CALIFORNIA ENERGY COMMISSION

CALIFORNIA NATURAL RESOURCES AGENCY

California Energy Commission

Clean Transportation Program

FINAL PROJECT REPORT

Woodland Joint Unified School District Electric Vehicle Charging Station Installations

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PREFACE

Assembly Bill 118 (Núñez, Chapter 750, Statutes of 2007) created the Clean Transportation Program. The statute authorizes the California Energy Commission (CEC) to develop and deploy alternative and renewable fuels and advanced transportation technologies to help attain the state's climate change policies. Assembly Bill 8 (Perea, Chapter 401, Statutes of 2013) reauthorizes the Clean Transportation Program through January 1, 2024, and specifies that the CEC allocate up to $20 million per year (or up to 20 percent of each fiscal year's funds) in funding for hydrogen station development until at least 100 stations are operational.

The Clean Transportation Program has an annual budget of about $100 million and provides financial support for projects that:

- Reduce California's use and dependence on petroleum transportation fuels and increase the use of alternative and renewable fuels and advanced vehicle technologies.
- Produce sustainable alternative and renewable low-carbon fuels in California.
- Expand alternative fueling infrastructure and fueling stations.
- Improve the efficiency, performance and market viability of alternative light-, medium-, and heavy-duty vehicle technologies.
- Retrofit medium- and heavy-duty on-road and nonroad vehicle fleets to alternative technologies or fuel use.
- Expand the alternative fueling infrastructure available to existing fleets, public transit, and transportation corridors.
- Establish workforce-training programs and conduct public outreach on the benefits of alternative transportation fuels and vehicle technologies.

To be eligible for funding under the Clean Transportation Program, a project must be consistent with the CEC's annual Clean Transportation Program Investment Plan Update. The CEC issued PON-13-606 to provide funding opportunities to encourage widespread adoption of plug-in electric vehicles by the general public and deployment of an extensive charging infrastructure, particularly in high-visibility destination sites. In response to PON-13-606, the recipient submitted an application which was proposed for funding in the CEC's notice of proposed awards July 3, 2014 and the agreement was executed as ARV-14-033 on April 15, 2015.

ABSTRACT

Woodland Joint Unified School District contracted with the California Energy Commission to install 14 electric vehicle charging stations at six schools and the District Office. The school district contracted with Clean Fuel Connection, Inc. to perform a turnkey installation including purchase of the Clipper Creek charging stations. All stations were completed in September 2015. Following the installation of digital sub-meters in January 2016, data has been collected on usage of the chargers. All chargers are being utilized by teachers, parents, and the general public.

Keywords: Electric vehicle charging stations, Woodland Joint Unified School District, Kilowatt-hours

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EXECUTIVE SUMMARY

Woodland Joint Unified School District contracted with the California Energy Commission to install 14 electric vehicle charging stations at six schools and the District office.

The application was timed to coincide with the installation of solar arrays at the six schools and District office. A coalition consisting of the school district and the Sacramento Electric Vehicle Association, a local group of advocates for electric vehicles, initially submitted the project to the California Energy Commission under PON-13-606.

The solar installations provide a way to power the electric vehicle charging stations without greatly increasing the District's electricity costs. In addition, the solar and electric vehicle charging provide a wonderful opportunity to teach Woodland Joint Unified School District students about solar power, battery powered cars and the interconnection of the two technologies.

Of the ten schools receiving solar, six were chosen to also receive charging stations. These six schools were chosen to provide coverage of the entire district as shown on the map in Figure 1. The schools were also selected to represent diverse income and ethnic groups. At several of the schools, the chargers provide opportunities for residents of neighboring multi-family units to charge their electric vehicles if their own buildings cannot accommodate chargers.

The school district contracted with Clean Fuel Connection, Inc. to perform a turnkey installation including purchase of the Clipper Creek charging stations. The Clipper Creek units were selected because they are inexpensive and durable. No network connection or billing software was deemed necessary since the chargers were to be free to all users. The volunteers from the Sacramento Electric Vehicle Association offered to obtain donations to cover the cost of electricity for the chargers. Phil Haupt, a District parent and local electrical contractor, performed the installation work.

The installations were timed to coincide with the summer months. All stations were completed in September 2015. A ribbon cutting with officials of the school district, the Energy Commission was held in October 2015. Following the installation of digital sub-meters in January 2016, data has been collected on usage of the chargers see Table 1. All chargers are being utilized by teachers, parents, and the public.

Since the installation of the digital sub meters, three usage reads have been collected at each site. The results are in Table 1 below:

Table 1: Woodland Joint Unified School District: Cumulative Charger Usage by Site

School site	Cumulative Usage as of May 2016 in kilowatt-hour (kWh)	Cumulative Usage as of Nov 2016/Jan 2017 in kWh	Cumulative Usage as of March 2017 in kWh
Woodland H.S.	1700.8	4686.0	6341.2
Maxwell E.S.	1780.7	3561.9	3606.5
Zamora E.S.	1625.8	2021.8	2927.0
Whitehead E.S.	230.9	4122.0	6206.9
Plainfield E.S.	41.4	1241.2	2704.6
Tafoya E.S.	1271.6	2634.8	3280.00
District Office (435 6th Street)	827.6	2381.0	3198.3

Source: Clean Fuel Connection, Inc. from data provided by Woodland Joint Unified School District

As shown above usage of the chargers has been increasing over time at all locations. However, some locations, notably Woodland High School and Whitehead Elementary School, have almost double the usage of the other five locations. That seems to be due to the presence of plug-in vehicles among staff at those schools.

In conclusion, the electric vehicle charging project for Woodland Joint Unified School District has achieved its objectives of providing workplace charging for faculty and staff, public charging for local residents and an educational opportunity for District students to experience first-hand the benefits of solar power and zero emission vehicles.

CHAPTER 1:
Introduction and Overview

The objective of this project is to reduce one of the key obstacles to purchasing plug-in electric vehicles by installing and operating 14 Clipper Creek chargers at six school locations and the Woodland Joint Unified School District.

The purpose of the project is to provide workplace charging for school faculty and staff as well as public charging for parents and the public. The project also provides an opportunity to teach students about solar power and battery powered vehicles.

Project Partners

A coalition consisting of the school district and the Sacramento Electric Vehicle Association, a local group of advocates for electric vehicles, initially submitted the project to the California Energy Commission (CEC) under PON-13-606. The installation work was performed by electrical subcontractor Phil Haupt under the project management of Clean Fuel Connection, Inc. Clean Fuel Connection, Inc. also purchased the chargers.

Charging Equipment

Clipper Creek HCS 40, 240-volt pedestal-mount units were purchased for this project. The Clipper Creek units are reliable and durable and recommended as the best option since the school district did not intend to charge for usage. Pre-programmed Quadlogic digital electric meters were installed for as an add-on for data collection.

Site Selection

Woodland Joint Unified School District is a unified school district in Yolo County 20 miles northwest of Sacramento, California. The District covers the cities of Woodland, Knights Landing, Yolo, and Zamora. The District is comprised of 26 schools, ranging from preschool to senior high school instruction, nearly 11,000 students and more than 1,000 teachers and staff members.

Eugen Dunlap, a board member for the Sacramento Electric Vehicle Association, conceived of the project as an enhancement to the installation of solar arrays at 10 District schools. Eugen felt that installing charging stations at the solar arrays would provide an opportunity to teach students about both solar power and zero emission vehicles. The Woodland Joint Unified School District's School Board approved the application for CEC funding for the charging portion of the project.

The seven locations were chosen from the District's 26 schools for the following reasons:

1. They provide district-wide opportunities for charging.
2. They are located at schools that already have photovoltaic systems. The six schools have solar carports and the District office has a roof top solar system.
3. They cover a variety of neighborhoods including low income and dense multi-family residential areas.

Several of the schools are surrounded by multi-family housing units that may not be able to accommodate charging. Local students also spoke with neighboring residents to see if the chargers would be used during non-school hours and found that, at least in some areas, they would be used by residents on nights and weekends.

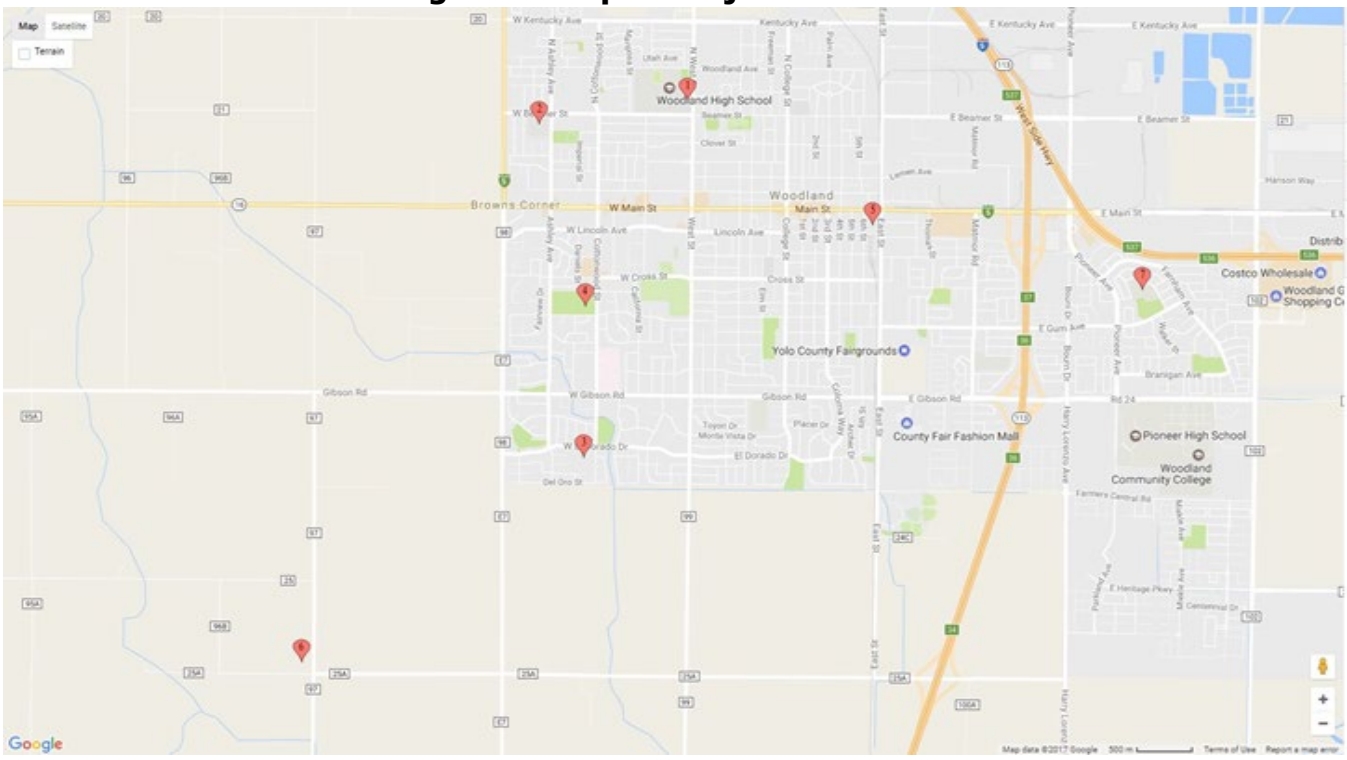
The District installed 14 Clipper Creek chargers at seven school district locations as shown in Table 2 and Figure 1.

Table 2: Woodland Joint Unified School District Electric Vehicle Charging Locations

Location	Address	Number of Units (connectors)
Woodland High School	21 N. West Street, Woodland, CA 95695	2
Rhoda Maxwell Elementary	50 Ashley Avenue, Woodland, CA 95695	2
Zamora Elementary	1716 Cottonwood Street, Woodland, CA 95695	2
Whitehead Elementary	624 Southwood Drive, Woodland, CA 95695	2
Woodland Joint Unified School District Office	435 6th Street Woodland, CA 95695	2
Plainfield Elementary	20450 Country Road 97, Woodland, CA 95695	2
Tafoya Elementary	720 Homestead Way, Woodland, CA 95695	2
Total		14

Source: Clean Fuel Connection, Inc.

Figure 1: Map of Project Locations



Source: Clean Fuel Connection, Inc.

CHAPTER 2:
Installation Process

Installation Process

The contract with the CEC for this project was signed by the District and the CEC in April 2015. A kickoff meeting with the CEC followed on May 5, 2015. The District school board approved a contract with Clean Fuel Connection Inc. on July 16, 2015 and a Notice to Proceed was immediately issued to their electrical subcontractor, Haupt Electric. The Clipper Creek charging equipment was ordered on July 22, 2015.

The goal was to complete the seven installations during the summer months before school resumed in August. It was possible to expedite the project because it did not require local city permits. By working at multiple schools simultaneously, Clean Fuel Connection Inc. and Haupt Electric were able to complete the seven installations by September 2015.

Data collection meters were approved by the District in September. Ordering the meters required approval of a CEC contract budget amendment which occurred in November 2016. The data collection meters were received in January 2016 and the installation of the meters was completed later that same month.

Operation and Maintenance

The Clipper Creek chargers are very simple to operate, requiring only that the user insert the connector and push start. Haupt Electric has a lot of experience with these charging stations and provided training on the units. The equipment is warrantied for three years and installation is warrantied for two years. An operations and maintenance plan were submitted to the CEC in January 2016. The units have been operating flawlessly since installation.

Description of Completed Sites

Photographs for each of the seven installed sites (Figures 2-8) are also shown below.

Woodland High School

Woodland High School with 1,286 students is in a neighborhood of single-family homes. There is a large park nearby and visitors to the park may park in the high school parking lot and use the chargers. Figure 2 below shows a picture of the charger at Woodland High School.

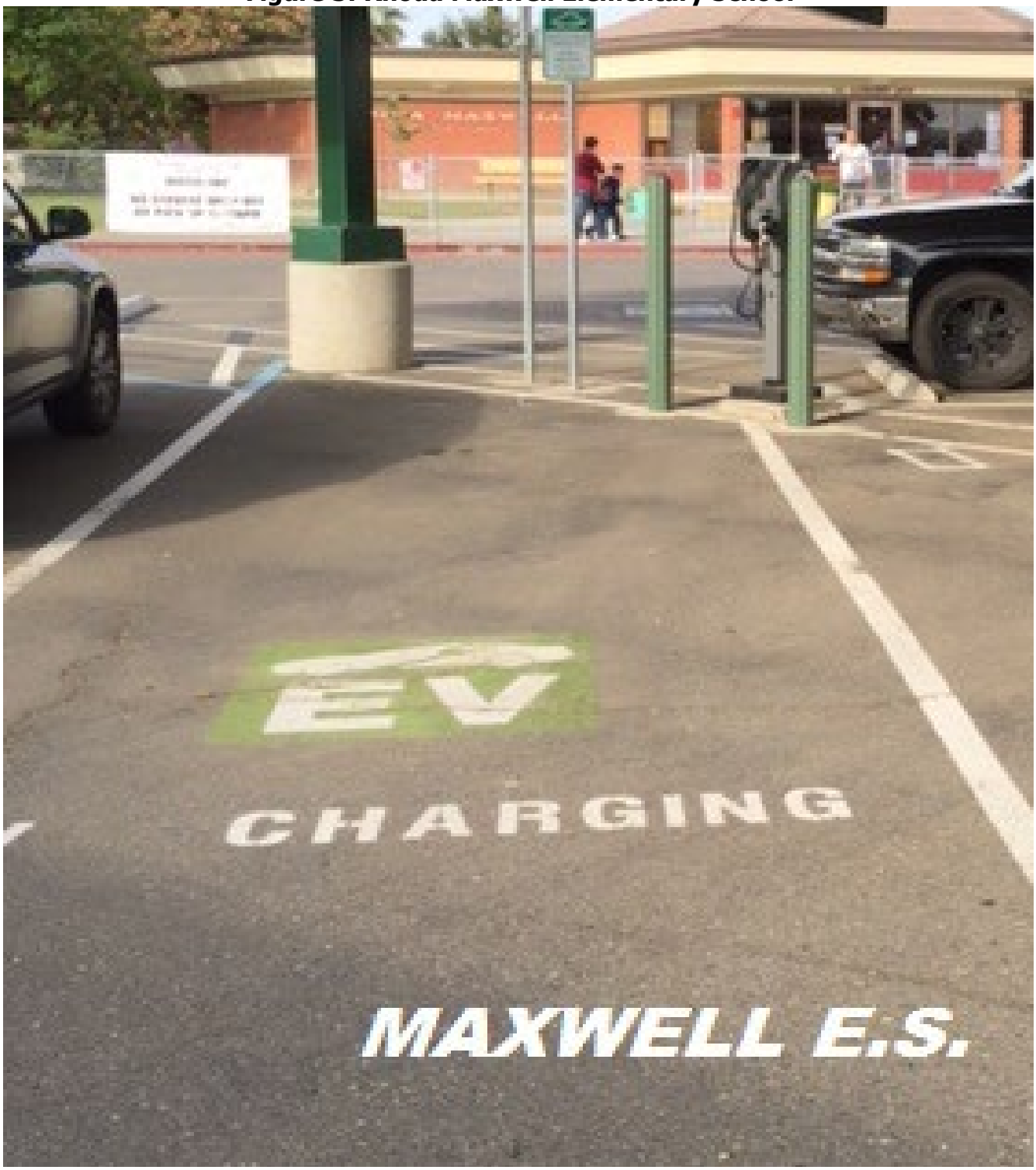
Figure 2: Woodland High School

Source: Woodland Joint Unified School District

Rhoda Maxwell Elementary School

Maxwell Elementary School has 475 students and is one of the lower income schools in the District, as measured by the high percentage of reduced-price school lunches (85 percent). The school is also within walking distance of a park. Figure 3 below shows a charger at Rhoda Maxwell Elementary School.

Figure 3: Rhoda Maxwell Elementary School



Source: Woodland Joint Unified School District

Zamora Elementary School

Zamora Elementary School has 533 students and is in an area of single-family homes. It is within walking distance of a park and adjacent to an agricultural area. Figure 4 below is a picture of a charger at Zamora Elementary School.

Figure 4: Zamora Elementary School

Source: Woodland Joint Unified School District

Whitehead Elementary School

Whitehead Elementary School has 450 students and is in a low-income area, as measured by the percentage of reduced-price school lunches. It is across the street from a large apartment complex. Figure 5 below is a photo of a charger at the Whitehead Elementary School.

Figure 5: Whitehead Elementary School

Source: Woodland Joint Unified School District

The Woodland Joint Unified School District Office

The District office is located very one block away from Woodland's commercial area (Main Street). It is also in an area that is rapidly redeveloping with a lot of new commercial and office construction. Figure 6 below shows a picture of the charger at the Woodland Joint Unified School District office.

Figure 6: Woodland Joint Unified District Office

Source: Woodland Joint Unified School District

Plainfield Elementary School

Plainfield Elementary has 310 students and is surrounded by agricultural fields. Figure 7 below is a photo of a charger at Plainfield Elementary School.

Figure 7: Plainfield Elementary School

Source: Woodland Joint Unified School District

Tafoya Elementary School

Tafoya Elementary is the District's largest elementary school. The surrounding neighborhood is a mix of single-family homes, apartments, and mobile home parks. Figure 8 below is a photo of a charger at Tafoya Elementary School.

Figure 8: Tafoya Elementary School

Source: Woodland Joint Unified School District

CHAPTER 3:
Data Collection and Analysis

Since February, the District has been periodically collecting data from the electronic meters installed with the chargers at each of the seven sites. Because the chargers are not networked the meters must be read individually.

To analyze the data, we took the actual read dates for each location. We assumed that the chargers all started collecting data on February 1, 2016. We also assumed that the chargers are used seven days a week since they are open to the public. The first digital meter reads were taken May 18 and May 23, 2016. The second set of reads was taken November 16 and November 21, 2016 and January 9, 2017. The third set of reads was taken March 28, 2017.

To determine average usage per charger per day, we multiplied the number of weeks between meter reads by seven to get the total number of days and then divided total new kWh by the number of days in the measurement period. We further divided that number by the number of chargers at each site (two). The raw reads and dates read are listed in Table 3 below.

Table 3: Usage Meter Reads for Woodland Joint Unified School District

School site	Cumulative Usage First Read (kWh)	Cumulative Usage Second Read (kWh)	Cumulative Usage Third Read (kWh)
Woodland High School	1700.8	4686.0	6341.2
Maxwell Elementary School	1780.7	3561.9	3606.5
Zamora Elementary School	1625.8	2021.8	2927.0
Whitehead Elementary School	230.9	4122.0	6206.9
Plainfield Elementary School	41.4	1241.2	2704.6
Tafoya Elementary School	1271.6	2634.8	3280.00
District Office (435 6th Street)	827.6	2381.0	3198.3

Source: Clean Fuel Connection from data provided by Woodland Joint Unified School District

Table 4 shows the average daily usage per charger for each of the two measurement periods. As can been from the data, all chargers are being used, but usage varies widely from school to school. In addition, some locations saw a great deal of use during the first measurement period and then dropped off (i.e., Zamora Elementary School), while other chargers had low initial usage and expanded later (i.e., Whitehead Elementary School). The reasons for the variations are not known but probably have to do with faculty or staff ownership of plug-in electric vehicles.

Table 4: Average Daily Use by Charger

School site	Average daily use per charger in kWh May 2016	Average daily use per charger in kWh Nov 2016/Jan 2017
Woodland High School	7.6	8.9
Maxwell Elementary School	7.9	5.3
Zamora Elementary School	7.3	1.1
Whitehead Elementary School	1.1	10.7
Plainfield Elementary School	0.2	3.2
Tafoya Elementary School	6.1	3.0
District Office (435 6th Street)	3.9	3.4

Source: Clean Fuel Connection from data provided by Woodland Joint Unified School District

CHAPTER 4:
Conclusions and Recommendations

The project to install electric vehicle charging stations at seven locations in Woodland Joint Unified School District was completed in less than a year after contract signing and the chargers have been operating without any problems since that time.

In general, the process went smoothly after some initial delays. There were also several budget revisions to synchronize the contract budget with the revised cost distribution. In construction, the one constant is change; as a result, the components of the budget (i.e., the material and labor breakdown) will change even if the total budget remains the same.

GLOSSARY

CALIFORNIA ENERGY COMMISSION (CEC)—The state agency established by the Warren-Alquist State Energy Resources Conservation and Development Act in 1974 (Public Resources Code, Sections 25000 et seq.) responsible for energy policy. The Energy Commission's five major areas of responsibilities are:

1. Forecasting future statewide energy needs
2. Licensing power plants sufficient to meet those needs
3. Promoting energy conservation and efficiency measures
4. Developing renewable and alternative energy resources, including providing assistance to develop clean transportation fuels
5. Planning for and directing state response to energy emergencies.

KILOWATT-HOUR (kWh)—The most commonly used unit of measure telling the amount of electricity consumed over time, means one kilowatt of electricity supplied for one hour. In 1989, a typical California household consumed 534 kWh in an average month.