 percent or below). Furthermore, many systems (42 percent) were performing with capacity factors below 8 percent.

**Siting and Permitting**

Only a small fraction of households and businesses are located in an area with sufficient wind conditions to make small wind turbines practical and economical. Of these, even fewer can support the space and siting requirements required for good operation and for fulfilling local permitting requirements. The siting process includes assessing a site for its adequacy in wind resource, determining whether the turbine might have significant noise/visual impact to the neighbors, and obtaining permits from local government agencies. Though technological advances continue to improve the noise level and aesthetics of small wind turbines, these issues often make obtaining permits from building departments and communities difficult. Complaints from neighbors about excessive noise, especially during high winds and at night, are common. This may result in severe curtailment of wind turbine operating hours.

**System Cost**

There are two distinct cost averages: those for systems under 3 kW and those for systems 9 kW to 10 kW. The small systems average between $7.00 and $7.50 per watt; the larger systems average around $5.00 per watt.

Considering the variation in capacity factors noted above, the calculated payback, after factoring in available incentives, can range from 6 years for systems with high capacity factors to 100 years or more for systems with low capacity factors. The California study calculated an average payback of 30.3 years and median payback of 21 years for all the turbines it studied.

**Incentive programs**

The California Self-Generation Incentive Program (SGIP) is administered by the three California investor-owned utilities. The incentive program for small wind turbines was suspended in 2011 due to discrepancies between expected performance and actual measured performance.

The Federal Energy Improvement and Extension Act of 2008 (H.R. 1424) created tax credits for qualifying small wind customers. To qualifying for this program a wind turbine must have a nameplate capacity of not more than 100 kilowatts. Under this program, residential and commercial small wind customers are eligible for a 30 percent investment tax credit, not to exceed $4,000, for systems placed in service by December 2016. In 2009, The American Recovery and Reinvestment Act (ARRA) removed the $4,000 maximum credit limit for small wind turbines.

## 5.3 Geothermal Heat Pump Assessment

A geothermal heat pump, also known as a ground source heat pump (GSHP), is a central heating and/or cooling system that pumps heat to or from the ground using the earth as a heat source in the winter or a heat sink in the summer. These systems take advantage of the moderate temperatures in the ground (usually between 50°F and 60°F) to boost efficiency and reduce the operational costs of heating and cooling systems.

Space heating and cooling in a geothermal system are provided by a system of water source heat pumps. A water source heat pumps (WSHP) is a self-contained, water-cooled, packaged heating and cooling unit, with a reversible refrigerant cycle. Its components are typically enclosed in a common casing, and include a tube-in-tube heat exchanger, a heating/cooling coil, a compressor, a fan, a reversing valve and controls.

**Typical Vertical Water Source Heat Pump**

Ground source installations differ from standard heat pump system installations in that the typical heat rejection of a cooling tower and the heat source of a boiler are replaced with sub-terranian closed-system hydronic loops. Exploiting the near constant temperature of the earth throughout the seasons, these loops provide the needed source of both heat rejection and supply for proper operation of the WSHP units. Installed as either deep-bore vertical loops, or shallow horizontal loops, each loop is typically sized for one ton of installed heat pump capacity. Once manifolded together, the ground source loop is pumped through a condenser water loop to the heat exchanger of each WSHP.

**Horizontal Ground Source Heat Pump Loop**

WSHP units can be suspended in the ceiling plenum, floor mounted behind walls or placed directly in the occupied space as a console unit. There are also rooftop and unit ventilator type water source heat pumps.

The efficiency of distributed WSHP systems typically operates at a coefficient of performance (COP) of 2-3 (for every kW of electrical energy consumed, 2-3 KW of cooling/heating capacity is generated).

Relative Advantages and Disadvantages

The advantages of a ground source heat pump system are as follows:

- Combination of refrigeration cycle with low-grade heat source from Earth can provide high efficiency levels,
- Elimination of natural gas or heating oil consumption for space heating,
- Waste heat can be used to pre-heat hot water,
- Heat pump units can be installed inside the building and therefore are not exposed to external conditions.

The disadvantages of this type of system are as follows:

- Requires replacement of all air-cooled air conditioning units with WSHP's,
- Requires installation of water piping to and from each new heat pump location and the hydronic circulation pump,
- Substantial disruption to the dealership due to the extensive excavation required to install the hydronic loops under the sales lots,
- Potential lack of local contractor awareness for installation and maintenance,
- Installation costs for ground source tubing loops can be high and may not operate properly with the site's soil conditions,
- Increased electrical infrastructure may be required to each heat pump location,
- Minimum humidity control,
- High maintenance costs due to year-round operation of multiple compressors and fans resulting heat pump unit replacement approximately every 8 years,

**System Cost**

The cost of a ground source heat pump system is high relative to conventional air-cooled package units. A recent study of installations in California found an average cost of $4,600/ton of capacity. So for a dealership needing 100 tons of cooling, the cost would be approximately $460,000.

**Incentive programs**

Utility Companies often do not offer a prescriptive rebate or incentive for this measure.

The savings for a system like this would be elimination of gas needed for space conditioning, but this would be partially offset by added electrical use to run the heat pumps for heating. Since HomeTown Ford has a heating bill of only about $8,000, the calculated payback would be in excess of 100 years even with any incentive that might be offered. So this is not recommended for HomeTown Ford.

# Appendix A:  Glossary

Below are definitions and explanations of some words and phrases used in discussion of energy and energy efficiency.  Words in CAPITALS are defined elsewhere in the Glossary.

- Absorption cooling systems: Cooling or air conditioning systems powered by the energy supplied by heat (e.g., from steam or gas- or oil-fueled fires) rather than electricity.
- Air conditioning setpoint: The room temperature that an air conditioning system is set to achieve; the higher the setpoint, the lower the demand for energy.
- Ampere: The unit used to measure the flow of electric current.
- Ballast: The device that provides proper starting and operating voltages for FLUORESCENT and HIGH INTENSITY DISCHARGE lamps and controls the amount of current these lamps draw.
- Ballast efficiency factor (BEF): The ratio of light output to energy input associated with a specific make/type of BALLAST.
- British Thermal Unit (BTU): A common measure of energy, defined as the quantity of heat required to raise or lower the temperature of one pound of water one degree Fahrenheit.
- Color rendition: A number assigned to different types of lighting to indicate how closely it approximates natural light; the higher the number, the closer it is.
- Compact fluorescent lamps: FLUORESCENT lamps that screw into standard INCANDESCENT fixtures to provide comparable light levels using significantly less electricity.
- Compressor: The element of a VAPOR COMPRESSION air conditioning cycle where REFRIGERANT vapor pressure is increased so that it can surrender heat (see CONDENSER).
- Condenser: The element of an air conditioning system where heat is surrendered from the REFRIGERANT to the outside air or water.
- Core-coil ballast: The standard BALLAST design, now available in energy-efficient versions.
- Cool storage: The storage of cooling energy produced during off-peak hours in the form of ice or chilled water so that the energy can later be used during peak, daytime hours.
- Daylighting control: A type of LIGHTING CONTROL that adjusts indoor lighting in response to natural light levels.
- Demand charge: The part of an electricity bill that consists of a charge per KILOWATT (kW) of peak demand over the period covered by the bill (it is to be contrasted with the ENERGY CHARGE).
- Delamping: Removing one or more lamps or fixtures to save on electricity, with a loss of illumination that can be minimized through the installation of REFLECTORS.

- Electronic ballast: A new type that offers even more energy-efficiency than high-efficient CORE COIL BALLASTS.
- Energy charge: The part of an electricity bill that is determined by the total amount of energy, measured in KILOWATT-HOURS (kWh), consumed over the period covered by the bill (it is to be contrasted with the DEMAND CHARGE).
- Energy Efficiency Rating (EER): A measure of the relative energy efficiency of cooling/air conditioning/ heating equipment; it is obtained by dividing output in BTU per hour by watts of input, and the higher the EER, the better.
- Evaporator: The component of an air conditioning system where REFRIGERANT 'soaks up' heat from the environment to be cooled.
- Fluorescent lighting: Lighting that employs lamps with a fluorescent phosphor coating on the inside of the bulb; the lamps transform ultraviolet energy, generated by passing current through low pressure mercury vapor, into visible light.
- Foot-candle: The unit used to measure illumination; it is equal to one LUMEN per square foot of area.
- Gas air conditioning systems: Cooling systems that employ gas to power VAPOR COMPRESSION cooling or to supply the heat needed for ABSORPTION COOLING.
- High-intensity discharge (HID) lighting: Lighting produced by passing current through a vapor (rather than a wire, as in an INCANDESCENT bulb); the result is usually bright light, produced very efficiently. Common types are MERCURY, METAL HALIDE, and high- and low-pressure SODIUM lamps.
- Incandescent lighting: Lighting produced by passing current through a fine tungsten wire, thus making it white hot.
- KBtu: One thousand British Thermal Units.
- Kilowatt: A thousand WATTs; and the unit used to measure DEMAND CHARGE.
- Kilowatt-hour: A unit of work or energy equal to the power expended by one KILOWATT over one hour; it is used to measure ENERGY CHARGE.
- Lighting control devices: Devices that automatically turn lighting off when not needed, and on again when it is. There are two major types: DAYLIGHTING and OCCUPANCY controls.
- Lumen depreciation: Accounts for the decline in light output that occurs as lamps age.
- Lumens: The unit used to measure the 'volume' of light emanating from a light source.
- MBtu: One million British Thermal Units.
- Mercury vapor lamp: A less efficient HID light source of blue-green color. Mercury vapor lamps suffer from significant LUMEN DEPRECIATION.
- Metal halide lamp: An HID light source that generally produces bright white light. Metal halide lamps produce 50 to 90 lumens per watt of electricity.

- Occupancy control: A type of LIGHTING CONTROL that turns lights off or on in response to electronic sensors set to detect the motion, sound or body heat of people in the room.
- Packaged air conditioning systems: Systems that incorporate all the basic components of the VAPOR COMPRESSION air conditioning cycle: i.e., COMPRESSOR, CONDENSER, and EVAPORATOR.
- Packaged terminal air conditioning units: Window or wall air conditioning units.
- Packaged water chillers: Air conditioning systems that produce chilled water, usually for the purpose of cooling large areas (e.g., a large, multi-story building).
- Payback, Simple: Payback measures how long it takes to recover investment costs. If you ignore the time value of money when you compute the payback period, you have the simple payback. The simple payback is calculated by dividing the measure cost by the first year cost savings.
- Reflectors: Mirror-type (specular), aluminum or film reflecting materials that reflect out light normally trapped in fixture housings, and thus can minimize loss of illumination through delamping.
- Refrigerant: The substance in air conditioning/refrigeration systems that 'soaks up' heat from the area to be cooled and moves to a place where it can be surrendered to the outside world.
- Sodium lamp: The most efficient type of HID light source, used most often for outdoor lighting applications; low pressure sodium lamps produce an intense yellow light while high pressure sodium lamps yield golden-salmon light. High Pressure Sodium lamps produce 55 to 115 lumens per watt of electricity
- Steam air conditioning systems: Cooling systems that employ steam to power turbines for VAPOR COMPRESSION cooling or to supply the heat needed to make ABSORPTION COOLING work.
- Therm: The measure of thermal energy commonly used for gas consumption: 1 therm = 100,000 BTU.
- Vapor compression: The cooling cycle used in most air conditioning and refrigeration systems; it involves three basic elements, COMPRESSOR, CONDENSER, and EVAPORATOR (and is to be contrasted with the ABSORPTION COOLING cycle).
- Volt: The unit used to measure electric potential difference and electromotive force.
- Watt: A unit of electrical power equivalent to one joule per second or 3.4 Btuh.

# Appendix B. Lighting Technology Overview

## Useful Lighting Terms:

- **Lighting Efficacy** – Refers to amount of visible light produced per unit of energy (lumens per watt) used. A higher efficacy means that more light produced per dollar of energy purchased.
- **CRI – Color Rendering Index** - On a scale of 0-100, CRI refers to the quality of the light being emitted. Higher CRI numbers indicate light that creates a better visual perception of colors. CRIs above 70 are often used in office, retail and living environments.
- **T5, 8, 12** – Describes the diameter of a fluorescent lamp in 1/8" increments. T8 lamps are 1" in diameter (8/8ths of an inch)
- **Induction lamps** – Similar to fluorescent lamps but instead of having wires and cathodes inside the lamp they use an induction coil outside the lamp to excite the gas inside. This makes induction lamps more efficient than fluorescent lamps.
- **LED** – Light Emitting Diode fixtures are entering the marketplace in increasing numbers. Efficacy of LED fixtures is increasing rapidly. Small size allows for innovative lighting opportunities.
- **Photometrics** – The shape or pattern of light provided by specific light fixture at illuminated surface.
- **Lumen Maintenance** – How well lamps maintain their light output over the life of the lamp. T12 fluorescents will lose about 25% of their light output over the life of the lamp. Newer T8 lamps lose about 10%. HID lamps lose 15-20%

# Lighting Technology Overview

| | Incandescent | Fluorescent | Induction | LED | Metal Halide (HID) | High Pressure Sodium (HPS) |
|---|---|---|---|---|---|---|
| **Common Uses** | Task Lighting, Storage, Display | General, Office, Shop, Display, Storage | Shop, Lot, General | Exit Signs, Lighted Signs, Displays, Lot | Lot, Shop, Showroom, Storage | Lot, Storage |
| **Efficacy** | 12 | T12 <70<br>CFL, T8,T5 80 to 95 | 48-70 | Rapidly improving from 30s to 200 | 75-115 | 50-140 |
| **CRI (0-100) higher is better** | >95 | T12: 60<br>CFL, T5, T8: 80-90 | >80 | >85 | 60-70 | 20-25 |
| **Age** | Old Standard | T-12: Old Standard<br>CFL, T 8 & T5 New Standard | Relatively New | Emerging Standard for signs, Developmental for all other uses | Current Standard | Current Standard |
| **Advantages** | Widely available, superior color rendition, Low initial first cost, controllable and dimmable | New lamps and ballasts can be easily retrofit into existing fixtures, wide variety of types and color, high CRI, relatively inexpensive first cost, wide variety of control opportunities including dimming | High efficiency, long life, instant start allows for control opportunities | Highly efficient, high cost per lumen for newer applications, some established applications very cost effective, industry is headed in the direction of this technology, dimmable, work well in cold climate, wide choice of colors | Efficient | Efficient - high lumens per watt |
| **Disadvantages** | Inefficient, low efficacy means high cost of energy for light levels achieved | Contain small amounts of mercury, CFLs not readily dimmable | Contain small amounts of mercury, CRI not as high as some other lamp types, high initial costs may slow payback, not dimmable | Technology improving rapidly but still developing, high cost per lumen (expensive), wide range of quality -lamp light levels can diminish rapidly and customer must use care in choices of manufacturers, photometrics of fixtures can lead to uneven lighting effects. Consult a lighting designer | Light output diminishes over life of lamp causing uneven color and light levels, restart time prevent control opportunities | Very poor CRI distorts perceived colors making it a poor choice for display, restart time limits control opportunities |