

**DEPARTMENT OF TRANSPORTATION
2004 ENERGY CONSERVATION PLAN
STATUS REPORT**



**Developed by
Division of Business, Facilities, and Security
Energy Conservation Program**

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**DEVELOPED BY DIVISION OF BUSINESS,
FACILITIES, AND SECURITY
ENERGY CONSERVATION PROGRAM**



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Departmental Energy Conservation Program

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I. EXECUTIVE SUMMARY

Report Structure Overview

The 2004 Energy Conservation Plan Status Report is an annual report prepared by the Department to highlight completed, in-progress and “under study” energy conservation opportunities available as the Department conducts the State’s transportation business. This report reviews the Department’s energy activities for the calendar year of 2003.

The report is divided into three parts:

- **Executive Summary:** Short overview of the Department’s Energy Conservation Program
- **The Energy Conservation Plan Status Report:** Reports on how and where the Department uses energy, highlights of current conservation activities, and the impact of implemented and future conservation activities.
- **Energy Conservation Opportunities:** Compilation of implemented and “under study” solutions that are the core of the Department’s Energy Conservation Program.

Energy Facts

- By the mid-1990s, the Department was spending over \$32 million in energy resources every year for its day-to-day operations.
- The Department’s major energy consuming activities include:
 - Lighting the State’s highway system
 - Powering facility lighting, heating/cooling/ventilation systems, computer-related operations
 - Lighting and ventilating State maintained tunnels
 - Fueling the Department’s maintenance fleet
- In 1994, Department of General Services (DGS) was directed by Executive Order W-83-94 to set savings goals for the top 10 energy-consuming departments and educational institutions. The Department’s 10-year goal is \$51.06 million in net savings or about \$5.1 million per year. These goals only include non-vehicular energy consumption by the Department.
- Value of energy savings during 2003 for projects implemented or being implemented nets out to \$16.2 million.
- This report describes the Department’s activities and identifies those areas of energy conservation.
- The Department has aggressively implemented energy conservation projects since the mid-1970. Conversion of highway lighting systems to high-pressure sodium fixtures allowed improved lighting conditions while reducing energy costs by 50 percent. These savings continue to this day.
- Most of the Department’s low cost energy retrofits were implemented during the 1980’s and early 1990’s.
- During the 1990’s, The Department set national standards, and was a national leader, with the private sector, to develop the Light Emitting Diode (LED) traffic signal module.

- The LED traffic signal field test in District 6 won both the California Energy Commission's 1995 Award of Merit for Industrial Technology, and the Department of Energy's 1995 National Energy Award.
- LED signals can reduce connected grid load up to 92 percent and last over six times longer than the incandescent signal fixture it replaces.
- The Department statewide full-color LED signal upgrade project expects to be completed during 2002/2003 fiscal year.
- In 2002, the National Association of State Facilities Administrators recognized the Department with two energy awards based upon the Departments total approach to energy conservation. One award was for Best innovations in the field of "Design/Operations" and the final award was for "Overall Best Innovations" and was awarded by the Council of State Government of America.
- In 2003, the department continued its work with other governmental agencies and interested private sector partners in developing hydrogen power generation options for both the transportation and "Green" power productions. The "Hydrogen Highway" project is supported by both the previous and current administration. The department identified a number of its facilities that would be initial test sites for both the production/storage of hydrogen for use as a transportation fuel, as well as an energy source for the onsite production of electricity. On site hydrogen production would be supplied through the use of photovoltaic (PV) panels integrated into the facility roof and covered parking structures.
- In 2003, the Department made a commitment to the California Power Authority (CPA) to participate in their efforts to establish government/private sector PV electricity generation partnerships. Whereby the participating government agencies would provide on-site solar access to the private sector PV power generation suppliers. The government agencies would agree to purchase all the generated power at a discounted price from the local utility. Implementation is expected to start in 2004, once CPA lets the DOF/DGS approved contracts. The Department's first candidate site is the District 10 HQ complex.
- 2003 saw three replacement district HQ projects (D-11 in San Diego; D-7 in Los Angeles; D-3 in Marysville) incorporate sustainable design features, including energy systems that better Title 24 standards, improved air and water quality projects, use of recycled materials, natural lighting, and improved site prep and construction methods. Working with DGS and DOF, the Department expects to receive the U.S. Green Building Council's LEED Certified Award for the D11 complex, a Silver award for the D-7 complex, and hopes to qualify for "Silver" or maybe "Gold" award for its D-3 project.
- In 2003, the Department continued its implementation of induction lighting upgrades on roadway sign lighting systems, and started a human factors testing program for the possible application of induction lighting systems for roadway lighting. The California Energy Commission's 2005 Title 24 standards set new exterior lighting standards for the State, and the Department is very interested in finding ways to reduce wasted nighttime lighting, improve the quality of lighting and reduce light glare impacts.

Conservation Opportunities Summary

The Department is currently in the study or implementation phase of 26 energy conservation projects. The Energy Conservation Opportunities (ECOs) discussed in this report are separated into seven categories:

1. **Traffic Signals** - Lighting modules to control the flow of traffic at intersections and “on ramp” metering (a sub-set of signals are beacons and status indicators).
2. **Roadway Lighting** - “Points of Conflict” on State owned roadways (Federal interstate highways, State highways and roads) are lighted at intersections, on/off ramps, and points of merging and separation.
3. **Roadway Sign Lighting** - Illumination of informational signage located over the roadway.
4. **Bridges and Tunnels** - Lighting systems used on bridges and tunnels.
5. **Facility Operations** - Energy consumed in the operation of office and other buildings occupied by departmental staff.
6. **Procedures** - Operation procedures that reduce energy consumption.
7. **Bulk Energy Procurement** - Energy dollar savings as a direct result of buying energy in large discount blocks.

The conservation projects listed in the report have been installed, are “in-process” of being installed, or are in study phase of development. Completed and in-process project savings data sets are easy to calculate, since the consumption baseline and current usage data is directly measurable. Projects in the under study phase may or may not have forecasted savings assigned to the ECO, depending upon the current level of data being collected. Individual ECOs are discussed at the end of this report. Refer to the table of contents for page number of each ECO.

Costs of project implementation and maintenance costs over time (if greater than current levels of operations and maintenance costs) have been included in the ECO’s cost analysis calculations, where data is available. Net dollar savings are discounted into 1995 dollars to determine if 1994 DGS goals are being met.

If all cost effective ECOs were fully implemented, the Department would:

- Reduce daytime and/or nighttime electrical grid loads by about 37.8 Megawatts
- Save over 205 million kilowatt-hours in annual energy consumption
- Save some maintenance costs for selected projects
- Pay back project costs through savings in energy and maintenance costs
- Save a combination of \$162 million in anticipated 10-year net present value (NPV) savings from implemented project elements.
- Potentially save \$87 million in NPV savings over ten years of operation from project elements yet to be implemented.

- There is a potential total ten-year net savings (avoided costs) for the Department of about \$248 million to apply against a ten-year goal of \$51.06 million.

ECO Funding

It is anticipated that any necessary expenditures discussed in this plan will be made through shifting the internal allocation of funds, the use of Energy Efficiency Bonds, SB1-5x funding resources, California Power Authority loans, State Highway Account Budget Augmentations and/or private sector funding resources should they become available. The Department will be coordinating its funding and implementation efforts with the Department of General Services and the Department of Finance to insure optimum investments.

Program Measurement and Monitoring Efforts

To monitor the effectiveness of the program, the Department will track energy savings at the project level as discussed within this report.

Individual facility managers, districts and program management will compile ECO data, noting changes in energy use and report those changes to the Division of Business, Facilities, and Security's (DBF&S) Energy Conservation Program staff on an as needed basis.

DBF&S' Energy Conservation staff will collect energy data from various departmental sources to be used to coordinate and update the Department's overall energy program and related requests for data from any internal or external source.

Stewards of State Resources

The Department's proactive efforts to reduce its cost to do business, through cost-effective energy conservation infrastructure investments, are consistent with its current efforts to meet the challenges of the twenty-first century.

II POLICY/GOALS/BACKGROUND

POLICY:

The Department's Energy Conservation Program is consistent with its "Mission, Vision, Goals, and Principles" which support the protection and enhancement of the environment and quality of life in accordance with the environmental, economic, and social goals of the State of California.

GOALS:

In 1994, through executive order administered by the Department of General Services (DGS), the Department of Transportation was given a 10-year energy conservation goal of \$51.06 million in avoided costs through the implementation of cost-effective energy conservation measures (ECMs), or about \$5.1 million dollars per year.

Since the mid-1970s the Department has been a trendsetter in the field of energy and resource conservation. As a direct result of these actions, the Department's energy conservation efforts have been consistent or exceeded state policies that pertain to state energy conservation goals.

BACKGROUND:

By the mid-1990s, the Department was spending over \$32 million in energy resources every year for its day-to-day operations. Some of the major energy consuming activities are:

- Lighting the State's highway system
- Powering facility environmental systems (lighting, heating ventilation and air conditioning {HVAC}, computer-related operations, etc.)
- Lighting and ventilating State maintained tunnels
- Fueling the Department's maintenance fleet

The Department has aggressively implemented energy conservation projects since the mid-1970. Conversion of highway lighting systems to high-pressure sodium fixtures allowed the Department to improve lighting conditions while reducing energy costs by about 50 percent. These savings continue to this day.

Most of the Department's low cost energy retrofits were implemented during the 1980's and early 1990's.

This report focuses on non-vehicular energy conservation issues at this time. However, future reports will include those conservation efforts as the Department looks at alternative power options that may allow its fleet to expand their roles/mission especially in the areas of electric/hybrid engine technologies.

As stated above, The Department consumes energy in a number of major use activities or categories. The Department has four energy load categories:

- 24-hour fixed loads: such as traffic intersections, data processing servers, traffic management centers, communications, toll collections, and some safety lighting and ventilation systems, where energy is consumed at all times at a relatively fixed rate.
- Nighttime only loads: such as roadway lighting at points of potential conflict, highway information sign lighting and exterior security lighting, where the equipment loads come on when daylight is not present.
- Weekday loads during the 6 a.m. to 6 p.m. time period: such as office buildings and maintenance complexes, where business hour operations and equipment may vary according to the level of required work activities.
- Variable loads: such as sump pumps, demand driven equipment, etc., where forecasting or planning for operation is dependent on external forces/causes.

Loads in these four categories come on either at a known time and stay on for a documentable period, or cycle on/off as a result of a need.

III ENERGY CONSERVATION HIGHLIGHTS FOR 2003

2003 saw the Department continue with proven conservation projects and add new projects to its Energy and Water Conservation Program. The Department's rate of energy savings exceeded the Governor's goal of \$51.06 million/year by over \$10 million. The biggest contributor to this success is still the Statewide Light Emitting Diode (LED) Traffic Signal upgrade project. Extensive teamwork by various departmental programs and private industries made this happen. Some of the recent highlights are:

- In 2003, The Department continued its formal statewide implementation of LED traffic signal upgrading program:
 - The Department purchased 70,000 plus LED signal fixtures for "State Furnished" LED signals on all new construction, rehabilitation and local government projects. Some districts are now changing out older LED signal heads installed in the early 1990s.
 - The Department qualified for utility and California Energy Commission rebates and grants to further reduce implementation costs and received a check from PG&E for \$667,507.50.
 - The Department's LED quality testing center at the TransLab facility in Sacramento represents the latest in state-of-the-art testing technology, continues to perform quality testing on LED fixtures.
 - The Department's LED Project team has upgraded most of the existing owned signalized intersections, staffing shortages in some of the Districts has resulted in delays to complete the program in 2003.
 - The Department continues to study the use of a multi-color LED module to be used as status lights at toll and inspection station booths. Performance specifications for the signal elements were completed in 2001. The use of these fixtures for ramp metering started in 2003.
- AB 1890 (chaptered in October 1996) and recent 1998 legislation (included in the FY 1998/99 State Budget Bill) allows State agencies to enter into energy service contracts (ESCOs) with the private sector or other state agencies. The Department, working with the Department of General Services/Energy Assessments (DGS/EA) established a pool of ESCOs. In June of 2000, The Department selected an ESCO to implement "turn key" energy service contracts at most of the Department's major facilities and Maintenance Centers. (Further information can be found in Project 5.1, page 23.) In February of 2000, the Department of Finance (DOF) declared that ESCO funding, in their opinion, could not be used to fund facility audits and retrofits. The Department worked with DOF staff and Department of General Services Energy Management Division (DGS-EMD) staff to develop an alternative program. Facility audits started in

the spring of 2002 and will continue through the summer. In 2003, the Department continued working with other agencies to develop sustainable design features for new construction and major retrofit state projects. Working with DOF staff, it is hoped that the knowledge gained from these efforts can be used to establish a working state government ESCO program to implement the cost effective conservation projects during this time of state funding shortages.

- Starting in the late summer of 2000, spot market energy prices for natural gas and electricity started to rise faster than utility companies could pass on those cost increases to the consumer. The energy crisis of FY 2000/2001 had started and continues into present day.

The Department continued to monitor and respond to the continuing crisis in a number of ways.

- Department staff continue to serve on numerous intra-agency teams, working groups, and committees with missions to develop solutions (short, mid, and long-term), policy and procedures as they relate to the California Independent System Operator (CAL-ISO) Stage 1, 2 & 3 Energy Emergency alerts. Use of alternative power options, etc.
- Internally, departmental staff implemented operation protocols that coordinate facility operations along with employee emergency action plans should rolling black outs occur at its facilities.
- The Department accelerated its Light Emitting Diode (LED) Traffic Signal program to a point of 95% completion by July 1, 2002. 2003 saw the continued implementation of the final intersections, as limited staffing permitted given the current budget conditions. A side benefit of this activity, the Department was also able to accelerate its LED signal intersection battery backup system (BBS) performance specifications. The introduction of full LED retrofits to intersections allows BBS system cost to drop from about \$60,000 per intersection down to about \$1,800. BBS installation upgrades the level of service at the intersection by reducing power outage generated risks, since the BBS allows normal signal function for all power loss conditions except those lasting beyond 4 hours. (*Battery change out program during major power loss periods could allow critical service routes to function normally, like in an earthquake recovery period.*)
- Departmental management generated memos, newsletter articles, emails, WEB based articles demonstrating top to bottom support for conservation activities.
- Buildings energy systems were placed on “Stage 2” alert status as a standard operational level until manually operated equipment could be automated under the Department’s Facility Audit and Retrofit project. (*Refer to project 5.1, page 34, for more details.*)

- Replacement district office projects in Los Angeles (D-7), San Diego (D-11) and Marysville (D-3) were modified to include cost effective “Sustainable Building Design Elements” during the preliminary design phase of their projects. Working with DGS Real Estate Services Division (RESA) all three sites are seeking to become certified by the U.S. Green Building Council’s LEED(Leadership in Energy and Environmental Design) Program, a nationally recognized building rating system. Based upon the time frame each facility’s development, D-11 is striving for LEED Certified, D-7 is to be Silver Certified, and a maximum effort is striving to have D-3 Gold Certified. This means that all three facilities will exceed current Title 24 environmental design features. Over the expected life of each complex any slight increases in front end costs will be returned in direct and indirect savings to the state within the first few years of operation and occupancy.
- As a direct result of the energy data collection over the past 48 months, Department staff were able to develop an energy educational document that discusses how and where the Department uses electricity, natural gas, and other heating fuels. The document also contains up to five years of monthly energy consumption data for the Department’s largest owned and leased facilities where the Department pays the utility bills. You can find this document at the following web site.

http://www.dot.ca.gov/hq/energy/CTnrgPrim%2003_01_04.pdf

- In 2003, many state energy utilities started to roll back emergency added fees to help pay for 2000/2001 revenue under-collection shortages. SMUD, SCE, SDG&E were some of the first to do so in the spring and summer months, and PG&E plans for similar fee reductions starting in 2004. While at the same time these added fees were being phased out, cost of living adjustment fee increases were also being proposed and implemented. The net result being that electric utility cost increases to the Department did not increase in 2003 at a rate seen in previous years. Natural gas, fuel oil and LPG, did not see seasonal reductions due to market conditions that normally allow storage tanks to be filled during off-season low cost periods. World oil prices remained high due to the war in the middle east, California fuel processors plant “down time” caused local price spikes, and out of state natural gas supplies were in very high demand by Eastern states and the new generation of natural gas powered electrical power generation plants coming on line throughout the US.
- 2003 saw the increased implementation of induction lighting systems for roadway sign lighting application and the start of Task Order 2 with U.C. Berkeley labs to study the visual tasking impacts, if any, by moving from current design levels for roadway lighting by high pressure sodium to lower lighting levels through the use of induction lighting systems. Part of the driving force behind this study is in direct support of the California Energy Commission’s 2005 Title 24 outdoor lighting standards that promote quality over quantity of exterior lighting applications. Elimination of “light tunnels” and the promotion of increased night vision tasking. Upon completion of the study and its recommendations, the Department quality teams will investigate alternatives to roadway “conflict” lighting applications. Current options include and are not limited to, proximity

sensor driven lighting systems (currently not possible with HID or HPS/LPS type fixtures.), LED alert beacons that trigger on when merging traffic is present, merge/exit lane improvements, etc.

- During 2003, the Department participated in a number of intra/inter-governmental committees, working groups, and taskforces that address energy conservation and its interrelated impacts upon building operation, transportation system and vehicle efficiencies, and climate change impacts. The common mission of these various groups are to plan for the future of the State of California, protect and improve the environment and ensure the continued profitability of the State's business climate for the common good of all Californians. Toward that goal, the various groups have produced a number of papers, reports, and policy documents. Links to some of the most recent documents can be found at the bottom of the Department's Energy Conservation Programs' web site:

<http://www.dot.ca.gov/hq/energy/>

- In 2003, the California Power Authority, working with DOF, DGS Legal, and a number of state agencies, UC and CSU systems started the development of a multi-agency request for bid (RFB) for photovoltaic (PV) electrical generation systems to be installed on State properties by private sector power generation contractors. The state would have no ownership of these systems, lease the location and solar rights to the contracts, and purchase all the resulting power from the PV systems at a discount off of existing tariffs. These contracts would be for long term and would provide State sites with daytime power reserves to augment emergency power production during times of utility outages (for any cause) as well as base load reduction by the site on the state power grid. By generating the non-fossil fueled power generation on site, the state's power grid will be able to increase customer base with reduced need to invest in the growth of the grid. The RFB package is expected during the spring of 2004, with installations occurring later that year upon approval of the contract documents by each participating State client. The Department's first potential site is at the Stockton District (10) Headquarters/Maintenance complex.
- 2003 also saw departmental staff investigate the "Hydrogen" economy in various applications as they relate to how the department does business. Hydrogen refueling stations at Caltrans maintenance centers and large facilities for state vehicles and possibly non-state vehicles, hydrogen powered fuel cell generation for mobile and fixed power generation systems, hybrid vehicles that could double as mobile power generation stations were topics of discussion within many units. The discussions and investigations currently under way are looking at current level of cost effectiveness, and short and long range planning for future applications. In some cases, just including emergency power outlets so building's emergency power equipment could except power from a hybrid vehicle, or portable fuel cell is all that is needed. In other applications, looking at converting parking areas and facility roof tops into PV power generation assets that convert sun light into electricity, then converting the excess power currently not used into hydrogen fuel for night time power operations or fuel for vehicles. This effort is not just

for the short-term, it is however, the start of a long-term effort by the Department to support the State's integrated efforts to transform the power generation industry from fossil fuel dependent to renewable resource dependent. In the future, fossil fuel generation will be known as the "alternative power source."

IV THE DEPARTMENTAL ENERGY ACTIVITIES

Energy Conservation Categories

Energy conservation project development falls into two primary categories:

- Projects either implemented since 1/1/94, or currently under study.
- Projects that are in the study phase of development, or have been identified as not feasible at this time due to: legal issues, resource assignment, or other conditions that must change before additional project development or implementation may continue.

Implementation and Energy Reporting Responsibilities

Implementation responsibilities for any conservation project lie within the functional unit (Division/District) that has management oversight of the impacted energy system and related portion of the energy utility budget. In some cases, responsibilities have been delegated to the energy system user. Energy consumption reporting responsibilities will also vary from project to project. Implementation and energy reporting responsibilities are defined in the “Energy Conservation Opportunities” section of this report.

While, in practice, it is every employee’s responsibility to optimize their usage of energy during the performance of their jobs, the Department’s Energy Conservation Program Project Management and Coordination focuses in four programs.

- **ADMINISTRATIVE SERVICES:** Headquarters (HQ) and Regional Centers, Leased and State-Owned Sacramento Office Buildings, State Lab Facilities, 12 District Office Complexes, Traffic Management Centers (TMC), and Conservation Program Management
- **HIGHWAY MAINTENANCE PROGRAM:** Maintenance Facilities, Equipment Shops, Highway Lighting Systems, Traffic Sign Lighting Systems, State-owned Traffic Signals, Irrigation System Pumps, Operation and Maintenance of Bridge and Tunnel Lighting and Ventilation Systems
- **INFORMATION TECHNOLOGY:** Computer Equipment Procurement Standards and Purchase Approval
- **ACCOUNTING:** Utility Bill Processing

Historical Energy Usage Data

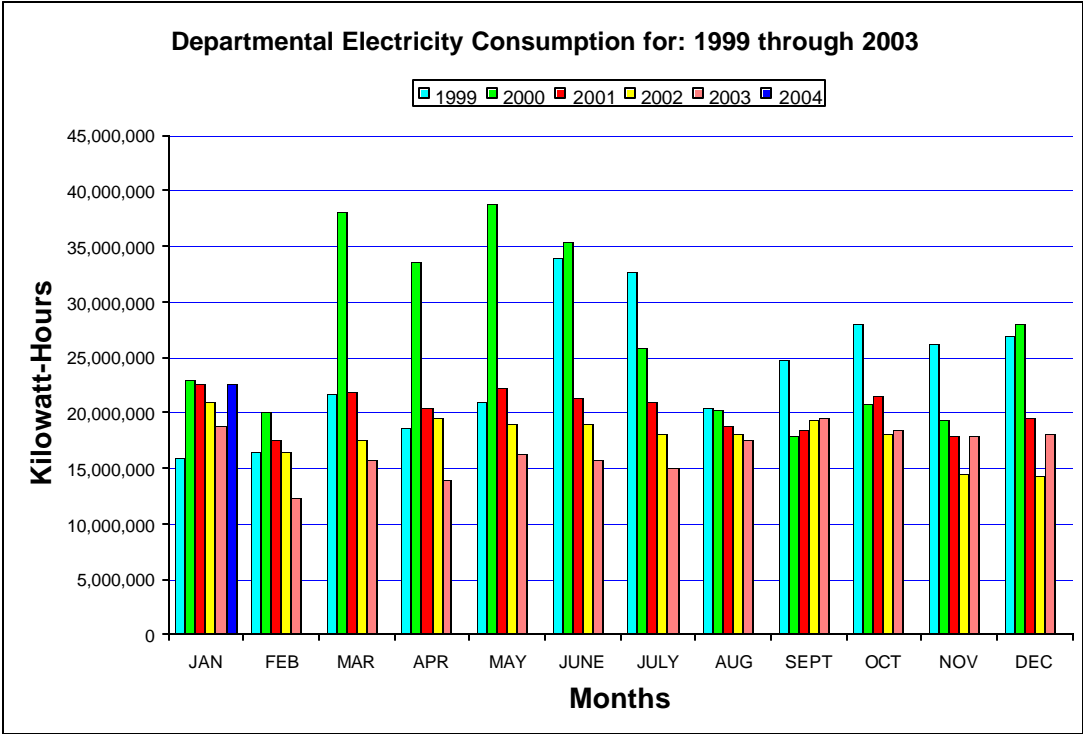
Unlike most State agencies, the Department’s energy consuming systems are spread throughout the State, with a majority of energy consumption not occurring at centralized facilities. Energy consumption occurs at each “on/off ramp”, irrigation system, traffic signal, changeable message sign, highway lighting, etc.

The Department processes over 27,000 monthly utility and energy suppliers account invoices. Some of those accounts are included in summary computer billing while other invoices are manually processed. About 60 accounts represent the Department's large facilities (buildings, bridges, and tunnels), and another 600± accounts represent maintenance station energy consumption. The rest of the accounts represent the energy consuming devices that support the safe use of the State's transportation system.

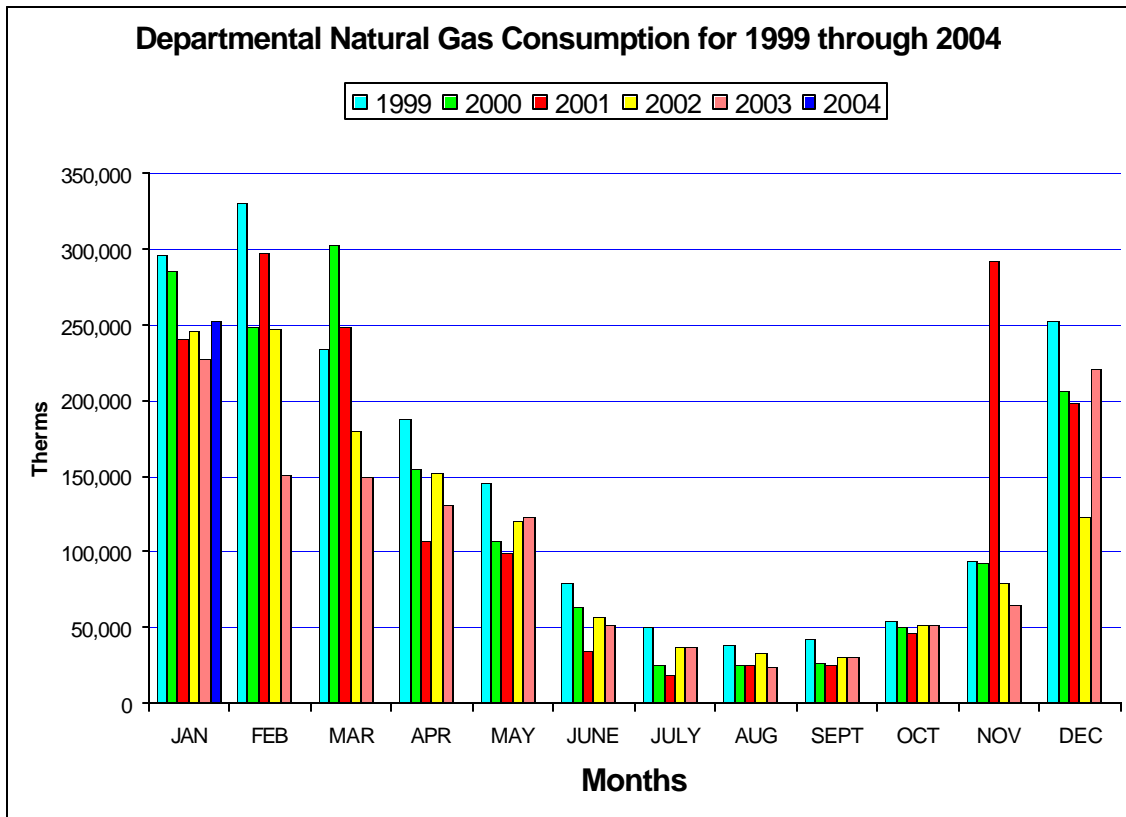
Since the early 1980's, the Department has elected not to use utility bill analysis as its primary method of determining the level of success for any energy conservation project. The preferred method is to track the actual energy loads that have received efficiency upgrades. By using facility energy management system operational data, load inventories, or metered circuits, the Department receives a clearer picture of its savings potential. This method is the only effective monitoring process available. Utility bill analysis is a helpful guide, but the dynamics of other loads operating in the building (i.e., computer usage, changes in size of work forces, etc.) and building usage changes will mask savings generated from most energy conservation measures (ECMs).

In May of 2001, all state agencies were requested by the Department of General Services to supply utility data for large state facilities. Fourteen of the Department's largest facilities were selected and their historical and monthly metered data is manually collected, recorded and forwarded to DGS staff. Data collected by DGS is then used to respond to information requests by the Governor's Office.

The following chart demonstrates statewide monthly kilowatt-hours consumed by departmental facilities:



The following chart demonstrates statewide monthly therms of natural gas consumed by departmental facilities:



Utility Bills

The Department receives two types of utility bills:

- Consumption Based Billing: Utility bills quantify energy consumption over a set period, normally 30 days, although durations can be longer.
- Flat Charge Billing: Utility bills of this type have a monthly fixed fee. Typically, lighted roadway signs and highway lighting accounts are billed on a fixed or flat fee basis. These accounts are normally off peak (nighttime) and the fee is based upon measured connected load. Monthly invoices do not change, unless the utility rates go up or the Department notifies the utility of a change in the size of the connected load. Most of these accounts have no consumption meter connected to the power circuit.

Types of Energy Consumed

The Department consumes energy in many forms at its facilities and roadway. They are ranked in order of consumption:

1. Electricity
2. Natural Gas (NG)
3. Liquid Propane Gas (LPG)
4. Fuel Oil (FO)
5. Gasoline/diesel fuel for portable generators

Electricity, as an energy source, represents about 80 percent of the Department's non-vehicular energy bill, and a majority of that energy is consumed by the highway-related energy systems.

Summary of Savings

The Energy Conservation Measures discussed in this report are separated into seven project categories:

1. **Traffic Signals** - lighting modules to control the flow of traffic at intersections and "on ramp" metering (a sub-set of signals are beacons and status indicators.)
2. **Roadway Lighting** - "Points of Conflict" on State owned roadways (Federal Interstate Highways, State Highways and roads) are lighted at intersections, on/off ramps, and points of merging and separation.
3. **Roadway Sign Lighting** - Illumination of informational signage located over the roadway.
4. **Bridge and Tunnel** - Lighting systems used on bridges and tunnels.
5. **Facility Operations** - Energy consumed in the operation of office and other buildings occupied by departmental staff.
6. **Procedural Improvement** - Operational procedures that reduce energy consumption.
7. **Bulk Energy Procurement** - Energy dollar savings as a direct result of buying energy in large discount blocks.

Each of the seven categories above contain savings from energy conservation measures that are currently in place, being installed, planned to be installed, or under development. Individual energy conservation measures (ECMs) are discussed at the end of the body of this report. Refer to the table of contents for page number of each ECM.

Costs of project implementation and maintenance costs over time (if greater than current levels of operations and maintenance costs) have been included in the cost analysis calculations, where data is available. Net dollar savings are discounted into 1995 dollars. From 1996 on, all savings will be converted back to 1995 dollars in order to compare accomplishment of planned versus 1994 DGS goals.

If all cost effective conservation projects are found cost effective, then have them fully implemented, current data forecasts that the Department would:

- Reduce daytime and/or nighttime electrical grid loads by about 37.8 Megawatts.
- Save over 205 million kilowatt-hours in annual energy consumption.
- Save/avoid some maintenance costs for selected projects.
- Payback project costs through savings in energy and maintenance costs.
- Save a combination of \$162 million in forecasted ten-year net present value (NPV) savings from implemented project elements. \$87 million in forecasted NPV savings over ten years of operations from project currently under study. Total of the two groups of projects yields a forecasted ten-year net savings (avoided costs) for the Department of about \$248 million to apply against a 10-year Executive Order W-83-94 goal of \$51.06 million.

Anticipated Savings Data
From All Energy Conservation Measures

Savings Areas	Implemented Projects	Planning Stage Projects	Totals
Kilowatts	19,700	18,200	37,900
Kilowatt-hours/year	121,000,000	84,600,000	205,600,000
10 yr. NPV Dollars	\$161,600,000	\$86,700,000	\$248,300,000

The following chart displays past annual rate of 1995 (NPV) savings realized by completed projects. Included on the chart is a forecast of fiscal 2004 annual rate of savings, based upon savings potential of projects slated to be implemented during that year. The Department will continue to implement all cost effective projects.

Savings-To-Date and FY 2001/2002 Savings Forecast



V ENERGY CONSERVATION OPPORTUNITIES

Energy savings and net dollar savings for all energy conservation opportunities listed in this section were calculated over a ten-year operational period. NPV calculations normalize all future costs and savings to 1995 dollars. Maintenance and material savings or cost increases have also been included in these calculations whenever data was available. Statewide average electricity rates of \$0.095/kWh (daytime loads) and \$0.075 (nighttime only loads) were used for 1995 energy costs. Electrical inflation rate averages were supplied by the DGS/Energy Assessments (from 2001 forward, \$0.14/kWh for daytime and \$0.11/kWh nighttime costs were used to reflect average rates during 2003. Utility rates in 2003 varied from utility to utility during this year as some previous surcharges were reduced and utilities added cost of living or seasonal energy adjustments.) A four percent discount rate was used in all NPV calculations for future years. Actual inflation rates were used for current and past years for NPV 1995 calculations. (Sources include spot sampling of utility bills, DGS Energy Management Division (DGS-EMD), California Public Utilities Commission (CPUC), CAL-ISO WEB site.)

The projects discussed in this report also have applications in new construction and in the rehabilitation of existing facilities. In many cases, these projects reduce the Department's base load profile for normal day-to-day operations. The automation system network described in project 5.1 (page 23) will also allow the Department to become more responsive to the changing electrical and gas load demands placed upon its facilities during energy emergencies over the next 10 years.

Descriptions of departmental Energy Conservation Measures (ECMs):

Category 1 - Traffic Signal Projects:

1.1 Project: LED Traffic Signal Head Upgrade Project (at traffic signals)

Description: Convert incandescent traffic signal fixtures to Light Emitting Diode (LED) arrays. This project will be implemented in three phases:

PHASE ONE: Consists of developing performance specifications for the following signal heads:

- 12 inch Red Ball (150-watt incandescent lamp replaced by a 10-watt LED array.)
- 8 inch Red Ball (70-watt incandescent lamp replaced by an 8-watt LED array.)
- 12 inch Red Arrow (150-watt incandescent lamp replaced by a 6-watt LED array.)
- Portland Orange “Upraised Hand” pedestrian signal module (70 watt incandescent lamp replaced by a 6-watt LED array.)

Upon completion of the specifications development phase, manufacturers were invited to supply The Department with products that are in compliance with departmental performance specifications. A pool of qualified vendor products has been established, and is continually being updated.

The Department worked with the Department of General Services/Procurement (DGS/Procurement) to develop a Multi-vendor Master Purchase Agreements (MPA) to allow the Department and local governments to purchase qualified LED fixtures at the lowest possible price. This contract would lock in product prices for 2 years with an option for a third year.

Post installation Quality Assurance (QA) testing will be performed on sampled lots of LED fixtures over the next five years to insure performance compliance of the products.

PHASE TWO: Same as PHASE ONE except for 12 and 8 inch green & amber balls, 12 inch green and amber arrow LED traffic signal upgrade modules, and Pedestrian “Walk” LED traffic signal upgrade modules. Also included in this phase is the development of amber cautionary beacons.

PHASE THREE: In the next five to six years, three color LED solid state traffic signal heads will become cost effective. These heads will be used to upgrade the full signal head as the RED LED modules in Phase One and Phase Two are replaced towards the end of their effective life.

In general support of this program, the Department Maintenance, Traffic Operations (Electrical), METS, and Project Development/Resource Conservation programs joint funded the construction of a fully equipped Quality Assurance testing facility at the

METS Electrical Labs in Sacramento. Also funded by the Department's Resource Conservation Program (RCP) was a Human Factors Study by ITS/PATH UC Berkeley. The study defined human vision impacts, conditions, limitations, and quality of reliability, by various light sources (including incandescent, LED, and neon). RCP also funded procurement of early prototypes of LED product and field test equipment. RCP staff coordinated and supported the various programmatic teams within the Department to get to the statewide implementation phase coordinated by HQ Maintenance and the Districts. In June 2000, the Department entered into a multi-year inter-agency agreement to the University of California at Berkeley for additional human factors studies. This latest contract is to resolve any visual task related questions that relate to illuminated signals and signage.

(Note: Due to the termination of Project 1.2, the energy base line has been updated for energy savings after July 1999. Future savings calculations for red, green, and amber fixtures now are based upon the use of 150- and 70-watt incandescent lamps.)

Status: PHASE ONE: For the most part, this phase is complete, red LED signals have been installed statewide, for some intersections in Districts 6 and 4 we have started to replace the first generation (early 1990's) red LED signals with current models, energy savings for these upgrades generates an additional 60% savings (23 watts signals being replaced by 9 watt signals.)

PHASE TWO: This phase was accelerated by the State's Energy Crisis of 2000, 2001, and 2002. Original completion was originally scheduled for 2003, however, the Department added resources in 2001/2002 to speed up implementation for energy savings and to allow for battery backup systems (BBS) to be installed at departmentally owned and operated signalized intersections. Therefore, as a direct result of these efforts, for the most part, this phase is complete, there are a few intersections awaiting module delivery.

The Department is now upgrading intersections where local agencies pay for utilities and the Department pays for maintenance. While this intersection upgrade activity does not directly financially benefit the Department's energy consumption program, it does directly reduce the connected electrical load to the State's electrical grid. The Department gains savings in the cost to maintain the intersections.

New construction adds additional intersections to the State's inventory every year. It is now standard practice to only install LED signals on all current and future State projects. About 6,500 new LED signals per year will be added to the department's installed base. Future annual reports will true up this estimated annual number to reflect actual installations. Future estimates will be limited to seven-year projections at this time (one average life cycle for red/green/yellow signals).

PHASE THREE: The Department continues to look at the next generation of LED technologies as they can apply to traffic signals, including organic LED signals and solid state TRI-Color LED traffic signal heads may become cost effective to replace existing LED signal modules with a single, lighter weight all-in-one product (This product may include 3 separate heads or a single signal head with three colors. NOTE: Single multi-color traffic signal heads will require Federal Highway Administration (FHWA) approval for intersection applications.

Energy Savings Potentials: To Date: 8,867 KW; 77,700,000 kWh per year (installed); 100 kW, 870,000 kWh per year (on order); New Construction Potential: 4,400 kW; 14,200,000 kWh per year

Data Collection and Tracking: Maintenance Installed Base Inventory Database

Estimated Implementation Timeline: Refer to Project Status section above.

Estimated Net Energy/Dollar Savings over ten years: Installed or ordered: 82.6 million; New Construction Potential: \$40 million.

1.2 **Project:** Traffic Signal Reflector Lamp Upgrade

Description: 12" and 8" traffic signal lamps are being upgraded with lower wattage reflector lamps replacing higher wattage lamps that do not have internal reflectors.

Status: Started in 1995 and completed in 1996, about 53,718 - 150-watt lamps are replaced by 120-watt lamps, and 74,232 - 70-watt lamps were replaced by 50-watt lamps. In 1997, the 50-watt lamp failure rates exceeded departmental allowable norms. The 50-watt lamps were discontinued that year. Late in 1998, quality assurance testing determined that the 120-watt lamps had failed their acceptability tests. The lamps were returned to the manufacture and the Department went back to installing 150 and 70-watt incandescent lamps. This change in the installed base line of energy consumption has a direct impact on the Life Cycle Cost Analysis for the LED traffic signal upgrade project. Savings below reflect the amount of energy savings realized by the project until the reflectorized lamps are replaced during normal replacement cycles.

Energy Savings Potential: 537 KW reduction; 9,100,000 kWh/yr.

Data Collection and Tracking: Maintenance Installed Base Inventory Database.

Estimated Implementation Timeline: Completed FY 1996, terminated 1/1/99.

Estimated Net Energy/Dollar Savings over ten years: \$3.5 million.

1.3 **Project:** 3M Traffic Signal Reflector Retrofit Study/Project

Description: (*NOTE: this project only impacts traffic signal heads not impacted by the various LED signal upgrade projects.*) In May of 1998, 3M Corporation approached the Department with a product concept for retrofitting traffic signal heads with a reflector upgrade kit that would allow the signal to operate with a lower wattage lamp. The signal light output with the lower wattage lamp would still meet ITE brightness levels for both 8" and 12" signal heads. Estimated wattage for 12" signals would drop from 150 watts to 116± watts, and 8" heads would drop from 70 watts to 45± watts. The Department is currently using 120-watt Phillips half-reflector lamps that allow us to

reduce all 12" signal head energy consumption. Therefore, the savings potential for 12" heads by the 3M-product does not seem cost effective at this time. The kit for the 8" heads, do have some potential since the Phillips reflector lamp option did not meet departmental field performance standards. Philips R&D staff have also discussed the possibility of further reductions of lamp wattage in the 12" reflector conversion kit, if they can get a lamp that runs in the 95 to 105 watt range. If they can get the lamp and it passes ITE brightness tests, then the Department would rethink the cost effectiveness of this conservation opportunity.

Status: To date, the reflectors have not met departmental performance criteria. Also LED implementation has rendered this option as unfeasible and unnecessary.

Estimated Energy Savings Potential: Not significant.

Data Collection and Tracking: Maintenance Installed Base Inventory Database.

Estimated Implementation Timeline: Resolved FY 2000/2001.

Estimated Net Energy/Dollar Savings over ten years: N/A

1.4 Project: LED Traffic Signal head Upgrade Project (at ramp meters)

Description: Convert incandescent traffic signal fixtures to Light Emitting Diode (LED) arrays. For background information see Project 1.1. This project will be implemented in one phase.

Status: Project to start implementation in FY 2001/2002, and completed as funding allows.

Energy Savings Potential: Commute hour peak reduction, 0.84 MW; 1,310,000 per year

Data Collection and Tracking: Maintenance Installed Base Inventory Database

Estimated Implementation Timeline: To be completed in FY 04/05 (depending on legislative approval)

Estimated Net Energy/Dollar Savings over ten years: \$2 million

Category 2 – Roadway Lighting Projects:

2.1 Project: Upgrade remaining Series Mercury Vapor (MV) Luminaries

Description: There are currently over 12,400 mercury vapor highway luminary fixtures installed in the Bay Area and Southern California. These fixtures are the last remnants of the Department's older series circuit highway lighting system. The remaining 92 percent of the system were upgraded between 1976 through 1986. Pending feasibility studies for each series circuit, remaining MV inventory will be replaced with High Pressure Sodium Luminaries as related sections of highway undergo renovation.

Status: Since 1/1/94, approximately 10,498 fixtures have been upgraded, leaving about 2,000 units in Southern California waiting for upgrading as their adjoining roadway is upgraded.

Energy Savings Potentials: Actual: 2,310 KW, 10,300,000 kWh/yr. Additional Potential: 440 KW; 1,930,000 kWh/yr.

Data Collection and Tracking: Maintenance Installed Base Inventory Database.

Estimated Implementation Timeline: Completion Estimate FY 2003/2004.

Estimated Net Energy/Dollar Savings over ten years: Actual: \$7.56 million; Additional Potential: \$1.39 million.

2.2 Project: Highway Lighting System LED Upgrade

Description: In early 1997, Hewlett Packard (HP) and Philips Electric formed a joint venture to develop LED cluster technology to replace current HID lamp technology. The impact on the Department and other cities and counties would be major. Highway lighting is the Department's single largest electrical load. Should this project become active, the Department's energy profile may no longer have a very large night load. Savings would be major.

Status: The introduction of the "Barracuda" LED by HP and Philips Lighting marks a major step forward in high intensity LED technology. The key to this developing industry will be the ability to develop a cost-effective product that can compete with sodium vapor lighting technology. To date, the product is not available.

Energy Savings Potential: Not quantifiable at this time.

Data Collection and Tracking: Maintenance Installed Base Inventory Database.

Estimated Implementation Timeline: As determined by project scope.

Estimated Net Energy/Dollar Savings over ten years: Not quantifiable at this time.

2.3 Project: Highway Lighting System Reduction Research and Design Activities.

Description: Since the mid-1970's, the Department has constantly reviewed its highway lighting design specifications for opportunities to maintain or increase the public's safety while reducing the Department's cost to do business. One result of this study was the Department's High-Pressure Sodium Highway Lighting System Upgrade Program, and another project removed about 25 percent of the number of fixtures at any

one location. While most of these projects have been completed, the Department has an ongoing program of research involving future roadway systems (including automated “smart” highways, collision avoidance systems, etc.). As new technologies develop, the Department will implement those cost-effective systems that reduce energy costs.

Status: R&D into sulfur-based lighting and light piping are starting to show some promise for highway applications.

Energy Savings Potential: Not quantifiable at this time.

Data Collection and Tracking: Maintenance Installed Base Inventory Database.

Estimated Implementation Timeline: As determined by project scope.

Estimated Net Energy/Dollar Savings over ten years: Not quantifiable at this time

2.4 Project: Highway Lighting System Conversion to Inductive Lamp Fixtures.

Description: Convert existing 200 watt high-pressure sodium (HPS) highway lighting to 165-watt inductive lamp technology. This new technology is essentially a fluorescent lamp that uses radio frequencies to excite the mercury vapor in the chamber instead of a filament. This new lamp has an equivalent light output to HPS fixtures that are currently standard while using 25 percent less energy and potentially tripling lamp life.

Status: Researching the technology for possible field-testing.

Energy Savings Potential: Annual Savings: 1,680 KW and 7,358,000 kWh

Data Collection and Tracking: Maintenance Installed Base Inventory Database.

Estimated Implementation Timeline: No completion date at this time.

Estimated Net Energy/Dollar Savings over ten years: \$7,358,000 million

Category 3 - Roadway Sign Lighting Projects:

3.1 Project: Highway Sign Lighting System Delamping Program

Description: In the late 1980s, a research contract with the Institute of Transportation Studies (ITS) at University of California at Irvine, recommended that the Department could turn off the powered lighting systems of some highway signs. (Under those conditions where alternative sources of illumination are present, i.e., headlights, local streetlights, etc.)

Since the late 1990s, many export vehicle manufacturers have introduced controlled head-lighting systems that reduce the amount of light distribution above the hood level of the vehicle. This was done to reduce glare upon vehicles coming from the opposite direction. This safety improvement also has a direct impact upon the available light generated by vehicles to see traffic information signage above the freeway. The Department is investigating various solutions at this time to increase the visibility of the signs in question. Investigated solutions include high tech lighting systems, higher level of reflectivity surfaces, in some rare cases sign relocation, also in some areas using highway lighting as the source for lighting up the impacted signage.

Status: By FY 1998/1999, most of the signs that have been identified to be delamped have been so and delamped. Studies are underway to find the most cost effective manner to increase the visibility of signs as the trend toward the controlled head-lighting systems increase in percentage of total vehicles on the roadway system. If signs are re-lamped, they will have a lower wattage higher output fixture installed, thus still generating a net saving for this project.

Energy Savings Potential: Annual Savings: 1528 KW, 7,200,000 kWh;

Data Collection and Tracking: Maintenance Installed Base Inventory Database.

Estimated Implementation Timeline: Completed 2004/2005

Estimated Net Energy/Dollar Savings over ten years: \$6.0 million;

3.2 Project: Highway Sign Lighting System Conversion to Mercury Vapor (MV) Fixtures.

Description: Fluorescent fixtures required lamp replacement every other year. Highway Maintenance staff decided to convert all fluorescent fixtures to 175-watt MV fixtures. While the amount of light per energy unit is slightly less with MV lamps, maintenance service periods could be stretched out to once every four years. When the conversions were made, two two-lamp fluorescent fixtures were replaced by one 175-watt MV fixture. Therefore, some energy savings did result from the conversion process. (*NOTE: Along with increasing the service period, a reduction of fixtures to service yields additional work force savings. Energy conservation was not the prime focus for this conversion program.*) Post January 1, 1995 and estimated potential savings are listed below.

Status: We are continuing to upgrade sign lighting systems as we upgrade roadway facilities. The Department is also looking into new lighting technology that may allow it to reduce existing lighting system wattage by as much as fifty percent. Testing of this new technology will occur until issues are resolved.

Energy Savings Potential: Annual Savings: 1200 KW and 5,400,000 kWh;
Forecasted Savings: 1,239 KW and 5,500,000 kWh.

Data Collection and Tracking: Maintenance Installed Base Inventory Database.

Estimated Implementation Timeline: Completion Estimate FY 2002/2003

Estimated Net Energy/Dollar Savings over ten years: \$4.8 million; Additional Potential: \$4.0 million.

3.3 **Project:** CMS and EMS Lamp Upgrade Program.

Description: The Department has 500+ Changeable Message Signs (CMS) and 99+ Extinguishable Message Signs (EMS) in its equipment inventory. Most of these message signs operate with an array of 2,400 25-watt incandescent lamps (an average of 600 bulbs are on at the same time, for less than 12 hours per day). Messages are broadcast to the highway user by spelling out words or signals with a combination of on and off lamps. All incandescent signs require more power than can be supplied due to the large number of lamps in each sign. This is true for both utility and generator powered signs. Since the late 1980s, departmental staff has conducted R&D field-testing of five types of alternative lighting sources. 7-Watt Xenon bulbs, Fiber Optics, Flip Disk, LED (2 Watt), and Phosphorescent Flip Disk (nighttime only signals) are the systems being tested. Newer technologies are investigated as they are developed. Energy savings potentials are directly dependent upon which alternative system(s) the Department adopts. Most of the current alternative systems consume about one third of the power currently consumed by the incandescent arrays. Xenon, LED, flip-disk, and combinations of those options now have performance specifications developed for procurement of alternative illumination sources. Replacement costs are equal or less than normal replacement costs, therefore, as older systems are ready for replacement, they are replaced with a newer energy efficient model.

Status: Currently the majority of the incandescent message signs are being retrofitted with Xenon lamp on a pixel for pixel basis. This represents an eighty- percent reduction in power consumption for the sign. LED and other alternatives are being leased and purchased. HQ staff (Traffic Ops, METS-Electrical Lab, Maintenance, and Project Development/Resource Conservation) are meeting to develop the next generation of solid-state EMS/CMS sign performance specifications. Late in FY 1999/2000, the Department purchased five LED based CMS signs (one for testing, and the rest for installation). The spec development work started in FY 2000/2001 with LED specs being completed in FY 2002/2003.

The systematic conversion/retrofit of the incandescent CMS inventory is being accelerated. Recently, the use of the CMS systems has become high profile due to the initiation of the "Amber Alert" child abduction notification system, and the need for

additional motorist information. Reliability of the incandescent lamps is questionable and often, CMS availability is reduced due to frequent multiple burnouts. The feasibility of an LED retrofit is being studied, and if that does not prove to be workable, the fall back position is to implement this retrofit using the xenon technology. In either case, the base design of the CMS will remain unchanged.

Energy Savings: Actual -5,200 KW reduction, 3,800,000 kWh/year savings; Additional Potential – 2,400 KW, 1,750,000 kWh/yr. (Energy calculations based on 2 hrs of operation per sign per day, and 48 characters per message)

Data Collection and Tracking: Maintenance Installed Base Inventory and Traffic Operations-Electrical Databases.

Estimated Implementation Timeline: Original schedule was as “ongoing upgrades”, on an as needed basis.

Estimated Net Energy/Dollar Savings over ten years: \$5.7 million. Additional Potential \$2.6 million

3.4 Project: Highway Sign Lighting System Conversion to Inductive Lamp Fixtures.

Description: Convert existing MV and fluorescent lighting to new inductive lamp technology. This new technology is essentially a fluorescent lamp that uses radio frequencies to excite the mercury vapor in the chamber instead of a filament. This new lamp has an equivalent light output to the mercury vapor HID lamps that are currently standard while using sixty percent less energy and potentially tripling lamp life.

Status: Department has installed or retrofitted about 5,000 fixtures as of the end of 2003.

Energy Savings Potential: Actual Annual Savings: 725 KW, 3,700,000 kWh; Additional Potential - 1,730 KW and 7,550,000 kWh (based on converting mercury vapor fixtures only)

Data Collection and Tracking: Maintenance Installed Base Inventory Database.

Estimated Implementation Timeline: As soon as possible given current budget and staffing levels.

Estimated Net Energy/Dollar Savings over ten years: 3.2 million. Additional Potential \$9.8 million

Category 4 - Bridge and Tunnel Projects:

4.1 Project: Upgrade Tunnel Lighting Systems.

Description: The Department operates a number of tunnels throughout California that require lighting systems. Lighting conditions/ requirements in all tunnels change during each day. Daylight hours require brighter transition zones at the openings of the tunnels and lower light levels within the tunnel. Nighttime hours require the transition zones to be lower in light levels than the interior of the tunnel. During rain, fog, dawn, and twilight hours the transition zones need to vary with the ambient light conditions. High-pressure sodium fixtures will replace the older existing fixtures. District 4 has decided to fully fund their projects.

Status: Projects are on planned schedule. Light pipes and other innovative lighting technologies are being included in the development plan.

Energy Savings Potential: About 1800 KW, 8,350,000 kWh/yr.

Data Collection and Tracking: District 4 staff, Structures and Highway Maintenance staff.

Estimated Implementation Timeline: As funding and staffing levels allow.

Estimated Net Energy/Dollar Savings over ten years: \$1.28 million
(From District 4 projects.)

4.2 Project: Eastern Span of the SF/Oakland Bay Bridge



Description: The Department is developing the construction plans for the lighting systems on the new Eastern span of the SF/Oakland Bay Bridge. The four lighting systems include safety/maintenance, roadway, pedestrian, and decorative lighting systems. Halide, light pipe, sodium, lighting sources are included in the mix of lighting sources.

Status: Skyway portion of the project is in construction phase.

Energy Savings Potential: Not quantifiable at this time.

Data Collection and Tracking: District, Structures and Highway Maintenance staff.

Estimated Implementation Timeline: FY 2007/2008.

Estimated Net Energy/Dollar Savings over ten years: Not quantifiable at this time.

4.3 Project: Upgrade Tunnel Ventilation Systems.

Description: The Department maintains a number of tunnels throughout California that require powered ventilation system. Except for the new Century Freeway tunnels in Southern California, all tunnel ventilation equipment control systems are being studied for upgrade requirements and operations automation. Variable Frequency Motor Control systems and new industrial CO and NOX sensing/control systems are faster reacting and lower in cost than earlier systems. District staff determines how and when these facilities are to be upgraded.

Status: Three tunnels in the San Francisco Bay Area are currently being studied for equipment and control system upgrades.

Energy Savings Potential: Not quantifiable at this time.

Data Collection and Tracking: District, Structures and Highway Maintenance staff.

Estimated Implementation Timeline: As funding and staffing levels allow.

Estimated Net Energy/Dollar Savings over ten years: Not quantifiable at this time.

4.3 Project: Wind Generation on Antioch Bridge



Description: During the late 1970's through the early 1990s, the Department took part in a number of studies to determine alternative power sites on or at departmental facilities and property. Working with the Governor's Office of Appropriate Technology, the California Energy Commission, and UC Santa Barbara staff, the Department developed a list of high potential sites. The highest yield site is located under the Antioch Bridge. Average wind speeds and consistent direction, due to the controlling nature of the bridge design, make this site equal or better than any other wind generation site in California. Working with UC Santa Barbara Department of Environmental Studies, the bridge has been wind-mapped for over three wind seasons including microclimate studies for over two seasons. The bridge structure functions as an elongated wing that compresses the air going under the bridge. The air compression increases the wind speeds, and forces the wind direction to become perpendicular to the bridge structure, thus reducing the need for a "YAW" control system (wind direction turning control system). The simplified design allows the wind generator systems to tuck up under the bridge structure during

periods of maintenance, and during high wind storms thus eliminating any kind of adverse wind loading stress on the bridge structure during storm conditions.

Status: Project on hold pending improvement in the electric procurement spot market. Once the economics are cost effective, the Department will market the opportunity for a joint development venture between the Department and the private energy generation market.

In addition to the proposed wind project at this site, the Department management has suggested the addition of photovoltaic panels and some river-powered-low-head hydro generation. The size of these systems has yet to be determined. Prototype development will take a few years of field study prior to full-scale project implementation. It has also been suggested that the alternative energy site be developed for public education regarding the “green” power application and how the systems interact with the environment and local wild life. For want of a better title for the project, staff is calling it the “E” Park. (“E” for energy/environment.)

Energy Savings Potential: 2 megawatts/hour, 3,600,000 kWh/5 months of wind season operation per year.

Data Collection and Tracking: Structures and Highway Maintenance staff.

Estimated Implementation Timeline: As funding and staffing levels allow, and after the CPUC defines the terms and conditions for power wheeling.

Estimated Net Energy/Dollar Savings over ten years: Not quantifiable at this time.

Category 5 - Facility Operations Projects:

5.1 Project: Facility Energy Conservation Audit/Retrofit Program

Description: From 1982 through 1986, the Department conducted a series of energy audits on a cross section of different types and sizes of its facilities. The goal of the study was to prioritize energy conservation measures (ECMs) and facilities. The studies results determined that every facility/complex with more than 40,000 square feet of office space had energy conservation measures (ECMs) with sufficient size and scope that they would allow the use of either Department-funded, Energy Efficiency Bond-funded, and/or Private Sector Energy Service Companies (ESCOs)-funded conservation programs.

In 1988, the Department contracted with an ESCO to fund and manage an audit/design/implement/track energy conservation "turn-key" demonstration project in three districts' facilities. At the same time, the Department contracted with DGS/EA to fund energy conservation projects at three district office complexes. The goal of the two demonstration projects being which approach was the easiest to implement and yielded the greatest benefit for the Department.

Since 1993, the Department has been working with DGS/EA to develop an ESCO bid package. To date, conflicting legal opinions within the Department and DGS have not allowed this project to move forward.

With the passage of AB1890, DGS/EA and the Department have been developing a pool of ESCOs and a client advocate to allow State government departments to enter into energy service contracts with those ESCOs. It is the intent of the Department to include all district and HQ facilities, over 40,000 square feet in size in a master energy service contract task order with the Department of General Services/Energy Assessments (DGS/EA). All cost effective energy conservation measures in those facilities will be implemented under this statewide effort. (Between 5.3 and 7.2 million square feet of facilities are involved in this program.)

Status: DGS/Procurement established a pool of qualified ESCO contractors in late 1999. The Department currently has an interagency contract in place (IA53A0004) with DGS/EA, which allows DGS/EA to assist the Department in their selection of and working with the selected ESCO contractor. On June 20, 2000, the Department selected an ESCO contractor to enter into contract negotiations. By January of 2001, the Department and INVENSYS Building Controls Company (the selected ESCO contractor), had signed a contract and sent the contract to DGS Legal for final approval. As structured at that time, INVENSYS was to fully fund the investment grade facility audits, then fund the statewide implementation of all departmentally approved cost effective conservation measures, the WEB site/communications systems, and a series of employee training. Upon acceptance of the completed projects by the Department, INVENSYS would start invoicing the State on a monthly basis whereby the amount of the invoice would be less than the real value of the documented energy savings.

The value to the State of this approach to conservation is the State does not invest taxpayer funds in the front end of the project, yet receives improvements to capital assets. And, the State repays the loan from documented savings to the Department's Utility Budget Line item. Side benefits to the State are a reduction in overhead costs by reducing the amount of contracts to be let. Compression of the amount of the processing time brings the projects on line at a faster rate.

In early February 2001, the State's efforts to use ESCOs to fully fund facility audits/retrofits was stopped and agencies who had projects to be implemented within this process had to find another way to identify and implement facility conservation measures. As a direct result of these decisions, the Department had to modify its facilities conservation efforts and is working with the Department of Finance (DOF) and DGS staff to implement a statewide facility audit program, and then develop an implementation program for identified conservation measures.

The Department worked with INVENSYS to restructure the contract for audit only work. Through the use of "typical" sites the square footage audit scope was further reduced.

From February through November of 2001, the Department staff met with DOF and DGS staff reviewed the draft contract to ensure "buy-in" by all participants once the contract was finalized and signed by INVENSYS and the Department. The contract was sent to DOF for a courtesy review as instructed by DGS Legal.

Once approved by DOF and DGS legal, the INVENSYS contract was executed in the first week of March 2002.

After some coordination meetings with the contract, regional contract "start-up" meetings were held in the Spring of 2002. Statewide audits started in late April and continued until completed in the summer of 2002.

Conservation measures investigations included all energy and water systems located within departmental facilities including environmental, process, and employee-sponsored equipment and systems. Alternative energy/water sources and load management/energy source shifting systems were investigated. The Department's ESCO 2002/03 Project attempts to integrate the Department's energy and water systems into a controllable network operated via a statewide computer based management system. The majority of the conservation measures highlighted in the completed audits focus on upgrading the environmental systems within the facilities, including lighting, heating and cooling systems and related subsystems. The load management portion of the Facilities Energy Management System upon implementation should allow the Department to reduce facility connected loads to the power grid during Stage 2 and Stage 3 alerts in support of the Governor's request for State agencies to shift loads during power supply emergencies.

Estimated Energy Savings Potential: 1,733 KW, 5,340,000 kWh/yr.

Data Collection and Tracking: Energy tracking and reporting to be a combination of the DGS/EA Utility Summary Billing System, and savings data generated from the ESCO contract.

Estimated Implementation Timeline: As funding and staffing levels allow.

Estimated Net Energy/Dollar Savings over 12 years: \$3.4 million.

5.2 **Project:** Whole or Partial Facility Power Generation

Description: Legislation in the early part of 2001 established the California Power Authority (CPA) to buy, sell, and develop in-state power generation resources. Partial or full funding of the resources can come from Bond Funds sold by the CPA. Currently, under development by the Governor's Office of Planning and Research is a task force to develop renewable power generation buy-down programs that allow implementing State agencies to fund full facility on-site generation systems (including fuel cell, photovoltaic, wind, small hydro, micro-gen, Bio-gas generators, etc.)

The Department would implement its portion of the statewide program as a partner with all other state government facilities, including the UC/CSUC systems.

On-site power generation would only include department-owned facilities. No roadway electrical systems would be included in this project at this time.

Status: The CPA is currently coordinating a statewide photovoltaic (PV) power generation cooperative venture project between state agencies, the UC and CSU systems, and private sector PV power producers. This prototype project will attempt to site private sector PV power generation systems on State property. The participating state sites would lease the solar rights and PV sites to the power generation suppliers, and in return the State would agree to purchase all the power for the systems at a rate less than local utility tariff. District 10 HQ complex in Stockton is the first test site for this program for the Department. CPA's RFB process was started in March of 2003, and with DOF and DGS' assistance the package is expected to go out for bid in April 2004, with contract award and construction in 2004.

Energy Savings Potential: Data still being collected at this time.

Data Collection and Tracking: On site sub metering will provide savings data for this project.

Estimated Implementation Timeline: Prototype planned for completion in 2004.

Estimated Net Energy/Dollar Savings over ten years: Not available at this time.

5.3 **Project:** New Facility Construction

Description: Since January 1, 1994, the Department has completed energy conservation upgrades to two new facilities. Lighting and heating, ventilating, and air conditioning (HVAC) systems were upgraded to higher efficiency units beyond Title 24

goals in the new District 4 headquarters and the Farmer's Market III (a lease facility where the Department pays utility bills). In FY 1997/1998, The Department relocated its San Bernardino (District 8) District Office into a new facility. In FY 2000/2001, the Department started preliminary building design for two new district office replacements (District 7 (Los Angeles), District 11 (San Diego), and in FY 2003/4 a new District 3 office buildings.) The Department is working with DGS Real Estate Services Division (DGS/RESD) in the development of these projects. As a direct result of Executive Order D-16-00, a multi-agency/Department task force established sustainable building guidelines for application in State construction projects (Guidelines report released by the Governor's Office.

DGS/RESD and the Department staff worked with the contractors to implement as many design elements as possible within current budget and project development timeline. In some instances, the Department has requested additional funds from the California Transportation Commission (CTC) and DOF. As of the spring of 2001, DOF had turned down the Department's request for added funds for co-generation and thermal storage projects at the San Diego District Office Replacement Project. Both the Department and DGS/RESD project staff continued to develop solutions.

Status: In 2002 and 2003, the replacement district office projects in Los Angeles (D-7), San Diego (D-11) and Marysville (D-3) were modified to include cost effective "Sustainable Building Design Elements" during the preliminary design phase of each respective project. Working with RESD and DOF, all three sites are seeking to become certified by the U.S. Green Building Council's LEED(Leadership in Energy and Environmental Design) Program, a nationally recognized building rating system. Based upon the time frame for each facility's development, D-11 is striving for LEED Certified, D-7 is to be Silver Certified, and a maximum effort is striving to have D-3 Gold Certified. This means that all three facilities will exceed current Title 24 environmental design features. Over the expected life of each complex any slight increases in front end costs will be returned in direct and indirect savings to the state within the first few years of operation and occupancy.

Energy Savings Potential: Data still being collected this time.

Data Collection and Tracking: The Department Facility Operations staff will track equipment operational data calculations.

Estimated Implementation Timeline: Project completion will vary with each of the major projects with the last project coming on line sometime around January 2008.

Estimated Net Energy/Dollar Savings over ten years: Not available at this time.

Category 6 – Procedural Improvement Projects:

6.1 Project: Utility Accounts Verification Program

Description: In 1983, the Department was one of the first state agencies to implement a Summary Utility Billing Program. Utility computer tapes were sent to the Department for downloading into our billing computers. This allowed the Department to process one invoice that listed hundreds of utility accounts. While this process greatly reduced the cost of processing energy utility bills, the Department gave up some of its ability to quickly audit account data. All billing data is in the computer. However, data history is not easily accessible. Gaining access to monthly billing data requires writing mainframe database routines. Over the years the various utility companies have changed account numbers for almost every electric and gas meter serving the Department facilities. Small portions of the thousands of utility accounts are no longer accurate. They fall into one of the following categories:

- 1) Abandoned meter;
- 2) Wrong utility rate is in force; or
- 3) Load and consumption profiles are no longer valid for a flat fee account; and,
- 4) Utility payment responsibilities have been transferred to local governments, however, due to a paperwork error on the part of the Department, the utility and/or the local government, the transfer of utility bill payment was not implemented and the Department is still paying someone else's utility bill.

Status: The Department Accounts Payables has implemented an electronic commerce and electronic fund transfer payment system to speed up the utility invoice payment process. This quicker payment response time can be used to take advantage of any "speedy payment" discounts that may be offered by utilities. Accounting staff has also established a Quality Team (made up of representatives from Accounting, Maintenance, Construction, Facility Operations, with Resource Conservation staff as a technical resource to the Team.) to identify and recommend procedural changes to reduce future utility account problems due to construction related utility scheduling and paperwork processes. This effort is focused on reducing the types of problems in all four of the account problems listed above.

The Department Maintenance and Facility Operations units completed their utility account auditing by the end of 2001, and continue to do account reviews as staffing levels permit. Auditing the accounts included field visits to verify activity level of the service. To date, these audits have found account errors that benefit both the utilities and the Department, with the Department coming out on the positive side of the equation. One-time savings and long term savings have been found through these audits. Account audits will continue where deemed necessary and staffing levels permit.

Estimated Energy Savings Potential: No real energy savings, only dollar savings due to invoice corrections

Data Collection and Tracking: Accounting and DGS/Energy Assessments Utility Summary Billing Program.

Estimated Implementation Timeline: Ongoing analysis and administration.

Estimated Net Energy/Dollar Savings over ten years: \$10.7 million.

6.2 Project: “100% Agreement” Program with Local Government Agencies.

Description: Over the years, the Department and local government agencies have shared some of the cost of operating intersections of state and “local” maintained roadways. To stabilize monthly costs and reduce the cost of invoicing and collecting monies from the locals, the Department has entered into “100% Agreements” with some local governments. These agreements call for the locals to pay the entire electric bill and the Department maintains the intersection, thus impacting utility line item costs. The numbers of contracts vary over time as locals and the Department determine how, when and where these contracts are of benefit to all parties.

Status: The Department Legal and Maintenance units are developing a new cooperative agreement to better reflect true costs of maintaining shared intersections once LED traffic signals are available for installation. The LED traffic signal upgrade program has been implemented in all districts. Local governments with “100% Agreements” in force have the option to buy LED modules from the Department’s qualified vendors, and departmental Maintenance staff will install the fixtures.

Energy Savings: No actual energy reductions, utility invoicing transferred to Local Agencies.

Data Collection and Tracking: Maintenance databases

Implementation Timeline: On going.

Estimated Net Energy/Dollar Savings over ten years: \$30 million in cost avoidance to the Department.

6.3 Project: Telecommuting and Teleconferencing Programs

Description: The Department is currently studying various alternatives to conducting business more efficiently. Telecommuting and teleconferencing offer the Department the ability to utilize computer technology to allow employees to work more effectively. Energy is saved as a side benefit from both of these programs. An employee's office computer and possibly their office lights are not turned on when they telecommute. Savings in equipment life, energy, and facility cooling loads are thus realized. Teleconferencing allows face-to-face meetings of staff without requiring long distance traveling costs (transportation fuel consumption savings). Eventually teleconferencing and telecommuting technologies may merge and allow the telecommuter to teleconference from remote work sites. This change in work environment will impact departmental facility requirements.

Status: Some offices have implemented telecommuting for all staff including management, while other offices have not for various reasons. Video teleconference

sites exist in all District Offices and HQ facilities. Some meeting rooms are equipped with speakerphone systems to allow teleconferencing to occur at that site.

Energy Savings Potential: No data available at this time.

Data Collection and Tracking: Telecommuting Office, Highway Maintenance and Facilities Operations staff.

Estimated Implementation Timeline: Estimate FY 2002/2003

Estimated Net Energy/Dollar Savings over ten years: Not quantifiable at this time.

6.4 Project: “Lights Out” Program

Description: Since 1979, the Department has had a standing policy of the last person out of a room should turn off the lights. Energy auditors, from 1982 through 1993 have all commented on how well departmental staff has continued that practice.

Part of the success of this program is due to the fairly static locations of staff. As people change positions or locations, existing staff explains the office routines and light switch location(s). In 1994/95, the Department’s restructuring has relocated most staff locations. Turning the lights out at the end of the workday routines will be reinstated at these new locations. Facilities Operations staff will implement an awareness program for all staff once restructuring is complete. As part of the facilities Master Energy Service Contract with DGS/EA, it is the intention to identify light switch locations in all office areas to allow staff to re-establish the “Lights-out” program on a statewide basis.

Status: As part of the ESCO work to be performed at the Department facilities, the energy audits will be looking at the current rate of staff turning off lights and equipment at the end of the work day. It is necessary to establish an energy consumption base line for energy conservation calculation purposes. Once base lines are established, Facility Operations will send out notices (probably via Lotus Notes email) to all staff outlining the “Lights-Out” policy, as well as other conservation policies in support of the current DGS 2003 Energy Conservation Management Memo 03-14. A link to this document can be found at the Department’s energy conservation web site:

<http://www.dot.ca.gov/hq/energy/>

Or directly at this link for a PDF copy of this DGS Management Memo:

http://www.documents.dgs.ca.gov/osp/sam/mmemos/mm03_14.pdf

Energy Savings Potential: Not quantifiable at this time.

Data Collection and Tracking: Facility Operations and Highway Maintenance Staff.

Estimated Implementation Timeline: FY 2002/2003.

Estimated Net Energy/Dollar Savings over ten years: Not quantifiable at this time.

6.5 **Project:** Computer Procurement and Operations Procedures

Description: From 1986 through 1993, the Department entered the computer age by supplying most of its employees with access to personal computers and/or terminals. Energy consumption increases from the computers, printers, servers, mini-mainframes, etc., and the increased cooling loads became almost as large as the facilities' lighting energy consumption loads. In 1991, computer related energy consumption by the Department was calculated at about 50 million kilowatt-hours (including added facility cooling costs).

About forty percent of the computer systems (mini-mainframe, CAD systems, and terminals) run 24 hours a day due to the system design. All but a few personal computers and terminals could be turned off when not in use. The gradual upgrading of personal computers and terminals to EPA "Energy Star" class of units, will further reduce departmental energy consumption.

The Department has developed a policy to upgrade all desktop and server computers in three-year cycles. In conjunction with Y2K upgrades and other "Data Highway" improvements, the Department will be shifting more and more of its information and distribution of the same over this Network. Typical "Energy Star" computer users consume about 850 watts per hour or about \$240 computer user per year. Some users who travel have computers at multiple locations and may have multiple machines on at the same time to allow access to common files. Based upon Computer Services' (ISSC) estimates, there are about 16,000 terminal, PCs and CAD workstations distributed statewide. Best estimates have the Department consuming from 27 to 35 million kWh/yr. to run its computers, servers, printers, plotters, modems, hubs, fax machines, and attached devices (like hard drives, scanners, CD-ROM burners, etc.) Computer related energy consumption now ranks as one of the top three energy-consuming components at our facilities, with lighting and HVAC systems being the other major energy consumers.

"Energy Star" systems reduce energy consumption when units are not used for set periods of time. Monitors turn off the main electron gun, CPUs spin down drives and reduce the speed of the processor chip. This reduction in operation may save up to forty percent of normal operational cost.

Turning off equipment when it is not needed is still the best form of conservation. Older systems used as much as 1500 watts per CPU/Monitor work station, so the trend to more energy efficient computing systems is going in the right direction. Flat screen (non-

CRT) monitor technologies, used in portable computers, are becoming less costly and will become the standard type of monitor within the next few years. This device should reduce user energy consumption by about 200 watts per hour of use. This innovation will also have a positive impact upon the amount of eWaste generated by the Department.

Status: Departmental memos have been issued every 6 months or so reminding all employees to conserve and use state resources wisely as part of the Department's ongoing best business practices efforts. These directives highlight various conservation activities that the employee can implement to reduce the consumption of resources, including energy, paper, printing supplies, and at the same time reduce the risk of office fires due to unattended powered equipment during non-business hours. DGS Management Memo 03-14 directs that unless there is a business reason to keep equipment on after business hours, all equipment needs to be turned off. The replacement of older CRT screens with flat screen monitors continues. At the same time, departmental staff is participating with other state and higher educational institutions in discussions as to how best to deal with the increasing eWaste issues, and to develop guidelines, policies, and procedures in dealing with the disposal or reuse of eWaste classified equipment and materials.

Energy Savings Potential: To date: 4,900,000 kWh. Est. Additional Potential: 4,200,000 kWh.

Data Collection and Tracking: Equipment operational data calculations tracked by the Department's Facility Operations Staff in cooperation with the Information Services Program staff.

Estimated Implementation Timeline: FY 2002/2003

Estimated Net Energy/Dollar Savings over ten years: \$5.2 million; Additional Potential \$5.2 million.

Category 7 - Bulk Energy Procurement Projects:

7.1 Project: State of California Natural Gas Bulk Purchasing Program

Description: DGS/Energy Assessments manages the State's Natural Gas Bulk Purchasing Program. The Department does not currently take advantage of the program. No facilities consume enough gas during the year to justify program participation. If, through consolidation of accounts, the Department could qualify as a participant, then net savings to the Department could amount to three to six percent of our natural gas expenditures per year. The Department's consumption would meet DGS/EA criteria should the Department convert a sizable portion of its non-construction/emergency vehicle fleet to natural gas power engines. Natural gas refueling stations would also help the state flatten out the natural gas consumption curve of winter heating bills, thus generating additional savings to the state. School districts and small local governments are combining their procurement efforts of bulk natural gas. The Department may be able to participate in this program. Another area of natural gas usage would be for the generation of heat for absorption chilling by micro-generators. Summer gas consumption may be cost effective given the changing electric marketplace.

Status: To date, no reasonable cost effective offer has presented itself to the Department. Market conditions are reviewed once per quarter. Department of General Services' Bulk Natural Gas program continues to grow beyond State and higher educational clients with city and county governments joining the program. About 1% of all natural gas procured and used in California is purchased under this contract. Should the Department implement natural gas fired on site power generation as part of an integrated power management solution, site consumption of natural gas would increase and qualify that site for future participation in the DGS Bulk Natural Gas Procurement program.

Energy Savings Potential: No energy savings, only energy cost savings.

Data Collection and Tracking: Accounting and DGS/Energy Assessments' Bulk Natural Gas Procurement Program.

Estimated Implementation Timeline: Estimated FY 2004/2005.

Estimated Net Energy/Dollar Savings over ten years: Not available at this time.

7.2 Project: California Power Authority (CPA)

Description: As a direct result of the State's energy crisis of FY 2000/2001, legislation established a California Power Authority that was established to develop and manage electrical resources in California. Part of the CPA's charter includes the co-funding of renewable power generation sites. Over the next year or so, power generation options may become available to government agencies including the Department of Transportation.

Status: As opportunities present themselves, and funding resources are made available to the Department, it will attempt to optimize its project implementation to best serve the

interests of the Department and the State. Project 5.2, above, may have full implementation as part of this program.

Energy Savings Potential: Not available at this time.

Data Collection and Tracking: Data to be developed and tracked on a project-by-project (site-specific) basis.

Estimated Implementation Timeline: Starting in 2003 completion as funding and staffing levels permit.

Estimated Net Energy/Dollar Savings over 10 years: Not quantifiable at this time.