Zero Emission Vehicle (ZEV) Demonstration Project

Phase Two Final Report



Mendocino Council of Governments

Renewable Energy Development Institute

Mendocino Council of Governments

367 North State Street ~ Suite 206 ~ Ukiah, CA 95482
Phone (707) 463-1859 ~ Fax (707) 463-2212

July 30, 1999

Jennifer Allen, Project Manager
California Energy Commission
1516 Ninth Street, MS-41
Sacramento, CA 95814

Re: Grant #MEM-97L-007

Dear Ms. Allen:

I am pleased to present the Draft Final Report of MCOG's Zero Emission Vehicle Demonstration Project, according to our contract with the California Energy Commission (due sixty days before the contract term expires on September 30, 1999).

The contractor, Renewable Energy Development Institute, in cooperation with MCOG, has completed this Draft Final Report to our satisfaction. I'm sure you will inform project manager Janet Orth of any adjustments you may require.

MCOG's final claim is attached for the remaining balance of the contract, including those amounts retained from the three prior quarterly claims on this grant. Thank you for all your assistance.

Sincerely,

Phillip J. Dow
Executive Director

PD/jmo
enc: 1 original and 2 copies of Report
Final claim

Zero Emission Vehicle (ZEV) Demonstration Project – Phase II

1997/1998 and 1998/1999 Overall Work Program – Work Element 13

Final Report

Prepared by
Renewable Energy Development Institute (REDI)
Consultant

Submitted to
Mendocino Council of Governments (MCOG)

September 30, 1999

TABLE of CONTENTS

Abstract
Executive Summary with Conclusions
California Energy Commission Formulae
Thanks and Acknowledgements
ZEV Project Funding
Contractors and Subcontractors
MCOG Transportation Planning Work Program - Element 13
ZEV Project Phase III Proposal

Task 1 – Infrastructure / EV Charging Stations

Tasks 2 through 7 – Vehicle Evaluations
Comparison of Vehicles Tested
- General Motors EV1
- Toyota RAV4-EV
- Ford Ranger EV
- Solectria Force EV
- Chrysler EPIC Minivan

Task 8 - Solar Net Metering

Appendix
- Alameda International EV Expo - List of Exhibitors
- 1998 San Francisco Auto Show - EV Report
- North American EV & Infrastructure Conference & Expo - Highlights
- ZEVolutions - Newsletter of the Planning & Conservation League Foundation

Bibliography

Mendocino Council of Governments
Zero Emission Vehicle (ZEV) Demonstration Project
Phase II Final Report

Abstract

The two-year ZEV Demonstration Project, an element in MCOG's Overall Work Program, evaluated the practicality of using commercially produced zero emission vehicles in the rural setting of Mendocino County, California. The project addressed infrastructure issues by installing charging stations to provide hands-on experience for local government agency and planning personnel. Use of renewable energy was demonstrated through solar net metering, which directly interfaces with power grids to produce electricity locally. This rural demonstration dealt with pollution prevention in a relatively pristine environment, and with the challenges of rugged and mountainous terrain, a somewhat colder climate, and remote locations. Five vehicles were evaluated: the General Motors EV1, Toyota RAV4-EV, Ford Ranger EV, Solectria Force EV, and Chrysler EPIC minivan. All five were successful in one or more specific rural applications, and recommendations were made for the appropriate use of each, such as commuting and public transit. Multimodal transit center design was identified as a key focus for future efforts. The ZEV Project findings provide valuable data for countywide and regional planning, and for other rural areas with similar concerns.

Mendocino Council of Governments
Zero Emission Vehicle (ZEV) Demonstration Project
Phase II Final Report

Executive Summary

Introduction. The purpose of the ZEV Demonstration Project was to evaluate the practicality of using zero emission vehicles, in this case commercially produced electric vehicles (EVs), in the rural setting of Mendocino County and generate a report of findings. The project initiated informed EV infrastructure planning efforts by providing hands-on experience for local government agency and planning personnel. This report can be disseminated to other rural areas with similar concerns.

Lead agencies and funding. The ZEV Project - Phase II was Work Element #13 in the Mendocino Council of Governments' (MCOG) 1997/98 and 1998/99 Overall Work Program, part of MCOG's role as the Regional Transportation Planning Agency. The project was managed by the Renewable Energy Development Institute (REDI), a charitable nonprofit educational and scientific corporation in Willits, California. This second phase was co-funded by the State Legislature with Petroleum Violation Escrow Act (PVEA) funds, through the California Energy Commission (CEC). (*See attached detail of funding)*

Previous work. The ZEV Project - Phase I was conducted as a feasibility study, part of the 1996/97 Overall Work Program, funded by MCOG and by public-private in-kind contributions. Phase II was conducted based on recommendations made.

Regional Priorities. The ZEV Project responds to state and federal mandates, the first priority in regional planning. According to MCOG's Overall Work Program (*see excerpts attached*), the ZEV Project also addresses two other regional transportation planning priorities, by "Creating Effective Partnerships" and "Utilizing New Technology."

Response to state and federal mandates. As the name suggests, the ZEV Project participates in statewide clean air strategies by demonstrating electric vehicles. California's Clean Air Act of 1990 is enforced by the Air Resources Board rules known as the ZEV Mandate, which has been weakened in recent years but is still in force. The amended schedule of EV deployment calls for four percent ZEVs in the state by 2003 (*refer to ZEVolutions publication in Appendix*). The ZEV Project also responds to the Clinton-Gore Administration's National Environmental Technologies Strategy.

Other issues. In addition, the ZEV Project responds to issues of global warming caused by greenhouse gas emissions. An important part of the project is the demonstration of solar net metering. By addressing opportunities with renewable energy sources, the project further responds to the need for energy effiency and conservation. These three main forces--clean air laws, global warming, and energy security-- are driving the development of new advanced vehicle technologies.

Rural emphasis. This is a rural demonstration and therefore different from work done to date with EV technology, which so far has been focused on urban areas with problems of air quality attainment status. It deals with pollution prevention in a relatively pristine environment, as a practical strategy to keep air attainment status through good planning. The project also deals with the challenges of more rugged and mountainous terrain, a somewhat colder climate, and remote locations.

Objectives of the project. The following were the state and local objectives.

PVEA Objective:
- Report energy savings during project (*see attached CEC formula*)

Work Element 13 Products:
- Report on rural trial performances
- Forecast of infrastructure requirements
- Data for countywide air quality and transportation plans
- Solar photovoltaic net metering demonstration

How objectives were accomplished. The above objectives were accomplished by the following OWP work element tasks, Phase I recommended approaches, and through extensive research. These have been completed and are incorporated in this report.

Work Element 13 Tasks:
- Install EV charging stations
- Acquire and test vehicles, train drivers, collect data, demonstrate to public
- Install solar net metering demonstration
- Document and present findings

Phase I Recommended Tasks:
- Compare vehicle performance in day-to-day use
- Collect and log driver experience and vehicle performance data
- Determine the best applications locally of EVs tested
- Address transportation planning and infrastructure
- Consider other factors of EV use
- Assess effectiveness of mitigating local air quality concerns
- Provide photographic documentation
- Develop educational materials specific to the project
- Prepare press releases for public outreach

Education was offered through presentations at schools, other public workshops, ride-and-drive events, REDI's "Tips" package available by request, an additional report format designed for MCOG and REDI's web sites on the Internet with links to other sites, and public copies of the final report made available.

Partners. ZEV Project participants represent a public-private partnership including these agencies and businesses in addition to MCOG, REDI and CEC.

The five MCOG member jurisdictions of County of Mendocino, and Cities of Ukiah, Fort Bragg, Willits, and Point Arena

Other public agencies including Mendocino Transit Authority, County of Mendocino Air Quality Management District, and Brooktrails Township Community Services District, Ukiah High School, Pomolita Middle School, Sacramento Municipal Utilities District

The private sector including Pacific Electric Vehicles, Plan-It, InnEVations, Homestead Enterprises, EV Transport, Burkhardt Turbines, Pacific Gas & Electric Company, Glenmoor Enterprises, Green Motorworks, Toyota Motor Sales USA, Ford Motor Company, It's Electric, Daimler-Chrysler Corporation, Energy Conversion Devices, Inc., Solar Electric Specialties/Applied Power Company, Earthlab Energy Systems, and Trace Engineering

Consumer and fleet emphasis. The EVs tested are designed for fleet and mainstream consumer markets. In other words, they are commercial production vehicles, a further evolution of earlier electric vehicle experimental models, prototypes, kits and conversions that have been displayed at REDI's Solar Energy Expo & Rally and REDI Conference events. While the earlier generation of EVs continue in use in Mendocino County and elsewhere, many consumers have waited for the new production EVs.

The new generation of EVs addresses consumer and fleet needs such as:
- Safety standards
- Manufacturers' service and support
- Insurance coverage
- Lease and purchase options
- Comfort features such as air conditioning and audio systems
- Acceptable performance compared to gasoline vehicles

Findings and conclusions. The following is a synopsis of findings, which are described in greater depth throughout the report.

Recommendations on rural uses for each vehicle tested:

General Motors EV1. This two-seat sport coupe is good for commuting. The model tested uses lead-acid batteries. For intercity commuters, this necessitates recharging during peak-demand hours. The new model with NiMH batteries would need to be charged only at one end of a round-trip commute, during off-peak hours. Either EV1 model would be well suited to town use or flat valley areas, including freeway driving. The extremely lightweight design makes this EV very energy efficient.

Toyota RAV4-EV. This compact sport utility vehicle with NiMH batteries performed well under all of the rigorous conditions tested in Mendocino County and is recommended for general use. It was tested during extremely hot weather, and even using the air conditioning it had plenty of range and power.

Ford Ranger EV. The 1998 model of this pickup truck with lead-acid batteries was limited in range, as was the EV1. The 1999 model with NiMH batteries increases the payload for utility applications, as they are lighter weight, and also should increase range for intercity use. The 1998 lead-acid Ranger performed well climbing hills and maintaining highway speeds, but was tested without cargo. For utility purposes, the NiMH model is expected to be more useful.

Solectria Force EV. This four-door compact sedan makes a useful town or valley vehicle, and is recommended for short trips as opposed to intercity commutes. The regenerative braking feature extends the range, but this EV does not maintain freeway speeds well, and works optimally at 45 mph according to the manufacturer. It was also under powered for the steep, hilly residential neighborhoods, but the "regen" feature was very effective going downhill.

Chrysler EPIC minivan. Accomodating up to eight passengers, this minivan with NiMH is well suited to public transit and family use. Despite the heavier weight, power seemed sufficient for all of the rural tests, although it was not tested fully loaded with passengers on the more challenging routes. With few passengers, it had no trouble with Mendocino County's steep terrain. The loaded vehicle did well with the flat valley driving of the transit routes tested, and its already fast charge time can be improved with the 440V charging option. This EV does use more energy than the lighter EVs.

EV charging infrastructure:

Charging stations to support EV use were recommended in strategic locations throughout the county, at six to eight initially (four of which are already operating). Further stations could be developed, as outlined in the attached Phase III proposal. A key issue is cost of electric "fuel," therefore attention should be paid to utility rates. Charging during off-peak hours is recommended. Solar net metering is another option. Recreational vehicle (RV) plug/receptacles were found compatible with all of the EVs tested and are cost effective. The EV industry has not yet settled on a standard and is still divided on choices of inductive vs conductive charging infrastructure.

Assessment of the effectiveness of mitigating local air quality concerns:

A countywide air quality study and emissions inventory completed earlier this year identified two key factors as a main focus, particulate matter (PM) and ozone. Ozone precursors are at far higher levels than previously thought. The volatile organic compounds (hydrocarbons) that lead to ozone formation are from vehicles,

the largest source of pollution in the county. Mendocino County consumes four times more gasoline than the statewide average. The study raised many questions and no specific mitigations were recommended, pending further study. In our opinion, because of the findings of transportation related pollution, EVs should be considered for any future mitigation measures.

Source: "A Study of Air Quality Conditions, Including Emissions Inventory, Ozone Formation, PM10 Generation and Mitigation Measures, for Mendocino County, California" prepared for the County of Mendocino Air Quality Management District by Sonoma Technologies, Inc., January 1999.

Transportation planning considerations:

Safety issues for electric vehicles were researched, all of which can and are being dealt with, through this project and industry wide. Traffic patterns could potentially improve, with EV drivers diverted away from congested areas to different refueling locations. Appropriate use of various EV models and types was considered in relation to traffic patterns.

Solar net metering demonstration:

Recent legislation in California and nationwide now is allowing small-scale renewable energy systems to directly interface with power grids and produce electricity locally. In utilizing renewable energy, the power production does not necessarily match the use of the vehicle, so the energy needs to be stored. Because of net metering, renewable energy produced from solar photovoltaic modules can be stored in the power grid and drawn out as needed to charge the vehicles.

Multimodal / intermodal transportation centers:

Multimodal transit center design is a key focus for future efforts. These should incorporate photovoltaic shade/shelter structures in parking designs with consideration for use of Neighborhood Electric Vehicle (NEV) station cars as demonstrated by the BART Station Project. This approach would be well suited to transit center designs currently in progress for the rehabilitation of rail depots in Mendocino County, and would enhance tourism and economic development.

Recommendations for followup or ongoing activities. As of this writing, MCOG has no specific future intent to maintain or further develop the ZEV Project. However REDI, as a nonprofit organization, is an appropriate entity to safeguard some of the ZEV Project investment of infrastructure, along with the Cities of Ukiah and Willits and other local agencies, such as Mendocino Transit Authority, County of Mendocino Air Quality Management District, and the railroads, as well as private local companies. Further funding and commitments for in-kind contributions and participation would be needed to develop the activities that were started.

Recommendations and future intent for further ZEV activities include:

- Maintenance of the two EV charging stations installed in Ukiah and Willits
- Maintenance of the solar net metering demonstration in Willits
- Input and testimony to the rewrite of Mendocino County's General Plan and MCOG's Regional Transportation Plan
- REDI's ongoing educational efforts through its library, web site, and other programs
- Funding proposals such as REDI's Phase III proposal to install more charging stations
- Multimodal transit center design with solar shaded parking designs and NEV station cars

It has been a great pleasure to lead this project. The ZEV Demonstration Project would not have been possible without the support of the MCOG and REDI Boards of Directors and State Senator Mike Thompson (now Congressman), the encouragement of my project advisors, and all those who participated. The findings clearly indicate that there are practical uses for clean air vehicles in Mendocino County's transportation scheme, to the public's benefit. I look forward to continuing our efforts together in this important work.



Janet Orth
ZEV Project Coordinator
Renewable Energy Development Institute
Willits, California

July 30, 1999

LEGAL NOTICE

This document was prepared as a result of work sponsored by the California Energy Commission. It does not necessarily represent the views of the Energy Commission, its employees, or the State of California. The Commission, the State of California, its employees, contractors, and subcontractors make no warranty, express or implied, and assume no legal liability for the information in this document; nor does any party represent that the use of this information will not infringe upon privately owned rights.

ESTIMATED EMISSIONS REDUCTIONS and PETROLEUM DISPLACEMENT
California Energy Commission formulae
1999 State Energy Plan (SEP) Grant
Mendocino Council of Governments' ZEV Demonstration Project
7/30/99

ASSUME:

EVs:

1. LDVs.
2. On gasoline, '93 GM Corsica (using ARB certified numbers)
3. 97% reduction from gasoline for NOx, CO, NMHC
4. Emission reduction factors per formula below
5. 20 mi/gal fuel economy
6. Electric Vehicle Miles Traveled 5,356

Emission reduction factors:			**Total Emissions Reduced:**
NOx (g/mi)	0.291 /454 g/lb	x 5,356 =	3.433 lb
CO (g/mi)	1.07 /454 g/lb	x 5,356 =	12.623 lb
NMHC (g/mi)	0.049 /454 g/lb	x 5,356 =	0.578 lb

Fuel economy factor:			**Total Petroleum Displaced:**
20 mi/gal	into	5,356	267.8 gallons

Thanks and Acknowledgements

MCOG and REDI extend our sincere appreciation to all those who helped make this innovative project a success. Their enthusiasm and support demonstrate a true partnership for a more livable community.

Decision Makers:

Mendocino Council of Governments (MCOG) Board of Directors
Renewable Energy Development Institute (REDI) Board of Directors
Janet Orth, ZEV Project Coordinator, MCOG/REDI
MCOG's Technical Advisory Committee

Advisors:

Keith Rutledge, President, REDI
Mary Hiatt, Owner, Hiatt Consulting Services, MCOG Staff
Phillip J. Dow, P.E., Owner, Dow & Associates, MCOG Staff
Rick Kennedy, Director of Public Works, City of Ukiah
Steve Turner, Assistant General Manager, Mendocino Transit Authority (MTA)
Walt Allen, Planner, Air Quality Management District, County of Mendocino

Technical Consultants:

William R. Warf, P.E., General Manager, Pacific Electric Vehicles, LLC
Peter W. Senkowsky, President, EVTRANSPORT

Subcontractors:

Marina Baird, Owner, Plan-It Organizing Services
Ron Moorhead, President, Glenmoor Enterprises
Gary Flo, Owner, InnEVations
John Takes, Owner, Burkhardt Turbines

EV Test Drivers:

Janet Orth, ZEV Project Coordinator, MCOG/REDI
Keith Rutledge, President, REDI
Tony Orth, Director, Brooktrails Township Community Services District
William R. Warf, P.E., General Manager, Pacific Electric Vehicles, LLC
Peter W. Senkowsky, President, EVTRANSPORT
Steve Turner, Assistant General Manager, Mendocino Transit Authority
Charles Cliburn, MCOG Chairman, Assessor, County of Mendocino
Thomas Bickell, Chief of Police, City of Fort Bragg
David Lohse, Associate Planner, City of Ukiah
Rick Kennedy, Director of Public Works, City of Ukiah
Jim Mastin, Mayor, City of Ukiah / MTA Board of Directors
Walt Allen, Planner, Air Quality Management District, County of Mendocino
Paul Williams, General Manager, Brooktrails Township Community Services District
Richard Shoemaker, MCOG Director / Supervisor, County of Mendocino
Alan Falleri, Senior Planner, County of Mendocino Planning and Building Services
Stephen Hall, Test Driver, Anderson Valley
Stephen Heckeroth, Owner, Homestead Enterprises

Car Companies:

Green Motorworks
Toyota Motor Sales, USA
Ford Motor Company and Lithia Sun Valley Ford
It's Electric!
Daimler Chrysler Corporation

Participants:

Bob Butler, MTA Maintenance Supervisor and other MTA personnel
Frank Howard, City of Willits
John Chocholack, Bob Bender, Glen Johnson, Faculty, Ukiah High School
Gary Weinkauf, Science Teacher, Pomolita Middle School, Retired
David Leverett, Phil Jergenson, Wayne Robertson, Jon Frey,
Keith Rutledge, Janet Orth, Directors of REDI
Christopher Koveleski, ZEV Research Assistant for REDI

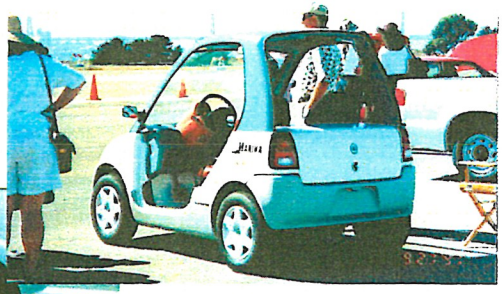
Honorable Mentions:

Mike Thompson, US Congressman, Former Senator State of California
Wayne Robertson, Sales Manager, Solar Electric Specialties
Darryl Barnes, Director of Public Utilities, City of Ukiah
Larry Deknoblough, Director of Community Services, City of Ukiah
Brian Dunlap, Manager / CEO of Redwood Empire Fair
David Colfax, Supervisor, County of Mendocino
Stanford Ovshinsky, President / CEO of Energy Conversion Devices, Inc.
Willits City Council
Sacramento Municipal Utility District
Al Beliso and Kent Harris, Pacific Gas & Electric Company

Zero Emission Vehicle (ZEV) Demonstration Project
Public Outreach



Hands-on experience was key to the ZEV Project.















ZEV Project
MCOG/REDI
Sept.. 1999

ZEV Project Funding
Phase II

A combination of Local, State, and In-Kind:

$15,000 **MCOG Local Transportation Funds**
- Overall Planning Work Program 97/98 and 98/99 (carryover)
- Local quarter-cent sales tax for regional transportation planning and public transit according to CA's Transportation Development Act

$20,000 **Petroleum Violation Escrow Account**
- Oil company fines for overcharges, by Act of Congress in 1970s
- Administered by State Legislature and CA Energy Commission
- For projects that demonstrate energy savings, conservation or efficiency
- This project funded by 2 PVEA subfunds: State Energy Plan, Exxon Settlement

$26,008 **In-Kind Contributions**
- Valuable services & materials from public & private sources to date including:

REDI staff time	Janet Orth (as unpaid volunteer)	341 logged hours	$ 8,525
" "	Keith Rutledge	50 estimated hours	$ 2,500
MCOG staff	Janet Orth (salary not paid by project)	103 logged hours	$ 3,605
MTA staff	Steve Turner, Bob Butler, others	40 min. estimated hrs.	$ 2,000
Pacific EV	Bill Warf, portion of services donated		$ 1,128
EVTransport	Peter Senkowsky, portion of services donated		$ 1,250
City of Ukiah	AB1890 Public Benefit funds and labor for EV charging station		$ 1,000
" "	Public space in city parking lot		Value Not Declared
City of Willits	Public space in city parking lot		Value Not Declared
Sacramento Municipal Utility District	Round-trip transport of EV by carrier		$ 700
Pacific Gas & Electric Company	Round-trip transport of EV by carrier		$ 700
Toyota Motor Sales	Round-trip transport of EV by carrier		$ 700
Ford Motor Company	Round-trip transport of EV by carrier		$ 700
Daimler-Chrysler Corp.	Round-trip transport of EV by carrier		$ 700
All 5 above entities	Loan of EVs		Value Not Declared
Trace Engineering	Donated inverter for solar demo, estimated cost		$ 2,500
Other local agencies:	Staff time contributed		Value Not Declared
	County of Mendocino Air Quality Management District (AQMD)		
	County of Mendocino Planning & Building Services		
	City of Ukiah		
	City of Willits		
	Brooktrails Township Community Services District		
TOTAL IN-KIND CONTRIBUTIONS			$ 26,008

$ 61,008 **Total Phase II Funding** *(not including undeclared in-kind values)*

Zero Emission Vehicle (ZEV) Demonstration Project

Contractors and Subcontractors

Project Management Services

Renewable Energy Development Institute (REDI)
PMB 234
383 S. Main Street
Willits, CA 95490

REDI, a 501(c)(3) charitable nonprofit educational and scientific corporation, provided the technical support needed to facilitate the entire ZEV Project.

Contracted: $6000 - 7-1-97 to 9-30-99

Project Consultant

William R. Warf, P.E.
Pacific Electric Vehicles, LLC
104 Mendocino Place
Ukiah, CA 95482

Pacific Electric Vehicles, LLC, acted as project consultant and technical advisor assisting in the acquisition, testing and reporting of the electric vehicles.

Contracted: $5000 - 9-10-97 to 6-30-98

Project Consultant

Peter W. Senkowsky
EVTRANSPORT
P.O. Box 1793
Glen Ellen, CA 95442

Pacific Electric Vehicles, LLC, acted as project consultant and technical advisor assisting in the acquisition, testing and reporting of the electric vehicles.

Contracted: $5000 - 10-7-98 to 9-30-98

Public Relations Consultant

Ron Moorhead
Glenmoor Enterprises
PMB 203
383 S. Main Street
Willits, CA 95490

Glenmoor Enterprises assisted with public outreach and produced project documentation.

Contracted: $1375 - 12/17/97 to 6-30-98

Project Assistant

Marina Baird
Plan-It Organizing Services
355 Warren Drive
Ukiah, CA 95482

Plan-It Organizing Services assisted in organizing project documentation and producing the final report.

Contracted: $3000 - 12/1/97 to 9-30-99

Zero Emission Vehicle (ZEV) Demonstration Project

Additional Subcontractors

Additional Technical Support

Gary Flo
InnEVations
P.O. Box 2012
Glen Ellen, CA 95442

InnEVations assisted on the acquisition of vehicles, installation of charging stations, and vehicle delivery.

Time and Materials: $250 - 1/99

Additional Technical Support

John Takes
Burkhardt Turbines
1258 N. Main St. #B2
Fort Bragg, CA 95437

Burkhart Turbines installed the Willits charging station.

Time and Materials: $500 - 3/99

Note:

According to the wishes of the MCOG Board of Directors, all seven contractors employed by the ZEV Project are local to the demonstration area.

FINAL

MENDOCINO COUNCIL OF GOVERNMENTS

TRANSPORTATION PLANNING WORK PROGRAM

FY 1998/99

June 1, 1998

Prepared by: Phillip J. Dow, P.E.
DOW & ASSOCIATES
367 N. State St., Ste 209
Ukiah, CA 95482
(707) 463-1806

TABLE OF CONTENTS

Topic	Page
Introduction	4
Funding Needs	6
Financial Summary	7
Work Element 1 - Overall Planning Process	9
Work Element 2 - ISTEA Planning	12
Work Element 3 - Five Year Transit Improvement Plan	14
Work Element 4 - Road System Traffic Safety Review	17
Work Element 5 - Route 101 Corridor Traffic Model	18
Work Element 6 - Special Studies	20
Work Element 7 - SB 45 Implementation	21
Work Element 8 - Intersection Traffic Delay Studies/City of Ukiah	23
Work Element 9 - Willits Downtown Specific Plan	24
Work Element 10 - Corridor Study - North State Street	26
Work Element 11 - State Route 1 Traffic Impact Fee Ordinance/Carryover *(formerly WE 8, 1997/98 Work Program)*	27
Work Element 12 - Revise Circulation Element/General Plan Ph. 1/Carryover *(formerly WE 10, 1997/98 Work Program)*	29
Work Element 13 - Zero Emission Vehicle (ZEV) Demonstration Project/ Phase II/Carryover *(formerly WE 13, 1997/98 Work Program)*	32
Work Element 14 - Willits Bicycle & Pedestrian Specific Plan/Carryover *(formerly WE 15, 1997/98 Work Program)*	34
Work Element 15 - CLUP/General Plan Consistency/Carryover *(formerly WE 17, 1997/98 Work Program)*	36
Work Element 16 - MTA Operations Database Update	37

TABLE OF CONTENTS -CONT.

Topic	Page
Work Element 17 - MTA Transit Professional Training	39
1998/99 Work Program Schedule	40
Appendix	41
Regional Planning Priorities	42
Planning Emphasis Areas	47
Memorandum of Understanding	49

INTRODUCTION

The Mendocino Council of Governments

The Mendocino Council of Governments (MCOG), as the transportation planning agency for Mendocino County, annually adopts its Transportation Planning Work Program to identify and program transportation planning tasks for the coming fiscal year. The objectives and tasks contained within this 1998/99 Work Program are developed in accordance with the goals and policies of MCOG's Regional Transportation Plan (1996 Update, adopted October 7, 1996).

MCOG is a Joint Powers Agency comprised of the unincorporated County of Mendocino (1994 Department of Finance estimates population of 57,988), and the incorporated cities of Fort Bragg (6,274), Point Arena (409), Ukiah (15,030), and Willits (5,104). As the Regional Transportation Planning Agency, MCOG is responsible for the preparation of the Regional Transportation Plan for Mendocino County.

The MCOG Board of Directors is comprised of two members of the County Board of Supervisors, one representative from each of the four cities, and one County-wide elected official. With the addition of a representative of the Caltrans District 01 Director, the MCOG Board becomes the Policy Advisory Committee.

Advising the MCOG Board of Directors on technical matters is the Technical Advisory Committee (TAC). This committee consists of representatives of planning and public works staff of each of the Joint powers entities, an MTA representative, an Air Quality representative, and Caltrans. The TAC is intensely involved in the coordination and review of the Regional Transportation Plan. Development of the Transportation Planning Work Program is also a major responsibility.

In 1986, the MCOG Board of Directors adopted a new method to provide citizen participation in the transportation planning process. Formal press releases will be used to disseminate information on issues before MCOG and encourage attendance at scheduled MCOG meetings. Additionally, all those citizens currently on the agenda mailing list will be notified in writing of issues to which public input is sought.

MCOG is now in compliance with requirements imposed by Senate Bill 498 (1987). A Social Services Transportation Advisory Council has been established to advise MCOG on the transportation needs of the elderly, handicapped, and economically disadvantaged. It also has statutory responsibilities to advise the transportation planning agency on any other major transit needs and recommending new service and service changes to meet those needs.

WORK ELEMENT (13) **ZERO EMISSION VEHICLE (ZEV) DEMONSTRATION PROJECT, PHASE II/CARRYOVER**
(formerly Work Element 13, 1997/98 Work Program)

PURPOSE: The purpose of this project is to generate a report of findings related to local use of one or more ZEVs (and/or Low Emission Vehicles), specifically in the rural setting of Mendocino County. The project will initiate informed electric vehicle/alternate fuel infrastructure planning efforts by providing hands-on experience for local government agency and planning personnel. This project will participate in statewide clean-air strategies.

PREVIOUS WORK: Phase I of this project was funded in the 1996/97 Work Program.

TASKS:

1. Install vehicle charging/fueling stations.
2. Acquire vehicles (lease and/or borrow).
3. Set up instrumentation for data collection.
4. Test vehicles.
5. Train/orient drivers in MCOG member governments.
6. Schedule shared vehicle use.
7. Conduct Ride & Drives.
8. Install photovoltaic net-metering demonstration.
9. Document and present findings.

PRODUCTS:

1. Report on rural ZEV/LEV trial performances with terrain/climate effects and driver experience/evaluations.
2. Forecast of power/fueling requirements with summary of standards and safety issues.
3. Data for ZEV/LEV air quality and transportation elements to County General Plan.
4. Photovoltaic Net Metering demonstration/report.

REGIONAL PRIORITIES: This project will **Create Effective Partnerships**; and utilize **New Technology**.

ADVANCED VEHICLE PROGRAM WHITE PAPER

Project Title: Zero Emission Vehicle (ZEV) Demonstration Project, Phase III - Infrastructure, Electric Vehicle Charging Stations

Key Contact:

Janet Orth, Director
Renewable Energy Development Institute (REDI)
(707) 459-1256
(707) 459-0366 fax
redi@saber.net

Business hours - contact Janet at (707) 463-4470

2 pages attached, total 3 pages with cover

Project Executive Summary. The ZEV Project, currently in progress, is a work element in Mendocino Council of Governments' (MCOG) Overall Work Program, in MCOG's role as the Regional Transportation Planning Agency. The project is being conducted by the nonprofit Renewable Energy Development Institute (REDI) as a subcontractor. The purpose is to test the feasibility of commercially produced electric cars in our rural environment. Using vehicles leased or borrowed, various public officials and community leaders are commuting and conducting everyday activities using the electric test vehicles. The primary concerns of the project are to demonstrate the actual operating range achievable by the average person in our rural environment and identify public infrastructure needed to support electric vehicles (i.e. charging station locations). This project will continue for the 1998/99 fiscal year. Early results of the ZEV Project - Phase II show that an electric car (such as the General Motors EV1, Toyota RAV4-EV and Ford Ranger EV that have been tested as part of the project) is useful for town and commute use in Mendocino County and has been well received by the participants. The vehicle was limited by lack of public EV charging locations. Additional charging infrastructure would extend the car's utility by augmenting charging units that may be already available in the home or workplace with locations in public places.

Public benefits of electric vehicle use have been well documented elsewhere, including air quality health benefits, prevention of petroleum pollution, energy efficiency and conservation, reduction of dependence on foreign oil, reduction of greenhouse gases, and potential fuel cost savings for consumers. This project would also assist other local projects such as Mendocino Transit Authority's Electric Vehicle Dial-A-Ride and Paratransit Electric Vehicle Conversion transit proposals, and REDI's Ultralight Electric Rail Commuter Van proposal. It would provide performance data for others pursuing similar goals in rural areas worldwide.

This project would advance commercialization by investigating the most favorable locations for public EV charging stations in the county and installing appropriate infrastructure, including local government properties, intermodal transportation centers such as rail and transit stops, park & ride facilities, shopping centers, and gasoline stations. The project would develop and construct EV charging stations that demonstrate use of solar photovoltaic systems, "net metering" on the utility grid, and compatible equipment for various vehicles serving both new commercially produced cars and various EV conversions.

This project has received funding and support because it is a rural study and therefore different from work done to date with electric vehicle technology, which so far has been focused on urban areas with problems of air quality nonattainment status. Our project deals with pollution prevention in a relatively pristine environment. It also deals with the challenges of more rugged and mountainous terrain , a somewhat colder climate, and remote locations.

Technical Advancement. A barrier to more widespread use of electric cars is the relative lack of standardization of infrastructure. This project would provide facilities that would be compatible with most electric vehicles on the market, whether inductive or conductive; any EV should be able to plug in, currently not always the case. It would enable communities to become "EV ready."

AVP Objectives. See benefits noted above. Objectives of this project are consistent with California's State Energy Plan, state and federal Clean Air Acts, and sustainable development plans of the Clinton/Gore Administration.

Business Case. EV technology is being promoted statewide because of California's ZEV mandate. We believe the technology can become successful if assistance is provided to make a transition to EV infrastructure. Shopping centers are interested in participating because EV drivers will plug in to recharge and will patronize shopping and dining establishments while they wait. Our plan involves soliciting business sponsorships as an inkind contribution to the funding of this project. Rural areas such as ours, California's North Coast, will have popular support for several reasons: 1) local gasoline prices are very high, 2) EV infrastructure is a cheaper investment that other alternatives such as compressed natural gas facilities which require high volume to be cost effective, and 3) there is a high local interest in environmental preservation.

Statement of Work Overview
Tasks: 1) Solicit contractors and inkind contributions, 2) Identify EV charging station locations, 3) Install EV charging stations, 4) Create publicity and signage, 5) Produce a report.
Deliverables: Up to 25 EV charging stations throughout Mendocino County and a report on equipment specifications, performance data and public response.
Project Schedule: Up to 24 months (details to be determined).
Obstacles/Risks: Should be minimal, as similar efforts are going on elsewhere, regional coalitions are available to share information, and the technology has been tested. The ZEV Project Phase I and II work will help gain support for Phase III.

Statement of Qualifications. REDI is a charitable nonprofit 501c3 educational and scientific corporation, focusing on renewable energy and clean air transportation since 1989 (incorporated in 1993). REDI has produced its Solar Energy Expo & Rally (SEER) four times, with 200 exhibitors, 100 speakers, and 10,000 attendees. The REDI Conference in 1993 and 1995 brought together participants from the solar industry, state agencies, utility companies, and academia to forge consensus on emerging issues such as utility restructuring. Funded projects include OHM Loans (Off-Grid Home Mortgage Loans - a nationwide directory of solar energy financing and lenders), the Zero Emission Vehicle Project, and the Noyo Harbor Ranch energy education center. The Board of Directors consists of six members, each of whom have been involved in the solar industry and environmental issues for ten to twenty years. Janet Orth, ZEV Project Coordinator, volunteers for REDI and works as staff to the Mendocino Council of Governments, the Regional Transportation Planning Agency. Further information is available on request.

Cost Summary
$100,000 Total; $50,000 AVP funds requested; $50,000 In-kind contributions estimated as follows: $7,500 REDI project management partially donated
$10,000 business sponsorships of charging stations
$7,500 donated solar equipment
$25,000 from other grants to be applied for

Charging Stations

Zero Emission Vehicle (ZEV) Demonstration Project
Charging Stations – Fort Bragg

The City of Fort Bragg was an early leader in public EV charging, with a multiple-plug configuration at a centrally located city parking lot.





This port can charge several EVs simultaneously.

Photos by Janet Orth



Zero Emission Vehicle (ZEV) Demonstration Project
Charging Stations - Ukiah



The Ranger EV gets a charge from one of the many outlets at the Redwood Empire Fairgrounds.

The charging station shown below was the first of two installed by the ZEV Project, located in the city's downtown public parking lot.









A plywood box was constructed as a temporary shelter for the EV 1's Magnecharger. This corner space across from the Post Office has been reserved for "Electric Vehicles Only."

ZEV Project
MCOG/REDI
Sept.. 1999

Photos by Janet Orth

Zero Emission Vehicle (ZEV) Demonstration Project
Charging Stations – Willits



This charging station is centrally located in downtown Willits between the City Hall / Community Center and the Justice Center / Police Department.





Tony Orth plugs in the Solectria Force. This port has various outlets to accommodate different EV models.







Normally mounted in a garage, this charger was carried in the rear of the EPIC for purposes of this test. This "smart box," with voice read-out of charge status, is situated between the power source and the vehicle.

Photos by Janet Orth

ZEV Project Final Report

Phase II, Task 1 - Infrastructure / EV Charging Stations

By Janet Orth with Keith Rutledge, REDI Directors

Questions from Phase I Report, Task 4
Recommendations for Phase II Report

1. "How many charging stations are required?"

An analysis was made of the strategic locations for EV charging stations in Mendocion County along the major transportation corridors. Spacing between population centers was considered, along with the range or mileage capabilities and duty cycle of the electric vehicles tested. Six to eight public charging stations are recommended, and even more could be phased in as appropriate, similar in concept to the call box system on state highways. *(See map attached)*

Pre-existing charging stations. The City of **Fort Bragg** was an early leader in public EV charging, with a multiple-plug configuration at a centrally located city parking lot, serving the northern part of the coast. Charging stations also are available at Real Goods Institute for Solar Living in **Hopland**. (Note that open hours are limited.) This is the most southerly inland station, providing a link closer to Sonoma County.

Installed by the ZEV Project. Two were installed by the ZEV Project. The first is at the City of **Ukiah**'s downtown public parking lot, on the street corner across from the Post Office and the Savings Bank of Mendocino County, served by the City's municipal electric utility. The second is at **Willits** City Hall and Community Center, in the parking lot next to the Justice Center and Police Department. Both sites were provided as in-kind contributions by city government for purposes of the ZEV Project; Ukiah also donated $1,000 toward installation costs from their public benefit utility charges fund. These two public stations facilitate inland commutes, and between inland and coastal Mendocino County when combined with the existing Fort Bragg public charging station.

Minimum recommended. At least two more are needed to complete the countywide loop, in Anderson Valley and the South Coast. This provides access between inland and the coast through Ukiah or Cloverdale in Sonoma County. Sites have been identified for both; an oral agreement has been made with a willing business owner in **Boonville**, and suggestions have been made for a possible site in **Point Arena**.

Additional recommended. Another link between the South and North Coasts would be helpful, such as the village of **Mendocino**. Note that the Phase I report identified a public charging station at the Environmental Center there; however, that station has since closed. **Gualala**, on the South Coast near the Sonoma County border, is another possibility. The ZEV Project's scope did not extend north of Willits on U.S. Route 101; however, a northern county loop including Laytonville and Leggett inland and Westport on the North Coast could be served with future locations in those towns and at travelers' rest areas on U.S. 101 and State Route 1.

More public EV charging stations are not required, when home and workplace charging locations are taken into account. Distances are workable with the six to eight locations identified. A total of four are currently open and operating. Also, the Redwood Empire Fair in Ukiah has many recreational vehicle (RV) plug/receptacles in place that, while not specifically designed for EVs, was found compatible with most electric vehicles and a convenient overnight charging location for a reasonable fee (*see #14*). The fairgrounds also have been used for the Solar Energy Expo & Rally, with a diverse line-up of EV entries on display and plugged in for the rally events.

ZEV Phase III proposal. More funding would be needed to complete the four remaining stations (Boonville, Point Arena, Mendocino, and Gualala). REDI has drafted an abstract for a ZEV Project, Phase III, for the purpose of installing further infrastructure (*refer to Conclusion*). Other ideas include adding charging stations, EV station cars, and solar shade structures (*see photo attached*) to plans for the two intermodal stations proposed by California Western Railroad at their historic Willits Depot and by Mendocino Transit Authority for North Coast Railroad Authority's rail station at Perkins Street in Ukiah. A Fort Bragg terminal at the appropriate location would add coastal linkage.

Future Maintenance. Another question is how to keep the existing stations up and running and continue to pay the utility costs. The Willits station includes a solar net metering installation, which offsets cost of energy use there (*see section on Solar Net Metering in this report*). The Ukiah station would need to be "adopted" via subsidies, sponsorships, business advertising, public funding, or a coin-op/debit card arrangement for user payments. The Fort Bragg station is operating independently of the ZEV Project. The Boonville business owner favors user charges and has offered to collect payments at the site. There are a variety of options to be addressed, as a third phase of the ZEV Project. Also, the best or most appropriate hardware configuration is not yet certain for additional stations, because of a changing and evolving forecast in the EV industry (*see #14*).

2. "Where will charging stations be located and how long will construction take?"

See #1 above and the attached map for locations. Construction is quick and usually can be done in a day or so. Time is needed to schedule a qualified electrician/installer and order parts. Also, an account may need to be opened with the electric utility provider. A month or two for each station should be sufficient. Work could be organized concurrently for the various sites.

3. "What are the safety issues related to charging stations?"

According to the attached excerpts of a federal study, "*There are no specific health hazards associated with the transmission and use of electricity at a fleet facility* [i.e. charging station]*...All of the safety issues associated with electricity are directly related to the transmission of electric power to the recharging station...There is no storage issue since the electrical energy is stored in the on-board batteries. The major safety concern is the exposure of personnel to electrical hazards as they work with the recharging system and connecting vehicles to that system. This is not expected to be a serious hazard because the normal design practices*

for setting up the connections involve safeguards to ensure that personnel are protected from direct exposure to electrical hazards."

4. "Are there safety issues related to the lack of appropriate charging stations?"

There are safety issues if not enough stations are available, particularly the risk of being stranded in remote areas, when challenging terrain reduces EV range.

5. "Are there any safety issues regarding the use of electric power for transportation?"

Some EV batteries contain toxic chemicals (such as lead-acid), so electric vehicles may carry some risk from crash potential, e.g. leaking of hazardous materials and corrosivity. However, the nickel-metal-hydride batteries are said to be nontoxic. There may also be some risk of burns with handling of high-temperature parts; however, major components of the EVs tested are typically sealed off from contact by the user. Also note that under the common lease arrangements, vehicles are turned back in to the manufacturer for replacement before such major parts are expected to show wear and risk failure.

Nos. 3, 4 and 5: *Refer to the attached excerpts this section relative to EV safety issues, from the U.S. Department of Transportation, Federal Transit Administration's "Clean Air Program - Summary Assessment of the Health, Environmental and System Risks of Alternative Fuel," Final Report, August 1995*

6. "Will the location of charging stations affect traffic patterns?"

The numbers of EVs will be negligible for the foreseeable future, according to the amended ZEV rollout schedule in California. Even though numbers will be few, however, it takes only one EV to create the need for infrastructure. Choice of locations for charging stations is crucial, and should be in central, high-use areas, such as multimodal transit stations. This is key to the success of a Phase III - Infrastructure plan. EV charging stations are fundamentally different from gasoline stations with their fast turnaround time, in that longer term parking is needed to accomodate the charge cycles. Therefore charging stations should be located where EV drivers want and need to spend time, or to link to another transportation mode and leave the EV behind to recharge. With customers diverted from gasoline stations located in congested areas to EV charging stations at home, at work, and in public places, the potential is there for traffic patterns to improve.

Another traffic consideration is appropriate use of various EV models. While recent advances in electric vehicle technology as the industry matures has given the new generation of production EVs the same or better acceleration characteristics as gas cars, some EVs are better applied to certain types of streets and roads. For instance, the Solectria Force tested was not well suited to freeway driving, as its optimum speed is 45 mph, and could go only 35 mph up the steep Ridgewood Grade of U.S. Route 101.

7. "What is the affect of charging on the peak electric power demand?"

Most EV commuters will have the choice of recharging at the home end of a round trip from home to work, or at the workplace end of the same trip. Primarily the commuter's choice for charging up will be overnight at home. In that case, the EV user can take advantage of off-peak rates, an important fuel cost consideration. (The ZEV Project found that cost of electricity for EVs is highly variable depending upon utility rates.) EV charging during off-peak hours can be beneficial to utilities by taking advantage of excess capacity and improving efficiency of the system.

Charging during peak demand hours, when rates and electricity usage are highest, should be needed only for convenience, "topping off" for extra range, or for fleet applications such as public transit.

8. "How will City and County facilities be affected?"

Willits has a new asset as a result of the ZEV Project, the public EV charging station with solar net metering demonstration at the City-provided space in the community center parking lot. The solar and EV meters are tied to the City of Willits account with Pacific Gas & Electric Company, so the City could possibly benefit if solar energy production exceeds EV energy use on the same account. Otherwise the options would include subsidizing the cost or charging users for EV energy. (*See also #1*)

Similarly, the ZEV Project installed a public EV charging station in Ukiah, at the downtown City parking space provided by the City and reserved for EV use. The City of Ukiah, a municipal electric utility, helped defray the cost with a contribution of $1,000 in public benefit charges and installation labor. The City loses coin meter income on the parking space. However, there are opportunities for the City, such as promoting the EV charging station with nearby visitor facilities (e.g. the School Street conference center) and increasing utility business with EV drivers.

Opportunities with multimodal or intermodal transit centers are significant, as mass transit on bus and rail get people to a station destination, but once there individual options are limited. Neighborhood electric vehicles (NEVs), i.e. EV station cars, could play a key role in providing individuals with increased linkage and flexibility, thereby increasing potential for local economic development such as shopping and tourism.

9. "How will distribution of gas be affected?"

There will be very little impact locally for the next several years. Refer to California's ZEV Mandate rollout schedule, with EVs gradually being deployed now, and hybrids and fuel cells as early as four years from now. Rural areas are not target markets and may take longer to integrate EVs. The impact on gasoline distribution would be a reduction of the current dependence on finite fossil fuels.

10. "Is the battery distribution and recycling infrastructure in place in the county?"

With the new generation of Original Equipment Manufacturers' (OEM) electric vehicles tested by the ZEV Project, from the major auto makers, batteries are dealt with by the EV dealerships, through leases designed to take the responsibility for replacement of major EV parts out of the hands of EV users and give it back to the manufacturer. In this way, the industry supports the users, and battery disposal and recycling is properly handled by licensed centers.

11. "What budget is needed to accomodate changes in transportation-related infrastructure and distribution of energy and energy storage?"

To answer this question would require a plan outside the scope of ZEV Project, Phase II.

12. "Will NEV (neighborhood EV) usage affect traffic patterns?"
13. "Will special routes for NEVs be needed?"

Should NEVs be incorporated into transit designs, special provisions can and have been made. Such plans are outside the scope of this project, which is focused on evaluating commercial and fleet type vehicles. Note references throughout this report to multimodal/ intermodal transit centers with NEV or "station car" design and usage.

Additional Question:
#14. "What is the industry forecast for EV charging infrastructure?"

The major auto manufacturers are choosing sides towards inductive vs conductive infrastructure types, as the industry, along with a statewide public-private task force, begins to standardize products. The situation is somewhat comparable to Beta vs VHS video formats, or Macintosh vs Windows computer operating systems. *(Refer to EVAA's NAEVI98 Conference)*

Note that the ZEV Project installed infrastructure based on current specifications for existing vehicles driven locally (*see chart attached*), designed for maximum flexibility. Also, the ZEV Project found that the vehicles tested all worked well with readily available and affordable electrical equipment designed for recreational vehicles (RVs)--see attached specifications for Ford Ranger EV infrastructure, which was found RV compatible.

Attachments:

Map of Public EV Charging Stations in Mendocino County

Specifications of EV Charging Stations Installed by the ZEV Project

Ford Ranger EV product literature
"Example of Recreational Vehicle Compatible Plug/Receptacle"
(title refers to ZEV Project's example)

"Preparing California for ZEVs" by California Air Resources Board, July 1997

Excerpts relative to EV safety issues, from the U.S. Department of Transportation, Federal Transit Administration's "Clean Air Program - Summary Assessment of the Health, Environmental and System Risks of Alternative Fuel," Final Report, August 1995

(*See Conclusion*) - "Zero Emission Vehicle (ZEV) Demonstration Project, Phase III - Infrastructure, Electric Vehicle Charging Stations," Advanced Vehicle Program White Paper by Janet Orth, REDI, submitted to CALSTART December 1998 for joint project funding by U.S. Department of Transportation (DOT as lead agency) and the Defense Advanced Research Projects Agency (DARPA)

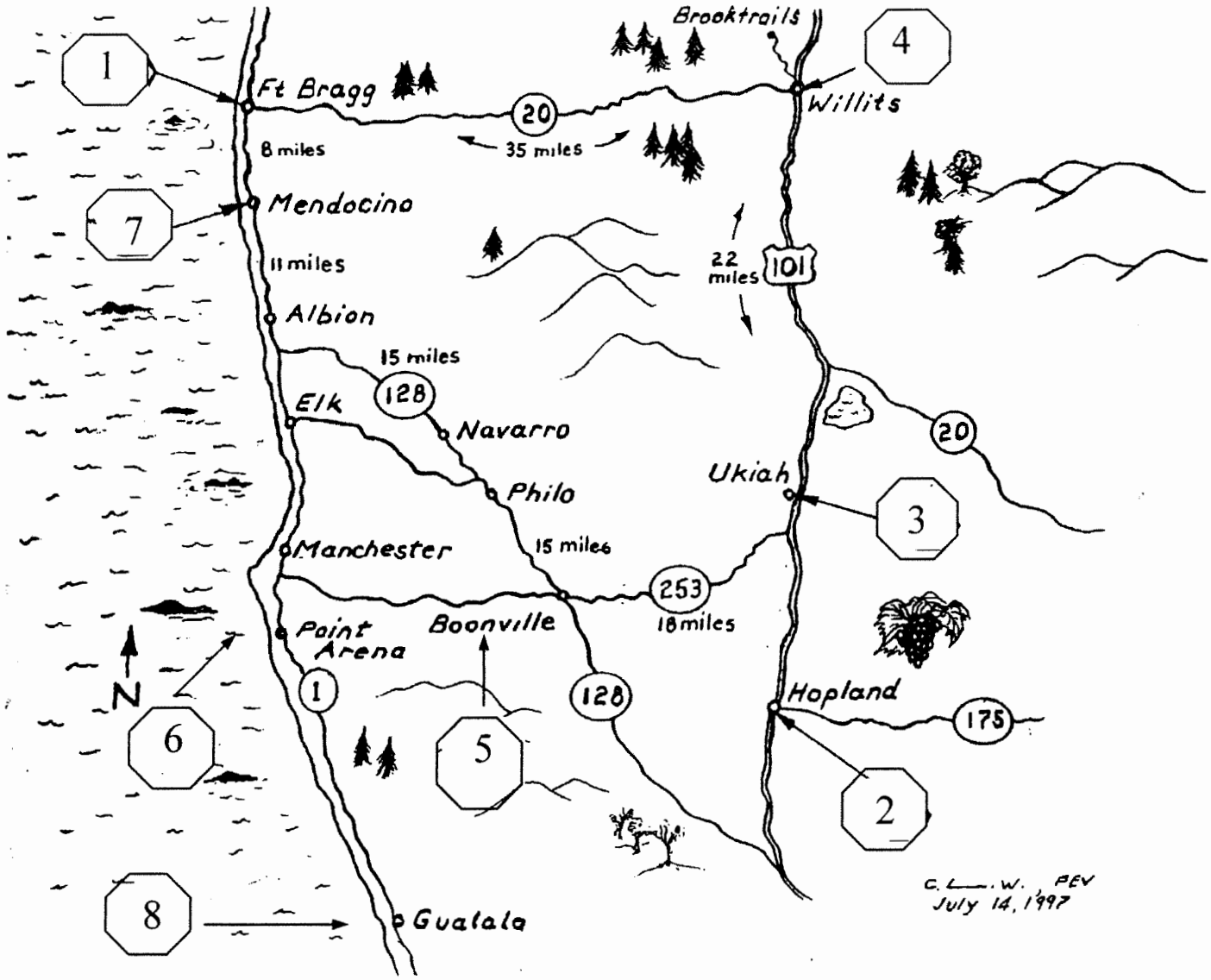
(*See later section*) - "Solar Net Metering Demonstration"

Photo of solar shade structure

For More Information:

Electric Vehicle Association of the Americas (EVAA)
www.evaa.org
NAEVI 98 Conference (*see Appendix*)

U.S. Dept. of Energy publication Alternative Fuel News article
"Remembering the Oil Embargo...and Preparing for the Next Storm," December 1998,
and monthly issues available from the National Alternative Fuels and Clean Cities Hotline at 800-CCITIES
www.ccities.doe.gov
www.afdc.doe.gov



Public EV Charging Stations in Mendocino County

Pre-existing:

1) Fort Bragg, at Laurel St. & Hwy 1
2) Hopland, at Real Goods on Hwy 101

Installed By ZEV Project:

3) Ukiah, at Oak and West Standley St. (Across From Post Office)
4) Willits, City Hall and Community Center at 111 E. Commercial St.

Minimum Recommended:

5) Boonville, site identified by ZEV Project on Hwy 128
6) Point Arena, possible sites identified by ZEV Project on Hwy 1

Additional Recommended:

7) Village of Mendocino, site not yet identified
8) Gualala, site not yet identified

ZEV Project
MCOG/REDI
July 1999

ZEV DEMONSTRATION PROJECT

Public EV Charging Stations in Mendocino County

Sites Operating as of 9/30/99 and Distances Between Sites

Location	Distance	Configuration	Remarks
Fort Bragg	38 miles to Willits station	100 Amp main breaker (1) 14-50R (50 amp), 240V (4) 1-15R (15 amp), 120V w/GFI (1) 5-30R (30 amp), 120V (1) 6-20R (20 amp), 120V	Combination 1893 No motorhomes, please.
Willits	25 miles to Ukiah station	60 Amp main breaker (1) 14-50R (50 amp), 240V (1) 5-30R (30 amp), 120V (1) 6-20R (20 amp), 120V w/GFI	Combination 1893 (same as FB)
Ukiah	18 miles to Hopland station	100 Amp breaker (1) 14-50R (50 amp), 240V (1) 5-30R (30 amp), 120V (1) 6-20R (20 amp), 120V w/GFI	New equipment installed 9/99 Space reserved for EVs Not locked
Hopland	23 miles to Boonville	Two stands, each with: (2) 5-15R (15 amp), 120V (1) L10-20 (20 amp), 120V (1) L14-30 (30 amp), 240V	Solar and wind power supply Open during business hours Self service
Boonville	41 miles to Mendocino 23 miles to Point Arena	None installed	Site identified
Point Arena	30 miles to Mendocino	None installed	Sites suggested
Mendocino	9 miles to Fort Bragg	None installed	Site not yet identified
Gualala	15 miles to Point Arena	None installed	Site not yet identified

Prep. by J. Orth
MCOG/REDI

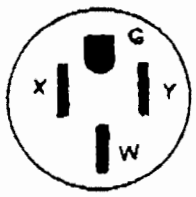
Example of Recreational Vehicle Compatible Plug/Receptacle

FORD RANGER EV
CONDUCTIVE POWER CONTROL STATION

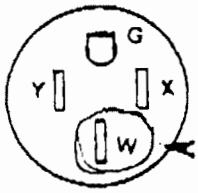
PURPOSE - This Power Control Station (PCS) is used to recharge the Ranger EV to facilitate customer visits and demonstrations. This station is equipped for temporary installation. It has an extension cord and NEMA 14-50 plug for connection to a provided electrical service The intent of this document is to define the single phase service needed to operate the PCS correctly and safely The service should be installed by the customer or event sponsor prior to the arrival of the Ranger EV at the site.



POWER CONTROL STATION



14-50P



14-50R

NEMA 14-50
PLUG/RECEPTACLE

Neutral Not Reqd.

SINGLE PHASE SUPPLY CIRCUIT (any one of the following choices is acceptable):

- 208V 3 phase Y-connected, any 2 phases, ~~plus neutral~~ and ground
- 208V 3 phase Delta-connected, with center-tap on one leg; the circuit must use only two phases on either side of the center tap. The two phases must both measure 120V to neutral. **Note:** On either of the 3 phase connections described above, the neutral must be connected to Safety Ground somewhere in the system.
- 240V single phase L1, L2, ~~neutral~~ and ground

NOTES:

1. For the 240V circuit, ensure that a neutral circuit is installed from the transformer to the sub-panel. This circuit provides the Safety Ground that is required by and verified by the PCS. The unit will not operate if this circuit is not in place.
2. The supply circuit cannot be equipped with a ground fault detector, since it will conflict with the GFCI already provided on the PCS . The unit will not operate with two GFCIs on the same circuit.

CIRCUIT PROTECTION - The supply circuit must be protected with a 2 pole circuit breaker, rated: 30 amps minimum, to 60 amps maximum. The L1/L2 wiring to the 14-50 receptacle must be connected to the load side of the circuit breaker. The L1/L2 poles shall both open in case of overcurrent.

PREPARING CALIFORNIA FOR ZEVs

This Page Last Updated July 10, 1997

Under the Memoranda of Agreement with major automakers, ARB is committed to developing ZEV infrastructure and removing purchase impediments to ZEVs. What does this mean? We need to make it just as easy for someone to purchase or lease a ZEV as a conventional car. This involves addressing many items.

- First, electric vehicles will be primarily charged at home. Home chargers need to be installed by electrical contractors expediently and safely. Contractors must be informed of the rules and procedures to follow and the importance of quick installation.

- Electric vehicle users may require options to charge away-from-home, such as their workplaces. We refer to this as convenience charging; the need for and amount of convenience charging sites throughout the state must be assessed.

- ZEV buyers will need to register their vehicles at various DMV offices across the state just as conventional vehicle owners. These offices will require preparation for the timely registration of ZEVs.

- ZEVs will require servicing and maintenance, although less frequently than gasoline vehicles. Training should be made available for auto technicians to respond to ZEV customer needs.

- Similar to other vehicles, ZEVs will be involved in roadway accidents. Although electric vehicles have been shown to be inherently safer than internal combustion engine vehicles, differences exist. Emergency responders who are first on the scene, such as firemen and policemen, must be prepared for incidents involving electric vehicles.

- With the development of a variety of battery types for electric vehicles, we must ensure that the means for proper disposal of batteries through recycling facilities is established.

- Purchasing or leasing ZEVs within state and local government fleets must be an easy and straightforward process, so that government can set an environmentally-conscious example for private purchasers.

- For those who wish to purchase or lease a ZEV, appropriate risk assessments for financing these technologically innovative vehicles must be developed.

- ZEVs will require insurance just as other vehicles, and promoting industry awareness of ZEVs can help ensure appropriate rate assessments.

- While we expect that most ZEVs offered for sale will meet the specifications described by their sponsors, it is important that critical ZEV features are not misrepresented to potential customers in this new market. Consumer protection efforts would ensure the availability of consistent information on various types of ZEV technology.

- Market incentives for ZEVs can enhance their near-term marketability. We are committed to supporting the development of reasonable ZEV incentives.

- Finally, greater public awareness of ZEV benefits is needed in order for consumers to be fully aware of their choices for clean transportation and to secure a growing demand for ZEVs over the long-term.

Preparing the market for ZEVs involves major tasks that require the input and assistance of a variety of parties. This is why we have established a ZEV Implementation Advisory Committee, consisting of public and private sector representatives from key stakeholder groups, including auto manufacturers, auto dealers, electric utilities, environmental groups, vehicle users, and state and local government. We believe that public/ private partnerships are key to developing the ZEV market. Below are some examples of successful public/private partnerships.

Building Code Modifications

ARB collaborated with stakeholders from state government, the automotive industry, and the electric utility industry to develop statewide emergency building code language to assure the safe installation and operation of electric vehicle charging equipment. As a result of this project, led by the California Energy Commission, the modifications went into effect in August 1996. Training of local building code inspectors regarding the new code began in March 1996 and will continue on an on-going basis.

Emergency Response Training

ARB partnered with the State Fire Marshal's Office, other state agencies, local governments, emergency response industry organizations, auto manufacturers, utilities, and battery manufacturers to develop a training program for emergency responders, including fire and law enforcement officials, for accidents involving electric vehicles. Input from the auto and EV battery industry ensures we have the most up-to-date technical information while input from emergency response personnel ensures that we are responsive to their concerns. Training began in Spring 1997 and will continue as needed throughout the State.

ZEV Leases to State and Local Government Fleets

ARB has teamed up with the California Department of General Services to facilitate electric vehicle leases within state and local government fleets. Since ZEVs have unique characteristics, are currently offered in a limited number of models at select dealerships, and in some cases are only available for lease, existing state and local government vehicle procurement systems do not accommodate them well. In order to streamline the process for a state or local agency to lease a ZEV of their choice, ARB is assisting the Department of General Services in working individually with major automakers to adopt lease terms for their ZEV(s) to which any state or local government agency can subscribe. The goal is for these "master lease agreements" to be made available to state and local government fleets shortly after each ZEV is offered for lease in California.

DOT-FTA-MA-90-7007-95-1
DOT-VNTSC-FTA-95-5

U.S. Department
of Transportation
**Federal Transit
Administration**

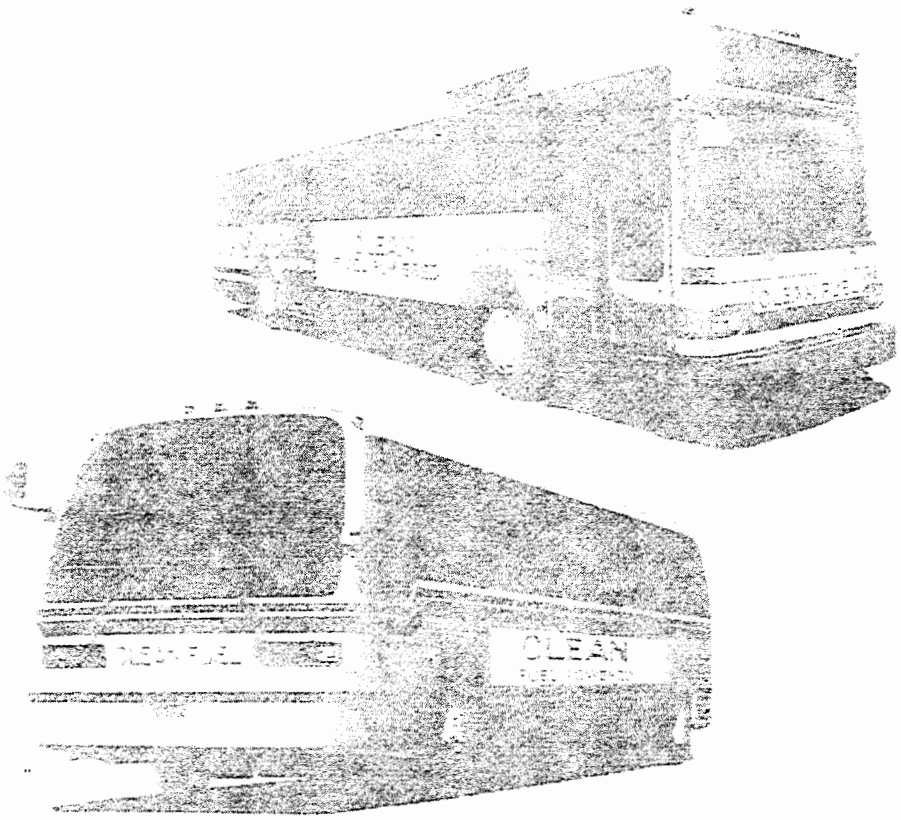
U.S. Department
of Energy

Clean Air Program

Summary Assessment of the Safety, Health, Environmental and System Risks of Alternative Fuel

U. S. Department of Transportation
Research and Special Programs Administration
John A. Volpe National Transportation Systems Center
Cambridge, MA 02142-1093

August 1995
Final Report



FEDERAL TRANSIT ADMINISTRATION

PREFACE

National goals for both energy security and clean air have resulted in heightened interest in the use of alternative motor fuels (AMFs) in the transportation market. The growth of interest in alternative fuels has expanded not only the numbers of alternative fuel vehicles, but also the list of viable alternative transportation fuels.

Thus, an increasing number of transit fleets and other fleet owners are operating vehicles on alternative fuels — often with a minimum of technical guidance related to the possible safety or operational impacts on traditional fleet operations, including fueling, inspecting, and cleaning vehicles, as well as performing the light and heavy maintenance activities necessary to keep the fleet in operation.

Moreover, the buildings or facilities used for storing, loading, and maintaining alternative fuel vehicles form an important portion of a fleet operation. Here, the experience with fire and building codes is not yet complete. This situation requires additional care on the part of the owners of these facilities to recognize all hazards associated with the use of alternative fuel vehicles and to ensure that these hazards are properly addressed in the design and operation of the facility.

Experience has shown that not all local community and regulatory groups view the use of alternative fuels as a purely positive option. Transit properties and others who propose the use of alternative fuels need to deal not only with the perceptions of fire and building code officials who grant approvals, but also with the perceptions and concerns of community and neighborhood organizations. The concerns of these groups are not limited to fleet operations, but may also include the production of the alternative fuel and the transportation of the fuel to the point of use.

In view of the diversity of these safety concerns, as well as the number of possible hazards, a comprehensive and systematic program is needed to recognize and organize the existing knowledge about the health, safety, and environmental hazards of alternative fuels and to identify where additional study is needed. The objective of this report is assist the Volpe Center, FTA and DOE in providing information on these issues to the transit and fleet operator community while avoiding a commitment to or bias against any given fuel or point of view.

This report presents the results of a research effort undertaken for the Volpe National Transportation Systems Center. This work was funded jointly by the U.S. Department of Transportation, Federal Transit Administration Office of Engineering and the U.S. Department of Energy, Alternative Fuels Utilization and Analysis Division. The interest, insight and advice of David Knapton of the Volpe National Transportation Systems Center, John Russell of the U.S. Department of Energy, and Tony Yen and Steven Sill of the Federal Transit Administration are gratefully acknowledged.

1.2 OBJECTIVES AND SCOPE

This study is intended to provide a systematic assessment of the safety hazards of AMFs from a fleet operations perspective. It is narrowly focused on the hazards associated with moving the fuel from the point of production to the point of use (bulk transport), the process of transferring the fuel from the transport vehicle, and on-site storage at the fleet operator's facility. The types of hazards that may be encountered during bulk transport, transfer, and storage generation have been categorized as follows:

- Safety Issues
  - Fire Hazards
  - Other Hazards
- Health Issues
  - Fuel Toxicity - inhalation/skin exposure
- Environmental Issues
  - Effects of spills

Six candidate fleet motor fuels received primary consideration during the assessment process. These fuels and the automotive engines that are specifically designed to use the fuel have been the subject of extensive research and development. The fuels are:

- Compressed Natural Gas (CNG)
- Liquefied Natural Gas (LNG)
- Propane
- Methanol and Methanol Blends (M-85, etc.)
- Ethanol and Ethanol Blends (E-85, etc.)
- Biodiesel
- Hydrogen
- Electricity

Hydrogen-fueled vehicles, including those using a fuel cell-electric drive, are just being introduced into actual operations on a prototype/demonstration basis. Battery-powered vehicles have received increased attention in recent years, including a number of applications involving battery electric transit buses.

The overall objective of this report is to organize, analyze, and present existing information about the potential hazards of the AMFs selected for this study. The specific focus is on the hazards associated with potential leaks and spills of the AMFs in the bulk transport, unloading, fleet storage processes, and fleet operations.

It should be noted that all of the potential hazards considered in this report are "acute" hazards, i.e., immediate- or short-term hazards. Long-term ("chronic") hazards have not been addressed.

3.3.7.3 Health Issues

Hydrogen is not considered to be toxic. However, it is a simple asphyxiant which is a health risk because it can displace oxygen in a closed environment.

3.3.7.4 Environmental Issues

There are no significant environmental hazards associated with the accidental discharge of LH_2.

3.3.8 Electricity

3.3.8.1 General Description

Electricity can be considered as an AMF based on the use of electrically powered fleet vehicles using batteries as the energy storage medium. Most fleet applications currently considered involve vehicle tours that are relatively short and low speed, e.g., shuttle service, due to the limited range (less than 100 miles) and power of battery electric-powered vehicles. Typical battery recharging times are on the order of 6 to 8 hours requiring that fleet vehicles be recharged overnight. The current research focus for electric propulsion vehicles is in the area of battery development where the goal is to develop batteries that have low initial cost, high specific energy (Wh/kg), and high power density.

The bulk transport of electricity via the electric power distribution system is a fundamental part of the nation's infrastructure. The hazards associated with high voltage power lines, substation transformers, and local power distribution systems are well known. The National Electrical Code developed under the auspices of the NFPA covers the safety and protection measures associated with the provision of electrical service to the facilities.

3.3.8.2 Safety Issues

All of the safety issues associated with electricity are directly related to the transmission of electric power to the recharging station at the fleet facility. There is no storage issue since the electrical energy is stored in the on-board batteries.

The major safety concern is the exposure of personnel to electrical hazards as they work with the recharging system and connecting the vehicles to that system. This is not expected to be a serious safety hazard because the normal design practices for setting up the connections involve safeguards to ensure that personnel are protected from direct exposure to electrical hazards.

One of the safety advantages of electricity compared to the other AMFs is that all facility personnel are generally familiar with the hazards associated with electrical power. Therefore,

personnel working with the recharging system can be expected to be aware of the dangers and follow the proper safety procedures.

3.3.8.3 Health Issues

There are no specific health hazards associated with the transmission and use of electricity at a fleet facility.

3.3.8.4 Environmental Issues

There are no specific environmental hazards associated with the transmission and use of electricity at a fleet facility.

3.4 ASSESSMENT OF ALTERNATIVE FUEL – BULK TRANSPORT, TRANSFER, AND FLEET STORAGE SAFETY RISKS

3.4.1 Introduction

The previous section provided a detailed discussion of the safety, health, and environmental issues associated with the bulk transport, unloading and transfer, and fleet storage issues associated with each individual AMF. In this section, the individual issues are combined with the intent of conducting a summary assessment. This assessment is divided into two parts:

- An assessment of the relative potential for AMF leakage or spills during bulk transport and storage operations; and
- An assessment of the consequences of a fuel spill or leak in the context of safety, health, and environmental risks.

In the absence of reliable statistical data on accidental releases of the various AMFs during bulk transport and storage, the following assessments are largely subjective. However, there are a number of physical and engineering principles that have been used as a guide in this assessment. Briefly, they are as follows.

1. The standard for assessment is based on both diesel and gasoline. These fuels are transported, handled, and stored at ambient temperatures and pressures and they are stable during long term storage.

2. The risk of a leak or spill increases as the transport and storage pressure of the AMF increases. Even with systems designed for high pressures, human errors, manufacturing defects, and material weaknesses are bound to take their toll.

TABLE 4-7(H). HYDROGEN -- ELECTRICAL ENERGY

Hazard -- Event	Background	Consequences	Knowledge
None -- no significant hazards identified.	Hydrogen fuel does not involve stored electrical energy and does not present a significant electrical hazard.	--	--

TABLE 4-8(A). ELECTRICITY -- FLAMMABILITY

Hazard -- Event	Background	Consequences	Knowledge
Fire -- due to electrical short or overload.	Currently, most fires on heavy duty fleet vehicles originate as electrical fires. Electric vehicles will have a much greater power capability and hence a greater potential hazard.	A fire can result in damage to or loss of the vehicle as well as injury to the occupants.	Recently (June 1994) two Ford Ecostar electric vehicles experienced electrical fires during battery charging.
Fire -- due to electrical component failure.	Currently, most fires on heavy duty fleet vehicles originate as electrical fires. Electric vehicles will have a much greater power capability and hence a greater potential hazard.	A fire can result in damage to or loss of the vehicle as well as injury to the occupants.	Several experimental electric vehicles have suffered electrical fires, including most recently the Ford Ecostar.
Fire -- due to contact with hot electrolyte.	Some battery systems use very hot electrolytes. Since the autoignition temperature of hydrocarbons can be as low as 220°C, contact with heat from the battery could lead to a vehicle fire.	A fire can result in damage to or loss of the vehicle as well as injury to the occupants.	Both the electrolyte temperature and the ignition temperatures of other materials are reasonably well-known. The major uncertainty is the ability to isolate the high temperature in all types of normal operation and during traffic accidents.

TABLE 4-8(B). ELECTRICITY -- CORROSIVITY

Hazard – Event	Background	Consequences	Knowledge
Corrosion – from battery electrolyte.	Most battery systems proposed for electric vehicles have electrolytes which are corrosive. Leakage of this electrolyte can cause damage to and/or failure of other vehicle components. A recent example from a non-electric vehicle is the failure of CNG fuel tanks from spilled electrolyte from batteries carried to start other vehicles.	The consequences can be either minor or major depending on the vehicle component affected and the importance of that component to maintaining safe operation of the vehicle.	Little data are available on the degree to which this will be a problem in actual electric vehicles.
Corrosion – from electrolysis.	Leakage current may cause electrolysis of metal vehicle components. While such electrolysis could take place with current battery-powered accessory circuits, the larger currents and higher voltages used for electric propulsion could increase the danger of electrolytic corrosion.	The consequences can be either minor or major depending on the vehicle component affected and the importance of that component to maintaining safe operation of the vehicle.	Little data are available on the degree to which this will be a problem in actual electric vehicles.

TABLE 4-8(C). ELECTRICITY -- TOXICITY

Hazard -- Event	Background	Consequences	Knowledge
Health hazard -- from contact with battery electrolyte.	Many candidate battery electrolytes are corrosive and toxic. They are potential hazardous via skin contact or inhalation of fumes or vapors.	The toxic consequences depends on the composition of the electrolyte.	The degree of knowledge depends on the material composition(s) involved.

TABLE 4-8(D). ELECTRICITY -- HIGH PRESSURE

Hazard -- Event	Background	Consequences	Knowledge
None -- no significant hazards identified.	The use of electricity does not involve high pressures and hence there is not a significant high pressure hazard associated with the use of electricity.	--	--

TABLE 4-8(E). ELECTRICITY -- HIGH TEMPERATURE

Hazard – Event	Background	Consequences	Knowledge
Burns – from contact with battery.	Some proposed battery systems operate at high temperatures. Contact with such temperatures could occur during vehicle repair and cause unexpected burns.	Any burn is a potentially serious injury.	The degree of hazard depends on the type of battery system used and on the design configuration of the vehicle.
Burns – from contact with leaking battery electrolyte after component failure.	Some proposed battery systems operate at high temperatures. Contact with such temperatures could cause burns.	Any burn is a potentially serious injury.	The degree of hazard depends on the type of battery system used and on the design configuration of the vehicle.
Burns – from contact with leaking battery electrolyte after traffic accident.	Some proposed battery systems operate at high temperatures. A damaged battery pack could leak electrolyte at high temperature. Contact with such temperatures could cause burns.	Any burn is a potentially serious injury.	The degree of hazard depends on the type of battery system used and on the design configuration of the vehicle.

TABLE 4-8(F). ELECTRICITY -- CRYOGENIC TEMPERATURE

Hazard – Event	Background	Consequences	Knowledge
None – no significant hazards identified.	The use of electricity does not involve cryogenic temperatures and hence there is not a significant cryogenic temperature hazard.	–	–

TABLE 4-8(G). ELECTRICITY -- MECHANICAL ENERGY

Hazard – Event	Background	Consequences	Knowledge
Lifting-falling hazard – from changing battery packs.	Electric vehicle battery packs are not expected to last the life of the vehicle and will need to be replaced. Such battery packs are heavy components and will require special handling.	Given the weight of battery packs, a falling battery pack could cause serious trauma.	Although engines and transmissions are heavy components which are routinely replaced, experience with such techniques may not provide much information on battery packs which are several times as heavy and which require different handling techniques.

TABLE 4-8(H). ELECTRICITY -- ELECTRICAL ENERGY

Hazard-- Event	Background	Consequences	Knowledge
Shock hazard -- from battery charger connection.	Electric vehicles are likely to employ much higher voltages than used for vehicle accessory circuits, as many as several hundred volts. Battery charger connections are subject to severe handling and abuse. Connections may need to be made to vehicles which are wet with road salt or during heavy rains.	Major electric shocks can cause death or injury. Even minor electric shocks can cause injury by causing involuntary movement.	The hazards associated with electric shock are well-known, but there is relatively little experience with the hazard from electric vehicles in everyday use.
Shock hazard -- from on-board electric supply during vehicle repair.	Electric vehicles are likely to employ much higher voltages than used for vehicle accessory circuits, as many as several hundred volts. Mechanics and others who repair vehicles will need to follow strict procedures to avoid electric shocks.	Major electric shocks can cause death or injury. Even minor electric shocks can cause injury by causing involuntary movement.	The hazards associated with electric shock are well-known: voltages less than 24 volts are not considered to present a shock hazard, while voltages greater than 50 volts are considered potentially lethal.[34] There is relatively little experience with the hazard from electric vehicles in everyday use.
Shock hazard -- from on-board electric supply due to component failure.	Electric vehicles are likely to employ much higher voltages than used for vehicle accessory circuits, as many as several hundred volts. A component failure could expose the occupants to these voltages.	Major electric shocks can cause death or injury. Even minor electric shocks can cause injury by causing involuntary movement.	The hazards associated with electric shock are well-known, but there is relatively little experience with the hazard from electric vehicles in everyday use.
Shock hazard -- from on-board electric supply after traffic accident.	Electric vehicles are likely to employ much higher voltages than used for vehicle accessory circuits, as many as several hundred volts. A damaged electrical system component could expose the occupants to these voltages.	Major electric shocks can cause death or injury. Even minor electric shocks can cause injury by causing involuntary movement.	The hazards associated with electric shock are well-known, but there is relatively little experience with the hazard from electric vehicles in everyday use.

TABLE 4-8(H). ELECTRICITY -- ELECTRICAL ENERGY (cont.)

Hazard– Event	Background	Consequences	Knowledge
Electromagnetic field damage – from electric traction equipment.	Cargo carried on-board vehicles commonly includes magnetic data processing media as well as a variety of electronic devices which may be subject to interference from electromagnetic fields arising from electric traction equipment. Because of the relatively large power involved in electric traction as well as the complex waveforms generated by traction control modules, such interference may be much more severe than from traditional vehicle electrical systems.	Damage to electronic media or interference with the operation of electronic devices.	While the principles of EMI control are well-known, it is difficult to predict whether a given device in a real-world situation will be affected by EMI.
Electric and magnetic field health effects – from electric traction equipment.	Several types of health effects have been imputed to human exposure to electric and/or magnetic fields. The main concern is possible elevated rates of cancer, though various other physiological changes are also suspected to be caused by electric and/or magnetic fields.	The suggested health effects of exposure to electromagnetic radiation are serious, especially cancers, such as leukemia. However, the cause and effect and dose response relationships are far from proven.	Much additional information is needed confirm or deny the various hypotheses on health effects of electromagnetic fields. The physical principles involved are well-described in Reference[35]. A summary of the issues is given in Reference[36]. Current epidemiologic results are reviewed in Reference[37]. A report on the most recent results is given in Reference[38].

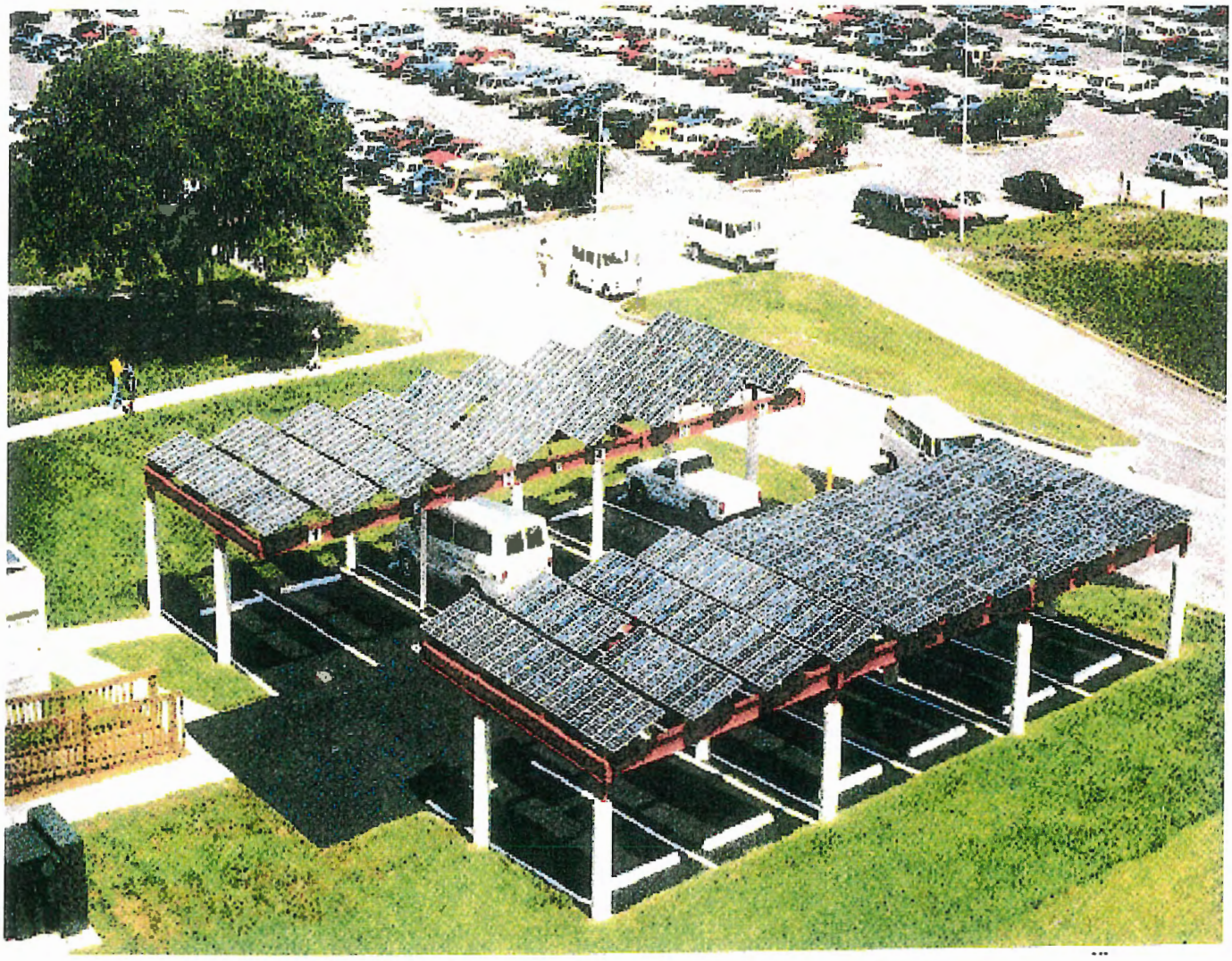
Electricity:

"An Illustrated Guide to Electrical Safety," William S. Watkins, Editor, American Society of Safety Engineers publication, 1983. [While not specifically directed towards electric vehicles, this publication contains a good summary of the principles of electrical safety as well as of relevant OSHA regulations.]

"National Electric Code," National Fire Protection Association, NFPA-70, 1993.

"Overview of Epidemiologic Research on Electric and Magnetic Fields and Cancer," David A. Savitz, American Industrial Hygiene Association Journal, Vol. 54, 1993, pp. 197-204.

Example of Parking Design with Solar Shade Structure



Siemens Solar Industries, Camarillo, CA
Originally printed in
"The Timeless Energy of the Sun – for Life and Peace with Nature"
by Madanjeet Singh
Sierra Club Books, San Francisco, CA © 1998
UNESCO

Vehicles

Comparison of Electric Vehicles Tested
Zero Emission Vehicle (ZEV) Demonstration Project
Final Report 9/30/99

MAKE	GM	Toyota	Ford	Solectria	Chrysler
MODEL	**EV1**	**RAV4-EV**	**Ranger EV**	**Force EV**	**EPIC**
	Advanced VRLA		1998 model	(NiMH opt.)	1999 model
Battery Type on Model Tested	Lead-Acid	NiMH	Lead-Acid	Lead-Acid	NiMH
Battery Pack's Total Voltage	312 v.	300 v.	312 v.	156 v.	336 v.
Regenerative Braking	Y	Y	Y	Y	Y
Regenerative Coasting	Y	Y	Y	Y	Y
Manual Control of Regen	Y	Y	Y	Y	N
ENERGY USE DURING PROJECT:					
Note: This was a rural test in the coastal mountains and valleys of Mendocino County,					
California, with elevation changes from 600 to 2,500 feet.					
Season Tested	Winter	Summer	Fall	Winter	Spring
Total Miles Driven	2,226 m.	1,110 m.	260 m.	540 m.	1,008 m.
Total Days Driven	61 d.	22 d.	15 d.	21 d.	24 d.
Average Daily Miles	36 m/d.	50 m/d.	17 m/d.	26 m/d.	42 m/d.
Total Weeks Driven	9 w.	3 w.	2 w.	3 w.	3 w.
Average Weekly Miles	247 m/w.	370 m/w.	130 m/w.	180 m/w.	336 m/w.
Total Kilowatt-Hours Used	813 kW-h.	Not Avail.	112 kW-h.	97 kW-h.	567 kW-h.
Average Watt-Hours per Mile	365 W-h/m.	Not Avail.	431 W-h/m.	180 W-h/m.	562 W-h/m.
Cost per Mile at $.14 per kW-h	5.1 cents	6.3 cents	6.0 cents	2.6 cents	7.9 cents
Brooktrails/Ukiah Commute:					
Round Trip kW-hours Used	20 kW-h.	25 kW-h.	Not Avail.	est. 10 kW-h.	30 kW-h.
Est. Mileage Range Between Charges	40-60 m.	80-109 m.	40-50 m.	40-45 m.	50-90 m.
CHARGING:				(with adaptor)	
Receptacles	14-50R	14-50R	14-50R	14-50R	14-50R
Inductive / Conductive Design	I	C	C	C	C
Service Required in Amps	40A	40A	30-40A	15-30A	60A
240V Charger Standard	Y	Y	Y	Y	Y
On-Board/Off-Board Charger	Off	On	Off	On	Off
120V Convenience Charger Provided	Y	N (avail.)	N	Y	N
440V Charger Available	N	N	N	N	Y
Recreational Vehicle (RV) Compatible	Y	Y	Y	Y	Y
INSTRUMENTATION:					
Battery State of Charge (SOC)	Y	Y	Y	N	Y
Power Voltage	Y	Y	Not Avail.	Y	Y
Range/Miles Remaining (Dist. to Empty)	Y	N	Y	N	N
Odometer/Trip Meter	Y	Y	Y	Y	Y
Driving Modes	Regen, Drive,	Engine Braking	Econ (Regen),	Regen, Drive,	Drive Only
	Coast	(Regen), Drive	Drive	Power	
Other			Power limit,	Amp-hours used	Low Power
			other warnings	(digital)	Power Limit
ZEV REPORT RECOMMENDATIONS:					
Best use in rural area	Commute	General	Utility	Town	Transit
	& Local	(All except	(Local)	(Local)	Demand-
		public transit)			Response

Comparison of Electric Vehicles Tested
Zero Emission Vehicle (ZEV) Demonstration Project
Final Report 9/30/99

MAKE	GM	Toyota	Ford	Solectria	Chrysler
MODEL	**EV1**	**RAV4-EV**	**Ranger EV**	**Force EV**	**EPIC**
MANUFACTURER'S SPECS:					
Performance Specs:		City/Hwy/Comb.			
Driving Range	50 to 90 m.	130/106/118	58	50m.@45mph	80 to 90 m.
Top Speed	80 mph	79 mph	75 mph	70 mph	80 mph
Acceleration	0-60/8 sec.	0-60/17 sec.	0-50/12 sec.	0-30/8 sec.	0-60/17 sec.
Recharge/Refuel Time	2 to 4 h.	6 to 8 h.	6 to 8 h.	3.5 h.	6 to 8 h.
Passenger Capacity	2	5	2	4	5 to 8
Technical Specs:					
Dimensions - Length x Width x Height	170x69x50"	162x67x64"	Similar to	164x70x56"	186x75x68"
Curb Weight	2,970 lb.	3230-3439 lb.	Ford	2,460 lb.	5,100 lb.
Gross Vehicle Weight	3,410 lb.	3,373 lb.	Ranger	2,376 lb.	5,800 lb.
Engine Motor	137 hp.	67 hp.	75 hp.	Not Avail.	100 hp.
	3-phase AC	50 kW @	3-phase AC		AC induction
	induction	2,600-2,800 rpm	induction		
Payload	Not Avail.	827 lb.	700 lb.	Not Avail.	925 lb.
			(1,250 w/NiMH)		
AC and Heater	Y	Y	Y	Y	Y
Preheat/Precool Cabin Timer Function	Y	Y	Not Avail.	Y	Not Avail.
Other Features Include:	Aluminum	Heated seats,	Electrohydraulic	Power assist	Power steering,
	structure,	power windows	power steering,	brakes,	brakes & door
	composite body,	and door locks,	lightweight	rear window	locks; rear
	keypad entry,	rear window	aluminum	defogger,	defrost & wiper;
	many unique	defrost & wiper,	wheels,		2 sliding doors;
	design features,				tinted glass;
	AM/FM radio,	AM/FM radio,	AM/FM radio	Opt. AM/FM	AM/FM radio
	CD & cassette	cassette		w/CD or cass.	
Safety Features:					
Air bags	Dual	Dual	Dual	Dual	Dual
ABS	Y	Y	Y	Not Avail.	Y
Fed. Standards	Y	Y	Y	Y	Y
Other	Traction control,	Supplemental	Electrical	Not Avail.	Not Avail.
	daytime running	Restraint	hazard		
	lamps	System	warning lamp		
PRICE / LEASE OPTIONS:					
Price	$33,995	est. $40-42,000	$14,455 pre-pd.	$35,000	$15,000 pre-pd.
Payment Terms	Lease only	Contact	or $450/mo.	Contact	$450/mo.
	Contact Saturn	Toyota USA	3-yr. lease	dealers or	36-mo. lease
	dealers or	for current info	$199 special	Solectria	or purchase with
	gmev.com		at Lithia Sun	for add'l info	buyback at 3 yrs.
			Valley Ford		Contact Chrysler
Warranty	3 yr/36,000 m.	Not Avail.	3 yr/36,000 m.	1 year	3 yr/36,000 m.
				3 yr. opt. @ $2K	
Availability	Consumers,	Fleets only	Fleets,a few	Consumers	Fleets only
	at Saturn		consumers		

EV 1



The EV1 proves its durability after the long climb up the Ridgewood Grade in an unexpected snowfall.

GENERAL MOTORS

Tested:
Mendocino County
November 2 to December 31, 1997

Photo by William R. Warf



General Motors EV1

Description: General Motors' EV1 is the first electric vehicle built from the ground up and produced for sale by any major automaker. It is the world's most aerodynamic production vehicle and carries 23 new patents in a variety of new technologies.

Performance Specs

Driving Range: 50-90 miles
Top Speed: 80 mph
Acceleration: 0-60 in 8.5 seconds
Recharge/Refuel Time: 2 to 4 hours
Passenger Capacity: 2

Technical Specs

Dimensions: Length: 169.8"; Width: 69.3"; Height: 50.5"
Curb Weight: 2,970 lb.
Gross Vehicle Weight: 3,410 lb.
Engine Motor: 137 Horsepower, Three-Phase AC Induction Motor
Payload: Not Available
A/C and Heater: Yes
Preheat/Precool Cabin Timer Feature: Yes
Other Features: Aluminum Structure, Composite Body, Electronic Keypad Entry/Start

Safety Features

Air Bags: Yes, Dual
Anti-lock Braking System: Yes
Meets All Federal Standards: Yes
Other: Traction Control, Daytime Running Lamps

Price/Lease Options

Price: $33,995
Payment Terms: Lease Only
Warranty: 3 years/36,000 Miles
Availability: To Consumers at Saturn Dealerships in Selected Markets

For More Information Contact

Saturn/General Motors
100 Saturn Parkway, Mail Drop S24, Spring Hill, Tennessee USA 37174
www.saturncars.com/EV1/
www.gmev.com

More information on the EV1 Lease:



The M.S.R.P. for the EV1 is $33,995. The monthly lease payment ranges from $399 to $549. Your monthly payment may be higher depending on where the lease is issued. The reason for the variance has to do with governmental incentives for environmentally advanced cars, which vary based on your state and air quality district. The highest incentives currently are those available to customers living in some areas of California. In such areas of California the lease is $399 per month for 36 months with $399 due at signing. Payments are based on 1997 EV1, including wall-mounted charger, with M.S.R.P. of $33,995. License, title, registration, taxes, insurance and charger installation fees are extra. First month's lease payment of $399 plus $0 down and no security deposit ($399 due at signing). No option to purchase at lease end. 36 monthly payments total $14,364. GMAC must approve lease. Mileage charge of $.20 per mile over 30,000 miles. Lessee is responsible for excessive wear and use. Delivery must be taken from participating California Saturn retailer stock. In Arizona the lease is $549 per month for 36 months with $549 due at signing. Payments are based on 1997 EV1, including wall-mounted charger, with M.S.R.P. of $33,995. License, title, registration fees, taxes, insurance, and charger installation are extra. First month's lease payment of $549 plus $0 down and no security deposit ($549 due at signing). No option to purchase at lease end. 36 monthly payments total $19,764. GMAC must approve lease. Mileage charge of $.20 per mile over 30,000 miles. Lessee is responsible for excessive wear and use. Delivery must be taken from participating Arizona Saturn retailer stock.

EV1
ELECTRIC

©1998 General Motors

GENERAL MOTORS EV1 — TECHNICAL INFORMATION

PERFORMANCE

- 183 mph—EV1 prototype set a land speed record in 1994 for electric vehicles
- 0–30 mph in under 3 seconds
- 0–60 mph in under 9 seconds
- Electronically regulated top speed of 80 mph
- Braking distance 60–0 mph under 160 feet
- Propulsion system—3-phase AC Induction Motor, 102 kilowatt (137 hp) @ 7000 rpm
- Motor torque—110 lb ft @ 7000 rpm
- Axle torque—1209 lb ft @ 7000 rpm
- Low rolling resistance tires



AERODYNAMICS

- Coefficient of drag 0.19—25% lower than any other production car
- Teardrop or raindrop shape—one of the most aerodynamic shapes
- Full underbody panel system
- Rear-wheel fender skirts
- Antenna integrated into roof panel

INTERIOR FEATURES

- Air conditioning utilizing electric heat pump
- Cruise control
- Power windows, door locks, and dual outside mirrors
- AM/FM Stereo with CD and Cassette
- Keyless entry/start-up with security system
- Cabin preconditioning
- Electrically heated front windshield
- Centrally mounted digital display



SAFETY

- Meets all Federal Safety Standards
- Side guard door beams
- Dual airbags
- Anti-lock Braking System (ABS)
- Traction Control System
- Daytime running lamps

ENVIRONMENT

- EV1 is a ZEV (zero emission vehicle)
- Batteries are 98% recyclable and made from recycled lead
- Body panels and frame are 100% recyclable
- 97% fewer emissions than a conventional gasoline engine—this includes the electricity-generating emissions from the power plant

INFRASTRUCTURE

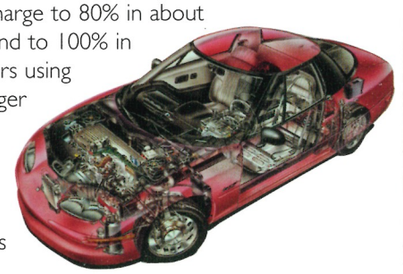
- Numerous public charging stations are available at locations EV customers frequently visit
- Use of public charging will provide convenience and extended operating range for EV customers

BATTERIES

- Advanced Valve-Regulated Lead-Acid (VRLA) design
- Utilize recombinant technology to reduce hydrogen gassing
- Electrolyte is contained within absorptive fiberglass matting material
- Small quantity of electrolyte in each module
- Maintenance free
- Batteries are covered under the "Bumper to Bumper" Warranty, 3 years/36,000 miles

CHARGING

- Inductive charging provides optimum safety—even in the rain
- Ability to charge using 110-volt or 220-volt power supply
- Vehicle communicates with chargers using FCC-regulated radio frequency
- At 70°F, vehicle will charge from 20% to 80% state of charge in up to 90 minutes and to 100% in approximately 3 hours using a 220-volt charger
- 110-volt portable charger stored in trunk
- Vehicle will charge to 80% in about 8–10 hours and to 100% in about 15 hours using 110-volt charger
- 220-volt charger available in wall- or floor-mount models



BODY/CHASSIS

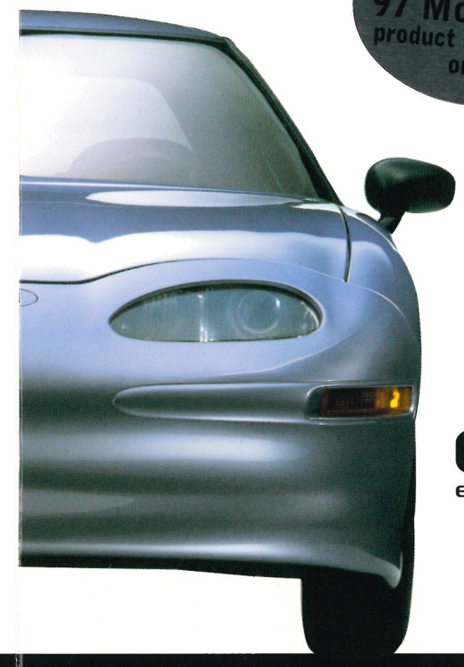
- Body panels made up of two types of composites—Sheet Molding Compound (SMC) and Reinforced Reaction Injection Molding (RRIM)
- Body panels are 100% recyclable and very lightweight
- Short/Long Arm (SLA) front suspension and multilink rear suspension designs—made of aluminum and composite materials
- Suspension is set up similar to that used in race cars
- Brake by wire—computer-controlled braking system
- Electric rear brakes
- Electric/hydraulic front brakes
- Regenerative braking with coast-down feature
- 50 psi tires with Tire Inflation Monitor System
- Electric/hydraulic power steering system

ALUMINUM STRUCTURE

- Lightest, strongest and stiffest structure (290 lb) for any vehicle its size
- 100% recyclable
- Made up of welded and bonded aluminum
- Extremely rigid platform—natural frequency of 25 hertz

GENERAL MOTORS EV1 — FREQUENTLY ASKED QUESTIONS

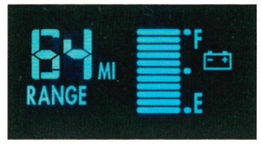
This brochure contains '97 Model Year product information only.



EV1 ELECTRIC

GENERAL MOTORS EV1 — FREQUENTLY ASKED QUESTIONS

1. How far will it go?
Range may vary anywhere from 50 to 90 miles depending on factors such as driving style, terrain and outdoor temperature.





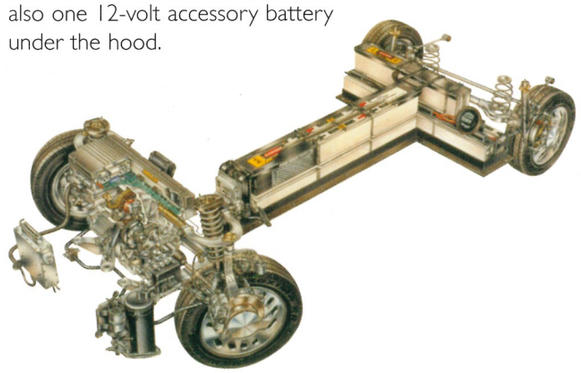
2. How fast is it?
The EV1 travels from 0-30 in under 3 seconds and 0-60 in under 9 seconds. An EV1 prototype set an electric vehicle land speed record in 1994 at 183 mph.

3. How much is it?
The EV1 is available through a lease-only program based on an M.S.R.P. of $33,995. This includes the cost of a 220-volt (6.6 kilowatt) wall-mount charger. License, title, registration fees, taxes, insurance, and charger installation are all extra. For more information please visit our Web site at **www.gmev.com** or call **1-800-25ELECTRIC**.

4. Why is the EV1 lease only?
Saturn, in partnership with General Motors Advanced Technology Vehicles, offers the GM EV1 to the consumer through a lease-only program. Saturn believes this is the best way to ensure total customer enthusiasm for the early customers of this unique vehicle. Leasing provides EV1 customers with a known, consistent cost of ownership. Saturn covers all routine maintenance and service under the terms of the 3-year/36,000-mile warranty—this includes everything from batteries to tires. Saturn also provides a 24-hour roadside assistance program to make every aspect of the EV1 lease worry free.



5. Where are the batteries located?
There are 26 valve-regulated lead-acid batteries located between and behind the two seats in a "T" shape. There is also one 12-volt accessory battery under the hood.



6. How long does it take to charge?
At 70°F, it takes up to 90 minutes to charge from 20% to 80% state of charge using a 220-volt charger (6.6 kilowatt). Approximately 3 hours is required for a complete charge using a 220-volt charger. The portable charger (110-volt) requires about 15 hours for a complete charge.



7. How much does it cost to charge?
Energy cost for the EV1 as tested by EV America and the U.S. Department of Energy is 2.48 cents per mile at 10 cents/kilowatt hour. For a 75-mile trip in the EV1, the energy cost would be $1.86. In comparison, a gasoline vehicle that gets 22 miles per gallon has an energy cost of 6.82 cents per mile (assuming gasoline costs $1.50 per gallon). For a 75-mile trip in the gasoline vehicle, the energy cost would be $5.11. Using this example, the gasoline vehicle has an energy cost that is nearly three times greater than the EV1.

8. Where can I test-drive an EV1?
The following Saturn retail facilities in California and Arizona distribute and service the EV1:



Southern California

Saturn of Airport Marina
5850 Centinela
Los Angeles, CA 90045
310-645-6868

Saturn of Alhambra
1800 West Main Street
Alhambra, CA 91801
626-284-9291

Saturn of Antelope Valley
401 Auto Vista Drive
Palmdale, CA 93551
805-274-9644

Saturn of Cerritos
Cerritos Auto Square
18400 Studebaker Road
Cerritos, CA 90703
562-860-2424

Saturn of The Desert
68080 Perez Road
Cathedral City, CA 92234
760-324-2424

Saturn of El Cajon
541 North Johnson Ave.
El Cajon, CA 92020
619-444-7200

Saturn of Escondido
859 North Broadway
Escondido, CA 92025
760-738-8500

Saturn of Huntington Beach
18801 Beach Blvd.
Huntington Beach, CA 92648
714-841-9828

Saturn of Kearney Mesa
4525 Convoy Street
San Diego, CA 92111
619-292-9700

Saturn of Loma Linda
25140 Redlands Blvd.
Loma Linda, CA 92354
909-799-9900

Saturn of Monrovia
1305 South Mountain Ave.
Monrovia, CA 91016
626-303-0077

Saturn of National City
2202 National City Blvd.
National City, CA 91950
619-336-1600

Saturn of Ontario
1195 Auto Center Dr.
Ontario, CA 91761
909-605-5655

Saturn of Oxnard
1450 Auto Center Dr.
Oxnard, CA 93030
805-983-3333

Saturn of San Juan Capistrano
33033 Camino Capistrano
San Juan Capistrano, CA 92675
949-248-5411

Saturn of Santa Ana
1350 Auto Mall Drive
Santa Ana, CA 92705
714-648-2444

Saturn of Santa Clarita
23645 Creekside Rd.
Santa Clarita, CA 91355
805-284-3800

Saturn of Thousand Oaks
344 Thousand Oaks Blvd.
Thousand Oaks, CA 91362
805-379-4088

Saturn of Torrance
20410 Hawthorne Blvd.
Torrance, CA 90503
310-370-3737

Saturn of The Valley
15421 Roscoe Blvd.
Sepulveda, CA 91343
818-895-3800

Saturn of West Covina
1900 E. Garvey South
West Covina, CA 91791
626-915-4440

Saturn of West 78
2205 Vista Way
Oceanside, CA 92054
760-433-8000

Saturn of Whittier
13809 E. Whittier Blvd.
Whittier, CA 90605
562-698-8700

Northern California

Saturn of Capitol Expressway
755 W. Capitol Expressway
San Jose, CA 95136
408-979-5000

Saturn of Concord
1330 Concord Avenue
Concord, CA 94520
925-682-6400

Saturn of Fremont
39797 Balentine Drive
Newark, CA 94560
510-445-8700

Saturn of Marin
535 East Francisco Blvd.
San Rafael, CA 94901
415-455-1800

Saturn of San Francisco
711 Serramonte Blvd.
Colma, CA 94014
650-985-5000

Saturn of Fulton Ave.
2540 Fulton Avenue
Sacramento, CA 95821
916-972-8876

Arizona

Saturn of Glendale
4610 West Camelback Rd.
Glendale, AZ 85301
602-254-1111

Saturn of Scottsdale
15656 North Hayden
Scottsdale, AZ 85260
602-922-5200

Saturn of Tempe
7799 S. Autoplex Loop
Tempe, AZ 85284
602-496-8888

Saturn of Tucson
6020 East Speedway
Tucson, AZ 85711
520-748-7277

Zero Emission Vehicle (ZEV) Demonstration Project
General Motors EV1

Keith Rutledge picks up the EV1 for a twilight cruise in Brooktrails.

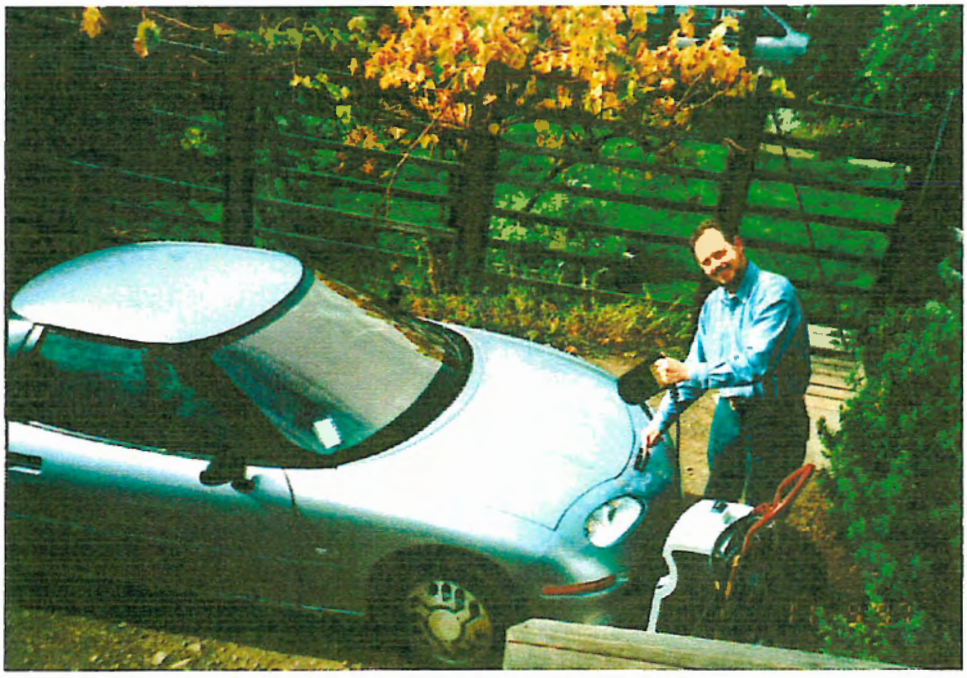




Charging the batteries thaws the EV1's hood on a frosty winter night.

Tony Orth inserts the paddle of the inductive charging system into the nose of the EV1. The Magnecharger unit was mounted on a hand truck for portability.

Photos by Janet Orth



Zero Emission Vehicle (ZEV) Demonstration Project
General Motors EV1

Local children take a peek at the space-age interior of the EV1.







Judging from the smiles on these faces, it's a lot of fun to ride in the EV1.





Dave Lohse and fellow City Planners give rides to the curious at MCOG's public Ride & Drive event at the Ukiah Civic Center.

Photos by Ron Moorhead

ZEV Project
MCOG/REDI
Sept.. 1999

Report on an EV1 Deployment in Mendocino County

Prepared By:
William R. Warf, Pacific EV
1 May, 1998

Prepared For:

Renewable Energy Development Institute (REDI)

and

Mendocino Council of Governments (MCOG)

Introduction:
A General Motors EV1 electric car was acquired from Green Motorworks for the months of November and December 1997 for use by the project. The EV1 was driven 2226 miles by 18 different trained and insured drivers. Over 60 local City and County employees and residents of Mendocino County were given rides in the car. The purpose of the deployment was to expose modern EV technology to MCOG constituent personnel, and to characterize the adequacy and therefore applicability of this technology to our rural county setting.

During the project, a charging station was constructed at Oak and Standley Streets in Ukiah, and used during the deployment. The EV1 was used for commuting from Willits to Ukiah, Redwood Valley to Ukiah, and was driven to Fort Bragg where it was used for a week. The EV1 utilizes a special inductive charging system. This system was wired with a plug to fit standard charging outlets, and moved around with the vehicle.

This report summarizes some interesting events and provides lessons learned about the use of an EV in Mendocino County. The EV1 was nearly brand new, having 608 miles on the odometer when it was delivered to Ukiah on November 1. When returned to Green Motorworks on January 3, the odometer read 2834.

Conclusions:
An electric car like the EV1 is useful for commuting in Mendocino County. Additional charging infrastructure would extend the car's utility. In general, drivers of the car liked using it and didn't want to return it for the next driver.

Driving Statistics:
The Car was driven an average of 36 miles per day throughout the deployment. Figure 1 provides graphic illustration of daily mileage and type of use. The highest daily mileage's were 75 miles on November 6 and 73 miles on November 19. On both of these long mileage days the car was charged during the day using the 6 kW Magnecharger, enabling more travel. The longest trip was 55 miles from Ukiah to Fort Bragg. Note this trip includes a 1500 ft (approximately) elevation change on the trip to Fort Bragg, and approximately 2000 ft change on the return trip.

The average weekly mileage was 247 miles per week over the 9 week deployment, and the highest weekly mileage was 362 miles.

Training:
Each driver received a training session and test drive before driving the car. The controls and displays were explained in detail to familiarize drivers with energy and power displays, and the operation of the regenerative braking. The energy estimate and range remaining display in the EV1 are very accurate, and drivers were instructed to "believe the instrument". The computer estimates the batteries state of charge, takes into account the batteries temperature, and estimates the range remaining for the driver. This

estimated range is a little tricky, because the computer can only learn how you have been driving, not how you are going to drive. If there is a significant hill coming up on the trip, the operator needs to make an estimate of remaining range, which requires some familiarity with the car and the route. The car exhibits repeatable energy use behavior over a given trip, and drivers learn quickly how fast they can drive, and how to estimate the energy required for hills like the Willits grade.

The power display allows a driver to maximize range by driving with a power budget. Basically, the driver can limit the power used by keeping the power gage below about half. This conservative driving technique was explained to each driver so that they would know how to get home if they somehow under estimated a trip length. This driving technique is often described as imagining there is a raw egg between your foot and the accelerator pedal. Throughout the deployment, no one was stranded with the car. The car has great acceleration. Use of the acceleration capability decreases range, but it is great fun to use.

Both the 120 V convenience charge and the 240 V Magnecharger charging systems were explained and demonstrated to each driver. Some effort was made to plan each driver's approach to keeping the vehicle charged, and all were instructed to charge the car overnight with one or the other system. Lead acid batteries have no memory, and all were instructed it is best to charge the car at every opportunity, unless their daily driving is short enough to be accomplished with night charging only. Our daily average mileage of 36 miles per day is in general possible charging only in the evening, however longer mileage days and commuting between Willits and Ukiah generally required charging in between trips.

Charging

The General Motors EV1 comes equipped with a proprietary inductive charging port and charging systems to match. Two chargers were available, one 6 kW Hughes Magnecharger, and the 1.3 kW "convenience charger". The concept of the inductive charging port is to prevent electrical shock to operators during plugging and un-plugging the vehicle. This section describes both chargers.

The 6 kW Magnecharger used for the project was intended to be permanently installed in a garage. Another more expensive charger is available for pedestal mounting in a parking area. The 6 kW charger requires a 240 V 40 Amp electric service. For our project, a garage mount type charger was fitted with an AC energy meter, and was mounted to a hand truck such that it could be moved around during the deployment. Since this indoor charger isn't water proof, a plywood box was constructed so the charger could be used at Oak and Standley in Ukiah, and at the Laurel alley charging station in Fort Bragg (please see photos). Additional NEMA 14-50 Receptacles were installed in Pacific EV's shop, in the MTA shop, and at the Orths' house in Willits. The 6 kW charger is capable of charging the vehicle in 2-4 hours depending on the depth of discharge. More importantly, the charging speed with this charger is approximately 20 miles of range per

hour of charging. This means the car gains about 20 miles of range for each hour it is parked in front of the Magnecharger.

Energy Use and Energy Cost

During the deployment the EV1 averaged 365 Watt-hours per mile (W-h/mi). Lowest energy use was 243 W-h per mile on the trip from Ukiah to Fort Bragg, and also during one of the trips from Brooktrails to Ukiah. The 55 mile return trip from Fort Bragg to Ukiah took 309 W-h per mile. Weekly Energy cost was $12.60 per week for driving for an average of 247 weekly miles. For the project energy cost is calculated as $113.77 ($0.14 / kW-h) for 2226 miles, or 5.1 cents per mile. Actual energy use per mile and for each week are depicted in Figure 2.

Commuting in Mendocino County

The project has shown it is possible to use an electric car like the EV1 for 25-30 mile commutes, given our terrain and winter temperatures. Commuting would be easier if additional charging facilities were available, however using the convenience charger at one end of such commutes and the Magnecharger at the other worked fine. With both ends of trip charging, the Willits grade could be driven at 55 mph with range to spare, although Project Manager Janet Orth wrote "the Brooktrails to Ukiah round trip works best without trips around town in Ukiah, it's better to charge all day". In this case Janet was charging the car during the day in Ukiah with the 120 V convenience charger, as the Magnecharger was at her house in Willits. A second Magnecharger in Ukiah would make travel during the day more feasible, as the 120 V 1.3 kW convenience charger is a little too slow.

Janet recorded her trip on November 19 as follows:
"Left Brooktrails with 37 mile range on display. Car was cold. Arrived in Ukiah with 29 mile range remaining, and half a charge on energy gauge. Drove to a meeting after charging on 120V for two hours. Drove to lunch and back to Mary's house and charger. Left Ukiah with 32 mile range showing on display. Stopped in Redwood Valley to pick up Chris. About one mile below the top of Ridgewood Grade (about 12 miles from Chris' house) -0- miles remaining appeared on the gage, and then "Battery Life" on the display."

Janet said she drove slowly on into Willits and plugged the car in at the REDI office near the high school for three hours to get 12 miles range on display. She then drove to her house and plugged into the Magnecharger.

Janet was the first to reach 0 miles remaining on the range display, but she correctly chose to drive gently to a plug. There is another operator message she would have seen if she had kept driving which reads "battery damage". Eventually the car goes into a reduced performance mode, which none of us experienced during the project. In an EV1 range display, the Willits grade is worth 10 to 15 miles of range driving 45 to 55 and depending on conditions.

On November 21, on approximately her tenth day with the car, Janet wrote in the log that she now felt very comfortable with the EV1, she "knew the capabilities of the car". It seems reasonable to take a few days to learn, and the EV1 provides good information to the operator as to what is going on with the energy storage. It just takes a little time to understand and get used to the displays.

Notes about the trip to Fort Bragg and back:.
I drove the EV1 from my shop at 3903 North State Street to Fort Bragg on December 8, 1997. The Magnecharger was loaded into my truck for hauling to the charging station in Fort Bragg, and to provide a ride back. While in Fort Bragg, the EV1 was to be driven by Chief Bickell and Planner Scott Cochran for the week. December 8 was cold and wet in Ukiah. The pack was fully charged, and the range available was shown as 49 miles for the 55 mile trip. I drove out North State Street at 45 mph conserving as much energy as possible. Up the grade, I set the cruise control at 48 miles per hour, and allowed the car to maintain a constant safe speed, until I reached the snow line, about a mile before Ridgewood. The snow was several inches deep at the top of the ridge, please see attached photos. I was of course running the defroster and the windshield wipers nearly the whole trip. Continuing driving, I limited the current to mid range on the power display, and continued on up the hill out of Willits. Up hill this sometimes resulted in 25 mph speed, but I held up no traffic. Upon arriving in Fort Bragg I had 6 miles range remaining, and had driven 54.3 miles by the trip odometer.

The return trip on 12/14/97 was more difficult, because there is an additional 500 ft elevation change. It was raining very hard, requiring almost full time use of wipers and defroster. I left Fort Bragg with an indicated range remaining of 41 miles. In Willits, the trip odometer read 35.5 miles, and the range remaining display showed 8 miles range. There were two bars left on the state of charge, and I decided to charge a little. Luna's market has an 120 V outlet in front of the store, and I paid them $1.00 for 1 kW-h, which required waiting around for almost an hour. This bit of charging restored an additional bar on the state of charge gage giving me three bars total, and gave a predicted range of 10 miles. South from Willits, still driving a little slow by using the power gage, the range remaining display went to -0- at the top of Ridgewood. I was able to drive down the grade and the additional 5 miles to the PEV shop from the bottom of the grade without reaching the reduced power mode. When plugged into the Magnecharger at the shop the display read 1% battery capacity remaining, and 3.5 hours to charge. I must have been pretty close to reduced power mode. Total trip energy was 17 kW-h (AC).

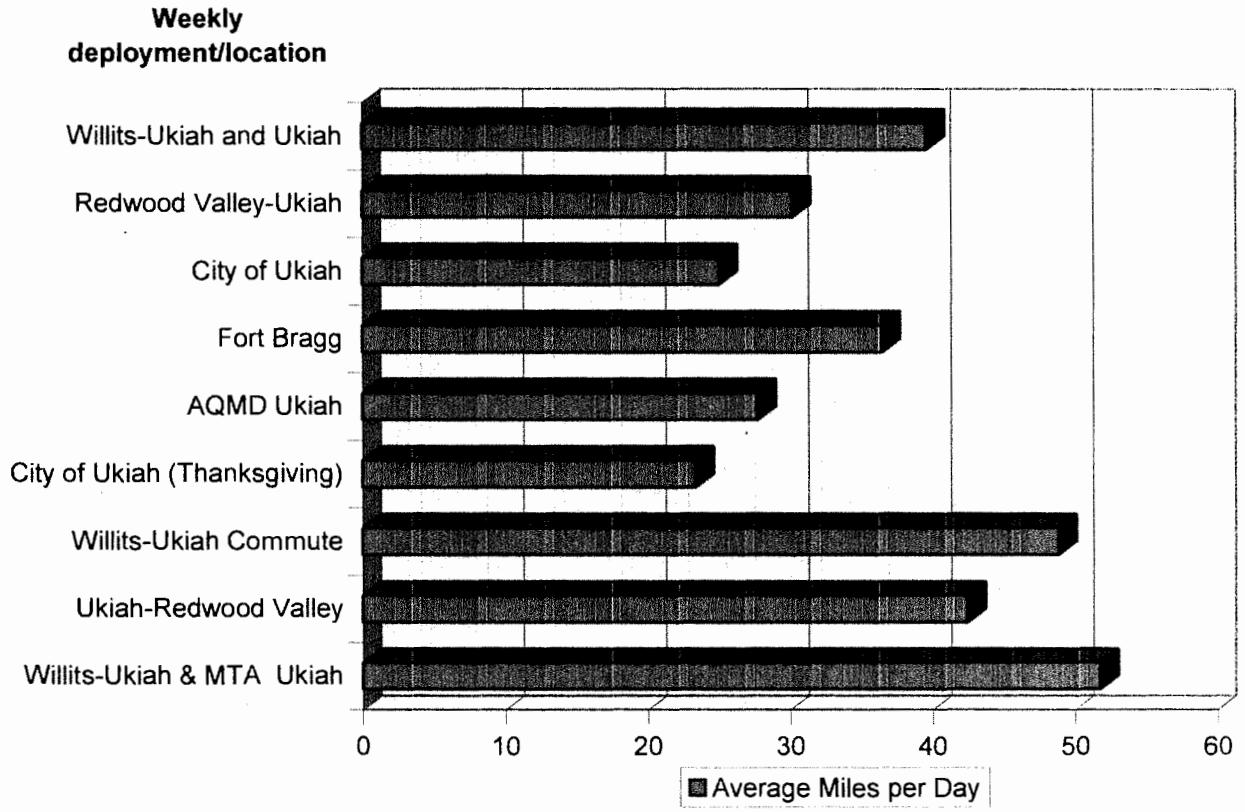
The trip from Fort Bragg to Willits or Ukiah in an EV1 really requires a Magnecharger in Willits, and an hour partial charge in Willits. This would allow travel between these towns without concern. The 55 mile trip with the 2000 ft elevation change is roughly equivalent to an 80 mile trip on the flat on a single charge, and requires pretty careful driving.

Some Driver Comments

On 11/14/97 after some fairly spirited driving by the author, Ken Fowler wrote: "Drove approximately 14 miles, very acceptable performance and handling, from a retail perspective I would be concerned over customer anxiety regarding the range and potential for being stranded. I was impressed with the smooth application of power and highway performance."

On 12/20/97 Dave Lohse wrote:
"I was fortunate to be able to drive the EV1 during the City of Ukiah's trial week, and run it through almost the entire range of driving I normally incur. Particularly during work. Truth be told, I have absolutely no complaints about the car other than the high cost to lease or purchase. Of course, I am well aware that this car is a "spoiler", and would not be the mainstay of any government fleet. However driving it illustrated that Electric Vehicles are not Inconvenient. Staff was able to do work related driving, provide rides to the public, and still had sufficient charge left to do a round trip to Redwood Valley."

The EV 1 Was driven extensively during it's Mendocino County Deployment

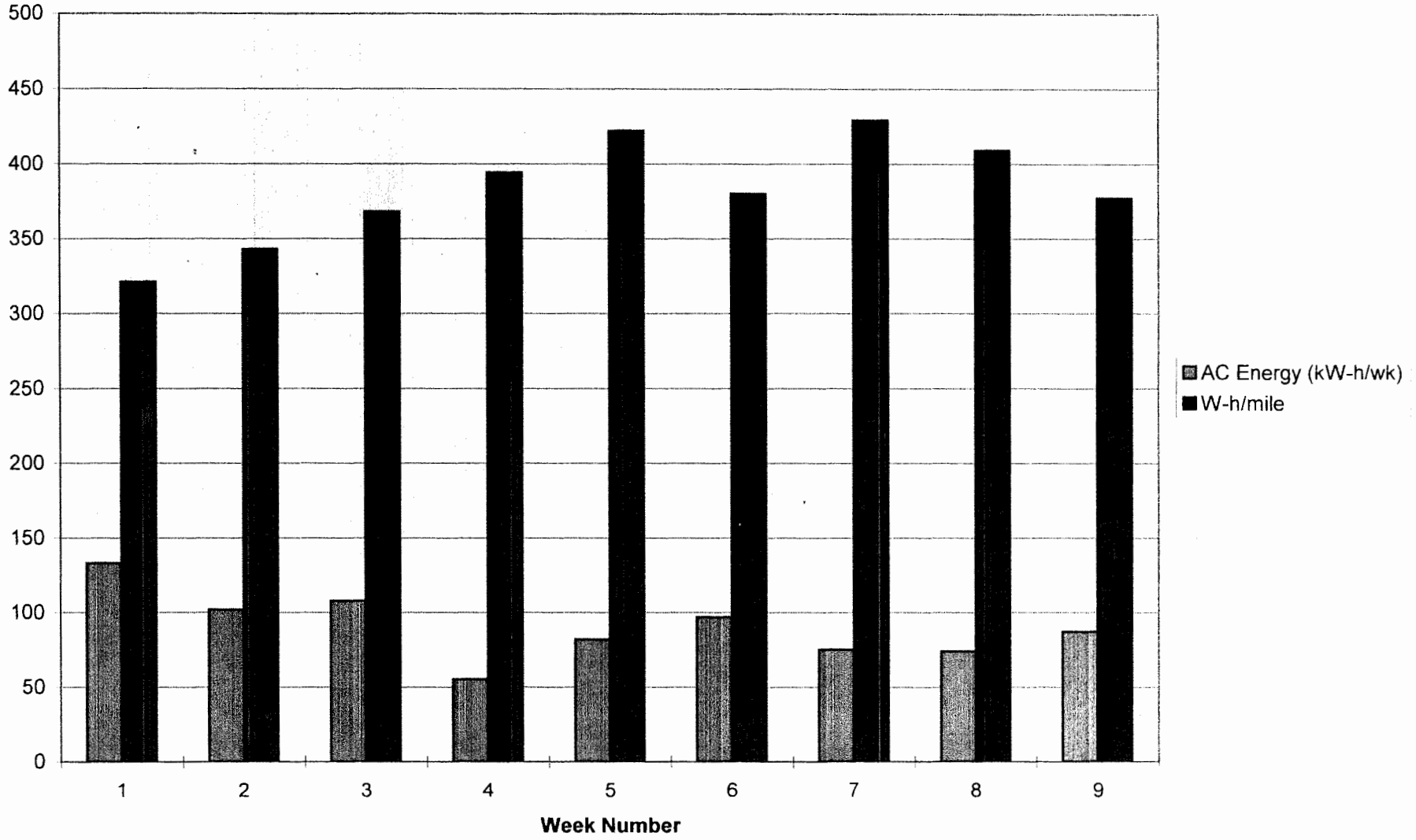


MCOG-REDI Report on EV1 Deployment, Figure 1

Ev1data1.xls

7/10/99

The EV1 averaged 365 W-h/mile (AC), and used 90 kW-h per week ($12.60)



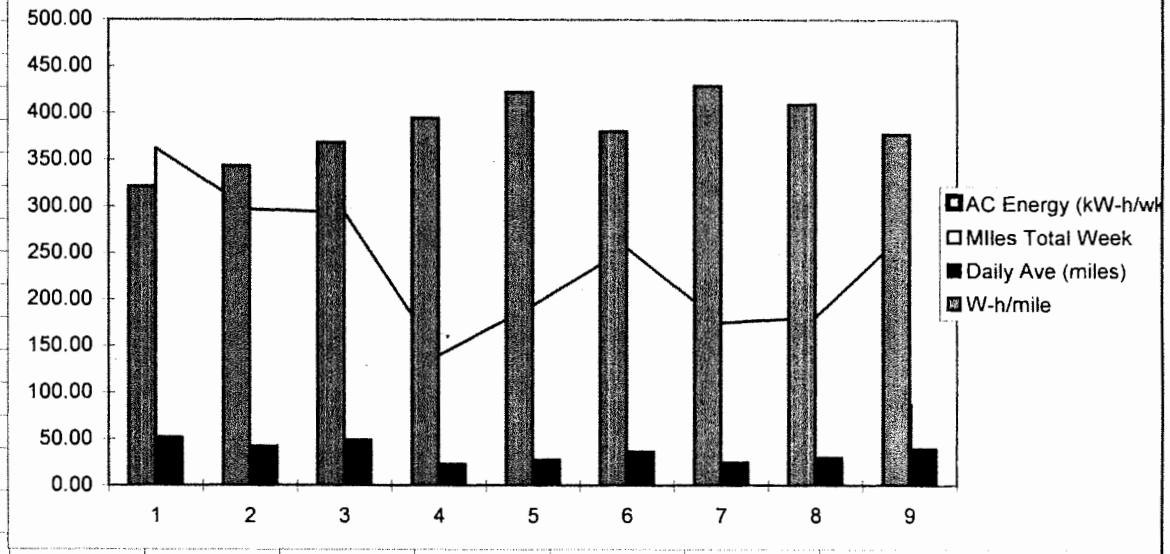
Date	Mileage	Miles- end	AC Energy	Trip Length	Energy use	Charger	Drivers	Hydria Counter		
11/1/97	608	660	15.51	52	0.298269	both	Tony, Janet, Bill			
11/2/97	660	695	8.91	35	0.254571	240V	Bill			
11/3/97	695	730	8.78	35	0.250857	both	Bill, MTA	12901		
11/4/97	730	759	14.8	29	0.510345	120v	MTA	27762	14.861	
11/4/97	759	787	6	28	0.214286	240v	MTA	27762		
11/5/97	787	817	7.3	30	0.243333	240v	Janet	27762		in town
1/5/97	817	838	7	21	0.333333	240v	MTA	27762		
11/6/97	838	858	8.413	20	0.42065	120v	Bruce Richard	36175	8.413	
11/6/97	858	877	5.22	19	0.274737	240v	Steve Turner	36175		turned cold
11/6/97	877	913	14.64	36	0.406667	120v	Steve Turner, demos	50818	14643	
11/7/97	913	934	10.48	21	0.499048	240v	Steve Turner			
11/7/98	934	967	9.93	33	0.300909	240v	Janet			
11/8/97	967	1022	16.05	55	0.291818	both	Janet			
11/9/97	1022	1062	10.4	40	0.26	240V part	Tony			
11/10/97	1062	1081	4.94	19	0.26	240V	Tony			
11/10/97	1081	1114	15.345	33	0.465	240V	Keith			
11/11/97	1114	1128	6.51	14	0.465	240V	Janet	57398		
11/12/97	1128	1170	13.44	42	0.32	both	Janet, Bill	61142	3744	
11/12/97	1170	1188	5.76	18	0.32	both	Bill			
11/13/97	1188	1235	11.46	47	0.24383	240v	Bill			
11/14/97	1235	1262	7.92	27	0.293333	240V	Bill			
11/14/97	1262	1278	4.86	16	0.30375	240v	Bill, demos	61142	??	
11/14/97	1278	1296	7.45	18	0.413889	120V	Rick Kennedy	74008	12866	
11/15/97	1296	1311	3.28	15	0.218667	120V	Rick Kennedy	77330	3322	
11/15/97	1311	1319	10.5	8	1.3125	120V	Rick Kennedy	87896	10566	
11/16/97	1319	1343	8.54	24	0.355833	240V	Bill			
11/18/97	1343	1368	9.68	25	0.3872	240v	Janet	trip to Brooktrails, used 28 miles for 25 mile trip		
11/19/97	1368	1441	28.57	73	0.39137	both	Janet	both, three partial charges+ one complete		
11/20/97	1441	1471	10	30	0.333333	120v	Janet	111508	note, .5 kW-h to condition cabin, not counted	
11/20/97	1471	1499	9.85	28	0.351786	240V	Janet			
11/21/97	1499	1527	10.2	28	0.364286	120V	Janet			

11/21/97	1527	1566	15.98	39	0.409744	240V	Janet	now says "know capabilities of car"		
11/22/97	1566	1609	12.86	43	0.29907	240V	Tony	partial charge		
11/22/97	1609	1612	2.08	3	0.693333	240V	Tony			
11/23/97	1612	1616	1.66	4	0.415	240V	Tony			
11/23/97	1616	1627	4.98	11	0.452727	240V	Tony			
11/24/97	1627	1662	10	35	0.285714	240V	Janet			
11/25/97	1662	1669	2.97	7	0.424286	240V	Bill			
11/25/97	1669	1675	2.43	6	0.405	240V	Bill	121741		
11/25/97	1675	1711	13.23	36	0.3675	both	Jim Mastin	124049	2308	Jim intended to go to Willits, but not enough charge.
11/26/97	1711	1726	9.04	15	0.602667	120v	Jim Mastin	133089	9040	
11/27/97	1726	1735	4.2	9	0.466667	240V	Jim Mastin			
11/28/97	1735	1752	6.58	17	0.387059	240V	Bill		0	
11/30/97	1752	1777	12	25	0.48	120V	Walt			
12/1/97	1777	1790	7.61	13	0.585385	120V	Walt			
12/3/97	1790	1796	6.9	6	1.15	120V	Walt			
12/4/97	1796	1837	17.7	41	0.431707	120V	Walt			
12/4/97	1837	1877	13.5	40	0.3375	240V	Walt			
12/5/97	1877	1883	3.6	6	0.6	120V	Walt	205020		
12/6/97	1883	1923	14.5	40	0.3625	120V	Walt			
12/6/97	1923	1946	6.1	23	0.265217	240V	Bill			
12/7/97	1946	1975	8.17	29	0.281724	240V	Bill			
12/7/97	1975	2020	13.2	45	0.293333	240V	Bill			
12/8/97	2020	2074	12.96	54	0.24	240V	Bill	Trip to Fort Bragg from Ukiah		
12/8/97	2074	2093	4.56	19	0.24	240V	Bill	Range display said 49 miles when I left shop		
12/9/97	2093	2111	14	18	0.777778	120V	Tom Bickell	0.24		
12/10/97	2111	2133	16.82	22	0.764545	120V	Tom Bickell			
12/11/97	2133	2153	8.64	20	0.432	240V	Scott Cochran			
12/11/97	2153	2170	7.52	17	0.442353	240V	Scott Cochran			
12/13/97	2170	2201	10.92	31	0.352258	240V part	Scott Cochran			

12/14/97	2201	2208	4.52	7	0.645714	240V	Scott Cochran			
12/14/97	2208	2263	16.97	55	0.308545	240V	Bill	Return trip from Fort Bragg		
12/15/97	2263	2289	9.33	26	0.358846	both	Dave Lohse			
12/16/97	2289	2313	12.785	24	0.532708	120V	Dave Lohse			
12/17/97	2313	2325	8.45	12	0.704167	120V	Dave Lohse			
12/18/97	2325	2359	17.65	34	0.519118	240V	Mike Harris			
12/19/97	2359	2370	4.27	11	0.388182	240V	Dave Lohse			
12/20/97	2370	2376	1.16	6	0.193333	120V	Dave Lohse	279715		
12/21/97	2376	2426	15.61	50	0.3122	both	Bill & Charles Cliburn	291178	11463	
12/23/97	2426	2439	4.55	13	0.35	240V	Charles Cliburn			
12/23/97	2439	2478	10.73	39	0.275128	240V	Charles Cliburn			
12/24/97	2478	2501	6.02	23	0.261739	240V part	Charles Cliburn			
12/24/97	2501	2515	5.73	14	0.409286	240V part	Charles Cliburn	291178		
12/25/97	2515	2527	15.1	12	1.258333	120V	Charles Cliburn	306280	15102	
12/28/97	2527	2557	16.2	30	0.54	120V	Charles Cliburn	322508	16228	
12/28/97	2557	2570	2.9	13	0.223077	240V part	Janet			
12/28/97	2570	2599	10.52	29	0.362759	240V	Janet			
12/29/97	2599	2623	15.3	24	0.6375	240V	Tony			
12/29/97	2623	2632	3.43	9	0.381111	240V	Janet			
12/30/97	2632	2653	3.7	21	0.17619	240V (part)	Tony			
12/30/97	2653	2674	8.05	21	0.383333	240V	Tony			
12/30/97	2674	2710	13.77	36	0.3825	240V	Tony			
12/31/97	2710	2753	14.2	43	0.330233	240V	Keith			
1/1/98	2753	2799		46	0	240V	Tony & Janet			
1/2/98	2799	2809	8.15	10	0.815	240V	Tony			
1/3/98	2809	2834	7.11	25	0.2844	240V	Tony			
		2226	812.653	2226	0.365073					

Week	AC Energy	W-h/mile
1	133.033	321.00
2	101.865	343.00
3	107.76	368.00
4	55.09	394.00
5	81.91	422.00
6	96.79	380.00
7	75.135	429.00
8	73.94	409.00
9	87.13	377.00

Week	AC Energy	MIles Total	W-h/mile	Daily Ave (miles)	
1	133.03	362	321	51.75	Willits-Ukiah & MTA Ukiah
2	101.87	297	343	42.43	Ukiah-Redwood Valley
3	107.76	293	368	48.83	Willits-Ukiah Commute
4	55.09	140	394	23.33	City of Ukiah (Thanksgiving)
5	81.91	194	422	27.71	AQMD Ukiah
6	96.79	255	380	36.43	Fort Bragg
7	75.14	175	429	25.00	City of Ukiah
8	73.94	181	409	30.17	Redwood Valley-Ukiah
9	87.13	277	377	39.57	Willits-Ukiah and Ukiah
Check:	812.65	2174.00		36.14	
		241.5556			



Mendocino Council of Governments

367 North State Street ~ Suite 206 ~ Ukiah, CA 95482
Phone (707) 463-1859 ~ Fax (707) 463-2212

July 27, 1999

Jennifer Allen, Project Manager
California Energy Commission
1516 Ninth Street, MS-41
Sacramento, CA 95814

Re: Grant #MEM-97L-007
Vehicle Acquisition Summary Letter

Dear Jennifer:

For purposes of our final report, this summarizes acquisition of the first vehicle for the Zero Emission Vehicle Project, Task 2 - "Negotiate acquisition of and acquire vehicles for testing through leases or loan programs."

Before MCOG's contract with the Energy Commision commenced, MCOG acquired a vehicle using local project funds. On November 1, 1997, we entered into a rental agreement for a General Motors EV1 for use by the ZEV Project. The vehicle was acquired for testing and ride-and-drive demonstrations from:

Mr. Bob Reese
Green Motorworks
1889 First Street, Alameda Point
Alameda, CA 94501
(510) 521-4300

The vehicle was rented for a two-month period, November 1 through January 2, 1998. Green Motorworks provided transport of the vehicle, with delivery and pickup at Ukiah. We successfully demonstrated the EV1 to various participants of the ZEV Project.

Sincerely,

Janet Orth
ZEV Project Coordinator

RAV4 – EV

TOYOTA



Festival goers learn first hand about the
RAV4 – EV at Solfest in Hopland, California.

Tested:
Mendocino County
June 15 to July 7, 1998

Photo by Janet M. Orth



Toyota RAV4 – EV

Description: The popular RAV4, a 4-passenger sport utility vehicle, is available to fleet users as an electric vehicle, named the RAV4-EV. Announced in April 1996 by Toyota, the RAV4-EV is among the first mass-produced vehicles to use advanced nickel-metal hydride batteries.

Performance Specs

Driving Range: City 130/Highway 106/Combined 118 miles
Top Speed: 79 mph – Electronically Controlled
Acceleration: 0-60 in 17 seconds
Recharge/Refuel Time: 6 to 8 hours
Passenger Capacity: 5

Technical Specs

Dimensions: Length: 162"; Width: 67"; Height: 64"
Curb Weight: 3,230 – 3,439 lb.
Gross Vehicle Weight: 3,373 lb.
Engine Motor: 67 Horsepower, 50 Kilowatts at 2,600 to 2,800 rpm
Payload: 827 lb.
A/C and Heater: Yes – CFC Free
Preheat/Precool Cabin Timer Feature: Yes
Other Features: Heated Seats, Power Windows and Door Locks, Rear Window Defogger and Wiper

Safety Features

Air Bags: Yes, Dual
Anti-lock Braking System: Yes
Meets All Federal Standards: Yes
Other: Supplemental Restraint System

Price/Lease Options

Price: $40,000 to $42,000
Payment Terms: Contact Toyota USA for Current Information
Warranty: Information Not Available
Availability: Fleets Only

For More Information Contact

Toyota Motor Sales USA, Inc.
19001 South Western Ave.
Torrance, CA 90509
www.toyota.com/inside toyota/rav4ev/

TOYOTA

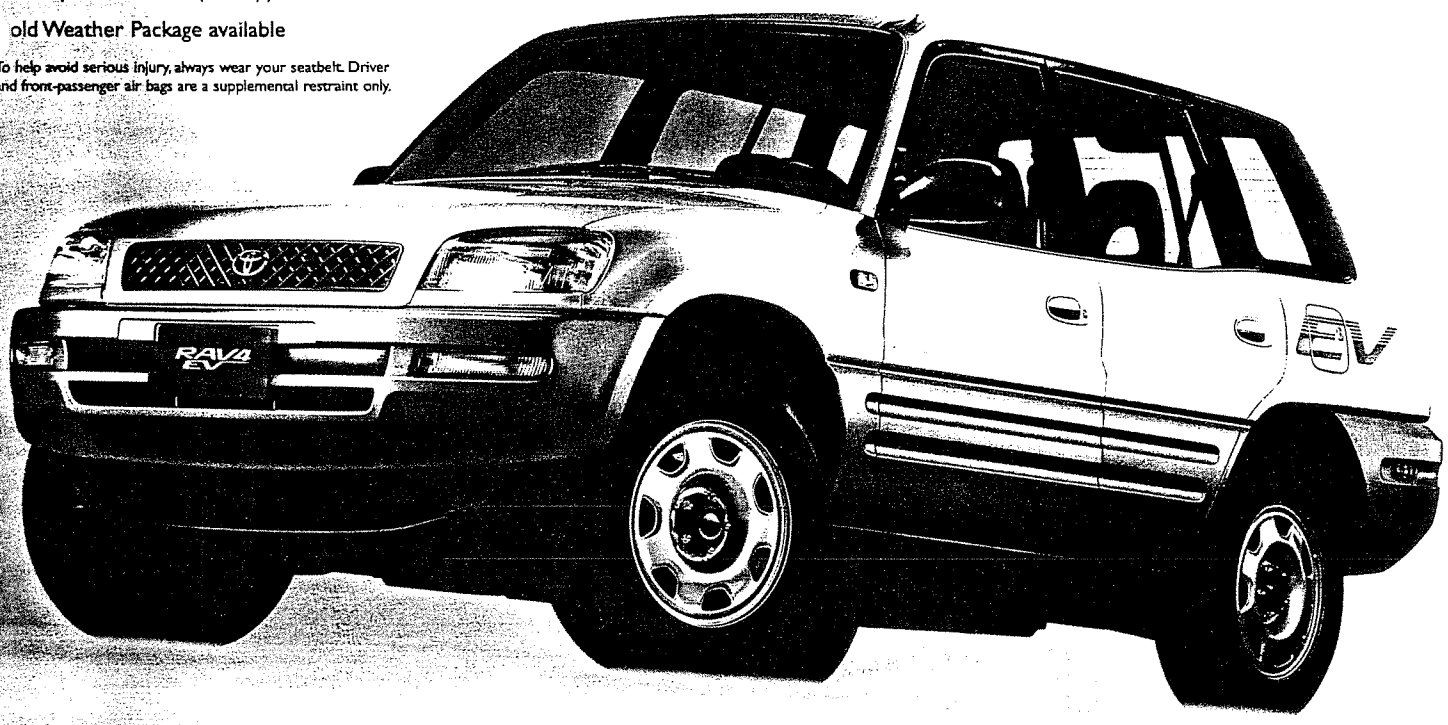
RAV4 EV

The popular RAV4 will soon be available to fleet users as an electric vehicle. The front-drive, four-door Toyotas will be among the first mass-produced vehicles to use advanced nickel-metal hydride batteries with twice the power of lead-acid batteries. With a combined per-charge range of 118 miles and an electronically controlled top speed of 79 mph, the RAV4-EV is a serious player in the race for zero emissions.

STANDARD FEATURES

- Front-wheel drive, 5-passenger, 4-door vehicle
- Dual air bag Supplemental Restraint System (SRS)*
- Fully reclining front and rear seats
- Low-energy heat pump-type CFC-free air conditioning
- Power windows, door locks and mirrors
- Deluxe AM/FM stereo with cassette
- ϟ Heated seats (driver and front-passenger)
- ϟ Heated and tinted windshield
- Rear window defogger and wiper
- ϟ Control panel with pre-heat and pre-cool cabin function
- Concealed spare tire
- 195/80R16 low rolling resistance steel-belted radial tires
- 50/50 split fold-down (and up) rear seats
- old Weather Package available

*To help avoid serious injury, always wear your seatbelt. Driver and front-passenger air bags are a supplemental restraint only.



EXTERIOR	Overall length	156.5 in.	INTERIOR, FRONT/REAR	Head room	40.3 in./39.0 in.	CURB WEIGHT	3,439 lbs.
	Overall width	66.7 in.		Shoulder room	53.1 in./53.1 in.	GROUND CLEARANCE	8.0 in.
	Overall height	65.7 in.		Hip room	55.9 in./56.0 in.	PAYLOAD CAPACITY	827 lbs.
	Wheelbase	94.9 in.		Leg room	39.5 in./33.9 in.	CARGO VOLUME	31.4 cu. ft. (behind rear seats)



The popular RAV4 will soon be available to fleet users as an electric vehicle. The front-drive, four-door Toyotas will be among the first mass-produced vehicles to use advanced nickel-metal hydride batteries — twice the power of lead-acid batteries. With a combined per-charge range of 118 miles and an electronically controlled top speed of 79 mph, the RAV4-EV is a serious player in the race for zero emissions.

GENERAL

- Front engine, front-wheel drive, 4-passenger, 4-door vehicle

DIMENSIONS AND WEIGHTS

• Exterior		• Interior, front/rear	
Overall length	162.0 in.	Head room	40.3 in./39.0 in.
Overall width	66.7 in.	Shoulder room	53.1 in./53.1 in.
Overall height	63.6 in.	Hip room	55.9 in./56.0 in.
Wheelbase	94.9 in.	Leg room	39.5 in./33.9 in.
• Curb Weight	3,230 lbs.	• Cargo Volume (behind rear seats)	31.4 cu. ft.

STANDARD FEATURES

- Dual air bag Supplemental Restraint System (SRS)
- Fully reclining front and rear seats
- Low-energy heat pump-type CFC-free air conditioning available
- Power windows and door locks available
- Deluxe AM/FM stereo with Cassette available
- Heated seats (driver and front-passenger)
- Heated windshield
- Rear window defogger and wiper
- Dual black outside mirrors
- Rear door-mounted spare tire
- 195/80R16 low rolling resistance steel-belted radial tires (unique to EV)



RAV4-EV

Zero Emission Vehicle (ZEV) Demostration Project
Toyota RAV4 – EV



Janet demonstrates the RAV4 - EV to MCOG's Technical Advisory Committee.



The County of Mendocino Administration Center in Ukiah.





The RAV4 – EV at Alex Thomas Plaza in downtown Ukiah. Summer temperatures can reach well over 100 degrees in the valley, nevertheless this EV's air conditioning kept it cool and comfortable.

Photos by Janet Orth and Marina Baird

Zero Emission Vehicle (ZEV) Demonstration Project
Toyota RAV4 – EV



New tech meets old tech at the Roots of Motive Power exhibit in the redwood mill town of Willits.



Janet takes the RAV4 – EV off road at the future site of REDI's Noyo Harbor Center for Sustainability.



Charging at the Orth's home in Brooktrails.

Photos by Tony & Janet Orth



ZEV Project
MCOG/REDI
Sept.. 1999

Toyota RAV4-EV Deployment in Mendocino County

Zero Emission Vehicle (ZEV)
Demonstration Project

Prepared by

Janet M. Orth
Director
Renewable Energy Development Institute (REDI)

Submitted to

Mendocino Council of Governments (MCOG)

July 30, 1999

Introduction

A Toyota model RAV4-EV electric vehicle was acquired from Toyota Motor Sales, USA for three weeks, June 15 to July 7, 1998, for use by the project. The RAV4 was driven 1,110 miles over the 22 days, by ten trained and insured drivers. Over 75 local agency elected officials and employees, business owners, and other Mendocino County residents took rides in the EV, and over 200 others viewed the vehicle during its evaluation.

The RAV4 was tested over the challenging terrain of the North Coast, with elevation changes from nearly sea level at the coast in Fort Bragg, to 600 feet in the Ukiah inland valley, to 2,500 feet in the mountain ridges above Willits (Brooktrails and Spring Creek subdivisions).

Conclusions

This compact sport utility vehicle with NiMH batteries performed well under all of the rigorous conditions tested in Mendocino County and is recommended for general use. It was tested during extremely hot weather, and even using the air conditioning it had plenty of range and power.

Driving and Vehicle Statistics

The car was driven an average of 50 miles per day throughout the deployment. No one was ever stranded in the RAV4 during the project. The most notable trip was from Brooktrails (Willits) to Fort Bragg and back, with an elevation change of 2,500 feet, proving the RAV4's ability to make the 82-mile round trip using only three-quarters of a battery charge.

The RAV4 did well in summer conditions, at well over 100 degrees in the enclosed Ukiah inland valley. The air conditioning (CFC free) was effective, and even with the AC on the EV had more than enough energy for the flat freeway driving and town use around the valley. It was more than able to keep up with 65 mph traffic, with an electronically controlled top speed of 79 mph. Acceleration, presumably also computer controlled, is not as impressive as GM's sporty EV1, but perfectly adequate at 0-60 mph in 17 seconds.

Overall, including the steep upgrades of U.S. Highway 101 and State Route 20, this EV got about 100 miles per charge. According to Toyota's brochure, the vehicle is rated at a combined city and highway range (130 and 106 miles respectively) of 118 miles per charge, so Mendocino County rural use achieved close to the design specifications. The nickel-metal hydride battery technology is well suited to these conditions, more so than the lead-acid type.

The regenerative brake system was also a factor in the car's performance in hilly areas, called "engine braking" on the driver's controls. This feature converts the kinetic energy of braking and deceleration into electrical energy to the batteries, thus increasing the vehicle's single-charge driving range. The RAV4 climbed well in the steep residential neighborhoods at 25-35 mph, although the voltage indicator dropped considerably. Still, it was able to carry a full load of passengers up the steepest ridges, from 1,300 feet in elevation at the Willits valley floor to about 2,500 feet at Ridge and Blue Lake Roads in Brooktrails and Spring Creek.

Training

Each driver received a training session from REDI personnel and a test drive before driving the car. The controls and displays were explained in detail to familiarize drivers with energy and power indicators and other features. Charging procedures were reviewed as well. Drivers were instructed to make entries in a logbook to record energy, mileage data, and anecdotal experiences.

When I first drove the RAV4-EV in February '98 with Kent Harris of PG&E, I got in the driver's seat and asked him to show me the ropes. He replied, "There are no ropes," referring to the ease and simplicity of driving this car.

In contrast to the GM EV1, the RAV4's dashboard displays were minimal. There is a state-of-charge (SOC) meter that resembles a fuel guage with a needle that marks off sections in eighths, with a warning zone at the bottom of the scale. This along with an odometer and a trip meter gives the driver an indication of range remaining on the battery charge. The ZEV Project's logbook entries were stated in terms of fractions on the guage. You can also set the trip meter and watch mileage. With a little experience of these two indicators, drivers can learn to estimate range available during trips.

There is also a meter that indicates energy usage continuously, so the driver can control energy efficiency and budget power usage for longer trips. Numerous other controls and indicators also are displayed for features such as power windows and door locks, heated seats, stereo, and AC.

Note that the RAV4 was deliberately designed to be "transparent," in other words the controls are familiar and not much different from those of cars most people drive. Toyota's brochure says, "Logical and legible, ergonomic and efficient, RAV4-EV's intrument panel was designed for easy use."

This 4-door EV seats five, with room for cargo in the rear. With all of these features, the practicality of the RAV4 was generally apparent to project participants.

Charging

The Toyota RAV4-EV comes equipped with an on-board, 220-volt/40-amp conductive charge system with a timer. No 120V convenience charger came with the vehicle, although the owner's manual notes the option. There is no interim unit between the vehicle and the power source receptacle, only the power cord with a charge connector nozzle to the EV on one end and a plug to the charging station on the other. All charge controller read-outs are visible on the EV interior's dashboard instrument panel. This arrangement was not especially convenient, as the start key must be used to read the SOC meter, and the owner's manual advises the operator to "as much as possible, avoid stopping the operation in the middle of charging." The charger stops automatically when the EV is fully charged; however there is no way to know how far into the charge cycle you are without interrupting the charge. Other than that, the overall design was simple and user friendly.

Charging stations used for the RAV4's deployment were 1) the public station in downtown Ukiah installed by the ZEV Project, 2) MTA's headquarters in south Ukiah, 3) the Orth residence in Brooktrails (my house), 4) once at the public charging station in Fort Bragg, and 5) once at Real Goods in Hopland. At home, we have a sheltered recreational vehicle (RV) type electrical outlet that worked with all five of the EVs tested by the project.

The product brochure states it takes six to eight hours to fully charge from depletion. This is about right based on our experience. Mostly charging was done overnight, so it was not always timed. We also plugged in for short periods during the day as needed to extend range. This can be a relatively expensive option, as detailed below.

The RAV4 owner's manual advises against charging "under scorching sun" or "in strong sunlight," as the equipment can overheat and the charge cycle shut down early. This supports our recommendation for solar photovoltaic shade structures in parking lots with EV charging stations.

Safety features
The owner's manual gives several other cautionary notes relative to the charging procedures, for user safety and to protect the equipment. Most of these are typical, common sense practices dealing with electrical equipment in general.

According to brochure, "An automatic disconnect system shuts off the battery voltage if a collision should occur. When servicing the vehicle, a manual safety plug will disable the power system....The [closed] power control unit houses the inverter, battery charger, air conditioning inverter and the control unit. It is water resistant and built for easy maintenance." The RAV4-EV comes equipped with dual air bag "Supplemental Restraint System," side-impact door beams, 4-wheel Anti-lock Brake System (ABS), and "front shoulder belt pretensioners with force limiters."

Energy Use and Cost
There were few hard numbers for analysis from the deployment, aside from mileage and SOC meter entries. There was no kilowatt-hour meter, so the only way to measure energy use by charging at one dedicated charge station and reading the utility meter before and after a trip. I performed this test on June 29 and 30 with the Ukiah downtown station. It used 25 kW- hours to make my round-trip commute of 55 miles, Ukiah to Brooktrails and back, with the terrain and elevation changes noted earlier in this report. (The EV1 takes about 20, the EPIC minivan about 30 kWh for the same round trip.)

It was with the RAV4 that I first comprehended the difference in energy cost between daytime peak-demand and off-peak charging. This larger, heavier vehicle used significantly more energy than the small, super-light, and aerodynamic EV1. So the cost of daytime charging at the rate of 16.5 cents per kW-hour, not counting the $10 in monthly fees for the City of Ukiah municipal utility account, would be prohibitive if most of the charging was done at that rate--more than the cost of gasoline.

A better plan is to charge during off-peak hours, in other words, overnight, at lower rates. Under my residential account with Pacific Gas & Electric Company, we have opted for "time of use" rates, for which we pay 31.5 cents/kWh weekdays from 9:00 a.m. to 5:00 p.m. and 8.5 cents/kWh the rest of the time. So it is very economical to charge overnight at home. There is also a special rate called E-9 for electric vehicles, according to the California Energy Commission.

Toyota encourages this strategy with the RAV4-EV's timer feature. The brochures say, "A built-in timer lets you set charge start time so you can take advantage of the lower electrical costs at night...You can charge conveniently during off-peak hours when electricity is cheapest."

An energy-efficient comfort feature provided is cabin preheating and precooling. Cabin conditions can be set in advance, for instance to preheat before starting in the morning or to precool while parked on warm days. In this way, the energy to accomplish this can be drawn from the utility connection while plugged in, thus conserving the EV's battery capacity for driving. Also, energy loss during charging is inherent, so this method would save energy.

Commuting in Mendocino County

My 55-mile round-trip commute between Brooktrails to Ukiah, with a few miles town driving during the day, was tested with all five of the vehicles. I called it the "Ridgewood Grade challenge" as the EVs had to make the seven-mile grade over the mountain, then the steep last three miles into Brooktrails at the end of the trip. The RAV4 used slightly more than three-eights of the battery charge on the uphill run from Ukiah to home in Brooktrails. Going south, downhill in the morning, is no problem for the RAV4, making full use of "regen" and using slightly more than a quarter of a battery charge. The total round trip took less than three-quarters of a charge. This enables overnight charging at affordable rates, with daytime charging only necessary for additional day trips. I tried to drive normally for comparison with a gasoline powered car. It is possible to drive for greater energy efficiency. I was impressed with this EV's performance.

Other ZEV drivers had easier commutes. Our informal survey bears out the statistic quoted in the Solectria report, that the average commute of most Americans is only 25 miles per day. Of 16 interviewed who drove or rode in the RAV4-EV and answered the question of their daily commute mileage, the average was 18 miles. This EV can easily accomplish such a commute in Mendocino County. Commutes longer than my 55 miles are certainly possible when charging facilities are available at each end.

Some Driver Comments

Driver Steve Turner, Assistant General Manager of Mendocino Transit Authority, was interviewed on August 10, 1998, after his experiences with the RAV4, summarized as follows.

> "The vehicle was comfortable and easy to drive. It was a pretty transparent mode of propulsion, almost indistinguishable from a gasoline car within a 100-mile range. You don't need to think of it as electric. The range is adequate--you don't need to think about energy. I took four passengers up Burke Hill (on Highway 101 between Ukiah

and Hopland) using air conditioning. Performance was good. For consumers, it's almost irrelevant that it's electric. For longer trips, take a gas car.

The RAV4's size is too small for transit use. It's okay for fully mobile persons, but many MTA Dial-A-Ride (DAR or demand response) riders have mobility problems and are not as ambulatory, so they have trouble climbing up and in. The energy capacity is probably adequate for an eight-hour shift, since during idle time no energy is used. MTA pays a commercial electricity rate of about 6-8 cents a kilowatt-hour. It would probably function well in Ukiah, where MTA has four DAR vehicles and the appropriate vehicle for the call could be dispatched. Fort Bragg and Willits, on the other hand, only have a single DAR vehicle each. The RAV4 could not be used, as it is not wheelchair accessible. The body style is an access issue, not an energy issue--the propulsion is irrelevant.

It would work okay for a staff vehicle, performing well for most trips. However, for MTA the RAV4-EV is too expensive for that application as retired DAR vehicles are used, so it's a cost issue. For city fleets, it should function very well, as it would be all local use. 80 percent of people can use electric vehicles. The bottom line issue is capital cost; the only thing you can criticize is the cost to acquire the RAV4-EV. MTA can use the state procurement process to purchase a vehicle. EVs are treated just the same and are easy to get. *[See the CALSTART Coop. List]*

It's a "smart car," you can program it to preheat or precool on a timer. It's easier--the cabin preconditioning feature is one you can't get with a gas car. It's better than a gas car in that there is no cold-start pollution. The first minute of operation is when gas cars emit the most pollution. Consumers are sophisticated enough that they don't have to care about the technical side--they know it works."

Informal Survey

An informal questionnaire was used to collect responses from 20 drivers, passengers, and viewers of the RAV4-EV. Results are attached.

Attachments:

Table of Toyota RAV4-EV Drivers, Passengers and Viewers - *ZEV Project participants*
- by Marina Baird, Plan-It

"Overall Consensus on the Toyota RAV4-EV" - *results of ZEV Project survey*
- by Marina Baird, Plan-It

"Testimonials on the Toyota RAV4-EV" - *results of ZEV Project survey*
- by Marina Baird, Plan-It

Source: The format of this EV technical report was provided for the ZEV Project by Bill Warf of Pacific EV. The content was compiled and written by Janet Orth of REDI.

Zero Emission Vehicle Demonstration Project
Toyota RAV 4 - EV

Entity Represented	Drivers	Number of Passengers	Number of People Viewed By
Mendocino Council of Governments Directors, Staff & Associates	Janet Orth Project Director Charles Cliburn Chairman	7	5
Mendocino Transit Authority Including Directors & Staff	Steve Turner Assistant General Manager	10	5
Renewable Energy Development Institute Directors	Keith Rutledge President Phil Jergensen, David Leverett & Wayne Robertson - Directors	15	100 +
City of Ukiah City Officials	Dave Lohse Associate Planner Rick Kennedy Director of Public Works	5	20+
City of Willits City Officials Business Owners Citizens	None	20	80+
Brooktrails Township CSD Directors & Staff	Tony Orth Director	9	10
City of Fort Bragg Mayor, Public Works Department & EV Technician	Lindy Peters Mayor	1	1
County of Mendocino Supervisor & Public Works Staff	Charles Cliburn County Assessor	6	12
Totals	10	73 +	232+

Zero Emission Vehicle Demonstration Project
Overall Consensus on the
Toyota RAV4-EV

by Marina Baird, Plan-It

The Toyota RAV4-EV was the demonstration vehicle for the Mendocino Council of Governments and the Renewable Energy Development Institute's ZEV Demonstration Project for the period of June 15 to July 6, 1998. This vehicle was either driven by, ridden in or viewed by over 300 people, many of whom also drove, rode in or viewed the General Motors EV1. The following information was compiled after interviewing those involved.

This vehicle was typically displayed in its charging position, at public events or private viewings. However, when driving around town, on rural roads and on freeways, most people were unaware that it was an electric vehicle. This was in contrast to the General Motors EV1, with its unusual sleek look and EV markings.

There were a total of ten drivers. The estimated 67 passengers and over 200 viewers were a representation of government officials, professional people, business owners, and average citizens, both male and female, young and old.

Everyone except for one person exposed to the RAV4-EV greatly altered their opinion in favor of electric vehicles. This one person was already an "extreme advocate of electric vehicles."

If affordable and available, all interviewed but a very few would consider owning or leasing an electric vehicle. The primary use of the vehicle would be commuting, local errands and recreation. Those who would not consider one at this time voiced that they would like to wait until electric vehicles had a longer driving range. However, the average commute in miles of those surveyed ranged only from one to 70 miles daily.

The most frequently asked questions were:

- How much does it cost?
- Where can I get one?
- How far will it go?
- How many hours will it go?

Zero Emission Vehicle Demonstration Project

Testimonials on the

Toyota RAV 4 - EV

The following are testimonials which were compiled from various drivers and passengers. These comments are based on the Toyota RAV 4 - EV, which was the demonstration vehicle for a three week period in June of 1998.

"I don't see why anyone would want anything else for around town." - County Supervisor

"Best car I've driven - smooth pleasant, simple with a good design. I even used the air conditioner, it worked just as an EV should!" - Director of Renewable Energy Institute

"I had a great time! The overall performance of the RAV 4 - EV was more user friendly than other EV's I've driven. There were no worries about energy rationing." - County Assessor/MCOG Chairman

"It was just like a real car - if there wasn't an EV sticker on it; no one would know. Everyone wanted to know how much they were to lease or buy" - Loan Officer/President of Renewable Energy Institute

"The Toyota RAV 4 - EV was very comfortable and ran like a top. I was very impressed with how it handled and the breaking and charging features." - Mayor

"A real car with great charging technology! I could see a realistic use of this vehicle." - Chamber of Commerce

"A comfortable and safe feeling car!" - State Highway Planning Coordinator

"I was very impressed with this car. It was very stable compared to other Sports-Utility vehicles. The high wheel base is good for rural areas." - Business Owner/Association Director

"I've owned an electric tractor since 1972. The Toyota RAV 4 - EV is a good piece of equipment!" - Farmer/Business Owner

MENDOCINO COUNCIL OF GOVERNMENTS
215 W. STANDLEY STREET
UKIAH, CALIFORNIA 95482
(707) 463-4470

October 16, 1998

Jennifer Allen, Project Manager
California Energy Commission
1516 Ninth Street, MS-41
Sacramento, CA 95814

Re: Grant #MEM-97L-007
Vehicle Acquisition Summary Letter

Dear Jennifer:

This summarizes progress on the Zero Emission Vehicle Project, Task 2 - "Negotiate acquisition of and acquire vehicles for testing through leases or loan programs."

In June, 1998, we acquired a Toyota RAV4-EV for ride-and-drive demonstrations from:

Mr. Mark Amstock
Toyota Motor Sales USA, Inc.
19001 South Western Ave., P.O. Box 2991
Torrance, CA 90509-2991

The vehicle was supplied to us at no charge for a three-week period, June 15 through July 6, 1998. Toyota supplied transport of the vehicle, with delivery and pickup at Mendocino Transit Authority in Ukiah. We successfully demonstrated the RAV4-EV to MCOG's Technical Advisory Committee members and other participants in the ZEV Project.

Please let me know if you would like further information.

Sincerely,

Janet Orth
Administrative Assistant
ZEV Project Manager

Ranger EV

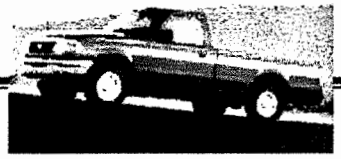
FORD



The Ford Ranger is perfectly compatible with the standard recreational vehicle outlets found at the Redwood Empire Fair.

Tested:
Mendocino County
October 26 to November 11, 1998

Photo by Janet M. Orth



Ford Ranger EV

Description: This electric pick-up truck is based on the best selling gasoline-powered Ford Ranger compact truck. The model tested was Ford's **1998** production electric vehicle with lead-acid batteries, designed for reliability and durability, and especially for the needs of fleet customers.

Performance Specs

Driving Range: 58 miles
Top Speed: 75 mph (governed)
Acceleration: 0-50 in 12.5 seconds
Recharge/Refuel Time: 6 to 8 hours
Passenger Capacity: 2

Technical Specs

Dimensions: Length: Not Available; Similar to 1998 Gasoline Powered Ranger
Curb Weight: Not Available
Gross Vehicle Weight: Not Available
Engine Motor: 75 Horsepower, Three-Phase AC Induction Motor
Payload: 700 lb. (1,250 w/NiMH)
A/C and Heater: Yes
Preheat/Precool Cabin Timer Feature: Information Not Available
Other Features: Electrohydraulic Power Steering, Lightweight Aluminum Wheels

Safety Features

Air Bags: Yes, Dual – Passenger Side Air Bag Deactivation Switch
Anti-lock Braking System: Yes
Meets All Federal Standards: Yes
Other: Electrical Hazard and Other Warning Lamps

Price/Lease Options

Price: $14,455 Prepaid Lease
Payment Terms: Lease Only, $450 a Month for 3 Years
Warranty: 3 years/36,000 Miles
Availability: Fleets and Limited Supply to Consumers

For More Information Contact

Lithia Sun Valley Ford
2285 Diamond Blvd.
Concord, CA 94257-0968
www.ford.com/electricvehicle

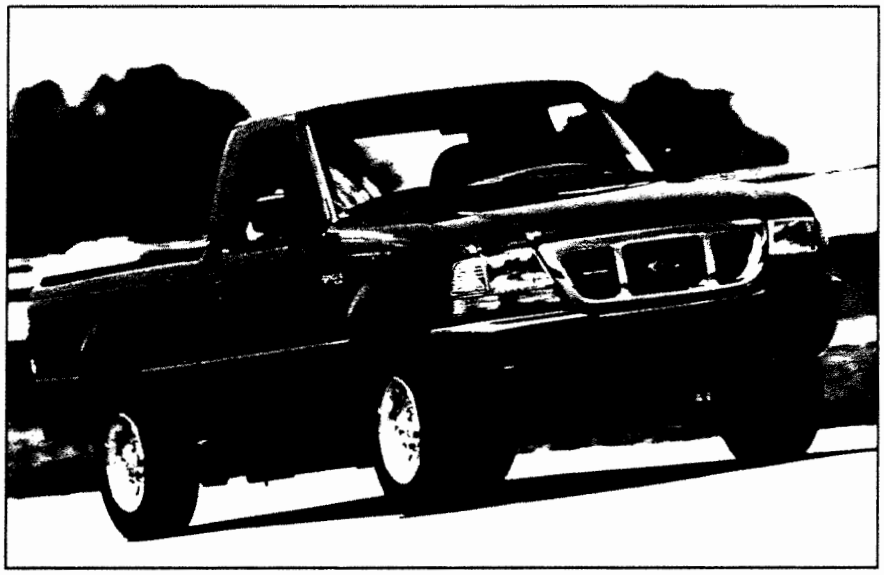
New for 1999, the Ranger Electric Vehicle Nickel-Metal Hydride

Dependable and Reliable - "Built Ford Tough"

The nickel-metal hydride (NiMH) Ranger EV is a practical, robust, light duty pick-up that balances performance, reliability and energy efficiency. Since the NiMH battery pack is lighter than the lead-acid version, the NiMH pick-up can carry an improved payload (up to 1,250lbs). Rear-wheel drive along with a rigid frame and suspension provide "Ford Tough" durability. With an attractive lease rate and a driving range of 65-85 miles, the NiMH Ranger EV can tackle a variety of real-world fleet applications.

Key Specifications

- Styleside Regular Cab 4x2 (112" wheelbase, 6' box)
- 90 horsepower; 140ft./lbs. Torque
- High-efficiency 3-phase AC electric motor/single speed transaxle
- 25 NiMH 12-volt modules; 300 volt system
- Range: 100 miles - estimated Federal Urban Driving Schedule (FUDS)*
- Energy Capacity Rating (FUDS): 28 KWH (25 KWH at 90% discharge)
- Payload: 1,250 lbs. (GVW: 5,350 lbs.)
- Zero-Emission Vehicle (ZEV) Certification - can be operated indoors as well as outdoors



Driving Range and Charging

The NiMH Ranger EV achieved a FUDS range of 100 miles @ 70° F w/o use of heater or air conditioning. The "Real World" range is approximately 65-85 miles, depending on climate and driving conditions. This range can decrease to 45 miles @ 45° F with full operation of the heater.

The vehicle can be fully charged in 6 to 8 hours depending on the ambient temperature; however, the use of opportunity charging during the day can significantly increase the range and use of the vehicle. Opportunity charging means keeping your Ranger EV "on plug" - charging whenever it's not in use. This type of charging will not harm the batteries. In fact, Ford recommends that the vehicle always be put on charge when not in use. This procedure will protect and extend battery life.

Charging is accomplished using safe and economical conductive charging infrastructure. The Power Control Station (PCS)[1] used with conductive charging is a separate piece of equipment necessary to charge the vehicle. It provides the link between the stationary electric power source and your Ranger EV. The PCS controls the power to the on-board vehicle charger and must be wired directly to a 208-240 volt, 32 amp continuous electric service source. Ford has elected to use conductive charging equipment because it is significantly less costly to purchase than the competing inductive charging equipment. Both conductive and inductive charging comply with SAE safety standards.

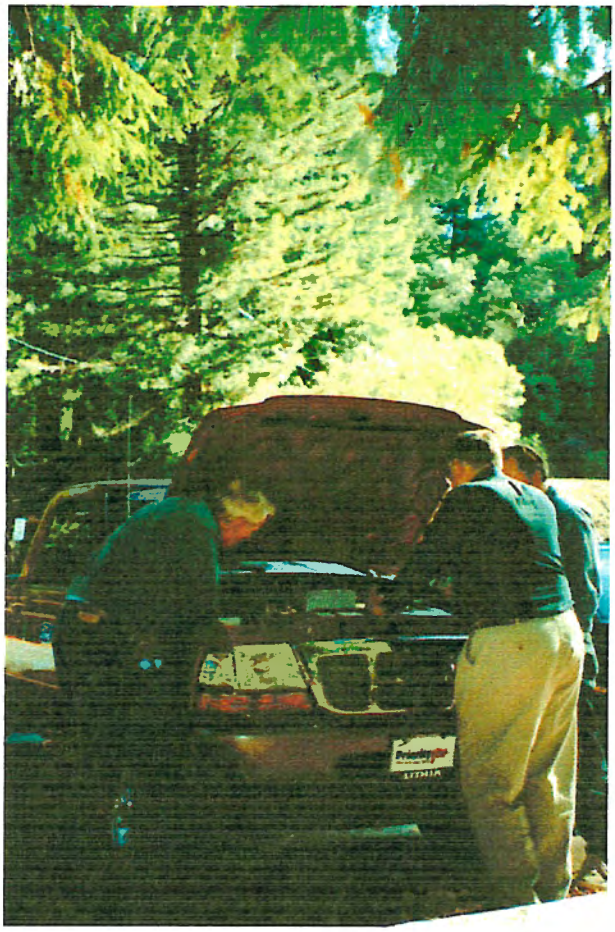
[1] The PCS and its installation are not included in the lease rate for the Ranger EV and must be individually contracted for by the vehicle customer. (The PCS may be included with the vehicle in a lease.) For a list of approved distributors for this equipment, please contact your Ford EV Dealer or call 1-800-ALT-FUEL

* NiMH Ranger EV FUDS testing to be completed in August, 1998

Zero Emission Vehicle (ZEV) Demonstration Project
Ford Ranger EV



The Ranger EV blends in with Brooktrails' fire department in the redwoods.



Brooktrails Township Community Services District personnel get their first look under the hood.



Tony Orth, Brooktrails Board Member, recharges the Ranger at home.

Photos by Janet Orth

Ford Ranger EV Deployment in Mendocino County

Zero Emission Vehicle (ZEV)
Demonstration Project

Prepared by

Janet M. Orth
Director
Renewable Energy Development Institute (REDI)

Submitted to

Mendocino Council of Governments (MCOG)

July 30, 1999

Introduction
A Ford Ranger EV pickup truck was acquired from Ford Motor Company for two weeks, October 27 to November 10, 1998, for use by the project. The Ranger was driven 260 miles over the 15 days, by 11 trained and insured drivers. Ken Stwertnik, AFV Specialist from Ford's Alternative Fuel Vehicle Center, gave a presentation on the Ranger EV to MCOG's Technical Advisory Committee. (This was the most personal attention that any of the car companies gave to the project.) REDI showed the vehicle to the Brooktrails Township Community Services District Board, and the district's personnel were among those who test drove the vehicle.

The Ranger EV was tested over the challenging terrain of Mendocino County, with elevation changes from about 600 feet in the Ukiah inland valley, to 2,500 feet in the mountain ridges above Willits (Brooktrails and Spring Creek subdivisions). The Ranger was tested in the inland part of the county only, as there was not enough time to extend the demonstration to the coast.

The 1998 lead-acid EV model was used, as the 1999 nickel-metal-hydride model Ranger was not yet available.

Conclusions
The 1998 model of this pickup truck with lead-acid batteries was limited in range, as was the EV1. The 1999 model with NiMH batteries increases the payload for utility applications, as they are lighter weight, and also should increase range for intercity use. The 1998 lead-acid Ranger performed well climbing hills and maintaining highway speeds, but was tested without cargo. For utility purposes, the NiMH model is expected to be more useful.

Driving and Vehicle Statistics
The car was driven an average of 17 miles per day throughout the deployment. No one was ever stranded in the Ranger during the project. Only the inland Highway 101 corridor (Brooktrails, Willits, Redwood Valley, and Ukiah) was covered. While tested in Brooktrails' hilly neighborhoods, District personnel noticed an effect on the brakes with the steep terrain. It was noted also that the Ranger is a heavily built utility vehicle, with the heavy lead-acid type batteries. Further testing with a 1999 NiMH model Ranger was requested by the participants. There was no time for this, so any future deployment should consider Brooktrails.

The Ranger has a two-mode regenerative system, identified on the controls as D and Econ. On November 9, I wrote in the logbook:

> "Experimented with regen on the mountain--on highway works best in 'D' not Econ mode, as E-mode has too much braking action for high speeds. Still has good regen effect in D-mode, gained 20 miles going down 7-mile grade. State of charge meter also gained. All drivers seem to agree that Econ meter not clear--not sure if working properly. Goes into negative area when brakes applied--dealer says should work the opposite way. Ranger drives smoothly, but vibrates a lot on rough roads--tight suspension. Both Ford Ranger and Toyota RAV4 should have cruise control. Otherwise nice car. Would help to have optional 110V convenience charger. Would not need with NiMH."

Training

I received an orientation from Ford personnel, driving the Ranger EV at the Alameda International EV Expo just prior to deployment, then trained subsequent drivers during the project. The controls and displays were explained in detail to familiarize drivers with energy and power indicators and other features. Charging procedures were reviewed as well. Drivers were instructed to make entries in a logbook to record energy, mileage data, and anecdotal experiences. The dealership, Lithia Sun Valley Ford in Concord, provided good support throughout the deployment.

The Ranger EV is another "transparent" design, with the intrument panel presumably the same as the traditional Ranger, with the meters reassigned to EV purposes. So the dash looks familiar to drivers and just requires a little orientation. There is a typical fuel-type guage for state of charge (SOC), like those of the RAV4-EV and EPIC minivan. Additionally, there is a "Distance to Empty" guage to show the calculated miles remaining on the battery state of charge. The GM EV1 was the only other of the five EVs tested with a similar feature, giving the driver the extra confidence of having a stated range-remaining estimate during trips. The Distance-to-Empty guage and SOC meter together with the "Econ" guage provide indications of the regenerative action, as noted in the log entry of October 27.

The Econ guage caused some confusion, as described by several comments from different drivers entered in the log: "*Econ guage not clear whether green is good or bad.*" "*Didn't understand Econ guage function.*" "*Econ meter still very hard to understand as it seems to give conflicting indicators of plus/minus readings...*" While the guage was supposed to indicate energy drawn from or returned to (via regen) the battery, it was not clear how driving affected the guage.

Charging

The Ranger EV comes equipped with an off-vehicle conductive 220-volt/40-amp charger with vocal readout, very similar to Chrysler's charger. The unit is smaller, but with the same front panel features as the EPIC's. Ford's "Home Charging Device" or "Power Control Station" is designed for installation in a fleet or home garage, as is the EPIC minivan's charging infrastructure. During deployment, this off-board charger unit was carried in the bed of the vehicle, under a waterproof cover.

Charge time is specified in the literature as six to eight hours. I made this note on October 30: "*Charger continues to trickle charge when "full"--reads out total hours--no indication of how long it takes to charge up. Stops after 12 hours. Voice readout, no visual.*"

Only two charging locations were used throughout the deployment, the fairgrounds and the Orth residence in Brooktrails. Both employ RV-type equipment. There was some difficulty finding an appropriate receptacle in Ukiah. Apparently the newer standard NEMA plug with four prongs did not fit older style receptacles that many city and county facilities still use. An alternative charging location was identified at the Redwood Empire Fair in Ukiah. The fairgrounds have a full range of recreational vehicle plugs--REDI's Solar Energy Expo & Rally event displayed many EVs there in 1994, plugged in for rally events. The staff was very helpful and

cooperative, and the 50-amp, 240-volt RV receptacles worked perfectly. The normal fee of $15 was paid for RV parking and plugging in overnight.

Energy Use and Cost
The first kilowatt-hour reading was on October 28, at 0162 kW-h, and the last was on November 9 before returning the vehicle, at 0274 kW-h. The kW-h readout from the charger is a cumulative number. So total usage for the deployment, not counting trips at the beginning and at the end, was 112 kilowatt-hours, averaging about 8 kilowatt-hours per day.

(*See Commuting below for more.*)

Commuting in Mendocino County
My 55-mile round-trip commute between Brooktrails and Ukiah, with a few miles town driving during the day, was tested with all five of the vehicles. I called it the "Ridgewood Grade challenge" as the EVs had to make the seven-mile grade over the mountain, then the steep last three miles into Brooktrails at the end of the trip. (The Ridgewood grade was a challenging part of REDI's "Tour de Mendo" course, an electric vehicle rally event held from 1990 to 1994.)

There were only two round trips made of this commute. In the lead-acid Ranger, as in the EV1, it was expected to charge at each end of the trip, due to the relatively limited battery capacity. The energy usage was consistent over the two trips made, and considered normal for a lead-acid EV. The Ranger used three-quarters of a battery charge going north (uphill). It used one-half of a charge going south (downhill). There was not enough energy usage logged in terms of kilowatt-hours during this short deployment to be meaningful. More data should be collected.

On October 27, I drove from Ukiah to Brooktrails and logged this entry:

> "First road test of the Ranger. Started after dark, used only lights and mist wipers of the accessories. At top of ridge, down to 12 miles on the 'Distance to Empty' guage. Shifted into regen (Econ Mode) and gained 20 miles (to 32) by the time I reached downtown Willits. Regen indicators (3 guages) seemed slow to respond, but showed definite gain by end of trip. Showed car to Brooktrails Board of Directors, staff and meeting audience. Still getting the hang of key start positions. Very quiet and smooth. Taking local deer by surprise."

Some Driver Comments
Paul Williams wrote on October 28: "*Like the ride and drive...a little paranoid about running out of juice when out at Third Gate, but recharged coming back.*"

On November 4, Keith Rutledge logged: "*Sluggish, heavy, bumpy stiff suspension. Regen difficult to work with on switching in and out for use on grades and deceleration in town, etc. No coast on Drive, use Neutral, then Econ.*"

On October 27, Tony Orth logged: "*Before charging, took short drive to familiarize myself with the Ranger drive characteristics. Driving on local streets and cornering in E-mode acted to*

govern speed to 15 to 25 mph with excellent handling. Misting conditions, ran defrost and intermittent wipers. Good seats and clean interior design."

Comments on the Ranger EV's handling characteristics seemed to vary based on subjective reactions and personal preference.

Informal Public Survey

The questionnaire format was not very popular so it was phased out, and during the Chrysler deployment was replaced with a simple guest register for sign-in and optional remarks. Of the Ford Ranger EV drivers and passengers who did fill out the questionnaire, the daily commute distance was a low of 1.5 and a high of 14 miles. One was a landscape contractor with a small fleet of utility vehicles, of which several were Ford Rangers. He said he would consider an electric such as the Ranger EV for his fleet.

Those who had not previously been exposed to a new generation EV responded that their opinion of EVs had changed for the better. One wrote, "*Very impressed with power and quiet ride. Would like electric vehicles in use for sake of environment.*" Another wrote, "*Now it seems a more realistic option...I like it. It's very quiet and rides nice. Seems to handle well, low maintenance.*"

REDI also took the Ranger EV to an open house mixer at Pacific Properties, where a group of local business people and city officials received an informal demonstration.

Source: The format of this EV technical report was provided for the ZEV Project by Bill Warf of Pacific EV. The content was compiled and written by Janet Orth of REDI.

LIFE-CYCLE COST COMPARISON

1999 FORD RANGER EV WITH NICKEL-MEDAL HYDRIDE BATTERIES

and

1999 FORD RANGER XLT 6 CYLINDER GASOLINE VERSION

TOTAL COST PER MILE – 15,000 MILES A YEAR

	XLT 6 Cylinder $20,360 MSRP	**EV NiMH battery** Lease @ $450 month
Operating Costs	**Per mile**	**Per mile**
Gas & oil/ elect. fuel @.05 kWh	7.4 cents	2.0 cents
Maintenance	3.9 cents	0.05 cents
Tires (Ranger EV uses special low rolling resistance tires that may wear out sooner)	1.4 cents	1.6 cents
Cost per mile	12.7 cents	3.7 cents
Ownership Costs	**Per year**	**Per year**
Comprehensive insurance ($250 Deductible)		
Collision insurance ($500 Deductible)		
Bodily injury and property damage ($100, 300 & 50 K)	$1064 (total insurance)	$1430(total insurance)
License, registration	$470	$195
Sales tax (8%)	$407	$779
Depreciation	$3364	0
Finance charge (20% down, 9% interest, 48 month loan)	$792	0
Closed-end lease payment for EV ($450 for 36months)	0	$5400
Ownership cost	$6097	$7804
Ownership cost per day	$16.70	$21.38
Totals		
Operating cost per mile x 15,000 miles	$1905	$555
Ownership cost per day x 365 days	$6097	$7804
Total cost per year	**$8002**	**$8359**
Total cost per mile	**53.3 cents**	**55.7 cents**

Notes:

1. XLT operating cost data provided by Auto Club of Southern California "Your Driving Cost in Southern California" 1998
2. Insurance cost are typical Southern California, but not for a specific location
3. EV operating fuel cost is from studies by Southern California Edison Company
4. EV maintenance cost is based on compliance with owners manual for yearly preventative maintenance (EV repairs, including the battery, are covered by the lease)
5. EV tire cost is estimated (low rolling resistance tires may wear sooner)
6. EV license reflects the 75% reduced cost beginning in 1999 (from $779 to $195)
7. Four years was used for XLT ownership data
8. Three years was used for EV ownership data because of the lease
9. The lease has a cap cost of $29,200

11/04/98 ken s.

1999 Ranger EV – Nickel Metal Hydride

For California Customers

Ford Motor Company is offering the best-in-State lease for the Ranger EV equipped with advanced NiMH batteries.

$14455 Single Payment Upon Delivery

or

$450/month

Plus tax and license. This is a special Ford Credit 36 month closed-end lease.

Included with the lease:

- **The Charging Equipment**
  (one station per vehicle)
- **Bumper to Bumper Warranty**
  (vehicle & batteries)
- **Unlimited mileage**

Comparisons with a conventional pickup:

- **Operating range approximately 85 miles**
- **Payload 1250 pounds**
- **Low lease cost, very low fuel cost, together with minimum maintenance = similar ownership cost**

The Rear Wheel Drive Ranger EV comes standard with best-in-class features, the lower cost conductive charging system, and outstanding appearance. The only option is the spare tire and jack. The Ranger EV even offers Ford's EV decals at no additional cost.

MENDOCINO COUNCIL OF GOVERNMENTS
215 W. STANDLEY STREET
UKIAH, CALIFORNIA 95482
(707) 463-4470

November 9, 1998

Jennifer Allen, Project Manager
California Energy Commission
1516 Ninth Street, MS-41
Sacramento, CA 95814

Re: Grant #MEM-97L-007
Vehicle Acquisition Summary Letter

Dear Jennifer:

This summarizes progress on the Zero Emission Vehicle Project, Task 2 - "Negotiate acquisition of and acquire vehicles for testing through leases or loan programs."

On Friday, October 23, 1998, I attended the 2nd Annual International EV Expo in Alameda and acquired a 1998 Ford Ranger EV (lead acid) for testing and ride-and-drive demonstrations from:

Ken Stwertnik, AFV Specialist
Alternative Fuel Vehicle Center
Ford Motor Company
2044 Loreto Place
Placentia, CA 92870
(714) 572-8856

Gary Billingsley
Commercial Fleet Manager
Lithia Sun Valley Ford
2285 Diamond Blvd.
Concord, CA 94257-0968
(925) 686-3325 ext. 387

The vehicle was supplied to us at no charge for a two-week period, October 26 through November 9, 1998. Mr. Stwertnik arranged to have the vehicle transported to and from the Concord dealership to MCOG's office in Ukiah, at no charge to us (a $700 value). We successfully demonstrated the Ford Ranger EV to various participants in the ZEV Project.

Mr. Billingsley indicated that he could release a 1999 model Ford Ranger EV with NiMH batteries for our use in December. I will keep you informed.

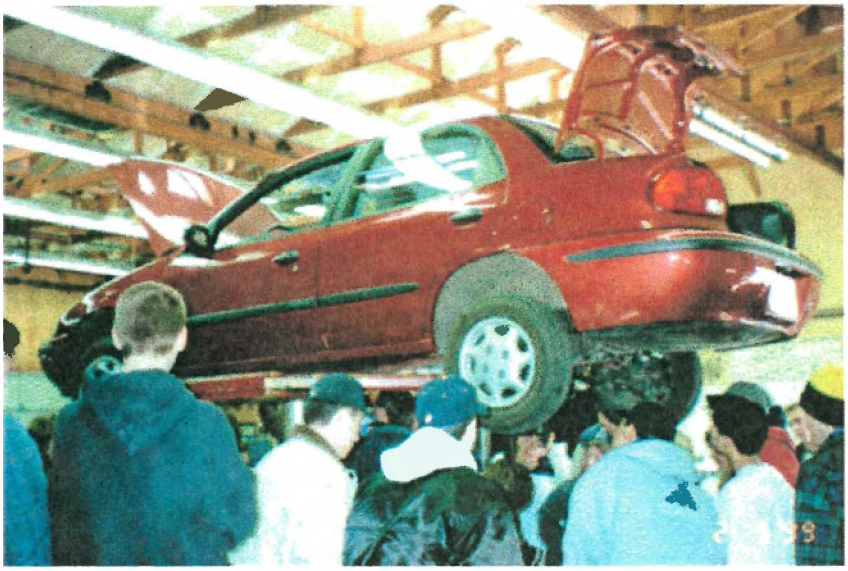
Also, I have enclosed a fully executed copy of our subcontract for clerical support on the ZEV Project, which I meant to send with my correspondence of October 16.

Sincerely,

Janet Orth
ZEV Project Manager

FORCE EV

SOLECTRIA



Ukiah High School students from Automotive Tech, Machine Shop and Physics classes examine the Solectria.

Tested:
Mendocino County
January 20 to February 10, 1999

Photo by Janet M. Orth



Solectria Force EV

Product Description: The Force 4-door sedan features smooth, whisper-quiet, shift-free operation, regenerative braking, a full-sized trunk, and a convenient onboard charger requiring only a standard household outlet. Solectria Corporation builds exclusively electric vehicles.

Performance Specs

Driving Range: 50 miles @ 45 mph
Top Speed: 70 mph
Acceleration: 0-30 in 8 seconds
Recharge/Refuel Time: 3 to 4 hours
Passenger Capacity: 4

Technical Specs

Dimensions: Length: 164"; Width: 70"; Height: 56"
Curb Weight: 2,460 lb.
Gross Vehicle Weight: 2,376 lb.
Engine Motor: AC Induction
Payload: Not Available
A/C and Heater: Yes - CFC Free
Preheat/Precool Cabin Timer Feature: Yes
Other Features: Power Assist Brakes, Rear Window Defogger

Safety Features

Air Bags: Yes, Dual
Anti-lock Braking System: Information Not Available
Meets All Federal Standards: Yes
Other: Information Not Available

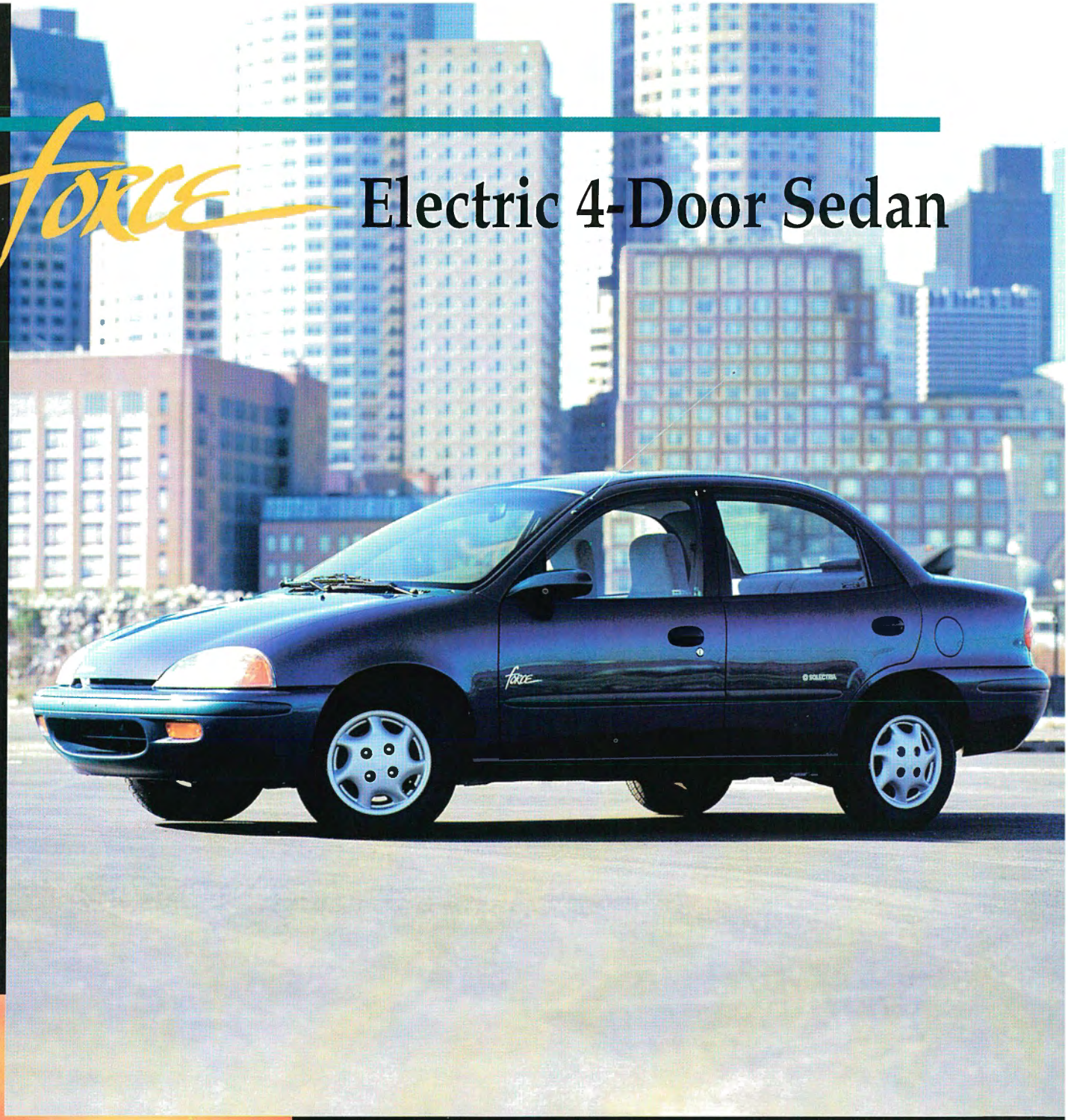
Price/Lease Options

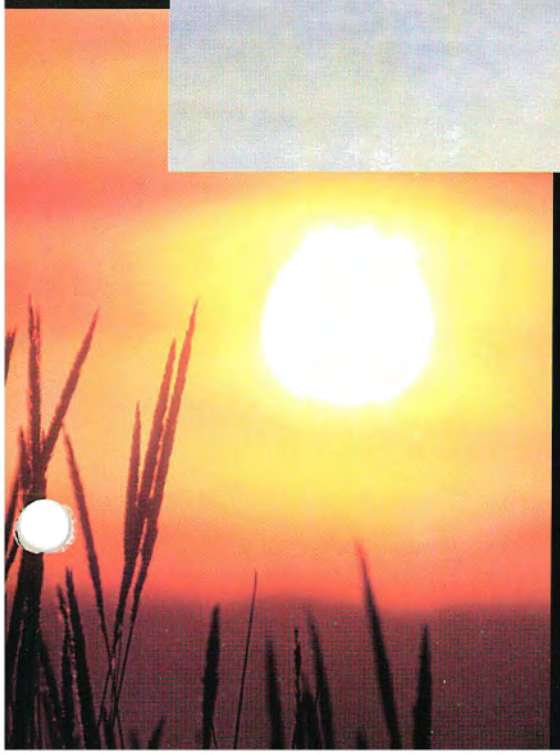
Price: $33,000
Payment Terms: Purchase Only, 50% Deposit Required
Warranty: Standard 1 Year. Comprehensive Warranty Available
Availability: To Consumers, Contact Solectria for Dealership Information

For More Information Contact

Solectria Corporation
33 Industrial Way
Wilmington, MA 01887
www.solectria.com

Force Electric 4-Door Sedan





SOLECTRIA

THE LEADER IN ELECTRIC VEHICLE TECHNOLOGY

With over two million miles of on-road experience, Solectria presents the Force electric sedan ...

Offering state-of-the-art electric vehicle technology in a safe, comfortable, and spacious four-door sedan, the Solectria *Force* is the *only* production electric sedan that met *all* of the grueling requirements established by the nationwide electric utility industry and U.S. Department of Energy coordinated EV America program. Solectria EVs today deliver reliable performance in challenging weather and geographic conditions ranging from Arizona to Vermont.

The *Force* features smooth, whisper-quiet, shift-free operation, regenerative braking, a full-size trunk, and a convenient onboard charger requiring only a standard household outlet. A Range-Power Selector facilitates efficient driving and maximizes battery life, while a battery thermal management system maintains range in cold weather and an optional Cabin Preheat system warms your vehicle before you climb in.

Low-maintenance, user-friendly, and cost-effective Solectria electric vehicles make a positive environmental statement without sacrificing personal comfort. Solectria ... *the leader in electric vehicle technology.*

SOLECTRIA

It's Electric!, Inc.
540 Irwin Street
San Rafael, CA 94901
415-456-7211
Toll Free 877-Go Green (464-7336)
www.greenkeys.com

VEHICLE SPECIFICATIONS

System Power		38 kW @ 156V; 42 kW @ 180V
Length		164"
Width		70"
Height		56"
Curb Weight		2460 lb
Top Speed		70 mph
Efficiency @ 45 mph		137 Whr/mi
Acceleration:	0 - 30 mph	8 sec
	0 - 50 mph	18 sec
Range:	Standard Lead Acid	50 mi @ 45 mph
	Optional Nickel-Metal Hydride	105 mi @ 45 mph

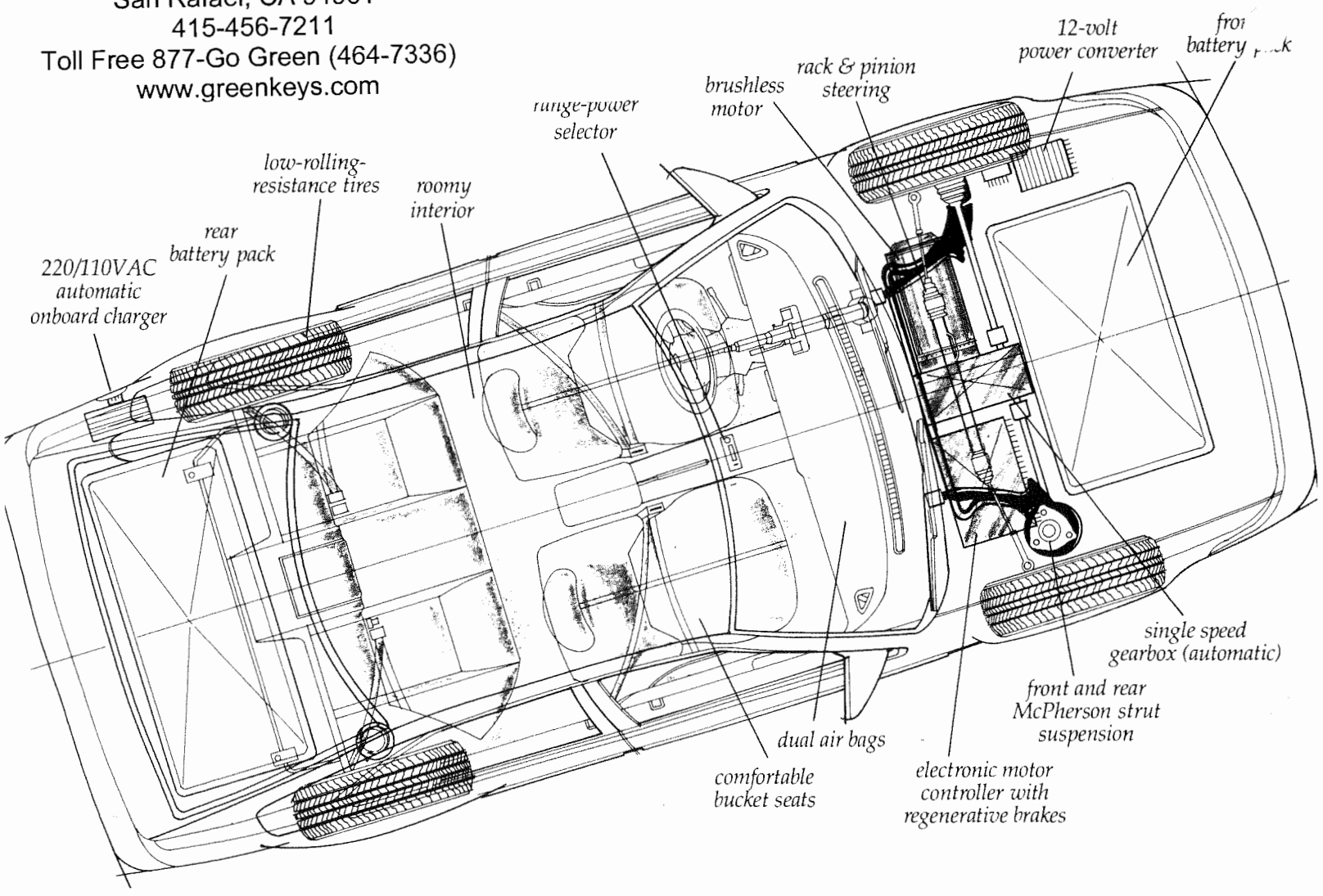
STANDARD

High-Efficiency AC Induction Drive System with Direct-Drive and Regenerative Braking, Range-Power Selector, Sealed Maintenance-Free Batteries, Dual Airbags, Power-Assist Brakes, Electric Heater/Defroster, 12V DC-DC Converter, Battery Level Gauge (Digital Amp-Hour Meter), 3 kW/220VAC Onboard Battery Charger, Reclining Cloth Front Bucket Seats, All-Season Radial Tires, Exterior Color White (unless otherwise noted), Battery Thermal Management System, Solectria Owner's Manual

OPTIONS

AM/FM Stereo with Cassette
AM/FM Stereo with CD
Air Conditioning with CFC-Free Refrigerant
Analog Ammeter *or* Analog Voltmeter
Rear Window Defogger
Cabin Preheat
Fuel Fired Heater

© Copyright 1998 by Solectria Corporation. All rights reserved. Printed in USA.
Photo of Solectria *Force* by Sam Ogden Photography, Boston, MA.

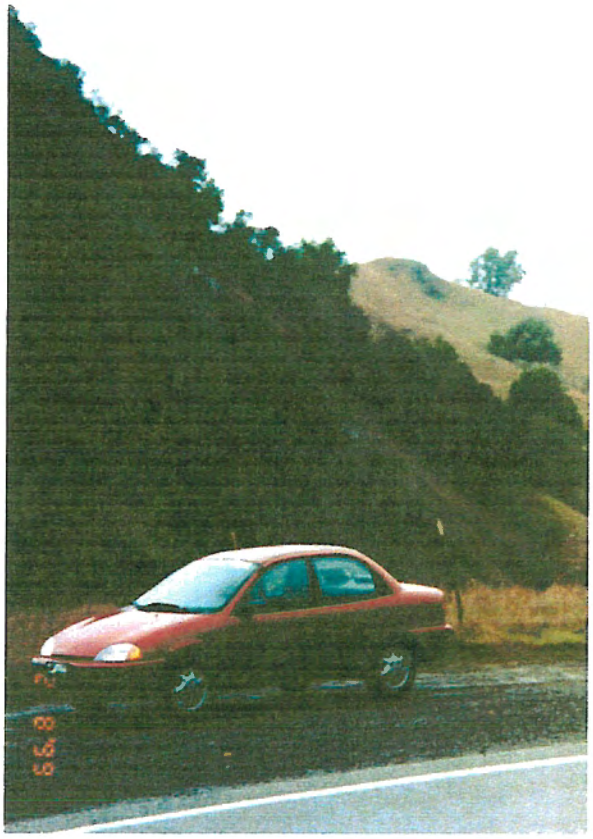


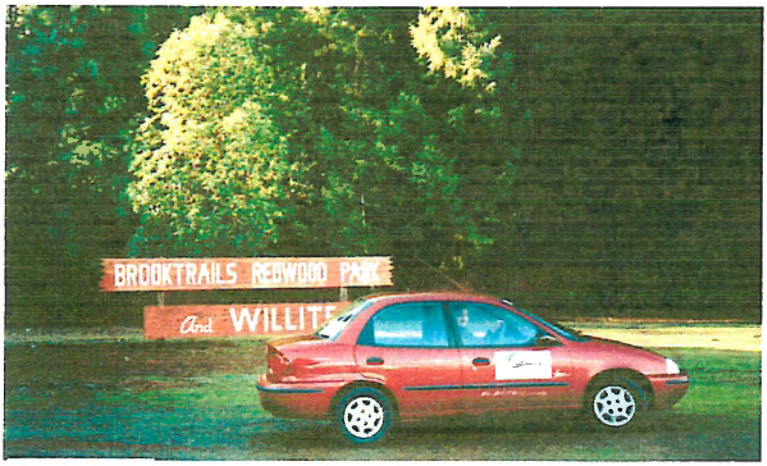
Zero Emission Vehicle (ZEV) Demonstration Project
Solectria Force EV



Tony Orth drove the Force EV over the misty mountain pass on this challenging test run.

The lowest energy use was recorded on a trip from Ukiah to Boonville, especially the section from the peak of the grade down to Anderson Valley, using the Solectria's "regen" system.





The Willits Airport, atop another mountain peak in Mendocino County, greets the Force EV.

Photos by Janet Orth

Solectria Force

Report on Deployment In Mendocino County

Prepared by:
Peter W. Senkowsky
EVTRANSPORT
June 1, 1999

For:
Renewable Energy Development Institute (REDI)
&
Mendocino Council of Government (MCOG)

Introduction:
A red Solectria Force 4-door, 5-passenger electric sedan was rented from "It's Electric", an electric car store in San Rafael, California for the duration of January 19 to February 11, 1999 to be used in the demonstration and evaluation of electric vehicles in rural areas.

Reduction on the rental cost was given in exchange for the placement of "It's Electric's" logo placed on the doors of the car as a means of sales promotion in Mendocino County.

Nine designated drivers drove the vehicle over a total distance of 752 miles. 540 miles are documented in the attached driver's log, the remaining 212 miles were long distance highway driving from the dealership in San Rafael to Ukiah and back.

The driving terrain ranged from level ground in the urban areas of Ukiah and Willits to steep hilly passages going up into Brooktrails above Willits, to over 2,500 feet in elevation, and to Anderson Valley west of Ukiah. The freeway from Ukiah to Willits climbs to 1953 feet at the summit.

The charging station at Oak and Standley Streets in Ukiah and Janet and Tony Orth's charging station at Brooktrail above Willits were used for recharging the vehicle during the test cycle.

The compatibility of the Solectria's charging cord was utilized by fabricating a simple adapter to fit the receptacle at the two mentioned charging outlets.

As opposed to GM's EV1, the Solectria used simple conductive power transfer. The Solectria could also be charged from any 110-Volt or any 220-Volt household or dryer outlet.

The Solectria found use in commuting from Ukiah to Willits and for a trip to Boonville. It also gave us some insight into the usefulness of the vehicle travelling distances beyond its single charge range.

The Solectria had 4277 miles on the odometer when it was picked up at the dealership in San Rafael and 5002 miles when returned.

Conclusions:
An electric car like the Solectria Force is useful for commuting and convenience trips in Mendocino County. Additional charging opportunities at public places such as banks, supermarkets and parking lots would greatly improve the practical use of EVs everywhere.

Vehicle Statistics:
The car is a conversion of a Geo Metro 4-door sedan. The conversion is done by Solectria in Wilmington, Massachusetts. The vehicle complies with all safety standards of the industry and 90% of its components are readily available.

Considering the small production volume of the vehicle, the price of approximately $35,000.00 is fairly competitive. Other EVs such as the GM EV1, Honda EV Plus, Chrysler's EPIC minivan, Toyota RAV4-EV are available on a "lease-only" basis because they are so prohibitively expensive. One can actually own the Solectria outright.

Driving Statistics:
During the program the Solectria was driven for 21 days with an average of 25 miles per day. This average distance represents the average commute distance of about 75% of working Americans, according to the data book produced by the U.S. Department of Commerce, Economics and Statistics Administration and Bureau of the Census. Including the delivery and return of the vehicle the number gets even better, an average of 32 miles in 23 days.

The highest mileage was 59 miles per day. During delivery and return, the vehicle traveled even longer distances. On both trips convenience charging at selected outlets were provided by American Coach Builder in Rohnert Park, Cloverdale Fire Station, a convenience store in Cloverdale across the street from Foster's Freeze , and a fast 220V outlet at Tardel's Restoration Shop in Windsor.

The driving conditions range from dry to heavy rains and even frosty weather.

Training:
Each driver was instructed thoroughly in how to operate the Solectria. The controls in the Solectria are similar to its gasoline cousin Geo Metro except it has Direction Selector with 3 power settings instead of the Automatic gearshift lever.

It has an Amp gauge and a Consumption gauge that indicates the use of Amp/hours.

It also has a switch to control the regenerative system. At full charge it reads "zero" and counts up to its full use of total capacity of about 50 mph (assuming an average of 1 mile per Amp-hour energy consumption). While using "regen" or during charging this gauge will count backward towards "zero" and below, into negative numbers. The explanation for this is that a battery needs to have more energy replaced than it will deliver. It is however only a small percentage. This is a little unusual for the novice but it quickly becomes second nature after a short period of use. Most of the drivers were comfortable with this arrangement.

The first trip of driver Janet Orth was an example that it is necessary to become familiar with controls and gauges and what they indicate. She aborted her attempt to climb a grade thinking that the gauge indicated only 20 Amp/hour left when in actuality there was still 30 Amp/hour left.

Being only a 156-Volts lead acid car, the Solectria performed remarkably well and clearly demonstrated its usefulness. The test also demonstrated that the regenerative braking system makes it possible to keep the energy consumption of the Solectria at about 1 Amp/hour per mile driven using the "egg" technique described by Bill Warf in previous reports. Under average driving conditions and driving skills the consumption is more likely to be around 1.5 Amp/hour per mile.

During the testing period none of the drivers were stranded with the vehicle. Some drivers noted a belt noise during warm up time when driving the first miles, this is an inherent characteristics of the driver belt arrangement. Once operating temperature is attained the car's power system operates entirely noiseless.

Charging:
The charging system is very straightforward and simple to operate. It automatically switches for use on 220V or 110V outlets using an adapter in the trunk. The car charges rather quickly on 220V in approximately 3 ½ hours. That gives you 15 miles of driving per hour of charging. The 110V is just an emergency option in case no 220V service is available. It will fill the car in about 8 hours to full capacity at a rate of 1000 Watts per hour.

The advantage of Solectria's conductive charging system is that it operates from any 30 Amp dryer wall outlet or 220V 15 Amp outlet in the country. Another advantage is that the car does not require any expensive subsystems for charging. It is all built in and included in the price.

Energy use and cost:
During the 3 week test phase of the Solectria Force at REDI the average consumption of the vehicle was 180 Watt-hours per mile (W-h/m).
The lowest energy use was recorded on a trip from Ukiah to Boonville, especially the section from the peak of the grade down to Steve's house in Boonville, using the Solectria's brilliant "regen" system. Also the trips from Brooktrails to Willits and back to Ukiah showed very low energy consumption data.

The project's energy cost is calculated this year at an average of 14 cents per kWh. Weekly energy cost was $6.73 per week of Solectria deployment. This number represents the actual consumption of the charger.

The actual energy use of the vehicle was only $13.98 for 540 miles of recorded driving, averaging a mere $0.0258 per mile. Note that the actual dollar values are higher by a small percentage due to the efficiency factor of the charging unit.

Please refer to **Figure 1** attached to this report for a graph representing the trip miles and vehicle consumption per day. **Figure 2** shows a chart of daily charging time.

Commuting in Mendocino County:
This project proves the adequacy of an electric vehicle like Solectria Force for a 25-35 mile commute given the terrain and cold climates during parts of the year in Mendocino County.

The simple charging system of the Solectria makes fast convenience charging at home, at work or at a friend's house very practical and feasible.

Janet reported on her first trip with the "Force" on Jan 20, 1999:

"First attempt on Ridgewood Grade (Ukiah to Willits) – Failed;
Flat-freeway-10 miles, used 15 A/h, 45-55 mph
Foot of grade - speed down to 35 mph, flooring it.
- at 12 miles, A/h meter at 20
Turned around at start of median barrier, calculated it took me 16-17 A/h from my office to foot of grade, must turn around now or be stranded – dark and stormy night on the Ridge. No Way!"
Well, she thought she had reached the design envelope of this particular electric car.
On January 29th after leaving the car she wrote as follows: "This was a successful run....reached destination, home at Brooktrails, used 38.57 Amp/h."

During the test period, the maximum state of discharge was reached twice, once by Steve Turner on the 29th of January and once by Alan Falleri at 52.68 A/h on February 3rd. In both cases the car made it safely "home" to the charging outlet. In both cases the car did not go into reduced power mode also called "limp home mode" to protect its batteries from over discharge.

The seven miles of upgrade driving from Redwood Valley (foot of grade) to the summit on the way from Ukiah to Willits displayed highest energy consumption. For on this road, next to serious climbing, also high speed is required. The consumption here is as high as 436W-h/m. With this car the energy consumption on this grade is equivalent to 17 miles of driving on level surface at 45-50 mph speed.

On January 28th Janet amended her original entry on the log book where she aborted her first trip home: "I think much of the problem was not knowing the battery capacity / level relative to Empty/Full scale. No indicators show the point on continuum like a fuel gauge. You need to know and monitor numbers, it's not "transparent" like the Ford and the Toyota. I might have had more confidence knowing the limits."

The gauge can show a discharge of up to 55 Amp/h until the batteries are at zero capacity.

Notes on the trip from San Rafael to Ukiah and back to San Rafael:
I drove the Solectria Force from "It's Electric" in San Rafael to American Coach Builders in Rohnert Park. While I worked on an electric bus the car was plugged in for 2 ½ hours on a 220V outlet. It was quickly topped up after the previous 22 miles of freeway driving. From Rohnert Park it was a rush hour stop and go driving to Windsor. From there it was 50 mph all the way to the fire station in Cloverdale. The fire station had only a 110V service, so it was time to get some sleep. The next morning the car greeted me with a "full" green charge light. I drove it to Hopland (oops.... the charging station at Real Goods open at 10:00 a.m., no good for early birds). Never the less I made it to Janet's office at the corner of Oak and Standley in Ukiah.

After the last day of deployment I had even more fun picking up the Solectria Force at the Fairgrounds in Boonville. I had a full charge. I went up the seemingly never ending incline from Boonville and then descended in "regen" mode down to Cloverdale using only 1 A/h a mile average. I gave the car a 10 A/h charge at the convenience store in Cloverdale and drove it all the way to Tardel's Restoration Shop in Windsor. When I arrived there at 8:00 p.m. the boys were still at work, after 4 hours of charging on a 220V outlet I drove home to Glen Ellen and made it to the top of Trinity Mountain by 1:00 a.m.

The following morning I gave the Solectria a thorough wash and detail before driving it the 36 miles back to the store in San Rafael. I was impressed with the dollar value of this electric 4-door sedan compared to the other electric vehicles I drove before.

Average trip miles per day: 25.71 miles
Average vehicle consumption per day: 30.48 Amp/hr.

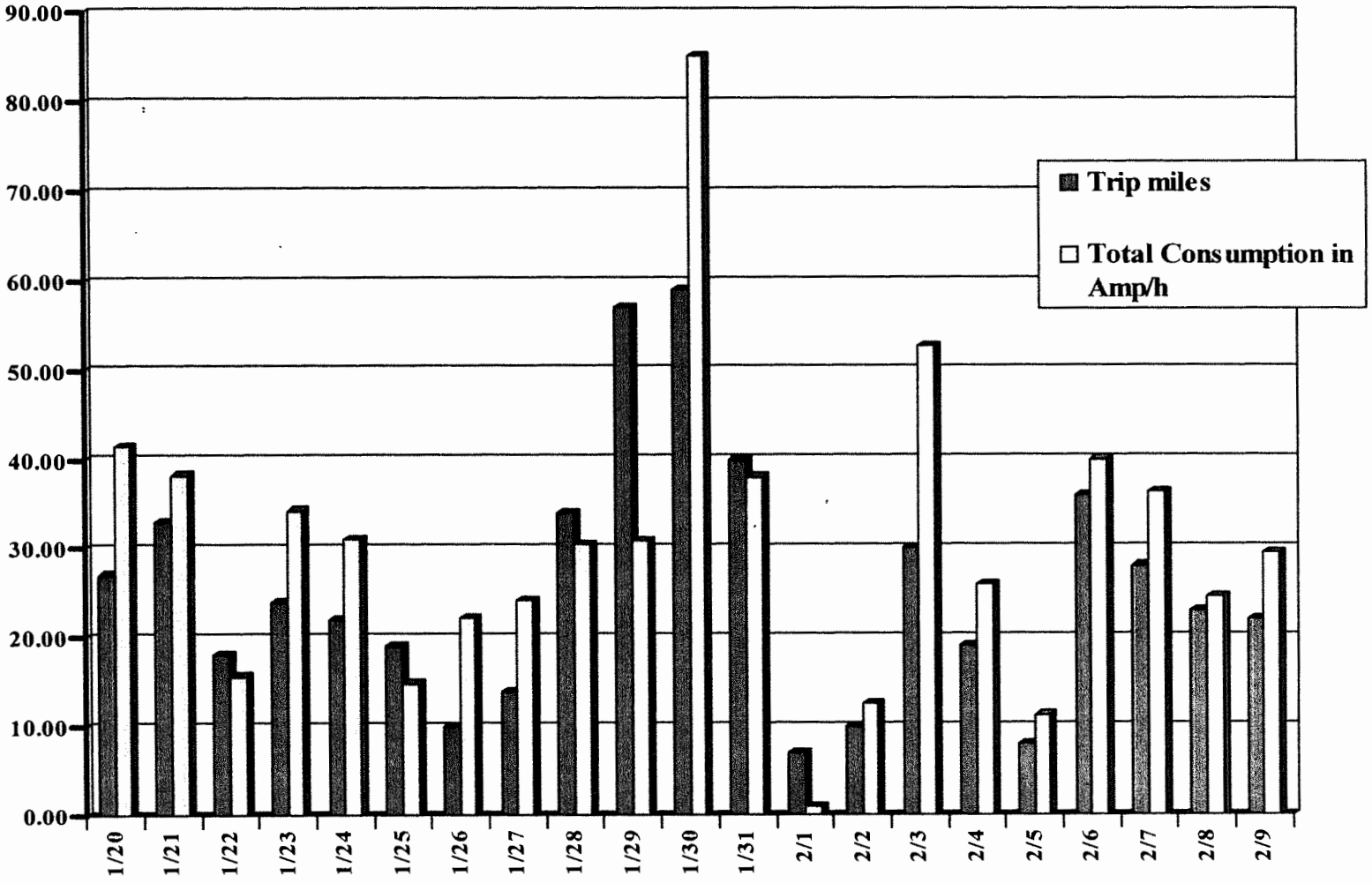


Figure 1

Average charging time per day: 2.5 hrs.
Average cost per day (calculated at $0.14/kWh): $1.27

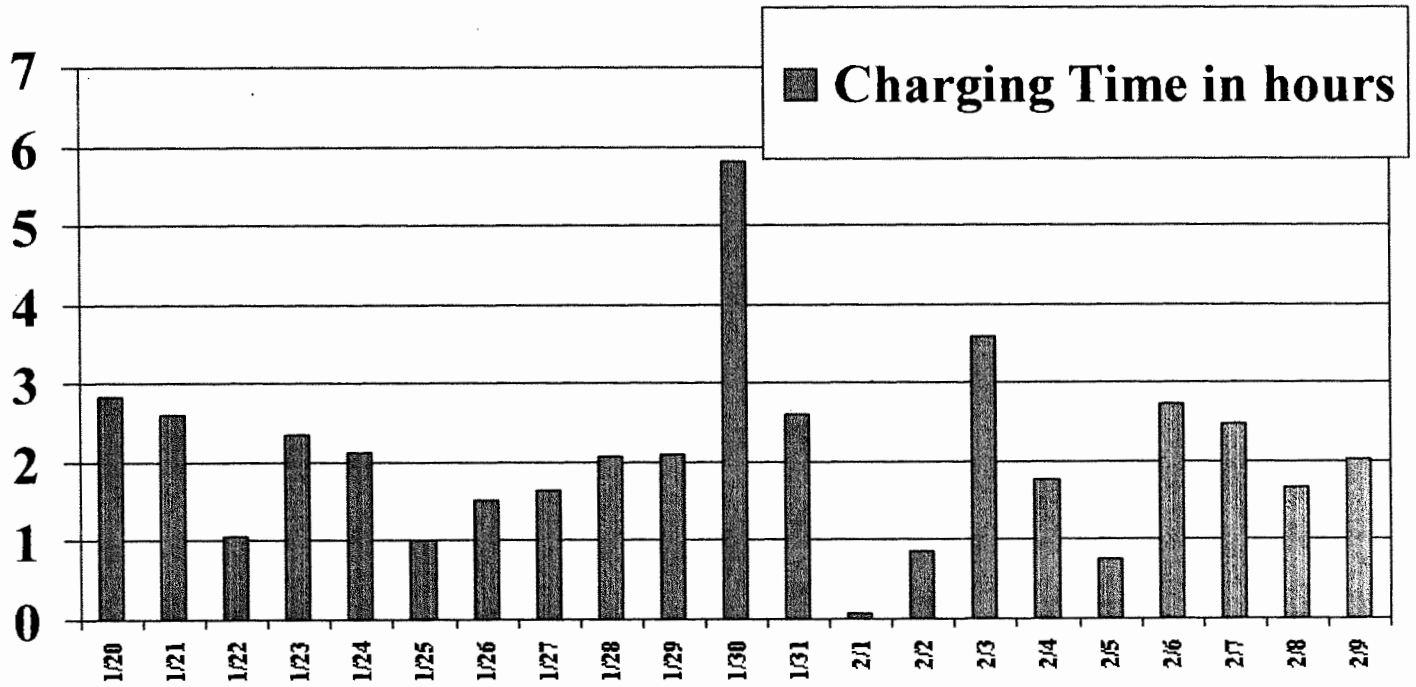


Figure 2

MENDOCINO COUNCIL OF GOVERNMENTS
215 W. STANDLEY STREET
UKIAH, CALIFORNIA 95482
(707) 463-4470

April 27, 1999

Jennifer Allen, Project Manager
California Energy Commission
1516 Ninth Street, MS-41
Sacramento, CA 95814

Re: Grant #MEM-97L-007
Vehicle Acquisition Summary Letter

Dear Jennifer:

This summarizes progress on the Zero Emission Vehicle Project, Task 2 - "Negotiate acquisition of and acquire vehicles for testing through leases or loan programs."

On January 19, 1999, I signed a rental agreement and acquired a 1998 Solectria "Force" EV for testing and ride-and-drive demonstrations from:

Anthony D. Agpaoa, CEO
It's Electric!, Inc.
540 Irwin Street
San Rafael, CA 94901
(415) 456-7211

The vehicle was rented to us a three-week period, January 19 through February 10, 1999. Our consultant, EV Transport, transported the vehicle to and from the San Rafael dealership to MCOG's office in Ukiah. We successfully demonstrated the Solectria Force EV to various participants in the ZEV Project.

In reference to my vehicle acquisition summary letter last November, the Ford dealership did make available a 1999 model Ford Ranger EV with NiMH batteries for our use. However, we decided that it would not significantly add to our findings, and in the interests of timely project delivery, we declined to test the 1999 model.

Also, we have arranged for acquisition of a Chrysler EPIC minivan for testing in May. The EPIC will probably be our final test vehicle under this project. I will keep you informed.

Sincerely,

Janet Orth
ZEV Project Manager

EPIC MINIVAN

CHRYSLER



Mendocino Transit Authority test drives the EPIC as a fleet vehicle on rural country routes.

Tested:
Mendocino County
May 10 to June 1, 1999

Photo by Janet M. Orth



Chrysler EPIC

Description: The EPIC Minivan is Chrysler's current offering in the electric vehicle category and is a factory conversion of its popular minivan to electricity. EPIC stands for Electric Powered Interurban Commuter.

Performance Specs

Driving Range: 80-90 miles
Top Speed: 80 mph
Acceleration: 0-60 in 17 seconds
Recharge/Refuel Time: 6 to 8 hours
Passenger Capacity: 5 to 8

Technical Specs

Dimensions: Length: 186"; Width: 75"; Height: 68"
Curb Weight: 5,100 lb.
Gross Vehicle Weight: 5,800 lb.
Engine Motor: 100 Horsepower, AC Induction Motor
Payload: 925 lb.
A/C and Heater: Yes
Preheat/Precool Cabin Timer Feature: Information Not Available
Other Features: Power Steering, Power Brakes, Power Door Locks, Rear Defroster and Wiper, Dual Sliding Doors, Tinted Glass

Safety Features

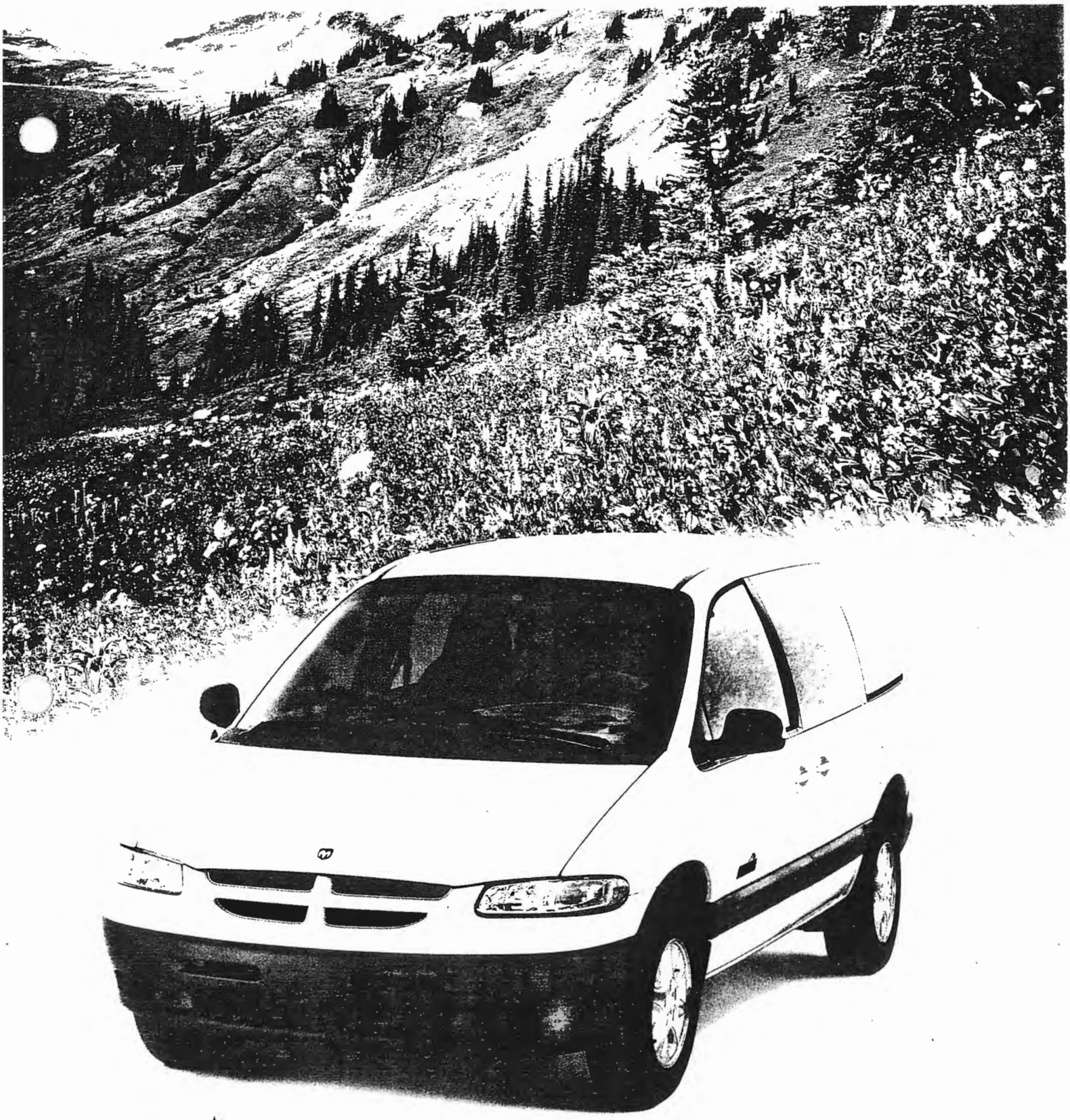
Air Bags: Yes, Dual
Anti-lock Braking System: Yes
Meets All Federal Standards: Yes
Other: Information Not Available

Price/Lease Options

Price: $15,000 Prepaid Lease
Payment Terms: Lease Only, $450 a Month for 3 Years
Warranty: 3 years/36,000 Miles
Availability: Fleets Only

For More Information Contact

Daimler Chrysler Corporation
27777 Franklin Rd. 19th Floor
Southfield, MI 48034
chrysler.com

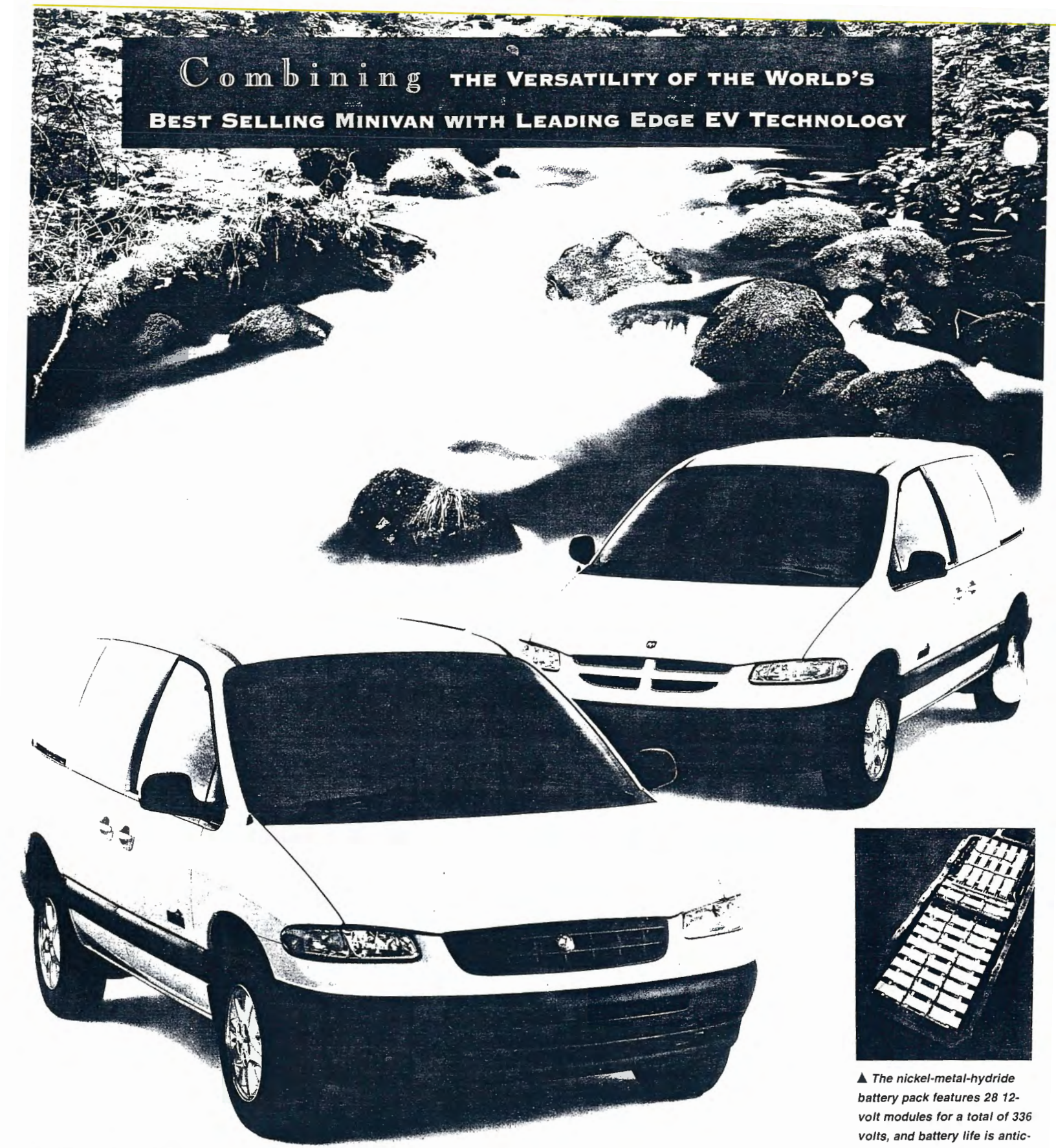


EPIC

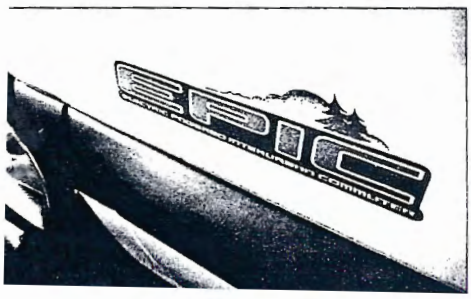
ELECTRIC POWERED INTERURBAN COMMUTER

DODGE CARAVAN PLYMOUTH VOYAGER

Combining the Versatility of the World's Best Selling Minivan with Leading Edge EV Technology

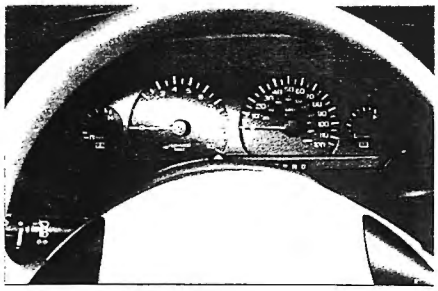


▲ *The nickel-metal-hydride battery pack features 28 12-volt modules for a total of 336 volts, and battery life is anticipated to be 4-6 years in normal use.*



◀ *Distinctive decals identify the owner as an environmentally responsible citizen.*

➤ *The "brain" of the vehicle, the Motor Control Unit monitors and controls a variety of operation and motor functior*



▲ *The instrument cluster features a state-of-charge gauge which calculates the charge remaining in the battery system.*

Chrysler Corporation understands electric vehicles. In fact, while some automakers are still working to develop their first electric vehicle, the 1999 Dodge Caravan and Plymouth Voyager electric minivans represent Chrysler's second-generation electric vehicle and fourth generation battery technology. The real-world experience and valuable customer feedback gained from the design and sale of the previous generation electric minivans have given Chrysler engineers the knowledge to improve performance and reduce costs for the current family of zero emission vehicles.

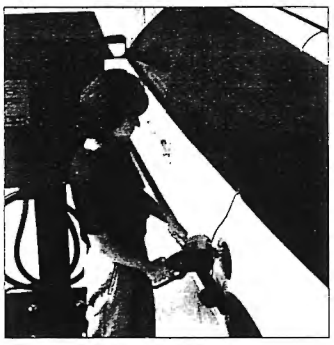
Known as *EPIC*, an acronym for Electric Powered Interurban Commuter, this new generation electric is based on the five-passenger/113" wheelbase version of the world's most popular minivan...and takes zero emission technology to a new level.

Featuring Advanced Nickel-Metal-Hydride Technology

For 1999, all-new nickel-metal-hydride batteries replace the lead-acid battery pack used in previous *EPICs*. "Fuel" for the *EPIC* comes from twenty-eight 12-volt modules, which combine to produce 336 volts of power. Thanks to lighter weight and increased energy density, the nickel-metal-hydride batteries provide the *EPIC* with a range of 80 to 90 miles, compared to 60 to 70 miles with the previous generation lead-acid batteries. And the new technology is less effected by cold weather than its lead-acid predecessor.

Power for the Dodge Caravan and Plymouth Voyager *EPIC* is supplied by a 100-peak horsepower AC induction motor and a single speed, front-wheel-drive transaxle for smooth and quiet operation.

For maximum vehicle range, the *EPIC* uses P205/75R/15 low rolling resistance tires to reduce road friction. In addition, an innovative regenerative braking system is activated when the brakes are applied and works to recharge the battery during vehicle deceleration.

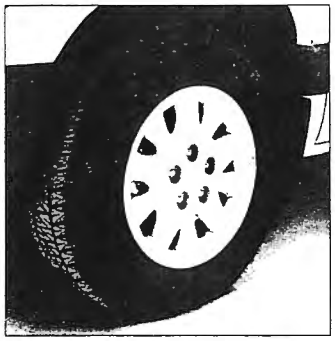


▲ *Right where it should be, the charging point is located in the same location as the fuel fill on a gasoline-powered minivan.*

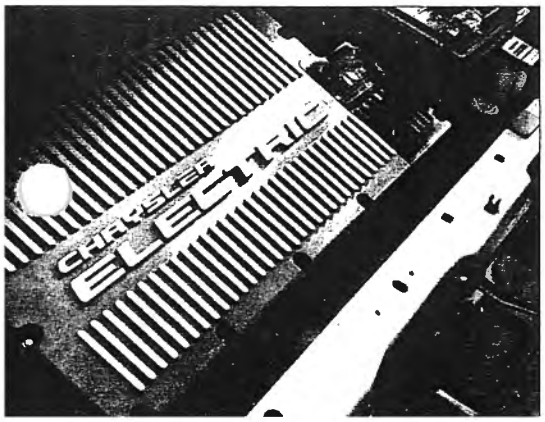
An EPIC Combination

When you combine the world's best-selling minivan with advanced electric vehicle technology, you end up with an unbeatable combination of style and functionality.

With a 925-pound payload, the *EPIC* can carry five passengers and 175 pounds of cargo or any combination of the two. Heavy duty springs, shocks and struts guarantee a smooth and controlled ride. Four doors make entry and exit a snap.

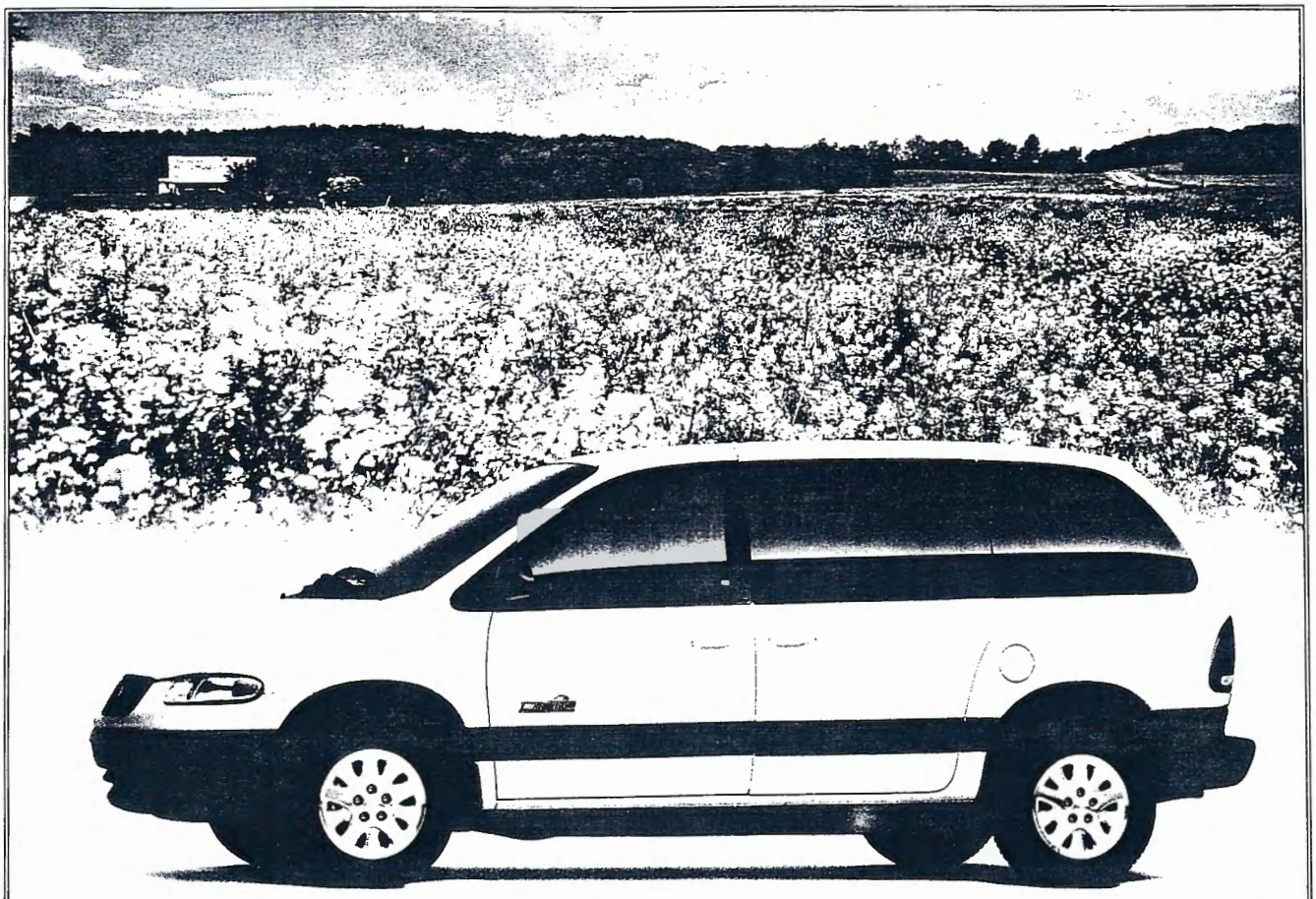


▲ *Low rolling resistance tires reduce road friction.*



The 1999 Dodge Caravan and Plymouth Voyager *EPIC*. The current technology in electric vehicles from Chrysler Corporation, a leader in alternative fuel vehicles.

For more information on the *EPIC*, call Chrysler's Fleet Operations Hotline at 1-800-999-FLEET or visit our website at www.chrysler.com.



EPIC ELECTRIC MINIVAN HIGHLIGHTS

VEHICLES Plymouth Voyager EPIC
Dodge Caravan EPIC

WHEELBASE Short Wheelbase (113")

POWERTRAIN AC induction motor (100 peak/75 continuous horsepower) • Single speed front-wheel-drive transaxle (with drive, reverse, neutral and park positions)

BATTERIES Nickel-metal-hydride (with thermal management) 336 volts (28, 12-volt modules) • Controlled by battery engine management system • Anticipated battery life of 4 to 6 years in normal use

CHARGING Compatible with off-vehicle charger—208/240-volt, up to 60-amp circuit (approximately 6 to 8 hour charge time) Also features quick charge capability (440-volt public charging facility where available)

CHASSIS 5800 GVW • 925-pound payload • Heavy duty shocks, springs and struts • Cast aluminum wheels • P205/75R/15 low rolling resistance tires.

PERFORMANCE 0 to 60 in 17 seconds and top speed of 80 miles per hour • Range of 80 to 90 miles (SAE J1634 combined city/highway in warm weather with no accessories) • Range is reduced in cold weather and varies with driving conditions and driving style

STANDARD EQUIPMENT Dual air bags • Anti-lock brakes Regenerative braking • Power steering • Power brakes • Power door locks • Four doors • Air conditioning and heater (heat pump with auxiliary electric heating system) • Rear defrost • Sunscreening glass • AM/FM radio • Rear wiper • Off-vehicle charger

WARRANTY Vehicle and battery: 3-year/36,000 mile limited warranty

All product illustrations and specification are based upon current information at the time of publication approval (August of 1998). Although descriptions are believed correct, complete accuracy can't be guaranteed. Chrysler Motors Corporation reserves the right to make changes from time to time, without notice or obligation, in prices, specifications, colors and materials, and to change or discontinue models. See your Chrysler Motors Corporation dealer for the latest information.

CHRYSLER CORPORATION
FLEET OPERATIONS

9669 998125 Printed on Recycled Paper Printed in U.S.A.

Zero Emission Vehicle (ZEV) Demonstration Project
Chrysler EPIC Minivan



At the MTA bus yard the EPIC is camouflaged in the fleet of identical Dodge Caravan transit vans.

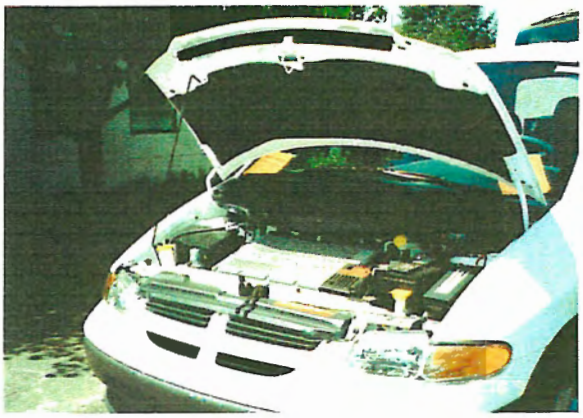


The striking similarity between the EPIC's logo and MTA's logo made them a perfect match!

MTA loads its passengers and takes off from a Willits bus stop.







The EPIC is not all that different from any other Dodge Caravan... until you pop the hood.

Photos by Janet Orth

Zero Emission Vehicle (ZEV) Demonstration Project
Chrysler EPIC Minivan

The EPIC climbed well up the steepest ridges, from 1,300 feet in elevation at the Willits valley floor to 2,500 feet or so at Ridge and Blue Lake Roads in Brooktrails and Spring Creek.







Guests already well familiar with electric vehicles and solar energy are fascinated with the advanced technology of the EPIC minivan.



The home of Keith Rutledge, REDI president, is off the grid, energy independent and powered by solar modules. It even boasts a hydrogen cook stove.

Photos by Janet Orth

ZEV Project
MCOG/REDI
Sept.. 1999

Chrysler EPIC Minivan Deployment in Mendocino County

Zero Emission Vehicle (ZEV)
Demonstration Project

Prepared by

Janet M. Orth
Director
Renewable Energy Development Institute (REDI)

Submitted to

Mendocino Council of Governments (MCOG)

July 30, 1999

Introduction
A Chrysler EPIC (Electric Powered Interurban Commuter) minivan was acquired from Daimler-Chrysler Corporation for three weeks, May 13 to June 6, 1999, for use by the project. The EPIC was driven 1,008 miles over the 24 days, by nine trained and insured drivers. The EPIC was demonstrated to MCOG's Technical Advisory Committee, as were the Toyota and Ford EVs.

Several passengers of Mendocino Transit Authority's demand response service received rides. This vehicle was requested specifically by MTA, to try out on their Dial-A-Ride (DAR) door-to-door service routes in Ukiah, Willits and Fort Bragg. This was done in addition to trials similar to the other four ZEVs tested.

The EPIC was nearly brand new, with only 419 miles on the odometer upon delivery in Ukiah. When returned at Ukiah, the odometer read 1,427. The EPIC was tested over the challenging terrain of the North Coast, with elevation changes from nearly sea level at the coast in Fort Bragg, to 600 feet in the Ukiah inland valley, to 2,500 feet in the mountain ridges above Willits (Brooktrails and Spring Creek subdivisions).

Conclusions
Accomodating up to eight passengers, or a 925 lb. payload, this minivan with NiMH batteries is well suited to public transit and family use. Despite the heavier weight, power seemed sufficient for all of the rural tests, although it was not tested fully loaded with passengers on the more challenging routes. With few passengers, it had no trouble with Mendocino County's steep terrain. The loaded vehicle did well with the flat valley driving of the transit routes tested, and its already fast charge time can be improved with the 440V charging option. This EV does use more energy than the lighter EVs.

Driving and Vehicle Statistics
The EPIC is the same model minivan as the Dodge Caravan, used by MTA in their new paratransit fleet. This body style works well for MTA's paratransit clientele, with low profile for stepping in and out, and slider doors on both sides. The car was driven an average of 42 miles per day throughout the deployment. Much like the Toyota RAV4-EV in specifications, and tested during the same time of year, these two vehicles gave similar performance. The EPIC is somewhat larger and heavier, but handles extremely well, for a safe and secure driving feel on the winding roads of Mendocino County.

The longest trip was 60 miles from Ukiah to Fort Bragg on May 24. On May 25, the EPIC was tested on the Fort Bragg local Dial-A-Ride route. It was driven back to Ukiah on May 26. This trip involves an elevation change of approximately 2,000 feet. The one-way trip from Ukiah to Fort Bragg used 66 percent of the battery charge, and the return from Fort Bragg to Ukiah used 62 percent. Steve Miller, MTA Coast Supervisor, logged the following comments: "*Great! Climbed Highway 101 grade and Route 20 easily. Primarily kept power level between 1.5 and 2.5 on the amp meter.*"

MTA had one occasion when the vehicle was stranded in town. In this case the driver was not mindful of energy usage and dashboard warning indicators during driving. She used the air conditioning and headlights all day, carried passengers, and enjoyed the responsive acceleration. With a bit more training and experience, drivers can learn to drive more efficiently and get more miles per charge from the vehicle. No harm was done, but the episode was an inconvenience. The driver made this log entry: "*Everyone liked it. Good pickup from dead start and on freeway. The day went great until battery situation. Many people said they like the quiet, as I do. Enjoyable to drive and sport people around in. Under hood looks great and clean.*"

The EPIC climbed well up the steepest ridges, from 1,300 feet in elevation at the Willits valley floor to 2,500 feet or so at Ridge and Blue Lake Roads in Brooktrails and Spring Creek. The amp meter climbs correspondingly, but because of the low speed limits in the neighborhood, it can make the climbs without entering the upper zone that triggers the "Power Limit" feature.

I noticed the action of the EPIC's cooling system, which uses fans to prevent the vehicle parts from overheating when parked in the sun. The car also has many of the same "creature comforts" as the GM EV1, Toyota RAV4 and Ford Ranger EV. There is a regenerative braking system that automatically engages when the brakes are applied; there is no manual control. Several drivers noticed a two-phase regen action.

Training

Kevin Morrow of E-Tech (Electric Transportation Engineering Corp.--Chrysler's contractor in Phoenix for the EPIC infrastructure) oriented me by phone before and after arrival of the EPIC. I then trained the other main drivers and MTA's maintenance supervisor, including charging procedures. MTA was responsible for orientation of their own personnel. The controls and displays were explained in detail to familiarize drivers with energy and power indicators and other features. Charging procedures were reviewed as well. Drivers were instructed to make entries in a logbook to record energy, mileage data, and anecdotal experiences.

Energy displays were comparable to the Toyota RAV4-EV, that is to say, "transparent." Where an RPM meter would be, the dial is used to display a continuous needle readout of amps, so the driver has some control over energy efficiency. The best efficiency is at "2" or 20 amps per hour--several drivers noticed this. (This feature is described in more detail below, under Energy Use and Commuting.) Where a fuel guage would be, the needle guage is used for battery state of charge. There is also a volt meter, which should stay fairly constant.

A "low power" indicator lights up on the dash when approaching battery depletion, so the driver has advance warning of about ten miles. Other indicators on the instrument cluster give error messages, although we never had any light up during deployment (except during the EV's normal startup routine).

Charging

The EPIC comes with a sophisticated, off-vehicle conductive charger unit made by Lockheed Martin that is usually installed as a permanent fixture in a fleet garage or at home. E-Tech worked extensively with us to customize the vehicle for the ZEV Project demonstration. The

sizable charger was mounted in the rear of vehicle so as to be available at the various locations tested, taking out the last row of seats. Designed to operate on a 240V, 60-amp circuit, the charger was programmed for the project at 40 amps to accomodate all of the existing public charging stations in Mendocino County. This should have the effect of slowing down charge time somewhat, although we thought it charged relatively quickly even so, the same or faster than the RAV4. An optional 440V configuration is available for even faster charge time. There is no 120V option. The EPIC uses a standard 1450-R receptacle. It worked fine with the recreational vehicle (RV) type outlet we installed at home.

The charger is a "smart" box situated between the power source and the vehicle, with the same design and features as the charger used by the Ford Ranger EV. It has a voice readout of charge status on demand, with SOC stated as a percentage during charging. When the charge cycle is complete, the unit reads out charge time and kilowatt-hours used. The arrangement is quite user friendly and simple to operate.

Safety Features
The EPIC's standard equipment includes dual air bags and anti-lock brakes.

Energy Use and Cost
During the deployment, the EV1 averaged 562 Watt-hours per mile. 567 kilowatt-hours were used over the total 1,008 miles driven. My round-trip commute from Brooktrails to Ukiah consistently logged in at 30 kW-hours for 61 miles of daily use, using three-quarters of a battery charge. This is compatible with the overnight off-peak charging recommended throughout the ZEV Project final report. At the average electricity rate used in this report of 14 cents/kW-h, this puts the cost at $4.20 for the daily commute, which comes out less than gasoline for the Dodge Caravan when estimated at 15 miles per gallon. However, charging at the after-hours "time of use" rate of 8.5 cents, the cost is only $2.55 for the same daily use, comparable to a fuel-efficient gas car like my compact Saturn sedan at the current price of gasoline.

Commuting in Mendocino County
As noted above, my 55-mile commute over the mountain, and a few miles of town driving during the day, can be accomplished easily on a single battery charge, with power to spare. It should be noted that this test was usually conducted with only the driver in the vehicle. With added passengers and the increase in payload, performance cannot be expected to be as good as reported here. For a single commuter, it would make more sense to use a smaller, more energy efficient vehicle such as the GM EV1.

For a short commute such as Brooktrails to nearby Willits, the number of passengers need not be a consideration. While steep in places, the trip from my house to town is only about three miles, with a speed limit on Sherwood Road of 35 mph. A typical round trip with town errands is about ten miles. On May 15, I made the following log entry: "*Takes next to no energy to go downhill to town* [the 'regen' feature activated]. *The ten-mile round trip takes one-eighth battery charge.*"

Such a large EV is put to best use carrying more passengers than just one commuter. Public transit or family use is ideal for the EPIC.

More on the "Power Limit" feature: On June 3, I made this logbook entry after driving to work from Brooktrails to Ukiah. "*For the first time, I went into Power Limit--light came on dash -- when climbing Ridgewood grade south of Willits, going 55-60 mph to keep up with traffic. Realized afterward I had heat on part way at the time. Amp meter went into yellow* [at 7 on the meter], *then all the way to 10 in the red for a moment, when Power Limit kicked in. At top of grade, regen started and amp meter went to 0. Power Limit light stayed on for about 20 minutes, went off before end of trip at Ukiah. No problems, just had to slow to about 50 mph on the climb. Still used only one-quarter charge for the whole trip.*" On June 4, a repeat of that trip, I wrote: "*Another commute, this time climbing the ridge I maintained 60 mph without going above 6 on the amp meter--avoided engaging Power Limit. Same energy use for the trip to Ukiah. Drove at highway speeds the whole way down Highway 101.*"

This Power Limit feature prevents driving at excessively high power levels, helping to save energy for more mileage range on a single charge.

Some Driver Comments

I made this entry on May 15: "*No one seems to notice the car--it looks like so many other minivans. It should turn heads because it's so quiet--but that's probably why it does not turn heads!*"

Driver Steve Turner, Assistant General Manager of Mendocino Transit Authority, wrote on May 21: "*Spoke about electric propulsion and this electric car to a science class of 30 at Pomolita Middle School and three combined automotive, machine shop, and physics classes, for a total of 300 students at Ukiah High School. Put car up on hoist to look underneath. Gave a few rides.*" Steve noted a high level of interest with the pre- engineering students, perhaps future EV maintenance technicians. He felt education was an important aspect of the project and noted Ukiah High School Industrial Arts vocational program is highly regarded.

Steve Turner of MTA was interviewed on July 12, 1999, after his experiences with the EPIC. His comments on transit applications are summarized as follows.

> Practicality issues: A regular Dial-A-Ride (DAR) shift is 6-8 hours, some shifts 5 hours. The incident with battery depletion occured after 3 hours or so. During extreme weather over four months of the year, two EPICs could cover the shift by swapping mid-shift for a fully charged one. The rest of the year, one EPIC could work. Charging could be done on lunch breaks, or special fast chargers such as the 440V option could be used if needed. Driving style and efficiency techniques are crucial. Monterey Transit has reported a 40 percent difference in EV performance between drivers.
>
> Energy costs and rates are an important issue for fuel cost comparison with present gas-powered vehicles. MTA would like to try out a propane-electric hybrid bus. It would be a perfect application for several MTA fixed routes, and the propane infrastructure is in place. The batteries are charged during driving.
>
> The Dodge Caravans have a 5-year life cycle of use for MTA's purposes. The present fleet is new, but after that life cycle expires, they could be replaced with EPICs or hybrids. A full life cycle of the EPIC needs to be tested to determine cost and viability. Cost, availability and funding issues might be more conducive in the future. MTA will look at incremental change of their fleet composition.

MTA has an interest in future funding of clean air vehicles for their fleet. Staff believes in a proactive rather than reactive approach, i.e. prevention of air pollution, greenhouse gas emissions, and energy shortages. Also, the policy element of MTA's recently updated Five-Year Plan includes clean air energy-efficient vehicles in its goals and objectives.

Informal Public Survey

A "Guest Register" was kept in the EPIC for comments by passengers. Most of the comments mentioned the quiet operation, comfortable ride, good acceleration and performance. Several said they wanted to own one. All those who made remarks in the register enjoyed the demonstration.

Attachments

Chrysler EPIC Minivan Guest Register - May 1999 - *ZEV Project survey*

Source: The format of this EV technical report was provided for the ZEV Project by Bill Warf of Pacific EV. The content was compiled and written by Janet Orth of REDI.

Chrysler EPIC Minivan
Guest Register
May 1999

Name:	Resident of:	Comments:
Raul Chavez	Willits	"Smoothest, quietest ride I have been in — The interior is great" -similar to EV golf cart he drove
Bruce Fisher	Willits	"It was neat!"
Karina Cotter	Willits	I want one.
John Wagonet	Willits	
Marcia Read	Willits	Wish I could afford one!
Jon Klein	willits	very quiet, nice.
[illegible]	"	
[illegible]	"	
[illegible]	Willits	Quiet, Quick & Quaint.
[illegible]	✓	Smooth & Powerful
Cindy Wagonet	✓	I'm IMPRESSED!
LOUIS ROHLICEK	WILLITS	It's great, and if the engine could shift from B flat to E minor, it would be even better.
David Hulse-Stephens	Willits	Why aren't we all driving these?
David Drell	Willits	Quiet and comfortable
Sally Rohlicek	Willits	Quiet & comfortable it's a car!
Denny McEntire	Willits	Great Ride!
Lynn KENNELLY	WILLITS	LOVE the Quiet! Smooth Ride!
John TAKES	CLEONE	Great shuttle bus!
PETE SWANTON	WILLITS	QUIETER THAN MY DIESEL - DUH!!!
Paul Williams	BTCSD	Best so far, great ride
Marta Turman	Ukiah	
Jacob Turman	Ukiah	
Luke Turman	Ukiah	
Steve Turman	Ukiah	
Dave Carstensen	Eureka	nice ride, good acceleration
Bob Parker	Redwood Valley	
Bruce Richard	Ukiah	
DAVE GOBLE	Ft. BRAGG	Great Ride, Good Acceleration, Quiet.

Chrysler EPIC Minivan
Guest Register
May 1999

Name:	Resident of:	Comments:
CHRIS WALLS	UKIAH CA,	WONDERFUL CAN'T WAIT TO SEE MORE,
~~Patricia~~ Mitchell	Ukiah CA	Liked the no "noise" I want one
Bruce Richard	Ukiah	Smooth @ Freeway speed, quick
Jim Martin	Ukiah	GREAT RIDE, GOOD SPEED. I LIKE IT!
DAR MTA passenger	Ukiah	smooth - economical
DAR MTA passenger	Ukiah	NICE - quiet
DAR MTA passenger	Ukiah	very quiet - wants one. - Refuses
Pam Boyer	Ukiah	as a passenger - it felt
		very smooth - extremely quiet
DAR Janice Lynette	Willits	LOVED IT! Very quiet & Smooth
DAR JOHN HERLICK	FT. BRAGG	DRIVES SMOOTH, QUIET, CLEAN!
Walt Allen	Sequel, CA	Smooth Ride, Quiet, Good Acceleration.
JAN ALLEN	Sequel CA	quiet, great ride
DAVE LOHSE	Ukiah	Quiet, comfortable, efficient
Louis Bigfoot	Willits	YES - YES
Marilyn Schultz	willits	a great car / Quiet + smooth.
Chris Kwiatkoski	Willits	Great!
RHC JORGENSON	WILLITS	TERRIFIC PERFORMANCE
[illegible]	WILLITS	unbelievably quiet + efficient
Lori Basgal	Ukiah	Great!
Joanna McMillan	Ukiah	Hope for the future!
Theresa Hanson	Redwood Vly	Very interesting, I'm excited
Bettye Jeffries	Ukiah	Wonderful I enjoyed the quietness & smoothness
Gigi Jergenson	Willits	Great - I really enjoy riding on it!!!

* DAR = Dial-A-Ride public transit passengers.

Mendocino Council of Governments

367 North State Street ~ Suite 206 ~ Ukiah, CA 95482
Phone (707) 463-1859 ~ Fax (707) 463-2212

July 27, 1999

Jennifer Allen, Project Manager
California Energy Commission
1516 Ninth Street, MS-41
Sacramento, CA 95814

Re: Grant #MEM-97L-007
Vehicle Acquisition Summary Letter

Dear Jennifer:

This summarizes progress on the Zero Emission Vehicle Project, Task 2 - "Negotiate acquisition of and acquire vehicles for testing through leases or loan programs."

On February 26, 1999, Daimler-Chrysler executives agreed to loan one of their Electric Powered Interurban Commuter (EPIC) minivans for use by the ZEV Project. The vehicle was acquired for testing and ride-and-drive demonstrations from:

Mr. Mike Clement
Daimler-Chrysler Corp.
27777 Franklin Road, 19th Floor
Southfield, MI 48034
(248) 948-3644

The vehicle was loaned to us for a three-week period, May 13 through June 6, 1999. Chrysler provided transport of the vehicle, with delivery and pickup at Ukiah. We successfully demonstrated the EPIC electric minivan to MCOG's Technical Advisory Committee, Mendocino Transit Authority and other participants of the ZEV Project.

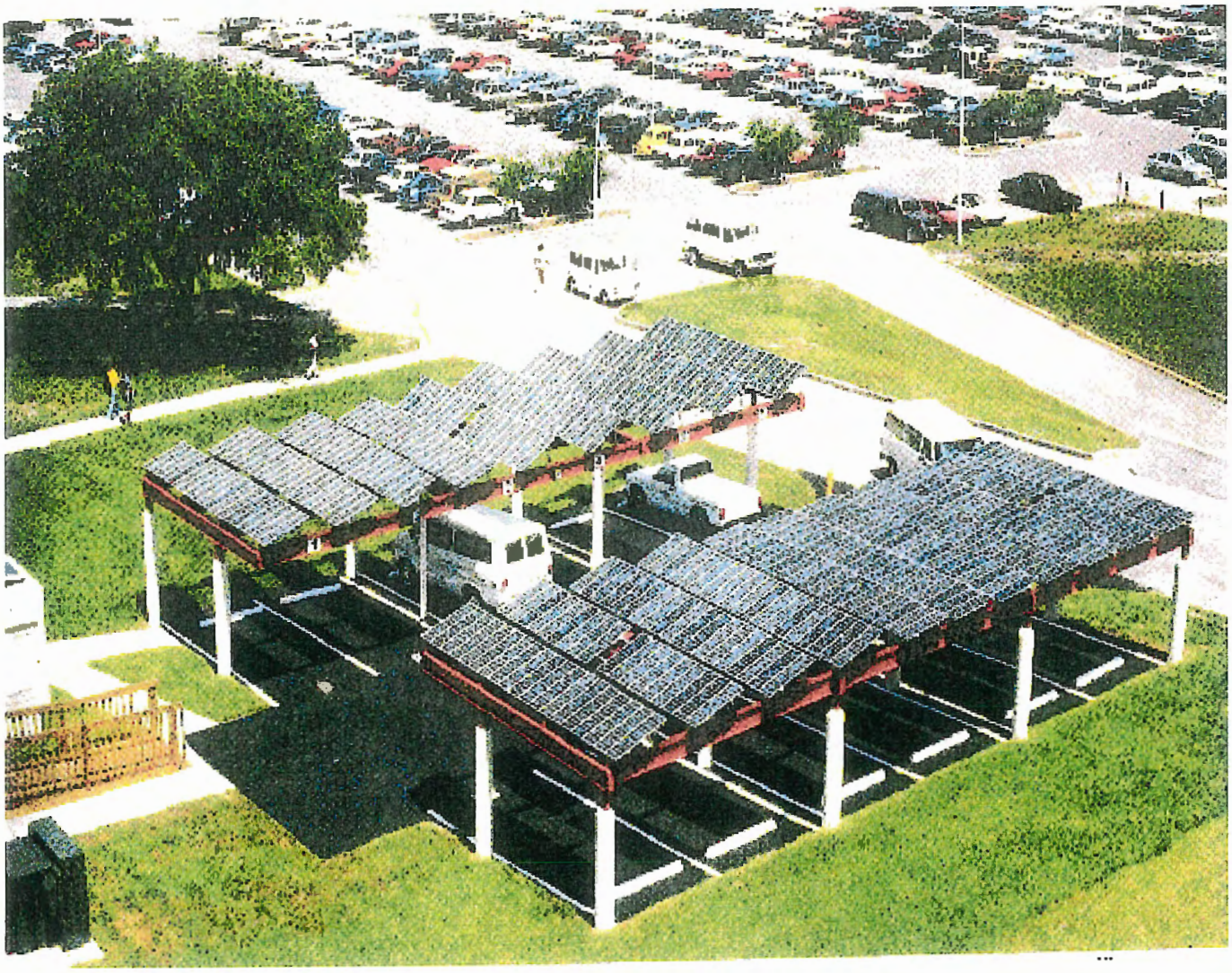
The EPIC was our final test vehicle under this project.

Sincerely,

Janet Orth
ZEV Project Coordinator

Solar
Net Metering

Example of Parking Design with Solar Shade Structure



Siemens Solar Industries, Camarillo, CA
Originally printed in
"The Timeless Energy of the Sun – for Life and Peace with Nature"
by Madanjeet Singh
Sierra Club Books, San Francisco, CA © 1998
UNESCO

ZEV Project Final Report

Phase II, Task 8 – Solar Net Metering Demonstration

By Keith Rutledge and Janet Orth, REDI Directors

Renewable energy EV charging

Why charge electric vehicles with renewable energy? EVs by nature imply clean energy. In reality, while they have zero tailpipe emissions, the charging power source may be fossil fuel, representing displaced emissions. In some areas however, as in California, the power grid consists of a good mix of available clean renewable sources. Overnight or off-peak charging takes advantage of excess capacity, in many cases using renewables such as hydropower. A common criticism of EVs has been that they have no emissions, yet often use polluting charging sources.

Existing solar vehicle designs are impractical. Solar electric modules are an obvious source to use for charging EV batteries; a common idea is to put solar panels on the car. International competitions and university-level design efforts have produced a number of vehicles that incorporate solar photovoltaic modules into the design, but have proven impractical for day-to-day use and consumer applications.

The new generation of EVs. The ZEV commercial vehicles tested by this project do not incorporate solar. In the ZEV Project, the EVs selected are aimed at the consumer and fleet markets, with "transparent" design characteristics that are familiar to drivers, with typical features and amenities. Therefore, renewable energy charging sources, if desired, need to be located separately from the vehicle.

Stationary solar energy charging

Net metering / electric utility restructuring. Until recently, it has been difficult for consumers, on a small scale, to produce electricity directly into the power grid. Recent legislation in California and nationwide now is allowing small-scale renewable energy systems to directly interface with power grids and produce electricity locally. (*See PG&E materials attached*)

Using the grid for storage. In utilizing renewable energy, the power production does not necessarily match the use of the vehicle, so the energy needs to be stored. Storage batteries are expensive, therefore not cost effective. Because of net metering, renewable energy produced from solar photovoltaic modules can be "stored" in the power grid and drawn out as needed to charge the vehicle.

California Energy Commission (CEC) buy-down incentive programs. The cost of solar photovoltaic modules is such that it is not currently competitive with power generated from more traditional fossil fuel sources. Recognizing this, states such as California that have implemented net metering are also providing financial incentives to encourage use of non-polluting renewables. The CEC buy-down program provides up to half the system cost for installing photovoltaics. (*See CEC materials attached*)

Incorporating solar into parking shade structures and/or on homes. The most logical locations for EV charging stations are at work and at home. Further cost savings for the use of renewables can be provided by incorporating photovoltaic modules into building structures. For example, businesses could cover parking spaces with solar roofs to provide shaded parking while producing renewable energy for EV charging, as demonstrated by Sacramento Municipal Utility District (SMUD) and Sacramento International Airport. Similarly, homeowners can incorporate photovoltaic modules into roof structures or shade structures for home charging.

Planning implications and recommendations

Home charging. Zoning and solar access ordinances are critical to the use of solar electricity in a residential application. Also Covenants, Codes & Restrictions (CC&Rs) should not be allowed to restrict the use of solar modules on planned developments. Building and fire codes should allow the use of roof-integrated photovoltaic modules.

Workplace charging. Parking designs should incorporate photovoltaic modules into combination shade/shelter structures as part of EV charging station designs.

Intermodal transit centers. These should also incorporate shade/shelter structures in parking designs, with consideration for the use of Neighborhood Electric Vehicle (NEV) "station cars" as demonstrated by the BART Station Project in the San Francisco Bay Area. (*See also section on Charging Stations*)

ZEV Project Solar Net Metering Demonstration

In order to demonstrate the concept of net metering as part of the EV charging station in Willits, a small solar-electric grid inter-tied system was installed at the Renewable Energy Development Institute offices adjacent to the Willits High School, including the following. (*See attached product literature*)

1 kW photovoltaic array on a pole mount

4 kilowatt grid-intertied inverter

Electrical output monitoring

Interpretive display

Trace Engineering, a leading manufacturer of solar photovoltaic inverters and power equipment, cosponsored a workshop with REDI at the ZEV Project's Willits net metering demonstration to teach members of their dealer/distributor network how to install a photovoltaic system intertied to a utility grid. Trace donated one of their latest model inverters to the ZEV Project.

Attachments:

California Energy Commission (CEC) Guidebook – Renewable Technology Program, Vol. 3, Emerging Renewable Resources Account, including CEC "Reservation Request Form – Emerging Renewables Buydown Program"

CEC's Consumer's Guide to Buying a Solar Electric System

Pacific Gas & Electric Company's Interconnection Agreement for Net Metering

PG&E's Schedule E-NEM – "Net Energy Metering Service Tariff"

Siemens Solar photovoltaic module SP65 product brochure

Trace Engineering Utility Line Tie Power brochure

Trace Engineering Model SW 5548PV product brochure

Mounting structure information literature

Photograph of solar shade structure

For More Information:

Call the California Energy Commission Energy Call Center
(800) 555-7794 inside California
(916) 654-5058 outside California

Download the guidebook, application forms, a list of eligible equipment, and other information from the California Energy Commission's website at: **www.energy.ca.gov/renewables**

Faxed copies of the program forms and list of eligible equipment and participating retailers, are available by calling the California Energy Commission Facts Line at (916) 653-6830.

Write to:
California Energy Commission
Emerging Renewables Buydown Program
1516 Ninth Street MS-45
Sacramento, CA 95814-5512

GUIDEBOOK

RENEWABLE TECHNOLOGY PROGRAM

VOLUME 3

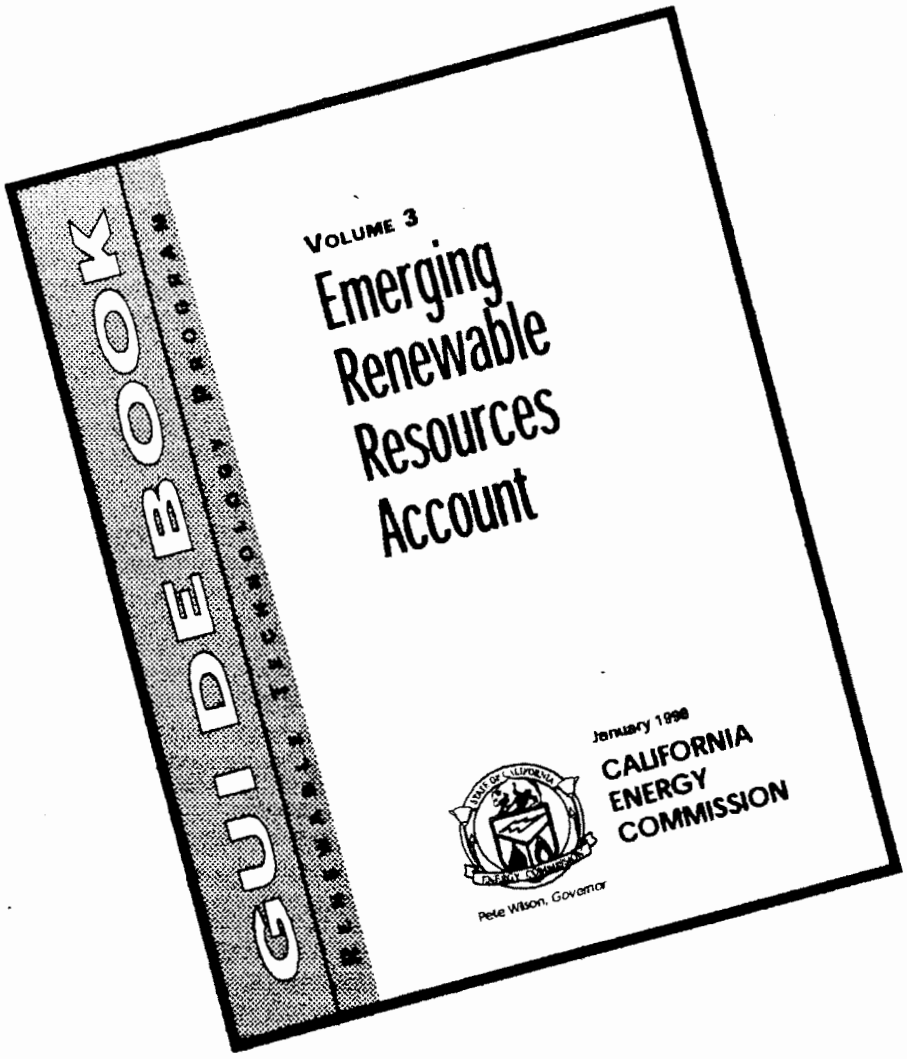
Emerging Renewable Resources Account

January 1998

CALIFORNIA ENERGY COMMISSION

Pete Wilson, *Governor*

P500-97-011V3



CALIFORNIA ENERGY COMMISSION

RENEWABLES COMMITTEE

Michal C. Moore, *Presiding Member*
Jananne Sharpless, *Second Member*

Marwan Masri, *Project Manager*
Charles Mizutani, *Manager*

TECHNOLOGY EVALULATION OFFICE

Nancy J. Deller, *Deputy Director*

ENERGY TECHNOLOGY DEVELOPMENT DIVISION

These guidelines were formally adopted by the California Energy Commission on January 21, 1998, pursuant to Senate Bill 90 (Chp. 905, Stats. 97).

This guidebook contains general instructions for purchasers, lessees, lessors, or sellers of emerging renewable technologies in distributed generation applications on how to qualify and receive funding from the Emerging Renewable Resources Account of the Renewable Resource Trust Fund. For more detailed information on the Renewable Resource Trust Fund, please see the Energy Commission's *Policy Report on AB 1890 Renewables Funding*. The report (Publication Number P500-97-002) may be obtained through the California Energy Commission's Publications Office at (916) 654-5200.

Table of Contents

Introduction....1

What Types of Financial Assistance Will the Program Provide?....5

Who Can Receive the Buydown Payment?....6

When Will the Buydown Program Begin?....6

What Generating Systems Are Eligible For Buydowns?....6

What Costs of a Generating System Are Eligible for the Buydown? 9

How Big Can My System Be?....9

How Much Is The Buydown?....10

Do Financial Incentive from Other Sources Affect the Amount of Buydown I Can Receive? 10

What is the Maximum Buydown Amount Any Single Project Can Receive?....11

How Do I Reserve a Buydown?....11

How Do I request a Buydown Payment? 17

Definitions....20

Forms and Samples....22

Introduction

Assembly Bill 1890 (AB1890), enacted on September 23, 1996, provides $540 million for the support of renewable electricity generation technologies. These funds will be collected from the ratepayers of the three largest investor-owned utilities in California from 1998 through March 31, 2001, to support existing, new, and emerging renewable electricity generation technologies. As part of the requirements of AB 1890, the California Energy Commission submitted a Policy Report[1] to the Legislature with recommendations for allocating the $540 million.

Senate Bill 90 (SB 90), enacted on October 12, 1997, places the $540 million into the **Renewable Resource Trust Fund**, and contains explicit directions for distributing this fund through four distinct accounts: the Existing Renewable Resources Account, the New Renewable Resources Account, the Emerging Renewable Resources Account, and the Customer-Side Renewable Resource Purchases Account. Table 1 shows the percentage funding allocations by year.

Table 1
Yearly Allocations to Renewable Technologies[2]

Account	1998	1999	2000	2001	Overall	(in millions)
Existing Technologies	57%	49%	41%	33%	45%	$243
New Technologies	24%	28%	32%	36%	30%	$162
Emerging Technologies	10%	10%	10%	10%	10%	$54
Customer-Side	9%	13%	17%	21%	15%	$81

To assist participants in the Renewables Program in applying for funding from the various accounts within the program, the Energy Commission developed this ***Guidebook for the Renewable Technology Program.*** The guidebook is divided into four volumes, each corresponding to an account in the **Renewables Resource Trust Fund**:

- Volume 1 - Existing Renewable Resources Account
- Volume 2 - New Renewable Resources Account
- Volume 3 - Emerging Renewable Resources Account
- Volume 4 - Customer Credit Subaccount of the Customer-Side Renewable Resource Purchases Account

---

[1] ***Policy Report on AB 1890 Renewables Funding***, published March 1997, publication number 500-97-002.

[2] These percentages apply to annual amounts of $135 million dollars for four years as assumed in the ***Policy Report on AB 1890 Renewables Funding***. Due to the fact that $135 million will not be collected in the early years, it may be necessary to borrow some funds from one account in order to make payments in another account equal to the absolute amounts expected annually in the Report. This will only be done if the account from which money is being borrowed is not adversely affected. All funds borrowed will be returned to their appropriate account.

This booklet, Volume 3 of the ***Guidebook for the Renewable Technology Program,*** addresses the application and funding process for the Emerging Renewable Resources Account of the Renewable Resource Trust Fund. SB 90 directs that ten percent of the renewables funds provided under AB 1890 be used for the support of emerging technologies. This $54 million is to be used to fund a multi-year, consumer-based program to foster the development of emerging renewable technologies in distributed generation applications.

SB 90 provides a number of specific requirements for an emerging technology program, including the following:

1) Funding for emerging technologies shall be provided through a competitive, market-based process that shall be in place for a period of not less than four years.
2) The program shall provide monetary rebates, buydowns, or equivalent incentives, to purchasers, lessees, lessors, or sellers of eligible electricity generating systems.
3) Incentives shall be issued on the basis of the rated electrical capacity of the system measured in watts.
4) The amount of the incentive shall decline over the term of the program.
5) There shall be a limit to the maximum percentage of an eligible system's cost that can be provided by the incentive.
6) Specified proportions of the incentive funds shall be available to smaller systems of specified sizes.

SB 90 determines that the emerging renewable technologies eligible to participate in this program are photovoltaic, solar thermal electric, fuel cell technologies that utilize renewable fuels, and wind turbines of not more than ten kilowatts rated electrical capacity per customer site. The legislation further states that these four technologies are only eligible to participate in the program if they meet the emerging technology eligibility criteria contained in the Commission's March 1997 ***Policy Report On AB 1890 Renewables Funding.***

Based on Energy Commission staff research (e.g., Energy Technology Status Report, Targeted RD&D studies), docketed information, and testimonials by various interested parties and stakeholders at public workshops and hearings held during the AB 1890/SB 90 process, the Commission finds that photovoltaic, small wind systems (not more than 10 kW), fuel cells using renewable fuel and solar-thermal technology all meet the qualifying criteria for eligibility contained in the Commission's Policy Report. These eligibility criteria were applied to individual systems representing each of the four technology categories. At least one or more systems in each of the four technology categories was found to satisfy the eligibility criteria. Therefore, technologies from all four categories are eligible to receive funds from the Emerging Renewables Resources Account.

To receive a buydown, however, individual systems in the four eligible technology categories must meet the stringent requirements contained in this guidebook for the

Emerging Renewable Resources Account. These requirements are system level specifications (for example, meeting of either standards or one-year performance, full warranties, permits and contractor installation), and must be met before a buydown can be approved. (Refer to section entitled "What Generating Systems Are Eligible For Buydowns," page 7.) The Commission recognizes that there may be individual systems employing each of the four technologies that may not be able to meet these requirements because of the system's stage in its research, development and demonstration, and therefore will not qualify for the buydown in spite of the eligibility of their underlying technology.

Those who wish to receive a buydown from the Emerging Renewable Resources Account must purchase an electrical generating system that employs an emerging renewable technology and meets certain eligibility requirements, and follow the reservation and claim procedures outlined in this guidebook. If after reading this guidebook, you require additional information about the emerging technology program please contact the Energy Commission Call Center at (800) 555-7794 or send e-mail to callcntr@energy.state.ca.us.

Summary

The Buydown Program is a multi-year program of payments to buyers, sellers, lessors or lessees of eligible electricity generating systems which are powered by emerging renewable resources. The payments from the Emerging Renewable Resources Account are intended to substantially reduce the current costs of generating equipment using emerging renewable technologies. The intent of the Buydown Program is to reduce the net cost to the end user of such generating systems and, thereby, stimulate substantial sales of such systems during a period of at least four years beginning in 1998. These increased sales of generating equipment are expected to encourage manufacturers, sellers and installers to expand their operations and reduce their costs.

To ensure that the costs of these systems decrease over time, the level of buydown payment will decline in five steps from $3 per watt to $1 per watt during the course of the program. Each level of buydown payment is tied to a "block" or specific portion of the program's $54 million in funding. These five blocks of funds vary in size from $10.5 to $12 million. When the funds in one block have been completely committed, the next block of funds with a lower level of payment will become available. (See Table 2 on page 5)

The buydown payments may be made either directly to the retailer of a generating system, to its purchaser, or to the lessee or lessor in a leasing arrangement. It is expected that most customers for these systems will find it preferable to have the buydown paid directly to the retailer, and thereby deducted from the price the customer will pay. The program, however, will also accommodate customers who wish to apply for and receive the buydown payment directly. Customers for these systems can be any class of utility customer, including residential, commercial, agricultural or industrial customers. This program, however, is open only to customers of

California's in-state electrical corporations whose customers contribute to this fund, and the generating systems must be connected to the electrical grid of such utilities. (See "Who Can Receive the Buydown Payment?", below)

This Buydown Program is also intended to foster the siting of small, reliable generating systems throughout California at locations where the electricity produced is needed and consumed. This is known as "distributed generation." To be eligible for this program, the generating system must be on the premises of customers of California's electrical corporations and be of a size such that the electricity produced is expected to primarily offset part or all of the customer's electrical needs at these premises. To help maintain minimum standards of quality, the program also requires:

1) a minimum of a full five year warranty on the entire generating system;
2) installation by an appropriately licensed contractor and in compliance with appropriate electrical codes; and
3) certain key system components, or the entire generating system, be certified to meet certain established standards, where available.

Specific requirements for eligibility are detailed in the following sections of this guidebook.

The amount of buydown payment an eligible system will receive is dependent on:

1) the block of funds available to pay buydowns at the time your system is purchased and a buydown is reserved or installed;
2) the size or rated electrical output of your system; and
3) the total eligible costs of your system.

Table 2 gives the sizes of the blocks of funds and the corresponding levels of buydown payment per watt of system output, as well as the percentage of eligible system costs that the buydown payment cannot exceed. In Block 1, for example, the level of buydown available is $3 per watt of output with a cap of 50 percent of eligible system costs. Therefore, until the Block 1 monies are committed by reservation, a generating system that had eligible costs of $7.00 per watt would receive a buydown of $3 per watt, while a $4 per watt system would receive the maximum of 50 percent of eligible costs, or a buydown of $2 per watt.

Since the level of buydown per watt of output and the maximum buydown as a percentage of system cost ("the percentage cap"), both decline over time as the blocks of funds are consumed, sellers and purchasers of generating systems may want certainty at the time their system is ordered of the amount of buydown payment they will receive when it is installed. To provide this certainty, customers or retailers can reserve a rebate amount using the Reservation Request Form (CEC-1890C-1). Submitting this form to the Energy Commission when signing a purchase order or letter of intent to purchase will allow customers or retailers to reserve a specified buydown payment for a period of 6 months for generating systems of 10 kilowatts or

smaller and for 12 months for all systems larger than 10 kilowatts. When the system is installed and in service, the Reservation Confirmation and Claim Form (CEC-1890C-2) should be submitted with documentation of a safe installation (a copy of the building permit). The Energy Commission will then issue a check for the buydown, typically within 30 days of receiving the CEC-1890C-2.

Table 2
Buydown Program Parameters

BUYDOWN PROGRAM FUNDS BLOCK	1	2	3	4	5	TOTALS
Total buydown monies per block (millions)	$10.5	$10.5	$10.5	$10.5	$12.0	$54.0
Maximum buydown per watt of system output	$3.00	$2.50	$2.00	$1.50	$1.00	
Maximum buydown as a percentage of eligible system cost	50%	40%	30%	25%	20%	
Minimum number of system kilowatts bought down by the program	3,500	4,200	5,250	7,000	12,000	32,000

The Buydown Program is open to generating systems of all sizes, subject to certain conditions and restrictions. The program, however, is intended to favor small generating systems, such as those typically used by residential or small commercial and agricultural customers. At least 60 percent of the total $54 million in program monies (and 60 percent of the funds in each block of funds) must be awarded to systems of 10 kilowatts or smaller in rated output. An additional 15 percent of the program funds in each block are reserved for systems rated at 100 kilowatts or less. For otherwise eligible generating systems placed in service (i.e., installed and generating) after September 1, 1998, there will be a maximum payment of $500,000 that any one project may receive from any block of funds, and a maximum payment of $1,000,000 overall for any single project. Also, for all systems placed in service after September 1, 1998, any incentive received through grants, rebates, buydowns, cost-sharing, or in any similar forms from any source other than this program must be deducted from the eligible system costs before the buydown payment is determined.

The Energy Commission will conduct random audits of systems which have received buydown payments to ensure that the systems were properly installed, are properly functioning and are in accordance with the information provided in the reservation request and buydown claim forms. The Energy Commission will also periodically review the results of the Buydown Program to determine if modifications or changes to the level of buydown or other program terms and conditions are necessary to achieve the overall program goals.

What Types of Financial Assistance Will the Program Provide?

The Buydown Program will make direct payments to the purchaser, seller, lessee or lessor of an eligible electricity generating system upon satisfactory evidence that the system meets the requirements of this program.

Who Can Receive the Buydown Payment?

The payment can be reserved by and paid to the purchaser, retailer, lessee or lessor of an eligible generating system, as long as the owner of the system is not an electrical corporation or local publicly owned electric utility, and the purchaser or lessee receives electrical distribution from a utility which is contributing to the renewables fund. Such utilities are at present limited to Pacific Gas and Electric, Southern California Edison, and San Diego Gas and Electric. It will most likely be the retailer, or seller, of the system that will request a reservation and receive payment of the buydown. State law, however, requires that regardless of who receives the payment, the amount of the payment shall "directly and exclusively reduc(e) the cost of the eligible system, or the cost of electricity produced by the eligible system". (Public Utilities Code Section 383.5(d)(2)(B)). For purposes of this guidebook and the accompanying forms, any reference to "purchaser" or "customer" shall apply equally to the lessee of an otherwise eligible generating system, and any reference to "retailer" or "seller" shall apply equally to the lessor of an otherwise eligible system.

When Will the Buydown Program Begin?

Immediately after the California Energy Commission adopts this guidebook and its associated guidelines for the Emerging Renewable Resources Account, copies of this guidebook and the Buydown Program forms will be made available via mail, fax and the Internet. Completed forms to reserve or claim a buydown will be received by fax or mail beginning at 8:00 am PST on March 20, 1998. (See "How Do I Reserve a Buydown?" for contact phone numbers and addresses.)

What Generating Systems Are Eligible For Buydowns?

Eligible generating systems must meet all of the following requirements:

1) They must use one of the designated emerging renewable technologies to produce electricity.

2) For certain technologies, specified components of the systems, or the entire systems, must meet national standards. The Energy Commission will maintain a list of components and systems that meet the required standards of the program.

This list may be obtained by calling (916) 653-6830 or through the Commission's website at: <www.energy.ca.gov>

3) The system must be installed by a licensed contractor, unless installed by the purchaser, and be installed in conformance with the system manufacturer's specifications and with applicable electrical codes and standards

4) The system must come with a minimum of a full five year warranty against breakdown or unusual degradation for the purchaser.

Approved Technologies

For a generating system to be eligible to receive a payment under this program, the system must use an approved emerging renewable technology for its production of electricity. Subject to Energy Commission approval, there are four eligible technologies:

1) Photovoltaics - the direct conversion of sunlight to electricity
2) Solar Thermal Electric - the conversion of sunlight to heat and its concentration and use to power a generator to produce electricity
3) Fuel Cells - the conversion of sewer gas, land fill gas or other renewable sources of hydrogen or hydrogen rich gases into electricity by a direct chemical process
4) Small Wind Turbines - small electricity producing, wind-driven generating systems with a rated output of 10 kilowatts or less

Certified Components or Systems

Photovoltaics

All flat plate photovoltaic modules must be certified by a nationally recognized testing laboratory as meeting the requirements of the Underwriters Laboratory Standard 1703. All inverters must be certified by a nationally recognized testing laboratory for safe operation. Further, at such time that Underwriters Laboratory Standard 1741 is adopted, all inverters must also be certified as meeting the requirements of UL 1741. as well. For concentrator modules, in the absence of a recognized testing standard, manufacturers of concentrator photovoltaic systems must provide acceptable evidence to the Energy Commission for each model of system they wish to sell under this program of one year of reliable operation of that model of equipment.

Solar Thermal

No standards exist at present for solar thermal electric generating systems. In lieu of certification manufacturers of solar thermal systems must provide acceptable evidence to the Energy Commission of one year of reliable operation for each model of system they wish to sell under this program.

Fuel Cells

All fuel cells must be certified as meeting the requirements of the American Gas Association, No. 8-90, " AGA Requirements for Fuel Cell Power Plants."

Small Wind

All small wind turbines must be certified by a nationally recognized testing laboratory as meeting the requirements of IEC 1400-2. Until such time that certification to this standard is available, manufacturers of small wind systems must provide acceptable evidence to the Energy Commission for each model of system they wish to sell under this program of one year of reliable operation of that model of equipment at a site with average annual wind speeds of at least 12 mph.

Contractors and Installation Codes and Standards

All systems must be installed by appropriately licensed California contractors, unless they are installed by the purchaser, and must in all cases be installed in conformance with the manufacturer's specifications and with all applicable electrical and other codes and standards.

Photovoltaics

Contractors must possess, or employ subcontractors who possess, either a C-10 or a C-46 license.

Solar Thermal

Contractors must possess, or employ subcontractors who possess, either a C-10 or a C-46 license.

Fuel Cells

Contractors must possess, or employ subcontractors who possess, an A or C-10 license.

Small Wind

Contractors must possess, or employ subcontractors who possess, a C-10 license.

Warranties

All retailers of generating systems which receive a buydown payment under this program must provide a minimum of a full five-year warranty to the purchaser against breakdown or degradation of output. The warranty must cover all of the components of the generating system which are eligible for the buydown against breakdown or degradation in electrical output of more than ten percent from their originally rated

electrical output. The warranty shall cover the full cost of repair or replacement of defective components or systems. Where the system is also professionally assembled and installed, the warranty shall also include the labor to remove and reinstall defective components or systems.

What Costs of a Generating System Are Eligible for the Buydown?

Those portions of a generating system that convert the energy source to electricity and the related power conditioning and control systems are eligible to be covered by the Buydown Program. In addition, the costs of installation and any applicable licenses, permits, fees and sales taxes are also eligible costs. The costs of any equipment for the storage of the electricity produced are not eligible. For each technology, the following specific components and equipment are eligible.

Photovoltaics

The photovoltaic cells, modules, mounting or tracking structures, wiring, inverters, foundation (for free-standing systems), and utility required interconnection equipment.

Solar Thermal

The concentrating and collecting apparatus, tracking and mounting structures, wiring, thermal engines or devices for the conversion of heat to mechanical energy, generator, inverter, support structure and foundation (for free-standing systems), and utility required interconnection equipment.

Fuel Cells

The renewable gas pre-treatment equipment (but not the gas collection or production equipment), fuel processor, cell stacks, inverter and power conditioning equipment, cooling equipment, foundation (for free-standing systems), and utility required interconnection equipment.

Small Wind

The wind turbine, tower, wiring , inverter, foundation, and utility required interconnection equipment.

How Big Can My System Be?

There is no minimum size or rated electrical output for systems to be eligible under this program. For small wind systems the combined electrical output of all wind turbines installed at one site cannot exceed 10 kilowatts. For all other eligible emerging technologies, there is also no specific limit on the maximum rated electrical

output of a system. For all eligible systems regardless of technology, however, the system must be sized so that the amount of electricity produced by the system primarily offsets part or all of the customer's electrical needs at the site of installation. This means that the expected annual production of electricity by the system should not exceed the historical or current electrical needs of the electricity consumer at the site of installation by more than 25 percent. For example, if a purchaser's home or business where the system will be installed has used about 10,000 kilowatt hours (kWh) of electricity per year in the past, the generating system should be sized to produce no more 12,500 kWh per year (25 percent more than the historical need).

How Much Is The Buydown?

The amount of buydown will depend on the electrical size of your system (its rated electrical output in watts) and the level of buydown incentive payment and the percentage cap available at the time your reservation is made (or, if no reservation is made, at the time your system is purchased or installed). The process to determine the buydown available to your system is as follows:

1) Determine the buydown level per watt and the percentage cap of system costs available for a system of your rated output. This information can be obtained by calling 1 (800) 900-3594.

2) Multiply your System Rated Output in watts by the applicable level of buydown payment per watt of output. (See "How Do I Reserve a Buydown?" to determine the System Rated Output for different types of generating systems.)

3) Multiply the Total Eligible System Costs by the maximum percentage of system costs applicable for your size of system. (See "What Costs of a Generating System Are Eligible for the Buydown?" to determine your eligible system costs.)

4) The lower of the amount resulting from #2 or #3 above will be your buydown.

Do Financial Incentives from Other Sources Affect the Amount of Buydown I Can Receive?

Possibly. The exact answer will depend on the cost of your system, the time it is placed in service and the level of available buydown payment. For all systems placed in service on or after September 1, 1998, any financial incentives from any source (other than this program) that have been or will be received by any manufacturer, supplier, installer, or retailer in conjunction with the sale or lease of a generating system under this program, must be subtracted from the otherwise eligible costs of such systems before the buydown the system will receive under this program is determined. In other words, when you are calculating the total eligible system costs to request a buydown reservation or to claim a buydown payment, the total eligible system costs should be net of any incentives from any other source. (See "How Do I Reserve a Buydown?")

What is the Maximum Buydown Amount Any Single Project Can Receive?

For all eligible generating systems placed in service on or after September 1, 1998, no single project can receive more than $1,000,000 in total buydown payments nor more than $500,000 from any one block of buydown funds. A "single project" is defined to be "all otherwise eligible generating systems installed during the term of this program at one physical site and serving the electrical needs of all real and personal property located at that site."

How Do I Reserve a Buydown?

The amount of the buydown payment will change during the course of the program as the blocks of funds tied to each level of buydown payment are used. Consequently, most sellers and buyers of generating systems will want to be certain of the amount of buydown payment they will be receiving before ordering and installing the generating equipment. You must submit Form CEC-1890C-1, Reservation Request Form, to reserve a specified and certain buydown amount when an order is placed to purchase a system. There is a separate form for each of the four eligible emerging technologies: CEC-1890C-1-PV (photovoltaic), CEC-1890C-1-ST (solar thermal), CEC-1890C-1-FC (fuel cells) and CEC-1890C-1-SW (small wind). The forms are included with this guidebook. Blank forms can be obtained directly from the Energy Commission's Fax Line System via fax by calling (916) 653-6830, by mail by calling the CEC Call Center at 1-800-555-7794 or from the CEC Website at:

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

Once a purchase order has been signed by a residential customer, or a purchase order or letter of intent has been signed for a non-residential system, the Reservation Request Form, along with a copy of the purchase order or letter of intent and a copy of a recent utility statement, if available, can be submitted to the California Energy Commission. **It is preferred and suggested that the form be delivered by FAX to (916) 653-1435.** If sent by mail, it should be addressed to: **Emerging Technologies Buydown Program,** California Energy Commission, Accounting Office, 1516 - 9th Street, MS-2, Sacramento, CA 95814-5512.

To be accepted, the form must be accompanied by a copy of the purchase order or letter of intent showing the name of the customer and the location at which the system is to be installed. Also, if the installation location currently has electrical service, the attached copy of a utility statement (bill) should show that the installation site receives electrical distribution from an eligible service provider (utility). (See "Who Can Receive the Buydown Payment?") The Energy Commission will promptly review the form for completeness and the eligibility of the proposed system and will send back to the submitter Form CEC-1890C-2, Reservation Confirmation and Claim Form (either by telefax or by mail). No buydown money will be reserved until all information and

documentation required for the Reservation Request Form is received by the Energy Commission.

The Reservation Confirmation and Claim Form will give the dollar amount of buydown reserved for the specified system size and proposed installation site. A buydown reservation is not transferable to any other purchaser or installation location. Additionally, the Reservation Confirmation will expire six months after the date of issuance for small systems (10 kilowatts of rated output or smaller) and after twelve months for all other system sizes (larger than 10 kilowatts). There will be ***no*** extensions of these time periods. Systems not installed by the expiration date of the reservation may reapply for a buydown. Such reapplications will receive the level of buydown payment available at the time of reapplication, which may be a lower rate of payment than the originally reserved buydown.

Should the actually installed system differ in its rated electrical output from the system originally specified in the Reservation Request Form, a new buydown payment amount will be recalculated. If the installed system is smaller in output and its eligible costs are lower than those originally specified in the Reservation Request Form, the new buydown amount will be determined using the same Buydown Program parameters of buydown per watt of system output and maximum buydown as a percentage of eligible system costs that were used to calculate the originally reserved buydown amount.

On the other hand, if the installed system is larger or more expensive than that originally specified for the reservation, we will provide the maximum allowable rebate available at the time the claim form is submitted. There are several factors that preclude or limit our ability to increase a rebate, including: 1) No additional funds are available in the original or subsequent block; 2) No additional funds are available within a size category within a block; and 3) We may be unable to increase the project size above 10kW or 100kW because of legislatively mandated minimum funding levels for projects up to 10kW (60% of block funds) and for projects up to 100kW (75% of block funds).

By way of example, an original reservation request was submitted for a 4,000 watt (4 kilowatt) system with eligible costs of $24,000. The proposed system was given a confirmed reservation of buydown payment of $12,000 using program parameters in effect at the time of reservation of $3 per watt or a maximum of 50% of system costs. The purchaser, however, eventually installed, within the six month reservation period, a system of 6,000 watts of rated output and with eligible costs of $30,000. The buydown program parameters available for eligible systems at the time this customer submitted a claim for a buydown payment had declined to $2.50 per rated watt or a maximum of 40% of system costs. The buydown would be recalculated by first applying the $12,000 already reserved and then determining the additional rebate. The calculation is summarized as follows:

Installed system cost/watt			$5.00 ($30,000/6,000 watts)
Rebate level ($/watt) from reservation			$2.50 (Lesser of 50% of cost or $3.00/watt)
Rebate level ($/watt) for additional payment			$2.00(Lesser of 40% of cost or $2.50/watt)
Reservation amount of $12,000		buys down	4,800 watts ($12,000/$2.50)
Additional	2,400	buys down	1,200 watts (1,200 watts x $2.00)
Total Buydown	$14,400		6,000

Temporary Suspension of New Reservations

Since the $54 million in funds to make buydown payments under this program will be collected and become available for use over the period 1998-2002, it may be necessary to temporarily suspend the issuance of new reservations if at any time during the term of the Buydown Program the amount of outstanding and unclaimed reservations exceeds the expected availability of program funds to honor these reservations in a timely manner.

Detailed instructions for completing CEC-1890C-1, Reservation Request Form, and the STD-204, Vendor Data Record, follow:

CEC-1890C-1, Reservation Request Form

Section 1: Provide the name, address and business phone number of the retailer (seller) or lessor of the system. Also include a telefax phone number if you wish to have the buydown Reservation Confirmation Form returned to you by telefax. If there is no telefax number provided, the Reservation Confirmation will be mailed to the retailer's address. If the purchaser (customer) is requesting the buydown be paid to the purchaser rather than to the retailer, the purchaser may enter the retailer's name, address, and phone numbers in Section 1. If the purchaser is buying system components from more than one retailer, Section 1 may be left blank.

Payee I.D. Number: Every retailer (or purchaser, if the purchaser will be receiving the buydown payment) must have a Payee I.D. Number assigned to them before a buydown payment can be made under this program. If the retailer will be receiving the buydown payment and has been previously assigned an I.D. Number by the program, enter it at the top of Section 1. If the purchaser is to receive the buydown payment, the purchaser's Payee I.D. Number should be entered at the top of Section 3. If this is the first Reservation Request Form you are submitting, please also submit a Vendor Data Record Form (STD. 204), a copy of which is included in the Forms section of this guidebook. The State of California requires that all parties entering into business transactions that may lead to payment(s) from the State provide their Taxpayer Identification Number (TIN) as required by the State Revenue and Taxation Code, Section 18646, and Internal Revenue Code, Section 6109. Form STD 204 must be on

file with the Energy Commission before any payments can be made. If you have any questions about this form, please contact the Franchise Tax Board at 1-800-852-5711.

When you receive your first buydown Reservation Confirmation Form acknowledging the amount of a buydown reservation, your Payee I.D. number will be printed on the top of this form and this Payee I.D. Number should be used on all future Reservation Request Forms that you submit.

Section 2. Provide the installer's name, if different from the retailer, and the California license class and number of the installing contractor. See "What Generating Systems are Eligible for Buydowns?" to be sure that the installer has the appropriate class of contractor's license. If the purchaser intends to install the system, write "Owner Install" in the space provided for the contractor's license class and number.

Section 3. Provide the name and daytime phone number of the purchaser or lessee of the system. Provide the street address or other description of the physical location where the system is to be installed. Insert the name of the utility or electrical service provider who currently provides electrical distribution services to the site where the system is to be installed, and attach a copy of a monthly statement or bill showing electrical distribution service to the installation site, if service presently exists. Provide the prior 12 months consumption of electricity at the premises where the system is to be located. This information can be obtained by summing up the usage from the monthly utility bills or by contacting the utility serving the premises. Designate whether the buydown payment is to go to the retailer (or lessor) or purchaser (or lessee). If the purchaser will be receiving the payment, a Payee I.D. Number will be required. See the instructions for Section 1, above, for information on how to obtain a Payee I.D. Number and how to include Form STD 204 with this reservation request in order to be issued a Payee I.D. Number, if you do not presently have one. Your Payee I.D. Number should be entered at the top of Section 3.

Section 4. Generating System

For Photovoltaic Systems (Form CEC 1890C-1-PV)

Enter the manufacturer's name, model number and number of photovoltaic modules that your system will contain. Only photovoltaic modules that have been certified by a nationally recognized testing laboratory are eligible for the Buydown Program. Enter the "PTC" (not STC) rating of the modules. PTC ratings can be obtained from the module manufacturer. The Energy Commission will maintain a list of certified modules and their PTC ratings which can be obtained via fax by calling (916) 653-6830, by mail by calling 1-800-555-7794 or through the Commission's Website at: <http://www.energy.ca.gov>

Enter the manufacturer, model and peak inverter efficiency of the inverter in your system. Inverters must likewise be certified by a nationally recognized testing laboratory and a list of certified inverters can also be obtained from the Energy

Commission. Multiply the Total Module Output by the Peak Inverter Efficiency to determine the System Rated Output and enter the output in the box provided.

For Fuel Cells Using Renewable Fuel (Form CEC 1890C-1-FC)

Enter the manufacturer's name and model number. Eligible fuel cells must be certified to meet all of the requirements of the American Gas Association, No. 8-90. For the System Rated Output enter the manufacturer's continuous duty AC rated output in watts (not kilowatts). A list of eligible fuel cells and their power output can be obtained via fax by calling (916) 653-6830, by mail by calling 1-800-555-7794 or through the Commission's Website at: <http://www.energy.ca.gov>

For Small Wind Turbines (Form CEC 1890C-1-SW)

Enter the manufacturer's name and model number. Eligible wind turbine models must have demonstrated one year of reliable operation to be eligible for this program. For the Wind Turbine Power Output enter the highest electrical output from the manufacturer's power output curve for wind speeds up to 30 mph or less. A list of eligible wind turbines and their power output can be obtained via fax by calling (916) 653-6830, by mail by calling 1-800-555-7794 or through the Commission's Website at: <http://www.energy.ca.gov>

For wind turbines that use an inverter to produce AC power and for interconnection to the electric grid, enter the manufacturer, model and peak inverter efficiency of the inverter. Inverters must be certified by a nationally recognized testing laboratory and a list of certified inverters can also be obtained from the Energy Commission. Multiply the Wind Turbine Power Output by the Peak Inverter Efficiency to determine the System Rated Output and enter the output, as measured in watts, in the box. The System Rated Output cannot exceed 10,000 watts (10kW) and be eligible for a buydown. Additionally, total wind electricity generating capacity at a single customer site cannot exceed in total 10,000 watts of System Rated Output.

For Solar Thermal Systems (Form CEC 1890C-1-ST)

Enter the manufacturer's name and model number. Eligible models of solar thermal systems must have demonstrated one year of reliable operation to be eligible for this program. Enter the PTC rated AC power output of the system, as measured in watts, in the box for System Rated Output. A list of eligible solar thermal electric systems and their PTC ratings can be obtained via fax by calling (916) 653-6830, by mail by calling 1-800-555-7794 or through the Commission's website at: <http://www.energy.ca.gov>.

Section 5. Enter the total purchase price of all eligible components on the line next to Cost of System. Do not deduct any amount expected to be received from this Buydown Program. See "What Costs of a Generating System are Eligible for the Buydown?" in

this guidebook for a definition of what system components are eligible for the buydown and can be included in this total.

Note: For all systems placed in service (that is, installed and operational) after September 1, 1998, the amount of any rebates, buydowns, grants, cost-sharing or other incentives received by the equipment manufacturers, suppliers, retailers or installers from any source other than this program, and which reduce or offset any of the costs of these systems, **must be deducted from the Cost of System or otherwise incorporated in determining the Total Eligible System Costs that are charged to the purchaser of the system and the number entered for Total Eligible System Costs**. Enter the amount of any other incentives and their source.

Subtract any amount entered on "Less Other Incentives" from the Cost of System to determine the Total Eligible System Costs. If the amount entered as Total Eligible System Costs differs from the purchaser's price of the system as shown on the accompanying copy of the purchase order or letter of intent, a written explanation of the difference must accompany the submission of this form.

Buydown Requested: The Energy Commission will determine the amount of the buydown your system is eligible to receive and that will be reserved for you based on the data submitted on this form. This amount will be contained in the Reservation Confirmation and Claim Form that will be returned to you to confirm your reservation of a buydown payment. You may, however, wish to enter (in the box labeled "Buydown Requested") the amount of buydown you are anticipating based on the available buydown level, caps on buydown amounts and the costs and output of your system. To estimate the amount of this buydown before receipt of the confirmation, applicants can call 1-800-900-3594 to receive information on the currently available buydown amounts per watt of System Rated Output and the maximum percentage of Total Eligible System Costs for small, medium and large systems. The applicant can use this information to calculate two numbers: first, the buydown amount per watt multiplied by their System Rated Output and second, the maximum percentage times the Total Eligible System Costs. (See "How Much Is the Buydown?") The smaller of these two calculations should be your reserved buydown amount.

Section 6. Both the retailer and the purchaser should read the Declaration section and both must sign and date this section. In particular, the section of this guidebook titled "How Big Can My System Be?" should be consulted to ensure that the expected electrical generation of the system is appropriately matched to the customer's electrical needs. If the purchaser is requesting the reservation directly, only the purchaser portion of Section 6 needs to be filled out.

STD-204, Vendor Data Record

1. **Return Form To** - Already completed by the Energy Commission

2. **Vendor information** - Please enter your business name and address; if you are a sole proprietor, enter the owner's full name. If you are a purchaser requesting the buydown payment, enter your name and address.

3. **Vendor Entity Type** - Please check the box corresponding to the appropriate entity type.

4. **Vendor's Taxpayer ID Number** - Please enter your federal ID number. If you are an individual/sole proprietor, please enter your social security number.

5. **Vendor Residency Status** - Please check the appropriate box corresponding to your residency status.

6. **Registering Signature** - The registration must be signed by an authorized representative or officer such as the Chief Executive Officer or Chief Financial Officer if the vendor is a corporation, or by the business owner or purchaser, if you are a sole proprietor or individual.

Submitting the Reservation Request Form

The CEC-1890C-1, the STD-204, and a copy of the purchase order or letter of intent, should be telefaxed to the Energy Commission at (916) 653-1435 or mailed to: **Emerging Renewables Buydown,** California Energy Commission, Accounting Office, 1516 9th Street, MS-2, Sacramento, CA 95814-5512.

For more information on how to apply for a buydown reservation, please call 1-800-555-7794 during normal business hours.

How Do I Request A Buydown Payment?

Once an eligible generating system has been placed in service, a claim for payment of the appropriate buydown amount can be made. A generating system is "placed in service" when it is completely installed and is operational, that is, capable of producing electricity in the manner and in the amounts for which it was designed. To request payment of a buydown, use CEC-1890C-2, Reservation Confirmation and Claim Form. A copy of this form is included with this guidebook. If you requested a reservation of a buydown, however, you will already have this form since it was sent to you to confirm the amount of buydown reserved for your system. If you did not previously request a reservation of buydown, you may directly request a buydown by submitting Form CEC-1890C-2, as instructed below.

CEC-1890C-2, Reservation Confirmation and Buydown Claim Form

1) Both retailer and purchaser must read, sign and date the Buydown Claim portion of Form CEC 1890C-2. If the purchaser alone applied for and is to receive the buydown, only the purchaser need sign the Buydown Claim Form.

2) Any changes or modifications to the information provided on a previously submitted Reservation Request Form (CEC 1890C-1) must be noted in the space provided. If additional space is required to note such changes or modifications, additional pages can be attached to this form. If changes or modifications are noted, the applicant must also attach to this Claim Form a new Reservation Request Form containing the corrected information. Changes in the Total Eligible Systems Cost or the System Rated Output or other information may affect the amount of the buydown.

3) A copy of the final building permit required for the installation of the system must also accompany the submission of this form. The name and address on the building permit must match that shown under the Confirmation of Buydown Reservation section of this form, if a reservation was previously granted for this system.

4) A copy of the final sales invoice showing actual price paid by the purchaser for the installed system must accompany this form. If this price is different from that price shown on any purchase agreement or letter of intent previously submitted with a Reservation Request Form, please explain any difference. Actual price paid will be used for calculating the buydown amount.

5) A copy of a recent utility bill for electrical distribution service to the address of the installed system must also be submitted with this form to verify that the premises of the installation are receiving electrical distribution service from an eligible California electrical corporation, if a copy was not originally submitted with a Reservation Request Form.

6) If the buydown payment is being claimed for a system that had not previously been issued a reservation of buydown per Form CEC 1890C-1, the buydown Claim Form must also be accompanied by a completed and signed CEC-1890C-1, Reservation Request Form. (See "How Do I Reserve a Buydown?" for information on how to obtain and complete these forms.)

7) If the Reservation Confirmation and Claim Form submitted does not have a Payee I.D. Number printed on it in the upper right corner, the applicant must enter their previously issued Payee I.D. Number in this space. If applicant has not been issued a Payee I.D. Number, the applicant should submit an STD-204, Vendor Data Record, along with the claim form. (See "How Do I Reserve a Buydown?" for information on how to obtain and complete this form.)

The completed claim form must be submitted to the Energy Commission's Accounting Office by telefax or mail by 5 p.m. on the date specified in your buydown award reservation, together with copies of the building permit, final invoice, and utility bill. Claim forms that are not complete, legible or received by the date specified in your buydown award reservation will be returned to you along with a written notice stating the reasons why your claim was rejected. All required forms and the copies of the building permit and utility bill shall be telefaxed to (916) 653-1435 or mailed to: **Emerging Renewables Buydown,** California Energy Commission, Accounting Office, 1516 9th Street, MS-2, Sacramento, CA 95814-5512.

The Energy Commission intends to make incentive payments within 30 days of receipt of a completed claim form. Payment will be made to the retailer or purchaser, as designated on the Reservation Request Form (Form CEC-1890C-1), and will be mailed to the address provided by the recipient on the Vendor Data Record (Form STD-204), which they previously submitted to the Energy Commission.

Definitions

California in-state electrical corporations -- Pacific Gas and Electric Company, San Diego Gas and Electric Company, Southern California Edison, and any other electrical corporations contributing funds to the Emerging Renewable Resources Account of the Renewable Resources Trust Fund.
commercially available -- complete generating systems based on a designated emerging technology are available for immediate purchase under typical business terms and deliverable within a reasonable period of time.
electrical corporation -- see Section 218 of the Public Utilities Code
full-scale --- of a scale or size equal or comparable to the scale at which commercially available generating systems are being sold or are expected to be sold.
full five year warranty -- a written warranty given by the retailer of eligible equipment to the purchaser of such equipment, and which complies with the conditions and definitions of 15 U.S.C. Sections 2301 et seq., and which shall be transferable to any subsequent purchaser during the five year duration, and which must include and provide for the labor to remove and replace any defective components, except where the warrantor did not provide for the original installation of the equipment as part of the original purchase transaction.
in-state renewable generation -- biomass, solar thermal, photovoltaic, wind, geothermal, small hydropower of 30 megawatts or less, waste tire, digester gas, landfill gas, and municipal solid waste generation technologies, as described in the Policy Report on AB 1890 Renewables Funding, including any additions or enhancements thereto, that are produced in facilities located in this state and placed in operation after September 26, 1996, or that were operational prior to that date, and that are also certified under Section 292.207 of Title 18 of the Code of Federal Regulations as a qualifying small power production facility either located in California, or that began selling electricity to a California electrical corporation prior to September 26, 1996, under a Standard Offer Power Purchase Agreement authorized by the California Public Utilities Commission.
investor-owned utility -- a utility that is organized as a tax-paying business, whose properties are managed by representatives elected by shareholders.
kilowatt (kW) -- one thousand watts. A unit of measure for the amount of electricity needed to operate given equipment. A typical home using central air conditioning and other equipment might have a demand of 4-6 kW on a hot summer afternoon.
kilowatt hour (kWh) -- the most commonly-used unit of measure telling the amount of electricity consumed over time. It means one kilowatt of electricity supplied for one hour. A typical California household consumes about 500 kWh in an average month.
landfill gas (LFG) -- gas produced by the breakdown of organic matter in a landfill (composed primarily of methane and carbon dioxide).
letter of intent -- a document signed by a prospective purchaser and seller which describes the generating equipment to be purchased or leased, including the make, model and electrical output, and the terms of such purchase or lease, including the cost of the equipment and location of installation, and which is subject to only limited conditions.

local publicly owned electric utility -- as defined in Public Utilities Code section 9604, subdivision (d), and which includes a municipal utility district, a public utility district, an irrigation district, or a joint powers authority made up of one or more of these entities.
municipal utility -- a local publicly owned (customer-owned) electric utility that owns or operates electric facilities subject to the jurisdiction of a municipality, as opposed to the California Public Utilities Commission.
new and unused -- not having been previously placed in service.
owned by electrical corporations or local publicly owned electric utilities -- generating systems purchased, owned, and operated by electrical corporations or local publicly owned electric utilities and, if installed on a customer's premises, the power produced by such systems does not offset the power consumed by the customer or otherwise directly benefit the customer. Systems purchased by electrical corporations or local publicly owned electric utilities and which in turn are leased or sold to customers or, if installed on a customer's premises, offset the customer's electricity consumption and are operated to the benefit of the customer as if owned by the customer are not considered as owned by such electrical corporations or local publicly owned electric utilities for the purposes of this program.
peak inverter efficiency –the highest measured efficiency over the operating range of the inverter and where the measured efficiency is the ratio of power output to power input expressed as a percent.
photovoltaic (PV) -- a technology using a semiconductor that converts light directly into electricity.
placed in service -- installed, operational and capable of producing electricity.
primarily offset(s) part or all -- annual electricity generation expected from the generating system shall not exceed 125 percent of the historical or current needs for electricity at the installation site.
project -- all otherwise eligible generating systems installed during the term of this program at one physical site and serving the electrical needs of all real and personal property located at this site, where a site is a single parcel of real property plus any improvements.
PTC -- PVUSA Test Conditions (PTC) are defined as follows: 1000 watts/square meter plane of array (POA) irradiance for flat-plate photovoltaic modules or 850 watts/ sq.meter direct normal irradiance for concentrating photovoltaic or solar thermal systems with 20 degrees Centigrade ambient air temperature and 1 meter/second wind speed.
purchase order -- a document signed by a purchaser and seller (or lessee and lessor) and which describes the generating equipment to be purchased or leased, including the make and model, the location at which the equipment is to be installed, and the cost of the equipment to the purchaser or lessee.
sewer gas -- gas produced by the anaerobic decomposition of sewage
solar thermal -- the conversion of sunlight to heat and its concentration and use to power a generator to produce electricity.

Forms and Samples

CEC 1890C-1- PV - Reservation Request Form (Photovoltaics)

CEC 1890 C-1- FC - Reservation Request Form (Fuel Cells)

CEC 1890 C-1- SW - Reservation Request Form (Small Wind)

CEC 1890 C-1- ST - Reservation Request Form (Solar Thermal)

CEC 1890C-2 - Reservation Confirmation and Claim Form

STD 204 - Vendor Data Record

RESERVATION REQUEST FORM
EMERGING RENEWABLES BUYDOWN PROGRAM

Completed forms can be faxed to (916) 653-1435 or mailed to:

Emerging Renewables Buydown
California Energy Commission
1516 9th Street, MS-2
Sacramento, CA 95814-5512

For detailed instructions on completing this form, please see Volume 3 of the Guidebook for the Renewable Technology Program

Please print or type

1. Retailer Payee ID No.

Name

Address

Business Phone | Fax

2. Installer (If different from Retailer)

Name

Contractor License Class & Number

3. Purchaser Payee ID No.

Name

Physical Address of System

Phone Number:

Utility Provider:

Most recent 12 months of electricity usage at the intended physical address of the system: _____ kWh

Payee Designation: Buydown payment should be sent to (circle one) Retailer / Purchaser.

4. Generating System

Photovoltaic Module Manufacturer:

Module Model Number:

Number of Modules _____

PTC Power Rating per Module _____ Watts

Total Module Output _____ Watts
(No. of modules x PTC Power Rating)

Inverter Manufacturer:

Inverter Model Number:

Peak Inverter Efficiency _____ %

System Rated Output
(Total Module Output x Peak Inverter Efficiency) _____ Watts

5. System Cost

Cost of System (before California buydown) $_____

Less Other Incentives (Source: _____) $_____

Total Eligible System Costs $_____

Buydown Requested $ _____

CEC Review

6. Declaration

The undersigned declare under penalty of perjury that 1) the information provided in this form is true and correct to the best of my knowledge, 2) that the above described generating system is intended primarily to offset part or all of the purchaser's electrical needs at the site of installation, 3) that the site of installation is located within service territory of PG&E, SCE, or SDG&E, and 4) that the purchaser has received a copy of this completed form.

Retailer	Purchaser
Signature: _____	Signature: _____
Print Name: _____	Print Name: _____
Date: _____	Date: _____

Attach a copy of the purchase order or letter of intent, and a copy of a monthly utility statement to this form.

RESERVATION REQUEST FORM
EMERGING RENEWABLES BUYDOWN PROGRAM

Completed forms can be faxed to (916) 653-1435 or mailed to: Emerging Renewables Buydown, California Energy Commission, 1516 9th Street, MS-2, Sacramento, CA 95814-5512

For detailed instructions on completing this form, please see Volume 3 of the Guidebook for the Renewable Technology Program

Please print or type

1. Retailer

Payee ID No.

Name

Address

Business Phone | Fax

2. Installer (If different from Retailer)

Name

Contractor License Class & Number

3. Purchaser

Payee ID No.

Name

Physical Address of System

Phone Number:

Utility Provider:

Most recent 12 months of electricity usage at the intended physical address of the system:

_____ kWh

Payee Designation: Buydown payment should be sent to (circle one) Retailer / Purchaser.

4. Generating System

Fuel Cell Manufacturer:

Fuel Cell Model Number:

System Rated Output (AC Continuous)

_____ Watts

5. System Cost

Cost of System (before California buydown) $ _____

Less Other Incentives Source: _____ $ _____

Total Eligible System Costs $ _____

Buydown Requested $ _____

CEC Review

6. Declaration

The undersigned declare under penalty of perjury that 1) the information provided in this form is true and correct to the best of my knowledge, 2) that the above described generating system is intended primarily to offset part or all of the purchaser's electrical needs at the site of installation, 3) that the site of installation is located within service territory of PG&E, SCE, or SDG&E, and 4) that the purchaser has received a copy of this completed form.

Retailer	Purchaser
Signature: _____	Signature: _____
Print Name: _____	Print Name: _____
Date: _____	Date: _____

Attach a copy of the purchase order or letter of intent, and a copy of a monthly utility statement to this form.

RESERVATION REQUEST FORM
EMERGING RENEWABLES BUYDOWN PROGRAM

Completed forms can be faxed to (916) 653-1435 or mailed to:

Emerging Renewables Buydown
California Energy Commission
1516 9th Street, MS-2
Sacramento, CA 95814-5512

For detailed instructions on completing this form, please see Volume 3 of the Guidebook for the Renewable Technology Program

Please print or type

1. Retailer

Payee ID No.

Name

Address

Business Phone | Fax

2. Installer (If different from Retailer)

Name

Contractor License Class & Number

3. Purchaser

Payee ID No.

Name

Physical Address of System

Phone Number:

Utility Provider:

Most recent 12 months of electricity usage at the intended physical address of the system: _____ kWh

Payee Designation: Buydown payment should be sent to (circle one) Retailer / Purchaser.

4. Generating System

Wind Turbine Manufacturer:

Turbine Model Number:

Wind Turbine Power Output _____ Watts
(Peak output up to 30 mph wind speed)

Inverter Manufacturer:

Inverter Model Number:

Peak Inverter Efficiency _____ %

System Rated Output
(Wind Turbine Power Output x Peak Inverter Efficiency) _____ Watts

5. System Cost

Cost of System
(before California buydown) $ _____

Less Other Incentives
Source: _____ $ _____

Total Eligible System Costs $ _____

Buydown Requested $ _____

CEC Review

6. Declaration

The undersigned declare under penalty of perjury that 1) the information provided in this form is true and correct to the best of my knowledge, 2) that the above described generating system is intended primarily to offset part or all of the purchaser's electrical needs at the site of installation, 3) that the site of installation is located within service territory of PG&E, SCE, or SDG&E, and 4) that the purchaser has received a copy of this completed form.

Retailer	Purchaser
Signature: _____	Signature: _____
Print Name: _____	Print Name: _____
Date: _____	Date: _____

Attach a copy of the purchase order or letter of intent, and a copy of a monthly utility statement to this form.

RESERVATION REQUEST FORM
EMERGING RENEWABLES BUYDOWN PROGRAM

Completed forms can be faxed to (916) 653-1435 or mailed to:

Emerging Renewables Buydown
California Energy Commission
1516 9th Street, MS-2
Sacramento, CA 95814-5512

For detailed instructions on completing this form, please see Volume 3 of the Guidebook for the Renewable Technology Program

Please print or type

1. Retailer

Payee ID No.

Name

Address

Business Phone | Fax

2. Installer (If different from Retailer)

Name

Contractor License Class & Number

3. Purchaser

Payee ID No.

Name

Physical Address of System

Phone Number:

Utility Provider:

Most recent 12 months of electricity usage at the intended physical address of the system: _____ kWh

Payee Designation: Buydown payment should be sent to (circle one) Retailer / Purchaser.

4. Generating System

Solar Thermal System Manufacturer:

System Model Number:

PTC Power Rating _____ Watts

System Rated Output (PTC Power Rating) _____ Watts

5. System Cost

Cost of System (before California buydown) $ _____

Less Other Incentives

Source: _____ $ _____

Total Eligible System Costs $ _____

Buydown Requested $ _____

CEC Review

6. Declaration

The undersigned declare under penalty of perjury that 1) the information provided in this form is true and correct to the best of my knowledge, 2) that the above described generating system is intended primarily to offset part or all of the purchaser's electrical needs at the site of installation, 3) that the site of installation is located within service territory of PG&E, SCE, or SDG&E, and 4) that the purchaser has received a copy of this completed form.

Retailer	Purchaser
Signature: _____	Signature: _____
Print Name: _____	Print Name: _____
Date: _____	Date: _____

Attach a copy of the purchase order or letter of intent, and a copy of a monthly utility statement to this form.

CEC- 1890C-2 FINAL 02/98

RESERVATION CONFIRMATION AND CLAIM FORM
EMERGING RENEWABLE BUYDOWN PROGRAM

Reservation Number _____

Payee ID Number _____

CONFIRMATION OF BUYDOWN RESERVATION

This is to confirm that _____ has been granted a reservation of $_____ for a _____Watt generating system to be installed at _____. This reservation of incentive will expire on _____. The generating system must be placed in service and the claim form below, including all appropriate documentation, must be faxed or postmarked by this expiration date or this reservation will be voided. This reservation is non-transferable and the generating system must be installed on the premises and sold to the purchaser listed above and as submitted on the original Reservation Request Form.

BUYDOWN CLAIM

The undersigned declare under penalty of perjury that the following statements are true and correct: (1) an electrical generating system meeting the terms and conditions of the California Energy Commission's Emerging Renewable Resources Buydown Program has been installed and is operating satisfactorily as of the date stated below; (2) the rated electrical output of the generating system and the physical location of the system are as stated above under Confirmation of Buydown Reservation; and (3) except as noted below, there were no changes in the information regarding the retailer, installer, purchaser, generating system specifications,installation location, or price from that information provided in the Reservation Request Form originally submitted by the undersigned. (List any changes, exceptions or modifications to the information provided in your Reservation Request Form. Attach a separate sheet if necessary)

_____

_____

_____

_____

_____

_____

_____

Retailer	Purchaser
Signature: _____	Signature: _____
Print Name: _____	Print Name: _____
Date: _____	Date: _____

Attach copies of 1) the building permit showing final inspection signoff, 2) the final purchase invoice and 3) a recent utility statement showing electrical service at the installation location.

STATE OF CALIFORNIA

VENDOR DATA RECORD

(Required in lieu of IRS W-9 when doing business with the State of California)

STD. 204 (REV. 12-94)

NOTE: Governmental entities, federal, state, and local (including school districts) are not required to submit this form.

SECTION 1 must be completed by the requesting state agency before forwarding to the vendor

1 **PLEASE RETURN TO:**

DEPARTMENT/OFFICE	California Energy Commission Accounting Office MS #2
STREET ADDRESS	1516 Ninth Street Sacramento, CA 95814
CITY, STATE, ZIP CODE	
TELEPHONE NUMBER	

PURPOSE: Information contained in this form will be used by state agencies to prepare Information Returns (Form 1099) and for withholding on payments to nonresident vendors. Prompt return of this fully completed form will prevent delays when processing payments. ***(See Privacy Statement on reverse.)***

2 VENDOR'S BUSINESS NAME

SOLE PROPRIETOR--ENTER OWNER'S FULL NAME HERE *(Last, First, M.I.)*

MAILING ADDRESS *(Number and Street or P. O. Box Number)*

(City, State, and Zip Code)

3 **VENDOR ENTITY TYPE**

CHECK ONE BOX ONLY

- ☐ **MEDICAL CORPORATION** *(Including dentistry, podiatry, psychotherapy, optometry, chiropractic, etc.)*
- ☐ **EXEMPT CORPORATION** *(Non-profit)*
- ☐ **ALL OTHER CORPORATIONS**
- ☐ **PARTNERSHIP**
- ☐ **ESTATE OR TRUST**
- ☐ **INDIVIDUAL/SOLE PROPRIETOR**

NOTE: State and local governmental entities, including school districts are not required to submit this form.

4 **VENDOR'S TAXPAYER I. D. NUMBER**

SOCIAL SECURITY NUMBER REQUIRED FOR INDIVIDUAL/SOLE PROPRIETOR BY AUTHORITY OF THE REVENUE AND TAXATION CODE SECTION 18646 *(See reverse)*

FEDERAL EMPLOYER'S IDENTIFICATION NUMBER (FEIN) ___ – _____

IF VENDOR ENTITY TYPE IS A CORPORATION, PARTNERSHIP, ESTATE OR TRUST, ENTER FEIN.

SOCIAL SECURITY NUMBER ___ – ___ – _____

IF VENDOR ENTITY TYPE IS INDIVIDUAL/SOLE PROPRIETOR, ENTER SSN.

NOTE: Payment will not be processed without an accompanying taxpayer I.D. number.

5 **VENDOR RESIDENCY STATUS**

CHECK APPROPRIATE BOX(ES)

- ☐ California Resident - Qualified to do business in CA or a permanent place of business in CA
- ☐ Nonresident *(See Reverse)* Payments for services by nonresidents may be subject to state withholding
  - ☐ WAIVER OF STATE WITHHOLDING FROM FRANCHISE TAX BOARD ATTACHED
  - ☐ SERVICES PERFORMED OUTSIDE OF CALIFORNIA

NOTE:

a. An estate is a resident if decedent was a California resident at time of death.

b. A trust is a resident if at least one trustee is a California resident. *(See reverse.)*

6 **CERTIFYING SIGNATURE**

I hereby certify under penalty of perjury that the information provided on this document is true and correct. If my residency status should change, I will promptly inform you.

AUTHORIZED VENDOR REPRESENTATIVE'S NAME *(Type or Print)*	TITLE	
SIGNATURE	DATE	TELEPHONE NUMBER

ARE YOU A RESIDENT OR A NONRESIDENT?

Each corporation, individual/sole proprietor, partnership, estate or trust doing business with the State of California must indicate their residency status along with their vendor identification number.

A **corporation** will be considered a "resident" if it has a permanent place of business in California. The corporation has a permanent place of business in California if it is organized and existing under the laws of this state or, if a foreign corporation has qualified to transact intrastate business. A corporation that has not qualified to transact intrastate business (e.g., a corporation engaged exclusively in interstate commerce) will be considered as having a permanent place of business in this state only if it maintains a permanent office in this state that is permanently staffed by its employees.

For **individuals/sole proprietors**, the term "resident" includes every individual who is in California for other than a temporary or transitory purpose and any individual domiciled in California who is absent for a temporary or transitory purpose. Generally, an individual who comes to California for a purpose which will extend over a long or indefinite period will be considered a resident. However, an individual who comes to perform a particular contract of short duration will be considered a nonresident.

For withholding purposes, a **partnership** is considered a resident partnership if it has a permanent place of business in California. An **estate** is considered a California estate if the decedent was a California resident at the time of death and a **trust** is considered a California trust if at least one trustee is a California resident.

More information on residency status can be obtained by calling the Franchise Tax Board at the numbers listed below:

From within the United States, call 1-800-852-5711
From outside the United States, call 1-916-854-6500
For hearing impaired with TDD, call 1-800-822-6268

ARE YOU SUBJECT TO NONRESIDENT WITHHOLDING?

Payments made to nonresident vendors, including corporations, individuals, partnerships, estates and trusts, are subject to withholding. Nonresident vendors performing services in California or receiving rent, lease or royalty payments from property (real or personal) located in California will have 7% of their total payments withheld for state income taxes. However, no withholding is required if total payments to the vendor are $1500 or less for the calendar year.

A nonresident vendor may request that income taxes be withheld at a lower rate or waived by sending a completed form FTB 588 to the address listed below. A waiver will generally be granted when a vendor has a history of filing California returns and making timely estimated payments. If the vendor activity is carried on outside of California or partially outside of California, a waiver or reduced withholding rate may be granted. For more information, contact:

Franchise Tax Board
Withhold at Source Unit
Attention: State Agency Withholding Coordinator
P.O. Box 651
Sacramento, CA 95812-0651
Telephone: (916) 845-4900
FAX: (916) 845-4831

If a reduced rate of withholding or waiver has been authorized by the Franchise Tax Board, attach a copy to this form.

PRIVACY STATEMENT

Section 7(b) of the Privacy Act of 1974 (Public Law 93-5791) requires that any federal, state, or local governmental agency which requests an individual to disclose his social security account number shall inform that individual whether that disclosure is mandatory or voluntary, by which statutory or other authority such number is solicited, and what uses will be made of it.

The State of California requires that all parties entering into business transactions that may lead to payment(s) from the State must provide their Taxpayer Identification Number (TIN) as required by the State Revenue and Taxation Code, Section 18646 to facilitate tax compliance enforcement activities and to facilitate the preparation of Form 1099 and other information returns as required by the Internal Revenue Code, Section 6109. The TIN for individual and sole proprietorships is the Social Security Number (SSN).

It is mandatory to furnish the information requested. Federal law requires that payments for which the requested information is not provided be subject to a 31% withholding and state law imposes noncompliance penalties of up to $20,000.

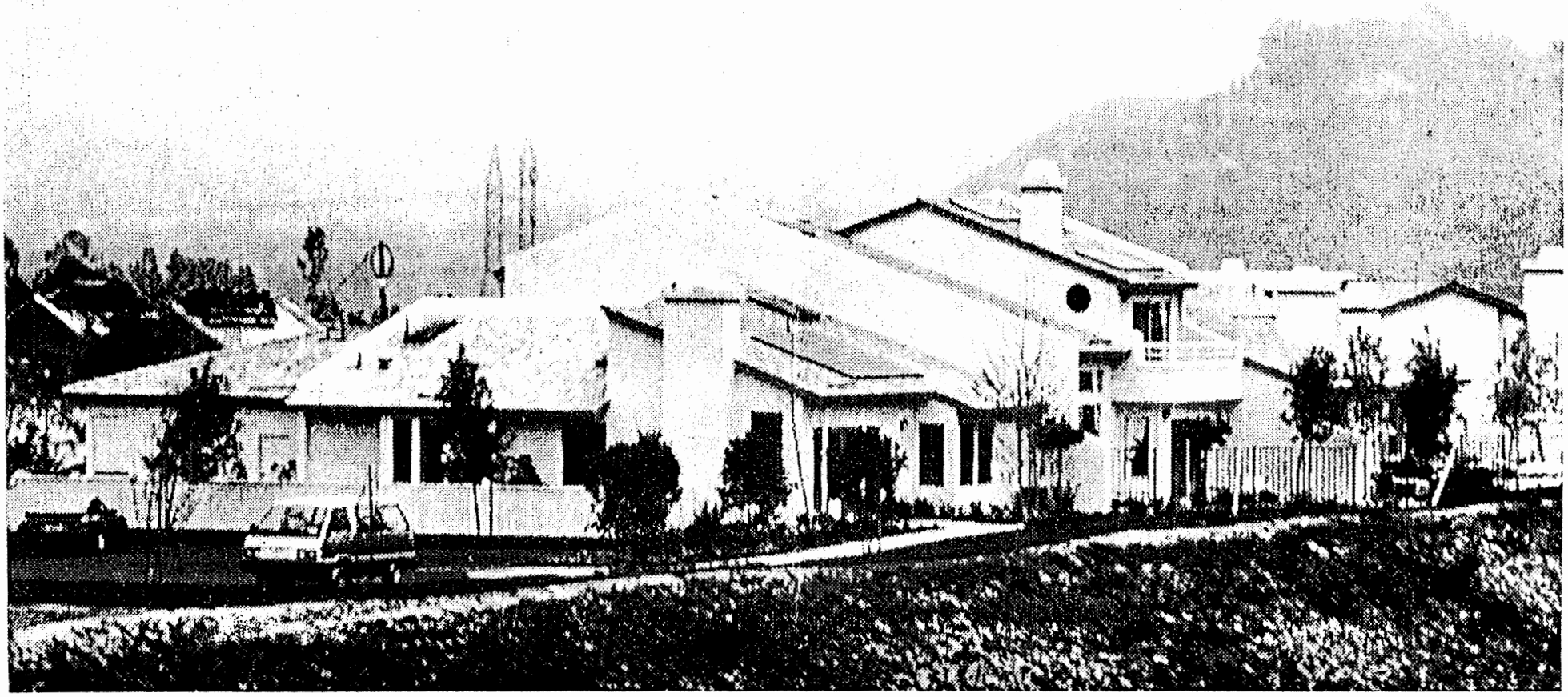
You have the right to access records containing your personal information, such as your SSN. To exercise that right, please contact the business services unit or the accounts payable unit of the state agency(ies) with which you transact business.

Please call the Department of Finance, Fiscal Systems and Consulting Unit at (916) 324-0385 if you have any questions regarding this Privacy Statement. Questions related to residency or withholding should be referred to the telephone numbers listed above. All other questions should be referred to the requesting agency listed in Section 1.



Consumer's Guide to Buying a Solar Electric System

For Participants in the California Emerging Technologies Buydown Program



California is now offering financial incentives through the California Buydown Program to encourage homeowners and businesses to buy photovoltaic (solar electric) systems. This booklet provides consumers with the basic information needed to guide them through the process of purchasing a solar electric system. The following checklist summarizes the issues that are discussed in detail in the accompanying text.

Consumer Checklist

Background Page

- ❑ What is a solar electric, or photovoltaic (PV), system? 1
- ❑ What is the California Buydown Program, and how do I qualify? 2

Investing in a PV system

- ❑ Why should I buy a PV system? 4
- ❑ Is my home or business a good place for a solar system? 4
  - ❑ Good orientation (will PV panels face west, south, east, or straight up)? 4
  - ❑ No shading from trees, nearby buildings, or other obstructions? 4
  - ❑ Enough area on roof or property? 5
  - ❑ Good roof (age of roof, roof type, roof warranty)? 5
- ❑ How big should my PV system be, and what features should it have? 5
- ❑ How much electricity will my PV system produce? How much will I save on my bill? 6
- ❑ How much does a PV system cost? 7
- ❑ Are incentives available to help reduce the cost? 8
- ❑ How can I finance the cost of my PV system? 8

Selecting a PV provider

- ❑ Who sells and installs PV systems? 9
- ❑ How do I choose among PV providers? 9
- ❑ How do I obtain and choose among competing bids? 10
- ❑ Is the lowest price the "best deal"? 11

Before connecting a PV system to the grid

- ❑ Permitting my PV system 12
- ❑ Insuring my PV system 12
- ❑ Obtaining an interconnection agreement 12
- ❑ Obtaining a net-metering agreement 13
- ❑ Utility and inspector signoff 14
- ❑ Warranties for my PV system (a minimum 5-year system warranty is required) 14

Getting help 16

Cover photo: These California townhomes use roof-top PV to supply part of their electricity. They also use the local utility as a backup to store any extra power they may produce. An extra meter on each home

This Consumer's Guide was written and published with the support of the National Renewable Energy Laboratory, the Interstate Renewable Energy Council, and the California Energy Commission. The authors, Tom Starrs and Howard Wenger, would like to thank Christy Herig of the National Renewable Energy Laboratory, Jane Weissman of the Interstate Renewable Energy Council, Vincent Schwent of the California Energy Commission, and the members of the California PV Alliance for their support and assistance in the preparation of the Guide.

September 1998

Getting Help

To get more information, report problems, lodge complaints, or make suggestions, please contact:

Help Topics	Help Contacts				
	California Energy Commission	California Solar Energy Industries Association	Independent Power Providers	PVUSA	Utility
California Buydown Program	X	X	X		
PV Provider List		X	X		
PV Provider Check-Up	X	X	X		
Insurance	X	X			X
Interconnection		X		X	X
Permitting & Inspection		X		X	X
Net-Metering Agreement		X		X	X
PV System Production & Savings				X	
PV System Cost	X	X			
Financing		X			
Problems, Complaints, Suggestions	X				

02512003m

California Energy Commission
Call Center
(800) 555-7794
callcntr@energy.state.ca.us

California Solar Energy Industries Association (CalSEIA)
Cathy Murnighan, Executive Director
(800) 225-7799

Independent Power Providers (IPP)
Don Loweburg
(209) 841-7001
i2p@aol.com

Pacific Gas & Electric Company (PG&E)
Keith Forsman
(415) 973-2380
kef1@pge.com

Photovoltaics for Utility-Scale Applications (PVUSA)
Technical Support
(530) 753-0725

San Diego Gas & Electric Company (SDG&E)
Mike Iammario
(619) 696-4688
miammari@sdge.com

Southern California Edison Company (SCE)
Tom Dossey
(626) 302-8242
dosseyt@sce.com

Background

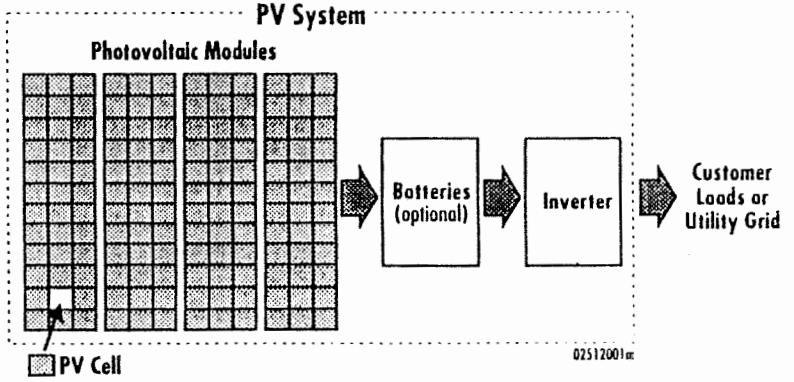
Are you thinking about purchasing a solar photovoltaic (or "PV") system to provide clean, renewable electricity for your home or business? If so, this booklet will provide you with some basic information that you may need to know before you buy and operate your PV system. A word of caution: It is not intended to be a technical guide for designing or installing your system—for that information, we recommend that you consult an experienced PV system designer or system supplier ("PV provider") who will have detailed technical specifications and other necessary information.

Buying a PV system can be a substantial investment in your property depending on the size of the system. As with any investment, careful planning will help ensure that you make the right purchase decision. Here are some issues for you to consider.

What is a solar electric, or photovoltaic, system?

PV technology converts sunlight directly into electricity. It works any time the sun is shining, but more electricity will be produced the more intense the light (as on a clear, sunny day) and the more direct the angle of the light (as when the sun is perpendicular to the PV array). Unlike solar systems for heating water, which you might be more familiar with, PV technology does not use the sun's heat to make electricity. Instead, PV technology produces electricity directly from the electrons freed by the interaction of sunlight with certain semiconductor materials in the PV array.

But you don't need to understand the detailed physics of how PV technology works to understand its appeal: investing in PV allows you to produce your own electricity with no noise, no air pollution, and no moving parts while using a clean, renewable resource. A PV system will never run out of fuel, and it won't increase our oil imports from overseas. In fact, it may not even contribute to the trade deficit, because many PV system components are manufactured in the United States. Because of these unique characteristics, PV technology has been called "the ultimate energy source for the 21st century."



PV System Compo...

The basic building block of PV technology is the solar "cell." PV cells are wired together to produce a PV "module," the smallest PV component sold commercially, and these modules range in power output from about 10 watts to 300 watts. A PV system connected to a utility grid consists of one or more PV modules connected to an inverter that converts PV's DC electricity to AC electricity—compatible with the electric grid and able to power devices such as lights, appliances, computers, and televisions. You may include batteries in the system to provide back-up power in case your utility suffers a power outage.

Before you decide to buy a PV system, you should understand the current status of the technology:

- First, it produces power intermittently because it works only when the sun is shining. This is not a problem for PV systems connected to the utility grid, because whatever additional electricity you might need is automatically delivered to you from your electricity supplier.
- Second, PV-generated electricity is still considerably more expensive than conventional utility-supplied electricity. Improved manufacturing has reduced the cost to less than one percent of what it was in the 1970s. Still, the cost of PV electricity (amortized over the life of the system) is about 25 cents per kilowatt-hour, roughly twice the retail price that most California residents pay for electricity from the utility grid. But not anymore. The California Buydown Program can make PV competitive with the cost of your electricity *today*, putting PV within the financial reach of many home and business owners.
- Finally, unlike purchasing your electricity from a utility, where you buy what you need when you need it, almost all the cost of PV electricity comes from the up-front expense of initially purchasing the PV system. This means that buying a PV system is like paying many years' worth of electric bills all at once. You'll probably appreciate the reduction in your monthly electric bills, but the initial expense is not insignificant. Later, we'll describe some ways to make that up-front expense easier on your pocketbook; however, we'll first provide some of the information you need to know about investing in a PV system.

What is the California Buydown Program, and how do I qualify?

You may already know that California's electricity industry has become partially open to competition in much the same fashion as the telephone industry during the 1980s and 1990s. As part of the deregulation process, the California Legislature and the California Energy Commission finalized plans to make $54 million available to customers of Pacific Gas & Electric Company (PG&E), San Diego Gas & Electric Company (SDG&E), and Southern California Edison (SCE) to help offset the cost of purchasing their own PV systems. These funds are available to "buy down" or reduce the up-front purchase price of a PV system, making the cost of the electricity produced by the system closer to the cost of electricity purchased from a utility. *Any electricity user who was served by PG&E, SDG&E, or SCE on December 31, 1997, is eligible to access these funds to help offset the cost of a PV system for their home or business, including state and federal buildings, as long as the PV system is connected to*

components that they sell you. If the retailer also installs the equipment for you, and the price of the installation is included in the overall system price on which the buydown amount is based, then the required warranty includes the cost of removing the defective component, shipping it to the manufacturer, and reinstalling the component after it is repaired or replaced. If, on the other hand, the retailer simply sells you the equipment, and you install it yourself or have it installed by someone other than the retailer, then the retailer is not responsible for the cost of removal, shipping, and reinstallation—you will have to bear those costs yourself. You should consider the implications for the warranty in deciding whether to have the retailer also serve as the installer.

The California Buydown Program's 5-year warranty requirement supercedes any other warranty limitations. In other words, even if the manufacturer's own warranty on a particular component is less than 5 years, the retailer must still provide you with a 5-year warranty. Similarly, even if the manufacturer's warranty is a limited warranty that does not include the cost of removing, shipping, and reinstalling defective components, the retailer must cover these costs if the retailer also installed the system.

The required 5-year warranty applies only to components of the generating system covered by the Buydown Program, including PV modules, mounting or tracking structures, inverters, wiring, foundations (only for free-standing systems), and utility-required interconnection equipment. The warranty does not apply to components used for electricity storage, including batteries and charge controllers.

Retailers participating in the California Buydown Program also are required to provide a warranty against degradation of electrical output. Ask your retailer for details.

The 5-year warranty requirement allows exclusions for damage, malfunction, or degradation of electrical output caused by factors beyond the manufacturers' or retailers' control. These exclusions may include (but are not limited to) failure to properly operate and maintain the system, failure to comply with applicable building codes and utility requirements, mishandling, neglect, vandalism, or acts of God. It also allows exclusions for systems that are not installed either by the purchaser or by an appropriately licensed California contractor, and for systems that are not installed in accordance with applicable safety and building codes and local utility requirements. Be sure to carefully read the warranty and review the terms and conditions with your retailer to avoid any later misunderstandings.

amended it to apply to small commercial customers, as well. Net metering allows eligible customers with PV systems to interconnect using their existing single meter. Almost all standard utility meters are able to measure the flow of energy in either direction. The meter spins forward when electricity is flowing from the utility into the building and spins backward when power is flowing from the building to the utility. Once a year, the customer is charged for the "net" energy consumed over the previous 12 months. There is no carry-over credit from year to year, so any "net" energy generated by the customer is lost at the end of the 12-month period. Net metering allows customers to get more value from the energy they generate by using the energy to offset retail electricity purchases, rather than selling it to their utility at the lower wholesale or "avoided cost" price. Net metering also simplifies both the metering process (by eliminating the need for a second meter) and the accounting process (by eliminating the need for payments from your electricity service provider). Most utilities have established simplified net-metering agreements for customers that qualify; be sure to ask your PV provider or your utility for a net-metering agreement.

Under the federal Public Utility Regulatory Policies Act (PURPA), utilities must allow you to interconnect your PV system, and they must also buy any excess electricity you generate (beyond what you use in your home or business). Usually, utilities require business customers without net-metering agreements to use two meters: one to measure the flow of electricity into the building, the other to measure the flow of electricity out of the building. The electricity you generate from your PV system goes first to supplying your own needs at the moment it is being generated. Any shortfall is purchased from the utility at the retail rate. Any excess electricity you generate and don't immediately use is sold back to the utility at the so-called "avoided cost" rate. This rate is much lower than the retail rate—about 2 ¢/kWh, as opposed to 10-15 ¢/kWh. Consequently, you have a strong incentive to use all the electricity as you generate it so that it offsets electricity you would otherwise have to purchase at the retail rate. Otherwise, you lose much of the value of the electricity because the utility pays you only the avoided-cost rate.

For commercial and industrial customers who generate their own power, this "dual metering" arrangement is still the norm.

Utility and inspection signoff

After your new PV system is installed, it must be inspected and "signed off" by the local permitting agency (usually a building or electrical inspector) and most likely by the electric utility you entered into an interconnection agreement with. The possibility exists that, as a result of these inspections, your PV provider may have to make "corrections" to satisfy the inspector's requirements. Corrections are fairly common in the construction business, so don't be alarmed if they are requested of you and your PV provider. A copy of the building permit showing final inspection signoff and a recent utility statement showing electrical service at the installation location are required to obtain a buydown payment from the California Buydown Program.

Warranties for my PV system

Retailers participating in the California Buydown Program are required to provide a 5-year warranty on the PV system *the electrical grid and is used to reduce or eliminate ongoing purchases of electricity.* We will refer to this arrangement as the California Buydown Program.

The buydown is based on the rated generating capacity of the PV system, measured in "watts." The amount of the buydown will decline over the lifetime of the program, starting with a block of funds at $3 per watt and ending with a final block of funds at $1 per watt. Each block is available on a first-come, first-served basis until it is totally depleted. Customers or PV providers can reserve a buydown amount at a specified funding level by submitting a Reservation Request Form (CEC-1890C-1) along with a purchase order or invoice (for systems that are 10 kilowatts or smaller) or a letter of intent to purchase (for systems larger than 10 kilowatts). This reserves the buydown payment for a period of six months (for systems 10 kilowatts or smaller) or twelve months (for systems larger than 10 kilowatts). When the system is installed and operating, customers submit a Reservation Confirmation and Claim Form (CEC-1890C-2) along with documentation verifying a safe installation (a copy of the building permit is required). The California Energy Commission then issues a check for the buydown amount, typically within 30 days.

What does the California Buydown Program mean for you?

Let's take an example. The initial block of funds provides a buydown of $3 per watt. If you bought a 2-kilowatt (2 kilowatt = 2000 watts) PV system for your home, the buydown amount would be $6,000. Assuming the system price was $20,000 (prices will vary), the buydown is equivalent to a 30% discount.

Many more details associated with the implementation of the Emerging Renewables Fund cannot be addressed here because of space constraints. Your qualified PV provider should be able to guide you through the process, however, so you do not necessarily need to know all the ins and outs of the program. If you have additional questions, go to the "Getting help" section at the end of this booklet. Alternatively, you can contact the California Energy Commission through its Call Center, either by telephone at (800) 555-7794, or by e-mail at callcntr@ energy.state.ca.us. Ask for a copy of the *Guidebook for the Renewable Technology Program, Volume 3 – Emerging Renewable Resources Account* (CEC publication number P500-97-011V3). You can also find this Guidebook on the CEC website at http://www.energy.ca.gov.

Investing in a PV system

Why should I buy a PV system?

People decide to buy PV systems for a variety of reasons. Some want to help preserve the earth's finite resources by obtaining their electricity from a renewable source. Others want to do their part to help clean the air by generating electricity with no pollution, or they believe that it makes more sense to spend their money on an energy-producing improvement to their property than to send their money off to a utility. Some people like the security of reducing the amount of electricity they buy from their utility, because it makes them less vulnerable to future increases in the price of electricity. Finally, some people just don't like paying utility bills and like the independence that a PV system provides.

Whatever your reason, solar energy is widely thought to be the energy source of choice for the future, and Californians have a unique opportunity to take advantage of a state-sponsored program to help make it their energy choice for today and tomorrow.

Is my home or business a good place for a solar system?

Good orientation (will PV panels face west, south, east, or straight up)?

The first and most obvious consideration is whether your property has good access to the sun. Also, the orientation of the system (the compass direction that your system faces) impacts performance. In California, the sun is always in the southern half of the sky and is higher in the summer and lower in the winter. Usually the best location for a PV system is on a roof facing south, but roofs that face east or west may also be acceptable. Flat roofs also work well for solar systems, because the PV array can be mounted flat on the roof facing the sky or mounted on frames tilted toward the south at the optimal angle.

If a rooftop can't be used, your solar array can also be placed on the ground, either in a fixed mount or a "tracking" mount that follows the sun and orients the PV array to maximize the amount of electricity generated. Other options (primarily for businesses) include using mounting structures to create covered parking or to provide window awnings. To reiterate, *it is important to have a location that has clear and unobstructed access to the sun for most or all of the day and throughout the year.* You can make an initial assessment yourself, and if the location looks promising, your PV provider has the tools necessary to trace the sun's path at your location and determine whether your home or business can accommodate a solar system.

No shading from trees, nearby buildings, or other obstructions?

To make best use of your PV system, you need most or all of the sun's path to be clear and unobscured by trees, roof gables, chimneys, buildings, and other features of your home and the surrounding landscape. It is important to note that even though the area where a system is mounted may be unshaded during one part of the day, it may be shaded during another. If this is the case, then this shading may substantially reduce the amount of electricity that your system will produce. Also, an existing California law (California Civil Code Section 801.5) establishes your right to receive sunlight on your property, should you be in a

separate contracts with your utility and your electrical service provider if you choose an electricity provider other than your utility.

California and federal law requires utilities and energy service providers to supply you with an interconnection agreement. Most California utilities have developed standardized interconnection agreements for small-scale PV systems as part of their implementation of a recent California law (discussed in the following section).

The interconnection agreement specifies the terms and conditions under which your system will be connected to the utility grid, including the technical requirements necessary to ensure safety and power quality, and other issues such as your obligation to obtain all necessary permits for the system, maintain the system in good working order, have the PV system insured, and generally be responsible for the safe operation of the system.

The purchase and sale agreement specifies the metering arrangements (usually net metering for residential customers, dual metering for commercial and industrial customers), the payment for any excess generation, and any other related issues.

The language in these contracts should be simple, straightforward, and easy to understand. If you are unclear about your obligations under these agreements, you should contact the utility or your electrical service provider for clarification. If your questions are not adequately addressed, contact one of the Help listings at the end of this booklet.

Fortunately, recent progress has been tremendous in developing nationally recognized standards for utility interconnection of PV systems. Although these standards are not necessarily binding on utilities, many utilities are adopting these standards rather than developing their own. The most important of these standards focuses on inverters. Traditionally, inverters simply converted the DC electricity generated by PV arrays into the AC electricity used in our homes. More recently, inverters have evolved into remarkably sophisticated devices to manage and condition power. Many new inverters contain all the protective relays, disconnects, and other components necessary to meet the most stringent national standards. Two of these standards are particularly relevant:

- Institute of Electrical and Electronic Engineers, *P929: Recommended Practice for Utility Interface of Photovoltaic Systems*. Institute of Electrical and Electronic Engineers, Inc., New York, NY (1988, with revision being finalized in 1998).
- Underwriters Laboratories, *UL Subject 1741: Standard for Static Inverters and Charge Controllers for Use in Photovoltaic Power Systems* (First Edition). Underwriters Laboratories, Inc., Northbrook, IL (December 1997).

You don't necessarily need to know about these standards, but your PV provider and utility should. It is your obligation to ensure that your PV provider uses equipment that complies with the relevant standards; so, be sure to discuss this issue.

Obtaining a net-metering agreement

Since 1996, a California law—Public Utilities Code Section 2827—has required all utilities in the state to offer residential customers with PV systems of 10 kW or smaller the option of interconnecting on a "net metering" basis. This law was

Before connecting a PV system to the grid

Permitting my PV system

If you live in a location where a "homeowners association" requires you to gain approval for a solar system installation from their architectural committee to comply with their "Covenants, Codes and Restrictions," you or your PV provider may need to submit your system plans to them and seek agreement from your neighbors to have the system installed. Complying with "CC&Rs" is a very important step that you should undertake *before* you begin installing your PV system. Under California law, you have the right to install a solar system on your home, so if this process becomes an obstacle, contact one of the Help listings at the end of this booklet.

In most locations, you will need to obtain various permits from, in most cases, your city or county Building Department. You will likely need to purchase a building permit, an electrical permit, or both to legally begin installing a PV system. Typically, your PV provider will take care of this task, rolling the price of the permits into the overall system price. However, in some cases, your PV provider may not know how much time or money will be involved in "pulling" a permit. Therefore, the permitting task may be priced on a "time and materials" basis, particularly when additional drawings or calculations must be provided to the permitting agency. In any case, make sure the permitting costs and responsibilities are addressed at the start with your PV provider.

Code requirements for PV systems vary somewhat from one jurisdiction to the next, but most requirements are based on the National Electrical Code (NEC). The NEC has a special section, Article 690, that carefully spells out requirements for designing and installing safe, reliable, code-compliant PV systems. Because most local requirements are based on the NEC, your building inspector is likely to rely on Article 690 for guidance in determining whether your PV system has been properly designed and installed. If you are among the first people in your community to install a grid-connected PV system, your local government may never have permitted one of these systems, and the building inspector may have never seen one. If this is the case, you and your PV provider can speed along the process by working closely and cooperatively with your local building officials to help educate them about the technology and its characteristics.

Insuring my PV system

Your electric utility will require you to enter into an interconnection agreement (described more fully in the next section). Usually, one of the sections of such an agreement sets forth minimum insurance requirements that you must keep in force. If you are buying a PV system for your home, your standard homeowner's insurance policy is usually adequate to meet the utility's requirements. However, if insurance coverage becomes an issue, contact one of the Help listings at the end of this booklet.

Obtaining an interconnection agreement

Interconnecting your PV system will require you to enter into an interconnection agreement and a purchase and sale agreement. These agreements may be a single contract with your local utility, or

situation where neighboring trees are shading your roof.

Enough area on roof or property?

The amount of mounting space needed for your solar system is based on the size, or "generating capacity" or "rating," of the system you purchase. Most residential systems require as little as 50 square feet (for a small "starter" system) and as much as 1,000 square feet of mounting area for the PV array. Commercial systems are typically much larger. System sizing is discussed later in this booklet and should also be discussed with your PV provider.

A rule of thumb is that a square foot of single- or poly-crystalline PV module area produces 10 watts of power in bright sunlight. Therefore, a 1000-watt system requires about 100–200 square feet of roof area, depending on the type of PV module used. The amount of roof area needed, however, also depends on the PV module's efficiency in converting sunlight to electricity. The following table provides approximate roof area requirements as a function of PV efficiency (%) and rating (watts).

Good roof (age of roof, roof type, roof warranty)?

If a roof-mounted system makes the most sense for you, it is useful to know that some types of roofs are simpler and cheaper to work with than others; however, a solar system can be installed on any type of roof. Typically, composition shingle roofs are the easiest type to work with, and slate roofs are the most difficult. Between these are the flat concrete tiles and the "barrel" tile roofs. In any case, an experienced solar installer will know how to work on all roof types and should use roofing techniques that eliminate any possibility of leaks. Ask your PV provider how the PV system impacts your roof warranty.

If your roof is older and may need to be replaced in the very near future, you may want to replace it at the time the PV system is installed, to avoid the cost of removing and reinstalling your PV system. If, however, your roof must be replaced after the system has been installed, some roofers will insist on a type of mounting system that uses common roof flashing techniques to ensure a watertight seal.

How big should my PV system be, and what features should it have?

You should consider several factors in sizing your system, including:

1. As a starting point, you might consider how much of your present electricity

Roof Area Needed in Square Feet (shown in **Bold Type**)

PV module efficiency* (%)	PV capacity rating (watts)							
	100	250	500	1,000	2,000	4,000	10,000	100,000
4	**30**	**75**	**150**	**300**	**600**	**1,200**	**3,000**	**30,000**
8	**15**	**38**	**75**	**150**	**300**	**600**	**1,500**	**15,000**
12	**10**	**25**	**50**	**100**	**200**	**400**	**1,000**	**10,000**
16	**8**	**20**	**40**	**80**	**160**	**320**	**800**	**8,000**

* Although the efficiency (percent of sunlight converted to electricity) varies with the different types of PV modules available today, higher-efficiency modules typically cost more. So, a less-efficient system is not necessarily less cost-effective.

needs you would like to meet with your PV system. For example, suppose that you would like to meet 50% of your electricity needs with your PV system. You could work with your PV provider to examine past electric bills and determine the size of the PV system needed to achieve that goal.

You can contact your utility and request the total electricity demand, measured in kilowatt-hours, for your household or business over the last 12 months (or consult your electric bills if you save them). Ask your PV provider how much your new PV system will produce on an annual basis (also measured in kilowatt-hours) and compare that number to your annual electricity demand to get an idea of how much you will save. In the next section, we'll provide more information on estimating how much you will save.

2. To qualify for the financial incentive provided by the California Buydown Program, your system must be sized so that the amount of electricity produced by the PV system does not exceed the historical or current needs of the building it is serving by more than 25 percent on an annual basis. For example, if you used 6,000 kilowatt-hours last year, a system that produces more than 7,500 kilowatt-hours per year does not qualify.

3. To qualify for "net metering" (discussed later), your PV system must have a peak generating capacity of not more than 10 kilowatts (10,000 watts). At the time this booklet was produced, legislation was pending that would make both residential and commercial systems eligible for net metering; however, current law (as of August 1998) only requires net metering for residential PV system owners.

4. There may be some additional features for you to consider. For example, some PV systems have batteries to provide back-up power to your home in case of utility grid outages. Batteries certainly add value to your system, but at an increased price.

5. There may be some "economies of scale" associated with your system, which means that a larger system costs less per kilowatt-hour generated, although it costs more overall. For example, many inverters are sized to accommodate systems up to 4-5 kilowatts, and if your PV array is smaller (say 3 kilowatts) you may still end up buying the same inverter. Similarly, your PV provider is likely to offer you a better price to install a 2-kilowatt system all at once than 1 kilowatt this year and 1 kilowatt next year, because multiple orders and multiple site visits are more expensive.

How much electricity will my PV system produce? How much will I save on my bill?

One of the first questions that prospective PV system owners ask is "how much will the PV system save me?" Because California has a net metering law, getting the answer may not be as difficult as you think, because most, if not all, of the PV electricity production is valued at the full retail rate. You can use the Calculating Electricity Bill Savings box at right to get a rough approximation of how much electricity your PV system will produce, and how much that electricity will be worth to you. Keep in mind that actual energy production from your PV system will vary by up to 20% from these figures, depending on your specific geographic location, the angle and orientation of your system, the quality of the components of your system, and the quality of the installation. Be sure to discuss these issues with your PV provider, and consider asking for a written estimate of the average annual energy production from the PV system. However,

Is the lowest price the "best deal"?

It might not be. Ultimately, you, the purchaser, must decide how much you wish to pay for your PV system. However, remember that a PV provider is a contracting business just like any other type of contractor, with overhead and other operating expenses that must be covered. Companies that plan to stay in business must charge a price for their products and services that is adequate to cover their costs, plus a fair profit margin. If price is your only consideration, you may wish—after some times goes by—that you had based your purchase decision on other factors, as well.

and off-grid as in a professional manner.

How many years of experience does the company have installing PV systems?

This issue speaks for itself: A company or contractor that has been in business a long time has demonstrated an ability to work with customers and to compete effectively with other firms.

Is the company properly licensed? The California Buydown Program requires PV systems to be installed by an appropriately licensed California contractor. For PV systems, this means either a C-10 (electrical) or C-46 (solar) contractor's license. Although using a properly licensed contractor is highly recommended, individuals who have adequate electrical and construction experience are not prohibited from installing their own system. A decision to do so, however, should be carefully considered and only attempted with a clear understanding of the complexities of the job.

Does the company have any pending or active judgements or liens against it? As with any project that necessitates hiring a contractor, due diligence is recommended. The California Contractor State License Board maintains records of the work history of contractors. These records can be accessed at (800) 321-2752, or in the Sacramento area at (916) 255-3900.

How do I obtain and choose among competing bids?

If you have decided to get more than one bid for the installation of your PV system, you should take steps to ensure that all of the bids you receive are made on the same basis. As an example, comparing a bid for a system that would be mounted on the ground versus another bid where the system would be mounted on a roof would be like comparing apples with oranges. Similarly, there are different types of PV panels, some of which generate more electricity per square foot than others.

Bids should clearly state the maximum generating capacity of the system (measured in watts or kilowatts). If possible, have the bids specify the system capacity in "AC watts" as defined by the California Buydown Program. Also, you may want to obtain some estimate of the amount of energy that the system will produce on an annual basis (measured in kilowatt-hours). Because the amount of energy depends on the amount of sunlight, which varies from season to season and year to year, as well as on a geographic basis, it is unrealistic to expect a specific figure; a range of ± 20% is more realistic. Bids should also include the total cost of getting the PV system up and running, including hardware, installation, connection to the grid, permitting, sales tax, and *warranty.*

Another important factor in evaluating bids is the system warranty. The California Buydown Program requires a 5-year full-system warranty against defective parts, workmanship, or degradation of output (performance). The equipment warranty must cover the full cost of repair or replacement of defective components. Where the system is professionally installed (rather than self-installed), the warranty must also include the labor of removing and reinstalling any defective components and shipping costs. Ask yourself, "Will this company stand behind the full-system warranty for the next 5 years?" Finally, the performance warranty must protect against a decrease in system output of more than 10 percent, as compared to the original rated output.

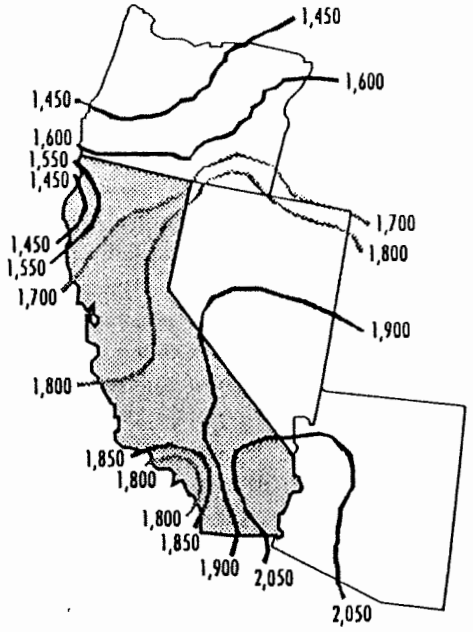
Calculating Electricity Bill Savings for a Net-Metered PV Syste

Step 1: Select your location and kWh/kW from the map below.

Step 2: Multiply the kWh/kW-yr times the PV system rating (in kW) to get the yearly PV system production in kWh/yr.

Step 3: Multiply the PV system kWh/yr times your retail rate in $/kWh to get the annual bill savings.

Example: A 2-kW system in Los Angeles, CA, at an electricity rate of $0.12/kWh will save about $432 per year (1,800 kWh/kW-year x 2 kW x $0.12/kWh = $432/year).



Photovoltaic System Production (kWh/kW-yr)

Photovoltaic system production estimates are for a 1-kW rooftop PV system facing due south at a 20° tilt. The PV system rating of 1 kW is based on the California Buydown Program "system rated output" methodology.

Example: A 2-kW rooftop PV system located in Los Angeles will produce about 3,600 kWh per year (2 kW x 1,800 kWh/kW-yr).

© Pacific Energy Group modeled with PVGRID™

02512004m

you should also keep in mind that even if an estimate is accurate for an average year, actual electricity production will fluctuate from year to year based on natural variations in weather and climate.

How much does a PV system cost?

There is no single answer. Keep in mind, the cost will be reduced by the California Buydown Program. Costs vary depending on a number of factors, including the PV system rating, the PV provider, if the home is new or a retrofit, if the PV is integrated into the roof or mounted on top of the existing roof, the PV manufacturer. So the cost depends!

With that in mind, the cost of a PV system does scale somewhat with the system size or rating and with the amount of energy produced. Small single-PV panel systems with built-in inverters that produce about 75 watts may cost around $900 installed, or $12/watt. These small systems will offset only a small fraction of your electricity bill. A 2-kilowatt system that will offset the needs of a very energy-efficient home may cost $16,000 to $20,000 installed, or $8/watt to $10/watt. At the other extreme, a 5-kilowatt system that will completely offset the energy needs of many conventional homes may cost $30,000 to $40,000 installed, or $6/watt to

$8/watt. These prices, of course, are just rough estimates, and prices depend on the configuration, equipment options, and labor costs. Your local PV providers can provide you with actual prices.

Are incentives available to help reduce the cost?

Yes! That's the primary feature of the California Buydown Program described earlier.

Other California Incentive Programs

If you don't qualify for the California Buydown Program (for example, if you're not a customer of one of the three eligible utilities) you're not necessarily out of the running for incentives. If you are served by a municipal utility, many of them—including the state's largest, LADWP and SMUD—are offering buydowns or other programs to help their customers get a PV system on their home or business. Contact your local utility for more information. Also, regardless of where you live, you will not have to pay property taxes on your PV system due to a recently enacted property-tax exemption for solar systems installed anywhere in California.

Federal Incentive Programs

The U.S. government also provides financial support for developing PV technology through a tax credit for commercial uses of solar energy. This energy investment credit provides businesses (but not individuals or utilities) with a 10% tax credit and 5-year accelerated depreciation for the cost of equipment used to generate electricity by solar technologies.

How can I finance the cost of my PV system?

There is nothing magical about financing the cost of purchasing and installing your PV system. Although there are some special programs available for financing solar and other renewable energy investments, most of the options will be familiar to you.

The best way to finance PV systems for homes is through a mortgage loan. Mortgage financing options include your primary mortgage, a second mortgage such as a U.S. Department of Housing and Urban Development (HUD) Title 1 loan, or a home equity loan that is secured by your property. There are two advantages to mortgage financing. First, mortgage financing usually provides longer terms and lower interest rates than other loans, such as conventional bank loans. Second, the interest paid on a mortgage loan is generally deductible on your federal taxes (subject to certain conditions). If you buy the PV system at the same time that you build, buy, or refinance the house on which the PV system will be installed, adding the cost of the PV system to your mortgage loan is likely to be relatively simple and may avoid additional loan application forms or fees.

If mortgage financing is not available, then look for other sources of financing, such as conventional bank loans. Remember to look for the best possible combination of low rates and long-term loans, which will allow you to amortize your PV system cost as inexpensively as possible. Because your PV system is a long-term investment, the terms and conditions of your PV financing are likely to be the most important factor in determining the effective price of your PV-generated power.

PV systems purchased for business applications are probably best financed through a company's existing sources of funds for capital purchases—usually Small Business Administration loans or conventional bank loans.

Selecting a PV provider

Who sells and installs PV systems?

In some locations, finding a PV provider can be as simple as picking up the telephone directory and looking under "Solar Energy Equipment and Systems—Dealers." However, many of those listings are for companies experienced in solar water heating system installations who may not be experienced in PV system design or installation. Similarly, many electrical contractors, although proficient in typical electrical contracting work, may not have expertise in working with PV systems or with residential roof mounting techniques. *How do you find the right company?* Here are a couple suggestions.

- Contact either the *California Solar Energy Industries Association*: phone (800) 225-7799, fax (916) 649-9757, or the *Independent Power Providers*: phone (209) 841-7001. Both organizations maintain a list of PV providers that will be sent to you upon request.
- Conduct a search on the Internet.

California is home to more solid, reputable contractors with experience installing PV systems than any other state in the nation. You may be a solar or electrical contractor, or may be technically proficient in understanding wiring schematics, electrical codes, and mounting techniques for roofs or other locations. But if not, you should hire a professional PV provider to help select, size, locate, and install your PV system.

Once you have identified one or more companies, investigate further by taking the steps outlined in the following section.

How do I choose among PV providers?

Once you've compiled a list, the next step is to narrow it down by calling the PV pro-viders and asking questions. When contacting any company, consider their location relative to yours. If you can locate a PV provider who is relatively close to where the system will be installed and who meets the other criteria outlined below, it will be easier to work with them rather than with a company located farther away. When contacting companies, you might ask some of the following:

Has the company installed grid-connected PV systems? If not, has it installed grid-independent PV systems? Experience installing grid-connected systems is valuable because some elements of the installation—particularly interconnection with the local utility—are unique to these systems. Because grid-connected systems are relatively uncommon, however, most contractors with PV experience have worked only on systems that are not connected to the electrical grid, such as those that power remote cabins far from the nearest utility line. This means they have experience with all aspects of PV system installation **except** the connection with the utility grid. Although grid-connection work is different from "off-grid" work, a competent contractor with PV experience should not be eliminated just because they have not installed grid-connected PV systems in the past. In fact, previous experience with off-grid systems is valuable because grid-independent systems are more technically complicated than grid-connected systems. The bottom line, however, is that a competent contractor will be able to work on both on-grid

SCHEDULE E-NEM—NET ENERGY METERING SERVICE (T)

APPLICABILITY: This net-metering schedule is applicable to a residential or small commercial customer who has a maximum peak demand of less that 20 kilowatts and who uses a solar or wind turbine electrical generating facility, or a hybrid system of both, with a capacity of not more than 10 kilowatts that is located on the customer's premises, operates in parallel with PG&E's transmission and distribution facilities, and is intended primarily to offset part or all of the customer own electrical requirements (hereinafter "eligible customer-generator"). Availability of this schedule to eligible customer-generators will be on a first come first served basis and will be until such time as either: (1) the total rated generating capacity used by eligible customer-generators equals one-tenth of 1 percent of PG&E's aggregate customer peak demand, or (2) when the combined total peak demand of all customer generators served by all electric service providers, in PG&E's service territory, and by PG&E, furnishing net energy metering to customer-generators in PG&E's territory equals one-tenth of 1 percent of the aggregate peak demand of those electric service providers, as required by Section 2827 of the California Public Utilities Code. (T)

TERRITORY: The entire territory served.

RATES: All rates charged under this schedule will be in accordance with the eligible customer-generator's otherwise-applicable residential or commercial rate schedule. An eligible customer-generator served under this schedule is responsible for all charges from its otherwise-applicable rate schedule including monthly customer and demand charges. Charges for electricity supplied by PG&E will be based on the net metered usage in accordance with Net Energy Metering and Billing (Special Condition 2 below). (N)

(D)

(D)

SPECIAL CONDITIONS:

1. METERING EQUIPMENT: Net energy metering shall be accomplished using a single meter capable of registering the flow of electricity in two directions. If the customer's existing electrical meter is not capable of measuring the flow of electricity in two directions, the customer generator shall be responsible for all expenses involved in purchasing and installing a meter that is able to measure electricity flow in two directions. An additional meter or meters, installed in a dual meter socket ("dual metering"), to monitor the flow of electricity in each direction may be installed with the consent of the customer generator, at the expense of PG&E, and the dual metering shall be used only to provide the information necessary to accurately bill or credit the customer according to the utility's otherwise applicable tariff or to collect solar or wind, or a hybrid system of both, electric generating system performance information for research purposes. PG&E shall determine whether dual metering is required under this provision. If dual metering is installed, the net energy metering calculation (see below) shall yield a result identical to that of a single meter capable of measuring the flow of electricity in two directions. (T) (L) (T) (L)

   If PG&E decides that dual metering is required for the purposes set forth herein, and the customer-generator refuses consent for installation of dual metering. PG&E shall have the right to refuse interconnection. (N) (N)

(D)

(D)

(Continued)

SCHEDULE E-NEM—NET ENERGY METERING SERVICE (T)
(Continued)

SPECIAL CONDITIONS: (L)
(Cont'd.)

2. NET ENERGY METERING AND BILLING: Net energy is defined as measuring the difference between the electricity supplied by PG&E through the electric grid to the eligible customer generator and electricity generated by an eligible customer generator and fed back into the electric grid over a 12-month period. At the end of each 12-month period following the date of final interconnection, and at each anniversary date thereafter, the customer-generator shall be billed for electricity used during that period. In the event the energy generated exceeds the energy consumed during the 12-month period, no payment shall be made for the excess energy delivered to PG&E's grid. If PG&E is the electric service provider, this condition may be modified where the customer has signed a contract to sell electricity to PG&E. In the event that the electricity supplied by PG&E during the 12-month period exceeds the electricity generated by the eligible customer generator during the same period, the eligible customer is a net electricity consumer and PG&E shall bill the customer for the net consumption during the 12-month period based on the average retail price per kilowatthour for the eligible customer generator's rate class over the same period. (T)

If PG&E supplies the customer-generator with electricity, PG&E shall provide the customer-generator with net electricity consumption information on each regular bill. That information shall include the current monetary balance owed PG&E for the net electricity consumed since the last 12-month ended. Upon the eligible customer-generator's request, PG&E will permit the customer-generator to pay monthly for the net energy consumed. (N)

3. INTERCONNECTION: Prior to interconnection, the customer-generator must execute and comply with the requirements of PG&E's "Interconnection Agreement for Net Energy Metering for Residential or Small Commercial Solar or Wind Electric Generating Facilities of 10 kW or Less," (Form 79-854). The customer-generator must meet all applicable safety and performance standards established by the National Electrical Code, the Institute of Electrical and Electronics Engineers, and accredited testing laboratories such as Underwriters Laboratories and, where applicable rules of the California Public Utilities Commission regarding safety and reliability. (N)

PG&E's

INTERCONNECTION

AGREEMENT

FOR

NET ENERGY METERING

FOR

RESIDENTIAL AND SMALL COMMERCIAL

SOLAR OR WIND

ELECTRIC GENERATING FACILITIES

OF

10 KILOWATTS OR LESS

Form No. 79-854** (Rev. 11/98)
Tariffs and Compliance
January 1, 1999

TABLE OF CONTENTS

SECTION	TITLE	PAGE
1.	DESCRIPTION OF CUSTOMER-GENERATOR'S SOLAR OR WIND ELECTRIC GENERATING FACILITY	3.
2.	CUSTOMER BILLING AND PAYMENT OPTIONS	3.
3.	PURPOSE OF INTERCONNECTION AND REPRESENTATIONS	4.
4.	INTERRUPTION OR REDUCTION OF DELIVERIES	4.
5.	INTERCONNECTION	4.
6.	DESIGN REQUIREMENTS	5.
7.	MAINTENANCE AND PERMITS	5.
8.	ACCESS TO PREMISES	5.
9.	INDEMNITY AND LIABILITY	5.
10.	INSURANCE	6.
11.	GOVERNING LAW	6.
12.	AMENDMENTS, MODIFICATIONS OR WAIVER	7.
13.	NOTICES	7.
14.	TERM OF AGREEMENT	7.
15.	GOVERNING AUTHORITY	7.
16.	SIGNATURES	8.
17.	APPENDIX A - BILLING AND PAYMENT OPTIONS	A-1.

_____("Customer-Generator"), and Pacific Gas and Electric Company ("PG&E"), referred to collectively as "Parties" and individually as "Party", consistent and in order to effectuate the provisions of Section 2827 of the California Public Utilities Code and PG&E's Electric Tariff E-NEM("E-NEM"), enter into this "Interconnection Agreement for Net Energy Metering From Residential and Small Commercial Solar or Wind Electric Generating Facilities of 10 Kilowatts or Less ("Agreement"). Accordingly, the Parties agree as follows:

1. DESCRIPTION OF CUSTOMER-GENERATOR'S SOLAR OR WIND ELECTRIC GENERATING FACILITY ("Facility"):

Customer-Generator has elected to interconnect and operate its solar or wind electric generating facility in parallel with the electric grid. The solar or wind electric generating facility is intended primarily to offset part or all of the Customer-Generator's own electrical requirements. This Agreement applies to the following identified facilities, with the specified characteristics and generating capacity, and does not allow interconnection or operation of facilities different than those described:

1.1 Project Identification Number: _____
(PG&E's Log Number)

1.2 Make: _____

Model:_____

1.3 Photovoltaic/Solar ("PV") Array Rating: _____kW; or

Wind Turbine ("WT") Rating: _____kW; or

Hybrid -- Wind/Solar ("HWS") Rating: _____kW

1.4 Site Address:

_____
(Street)

_____
(City)

1.5 Facility will be ready for operation on or about:_____
(date)

2. CUSTOMER BILLING AND PAYMENT OPTIONS

The rates charged under E-NEM will be in accordance with Customer-Generator's otherwise applicable residential or commercial electric rate schedule. Customer-Generator initial otherwise applicable electric rate and billing option are as designated in Appendix A - Billing and Payment Options.

3. PURPOSE OF INTERCONNECTION AND REPRESENTATIONS

The purpose of this Agreement is to allow customer-generator to interconnect with PG&E's distribution system, subject to the provisions of this Agreement and PG&E's rate schedule E-NEM. Customer-generator shall at all times comply with this Agreement and represents that it is and shall remain in compliance with all applicable laws and tariffs, including applicable CPUC requirements.

4. INTERRUPTION OR REDUCTION OF DELIVERIES

4.1 PG&E shall not be obligated to accept or pay for and may require Customer-Generator to interrupt or reduce deliveries of available energy:

a. when necessary in order to construct, install, maintain, repair, replace, remove, investigate, or inspect any of its equipment or part of its system; or

b. if it determines that curtailment, interruption, or reduction is necessary because of emergencies, forced outages, force majeure, or compliance with prudent electrical practices.

4.2 Whenever possible, PG&E shall give Customer-Generator reasonable notice of the possibility that interruption or reduction of deliveries may be required.

4.3 Notwithstanding any other provision of this Agreement, if at any time PG&E determines that either (a) the Facility, or its operation, may endanger PG&E personnel, or (b) the continued operation of the Facility may endanger the integrity of PG&E's electric system, PG&E shall have the right to disconnect the Facility from PG&E's system. Customer-Generator's Facility shall remain disconnected until such time as PG&E is satisfied that the condition(s) referenced in (a) or (b) of this Section 4.3 have been corrected.

5. INTERCONNECTION

5.1 Customer-Generator shall deliver the available energy to PG&E at the utility's meter.

5.2 The metering requirements are detailed in the E-NEM rate schedule and, if applicable, PG&E's Electric Rule 22. If the Customer-Generator refuses consent to dual metering pursuant to Rate Schedule E-NEM, PG&E shall have the right to refuse interconnection.

5.3 Customer-Generator shall not commence parallel operation of the Facility until written approval of the interconnection facilities has been given by PG&E. PG&E shall provide written approval within ten (10) working days from the utility's receipt of the inspection clearance of the governmental authority having jurisdiction. Such approval shall not be unreasonably withheld. PG&E shall have the right to have representatives present at the initial testing of Customer-Generator's protective apparatus. Customer-Generator shall notify PG&E five (5) working days prior to the initial testing.

6. DESIGN REQUIREMENTS

Customer-Generator shall meet all applicable safety and performance standards established by the National Electrical Code, the Institute of Electrical and Electronics Engineers, and accredited testing laboratories such as Under writers Laboratories and, where applicable, rules of the Public Utilities Commission regarding safety and reliability. Customer-Generator whose solar or wind turbine electrical generating system or a hybrid system of both, meets those standards and rules shall not be required to install additional controls, perform or pay for additional tests, or purchase additional liability insurance.

7. MAINTENANCE AND PERMITS

Customer-Generator shall: (a) maintain the Facility and interconnection facilities in a safe and prudent manner and in conformance with all applicable laws and regulations including, but not limited to, Section 6, and (b) obtain any governmental authorizations and permits required for the construction and operation of the Facility and interconnection facilities. Customer-Generator shall reimburse PG&E for any and all losses, damages, claims, penalties, or liability it incurs as a result of Customer-Generator's failure to obtain or maintain any governmental authorizations and permits required for construction and operation of Customer-Generator's Facility.

8. ACCESS TO PREMISES

PG&E may enter Customer-Generator's premises: (a) to inspect, at reasonable hours, Customer-Generator's protective devices and read or test meters; and (b) to disconnect, without notice, the interconnection facilities if, in PG&E's opinion, a hazardous condition exists and such immediate action is necessary to protect persons, or PG&E's facilities, or property of others from damage or interference caused by Customer-Generator's solar or wind electric generating facilities, or lack of properly operating protective devices.

9. INDEMNITY AND LIABILITY

9.1 Each Party as indemnifier shall defend, save harmless and indemnify the other Party and the directors, officers, employees, and agents of such other Party against and from any and all loss, liability, damage, claim, cost, charge, demand, or expense (including any direct, or consequential loss, liability, damage, claim, cost, charge, demand, or expense, including attorneys' fees) for injury or death to persons including employees of either Party and damage to property including property of either Party arising out of or in connection with (a) the engineering, design, construction, maintenance, repair, operation, supervision, inspection, testing, protection or ownership of, or (b) the making of replacements, additions, betterments to, or reconstruction of, the indemnifier's facilities; provided, however, Customer-Generator's duty to indemnify PG&E hereunder shall not extend to loss, liability, damage, claim, cost, charge, demand, or expense resulting from interruptions in electrical service to PG&E's customers other than Customer-Generator. This indemnity shall apply, notwithstanding the active or passive negligence of the indemnified. However, neither Party shall be indemnified hereunder for its loss, liability, damage, claim, cost, charge, demand, or expense resulting from its sole negligence or willful misconduct.

9.2 Notwithstanding the indemnity of Section 9.1, and except for a Party's willful misconduct or sole negligence, each Party shall be responsible for damage to its facilities resulting from electrical disturbances or faults.

9.3 The provisions of this Section 9 shall not be construed to relieve any insurer of its obligations to pay any insurance claims in accordance with the provisions of any valid insurance policy.

9.4 Except as otherwise provided in Section 9.1 neither Party shall be liable to the other Party for consequential damages incurred by that Party.

9.5 If Customer-Generator fails to comply with the insurance provisions of this Agreement, Customer-Generator shall, at its own cost, defend, save harmless and indemnify PG&E, its directors, officers, employees, agents, assignees, and successors in interest from and against any and all loss, liability, damage, claim, cost, charge, demand, or expense of any kind or nature (including attorney's fees and other costs of litigation) resulting from the death or injury to any person or damage to any property, including the personnel and property of PG&E, to the extent that PG&E would have been protected had Customer-Generator complied with all such insurance provisions. The inclusion of this Section 9.5 is not intended to create any expressed or implied right in Customer-Generator to elect not to provide any such required insurance.

10. INSURANCE

10.1 To the extent that Customer-Generator has currently in force all risk property insurance and comprehensive personal liability insurance, Customer-Generator agrees that it will maintain such insurance in force for the duration of this Agreement in no less amounts than those currently in effect. PG&E shall have the right to inspect or obtain a copy of the original policy or policies of insurance prior to commencing operation.

10.2 Customer-Generators shall meet the standards and rules set forth in Section 6, have the appropriate liability insurance required in Section 10.1 and shall not be required to purchase any additional liability insurance.

10.3 Such insurance required in Section 10.1 shall, by endorsement to the policy or policies, provide for thirty (30) calendar days written notice to PG&E prior to cancellation, termination, alteration, or material change of such insurance.

11. GOVERNING LAW

This Agreement shall be interpreted, governed, and construed under the laws of the State of California as if executed and to be performed wholly within the State of California.

12. AMENDMENTS, MODIFICATIONS OR WAIVER

Any amendments or modifications to this Agreement shall be in writing and agreed to by both Parties. The failure of any Party at any time or times to require performance of any provision hereof shall in no manner affect the right at a later time to enforce the same. No waiver by any Party of the breach of any term or covenant contained in this Agreement, whether by conduct or otherwise, shall be deemed to be construed as a further or continuing waiver of any such breach or a waiver of the breach of any other term or covenant unless such waiver is in writing.

13. NOTICES

13.1 All written notices shall be directed as follows:

PG&E
Atten: Electric Tariffs Director, Tariffs and Compliance Department
Mail Code H28H
P.O. Box 770000
San Francisco, CA 94177

CUSTOMER-GENERATOR:

_____
(Name)

_____
(Street or PO Box)

_____
(City) (State) (Zip Code)

13.2 Customer-Generator's notices to PG&E pursuant to this Section 13 shall refer to PG&E's project identification number set forth in Section 1.1.

14. TERM OF AGREEMENT

This Agreement shall become effective as of the last date set forth in Section 16 and shall continue in full force and effect until terminated by either Party providing 30-days prior written notice to the other Party in accordance with Section 12. This Agreement may be terminated prior to 30 days by agreement of both Parties.

15. GOVERNING AUTHORITY

This contract shall at all times be subject to such changes or modification by the Public Utilities Commission of the State of California as said Commission may, from time to time, direct in the exercise of its jurisdiction.

16. SIGNATURES

IN WITNESS WHEREOF, the Parties hereto have caused two originals of this Agreement to be executed by their duly authorized representatives. This Agreement is effective as of the last date set forth below.

"Customer-Generator" Name_____

By (Signature):_____

Type/Print Name:_____

Title:_____

Date:_____

PG&E

By (Signature)_____

Type/Print Name:_____

Title:_____

Date:_____

INTERCONNECTION AGREEMENT FOR NET ENERGY METERING FOR RESIDENTIAL AND SMALL COMMERCIAL SOLAR OR WIND ELECTRIC GENERATING FACILITIES OF 10 KILOWATTS OR LESS

APPENDIX A
BILLING AND PAYMENT OPTIONS

Customer-Generator Name: _____

Project Identification Number: _____
(PG&E's Log Number)

1. Customer-Generator selects PG&E's electric rate Schedule _____ as its otherwise applicable rate schedule.

2. Customer-Generator selects the following initial billing option (check one):

   [ ] **Monthly Energy Billing:** Customer-Generator pays monthly for all charges, including energy, due under Customer-Generator's otherwise applicable rate schedule, as designated above and per an Annual Reconciliation as described below.

   [ ] **Annual Energy Billing:** Customer-Generator pays monthly for the non-energy charges due under Customer-Generator's otherwise applicable rate schedule, as designated above. Customer-Generator pays annually for energy charges per an Annual Reconciliation as described below.

****

Annual Reconciliation: At the end of every 12 month period, the Customer-Generator's **charges** will be totaled including: 1) the 12 month total of all non-energy charges, 2) the charge for any annual net-energy consumption as defined in rate Schedule E-NEM, and/or 3) the residential minimum charge, if applicable. The Customer-Generator's total **payments** for the 12 months will then be subtracted from the total charges. The Customer-Generator will then be billed for any balance due. (If there has been an overpayment, it will be applied to the next month's bill.)

3. Signature

By (Signature): _____

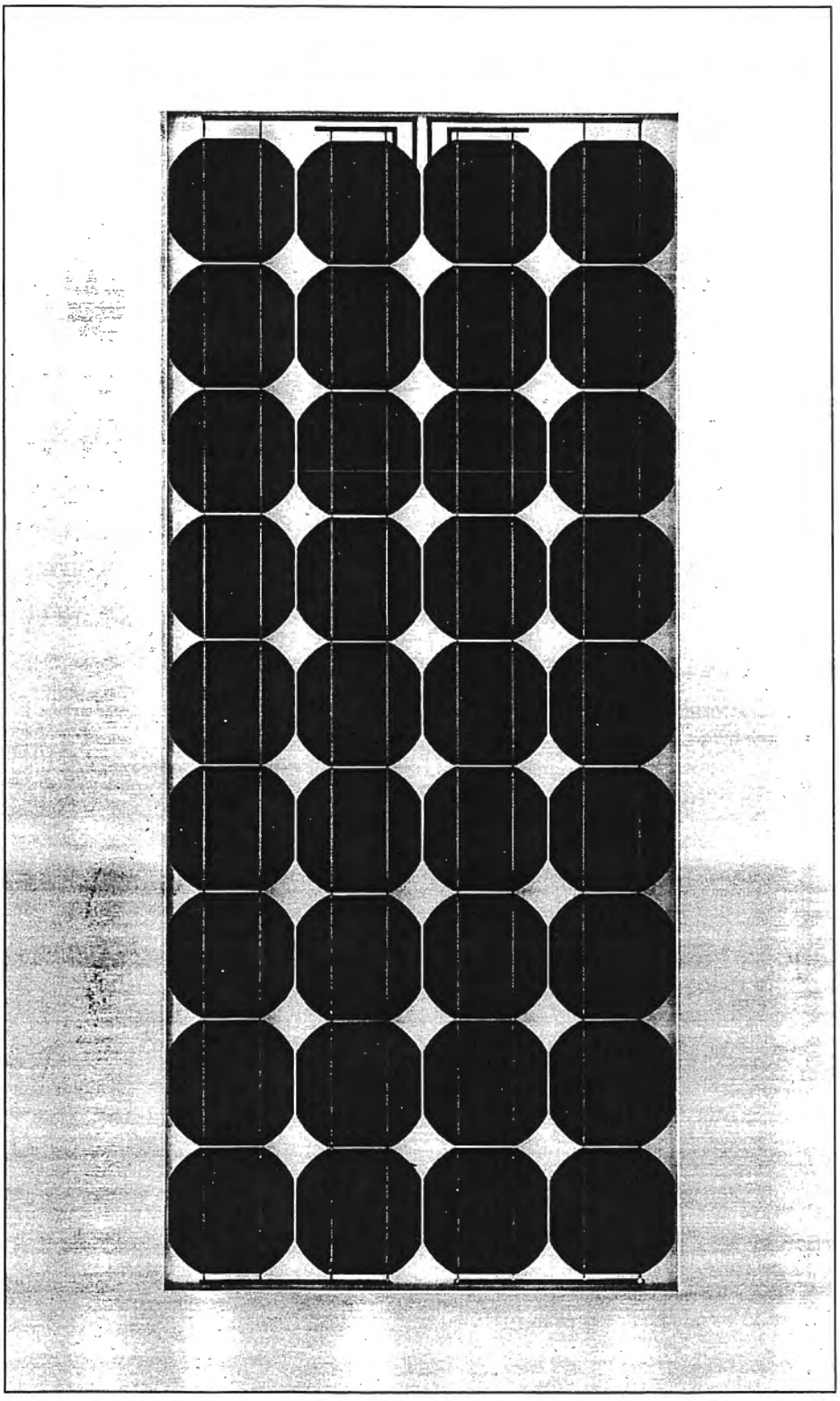
Type/Print Name: _____

Title: _____

Date: _____

SIEMENS

Solar module SP65



When it comes to reliable and environmentally-friendly generation of electricity from sunlight, solar modules from Siemens provide the perfect solution. Manufactured in compliance with the most stringent quality standards, Siemens Solar modules are designed to withstand the toughest environmental conditions and are characterized by their long service life. Siemens Solar modules are covered by a 25-year limited warranty on power output – your guarantee of trouble-free solar power generation.

PowerMax® technology

Siemens' proprietary PowerMax® technology optimizes the energy production of individual cells and solar modules for all types of environmental conditions. PowerMax® process optimization includes a special refining technique for ingots, a clean room semiconductor grade production process, and a multistage proprietary TOPS™ (Texture Optimized Pyramidal Surface) process. The TOPS process incorporates the formation of textured pyramids on the surface of the solar cell. These pyramids are then specially treated to passivate the surface. The cell's optical properties are optimized for maximum absorption of photons from the sun's light. TOPS also maximizes photon absorption from direct and diffused light (typical under cloudy conditions). This means that light absorption is especially high, even at low light levels. Siemens PowerMax® solar cells deliver maximum energy throughout the day.

Solar module

Model:	**SP65**
Rated power:	**65 Watts**
Limited Warranty:	**25 Years**

Certifications and Qualifications

- UL-Listing 1703
- IEC 61215
- TÜV safety class II
- JPL Specification No. 5101-161
- CE mark
- FM Certification

Intelligent module design

- All cells are electrically matched to assure the greatest power output possible.
- Ultra-clear tempered glass provides excellent light transmission and protects from wind, hail, and impact.
- Torsion and corrosion resistant anodized aluminum module frame ensures dependable performance, even through harsh weather conditions and in marine environments.
- Built-in bypass diodes (12V configuration) help system performance during partial shadowing.

High quality

- Every module is subject to final factory review, inspection and testing to assure compliance with electrical, mechanical and visual criteria.
- 36 PowerMax® single-crystalline solar cells deliver excellent performance even in reduced-light or poor weather conditions.
- Cell surfaces are treated with the Texture Optimized Pyramidal Surface (TOPS™) process to generate more energy from available light.
- Fault tolerant multi-redundant contacts on front and back of each cell provide superior reliability.
- Solar cells are laminated between a multi-layered polymer backsheet and layers of ethylene vinyl acetate (EVA) for environmental protection, moisture resistance, and electrical isolation.
- Durable back sheet provides the module underside with protection from scratching, cuts, breakage, and most environmental conditions.
- Laboratory tested and certified for a wide range of operating conditions.
- Ground continuity of less than 1 ohm for all metallic surfaces.
- Manufactured in (ISO 9001) certified facilities to exacting Siemens quality standards.

Easy installation

- ProCharger™-CR junction box accepts conduit, cable or wire and is designed for easy field wiring.
- Lightweight aluminum frame and pre-drilled mounting holes for easy installation.
- Factory configured for 12V operation and may be reconfigured in the field for 6V operation.
- Modules may be wired together in series or parallel to attain required power levels.

Performance warranty

- 25 Year limited warranty on power output.

Further information on solar products, systems, principles and applications is available in the Siemens Solar product catalog.

Siemens modules are recyclable.

Solar module SP65

Electrical parameters			12 V/6 V
Maximum power rating P_{max}		(Wp) 1)	65
Rated current I_{MPP}		[A]	3.95/7.9
Rated voltage V_{MPP}		[V]	16.5/8.25
Short circuit current I_{SC}		[A]	4.5/9.0
Open circuit voltage V_{OC}		[V]	21.4/10.7
Thermal parameters			
NOCT 2)		[°C]	45±2
Temp. coefficient: short-circuit current			2.06 mA / °C
Temp. coefficient: open-circuit voltage			-.077 V / °C
Qualification test parameters 4)			
Temperature cycling range		[°C]	-40 to +85
Humidity freeze, Damp heat		[%RH]	85
Maximum system voltage		[V]	600 (1000 V Per ISPRA)
Wind Loading	PSF	[N/m²]	50 [2400]
Maximum distortion 3)		[°]	1.2
Hailstone impact	Inches	[mm]	1.0 [25]
	MPH	[m/s]	52 [v=23]
Weight	Pounds	[kg]	16.7 [7.6]

1) Wp (Watt peak) = Peak power (Minimum Wp = 60 Watts)

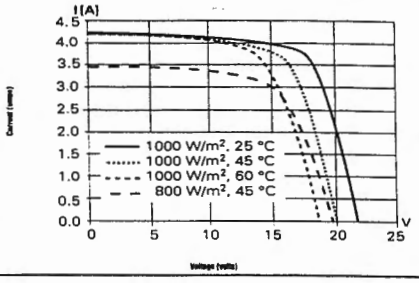
Air Mass	AM = 1.5
Irradiance	E = 1000 W/m²
Cell temperature	T_C = 25 °C

2) Normal Operating Cell Temperature at:

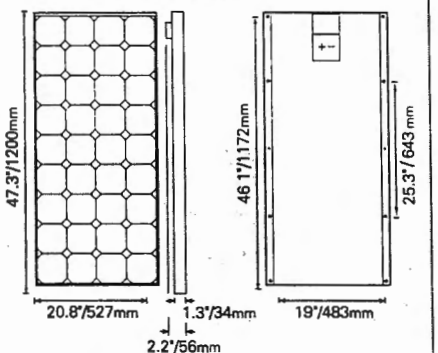
Irradiance	E = 800 W/m²
Ambient temperature	T_U = 20 °C
Wind Speed	v_W = 1 m/s

3) Diagonal lifting of module plane
4) Per IEC 61215 test requirements
5) 12 volt configuration

Voltage-current characteristic 5)



Module dimensions

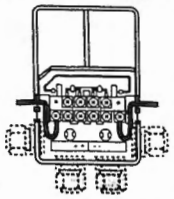


Hole Diameter 0.26 inch (6.6mm)
Mounting hole dimensions are center to center

ProCharger™-CR Junction-box

Maximum cable diameter: 4mm²

Type of protection: IP44



Your address for photovoltaics from Siemens Solar

© Siemens Solar 1998 Status 12/98 - Subject to modification.

Siemens Solar GmbH
A joint venture of
Siemens AG and Bayernwerk AG
Postfach 46 07 05
D-80915 München
Germany

Siemens Solar Industries
P.O.Box 6032
Camarillo, CA 93011, U.S.A.
Web site: www.siemenssolarpv.com
E-mail: sunpower@solarpv.com
Tel: 805-482-6800
Fax: 805-388-6395

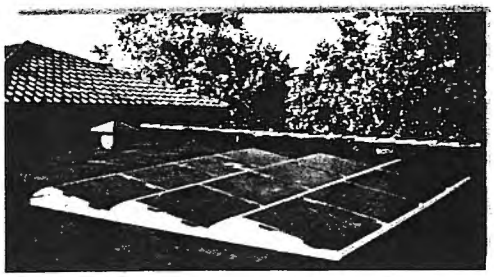
Printed in U.S.A.

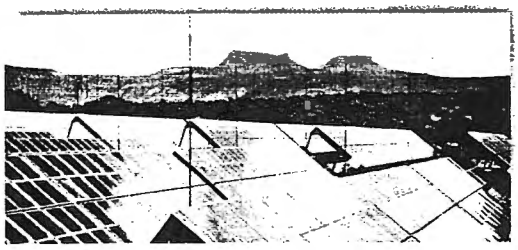
Siemens Showa Solar Pte. Ltd.
166 Kallang Way
Singapore 349249
Tel: 65-842-3886
Fax 65-842-3887

Order No. 020516, Rev. B

UTILITY LINE TIE POWER

Your Own Power Company











THE POWER COMPANY

trace
ENGINEERING

Trace Engineering

Trace Engineering was founded in 1984, and is the world's largest supplier of inverters and related components to the independent and back-up power markets. Together, Trace Engineering and Trace Technologies products address the power conversion and control requirements of any power system.

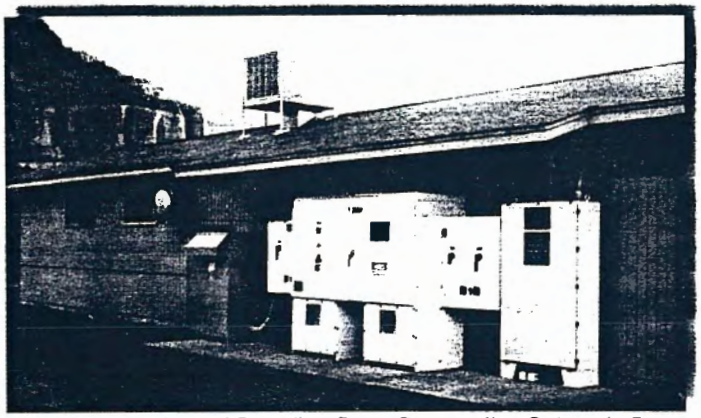
The owners of **Trace Engineering Corporation, Arlington, Washington, USA,** and the former management of Kenetech Windpower, Inc.'s power electronics division announced the acquisition of Kenetech Windpower's power conversion technology and manufacturing assets. The new business will resume operation in **Livermore, California**, under the name of **Trace Technologies Corporation** and will provide power inverter systems from 30kw to over 1 megawatt.

Trace Engineering will continue to manufacture inverters and systems up to 30kw at the plant in Arlington, Washington.

From 1992 to 1996, Kenetech's power conversion (inverters) group produced over 800 megawatts of inverter capacity for utility-scale wind, photovoltaic, battery energy storage and industrial drive applications. Collectively, the companies product lines will serve renewable and advanced energy production and power quality applications with power ratings from 100 watts to over one megawatt.



S.M.U.D. 20kw Sys., Sacramento, CA.



100kw solar system at Dangling Rope Park on the Colorado River.

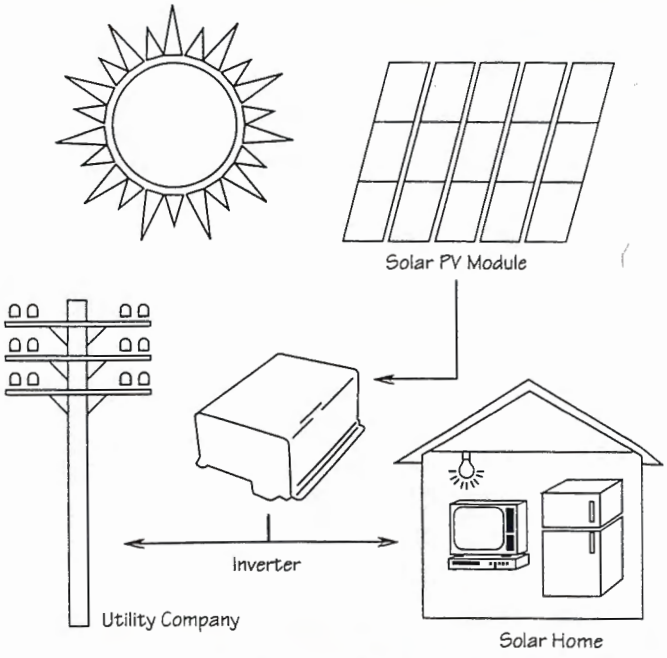
Top left cover photo courtesy of PowerLight Corporation.

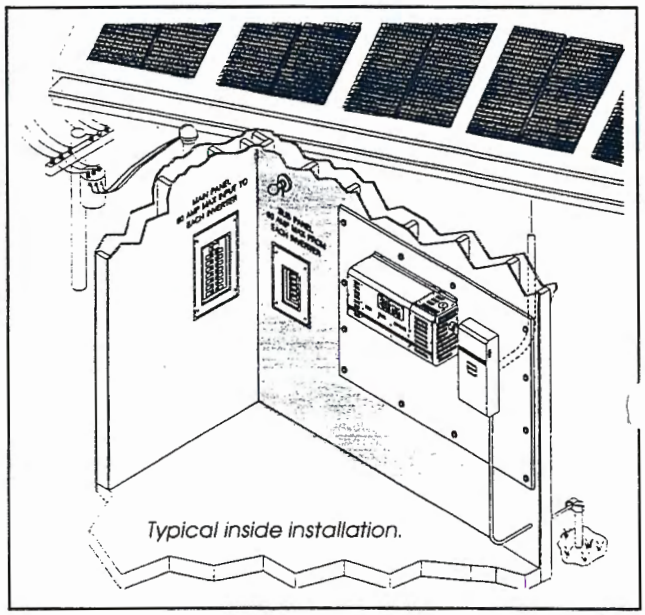
SW Series & S

System Overview: Trace Engineering power systems take electrical power generated by solar cells, convert it from direct current (DC) to alternating current (AC) using an inverter, and supply it for household use. Excess power generated during the daytime hours is fed back into the utility power grid for use at other utility locations. If the amount of power generated by the solar panels is insufficient for the home's needs, the system draws needed energy from the utility power network.



Cardiff St





Typical inside installation.

stem Overview



Photo courtesy of United Solar Systems.

each CA. *(Batten seam roofing system.)*

Grid Interactive Inverters and Converters: Trace Technologies grid interactive inverters and converters provide the critical interface between energy systems that produce or store electric energy in DC form and transfer that energy to an AC utility grid. Applications such as solar photovoltaics, batteries and fuel cells benefit from unique software control which allow Trace Technologies' inverters technology to be easily adapted to other applications.

Trace's SW series inverter has taken the concept of "Your Own Power Company" to new heights. Now you can start your own small-scale utility, powered by solar, wind, icro hydro, and ely interconnect with the local power company. (Check with local authorities for any restrictions.) At night, when solar power is unavailable, or when load demands exceed the capacity of your renewable generating system, utility power is automatically supplied through the Trace inverter. Designed for exacting utility standards, the SW series inverter automatically synchronizes with the utilities' power to produce a wave form suitable to feed into the electrical grid. Some users with large solar (PV) systems actually get monthly checks, instead of bills, from their local utilities, because their power demands are less than they generate.



Trace Engineering systems are certified for utility interconnection.

Trace now builds a variety of specially designed SW inverters that do not require costly batteries and can handle over 6 kW of solar-generating power.

Safety is a key feature of these unique inverters. If a power outage occurs, the Trace SW inverter immediately stops sending electricity to the grid in order to protect service personnel who may be working on the lines.

Options for these utility tie systems include ground-fault ruption for PV array, weather proof enclosure for the nverter, and fully code-approved AC and DC disconnects.



Photo courtesy of Atlantis Energy.

Integrated solar roof.

Microsine Modules

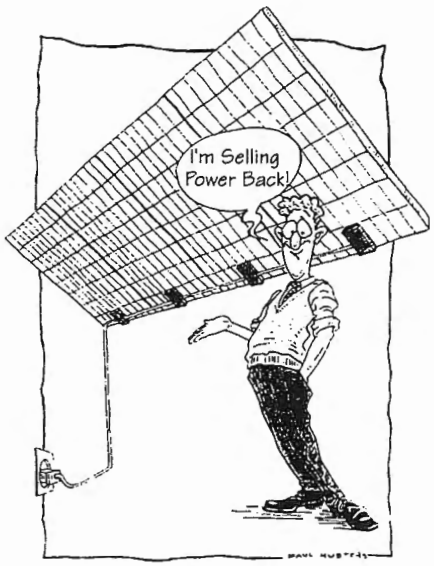
Trace Engineering is leading the way once again with our new miniature utility interactive inverter—the Micro Sine (AC PV Module). This unique product is a joint venture of Trace and OKE Services of Europe, with Trace being responsible for manufacturing and marketing in North America. Designed to fit on the back of an individual PV solar module, this totally weather proof inverter produces utility-grade power suitable for supply to a power distribution grid. Like its larger, safety-designed cousins in the SW series, the Micro Sine automatically stops sending electricity to the grid in the event of a utility power outage.

At last home owners can begin to reduce their dependence on utility power for their electrical requirements. As finances allow, additional PV modules coupled to a Trace Micro Sine can be added to your personal household utility system at any time. (Check with your local utility and electrical inspection authority on how to connect to the grid.)

The AC PV Module microprocessor control includes Maximum Power Point Tracking, a feature used to assure that your PV module is operating at maximum output under all light conditions. An optional communications system adaptor allows for full system monitoring and trouble shooting. Features of the Communications module include tracking and diagnostics of each Micro Sine in your system.



Micro Sine installed on solar module

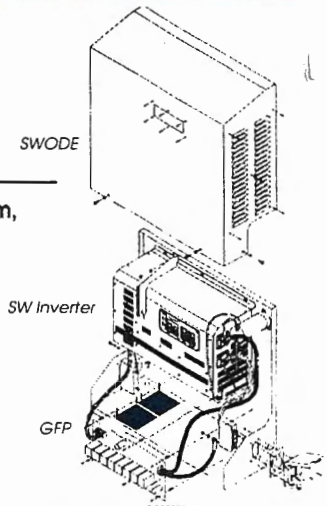


Now anyone, can contribute to the greening of local utility power. With a single solar PV module you can begin to reduce your electricity bill and dependence on utility power grid. As the price of solar modules decreases, or as your finances permit, you can increase your solar array, thereby further lowering utility bills.

Specifications • Utility Tie Systems/Inverters

TRACE ENGINEERING now offers the Utility Tie Systems/Inverters for utility-interactive photovoltaic applications where utility back-up ability is not required.

These inverters provide direct conversion of photovoltaic (solar) energy to Utility Power **without a battery storage system.** The TRACE ENGINEERING Utility Tie System/Inverters are designed to meet or exceed utility power company requirements. All Trace line tie inverters and systems can be paralleled for any power level requirements.



Utility tie system.

UTILITY TIE SYSTEM: Available for indoor or outdoor installation and comes pre-wired as a complete packaged system, includes:

SW (PV) Series, high efficiency Utility Tie power inverter features:
Built in islanding protection with over / under voltage and frequency shutdown and disconnection
Back-lit LCD display provides status, input and output voltages, AC currents and status
Maximum Power Point Tracking software which automatically tracks solar array's maximum power operating voltage
Automatic morning wake-up and evening shutdown (less than 1 watt draw at night)
Automatic fault condition reset for loss of grid, over and under voltage and frequency
DC operating range between 34 to 75 VDC (peak power point tracking range of 44 to 64 VDC)
***SWODE* - Sine Wave Outdoor Enclosure:** With DC input capacitor, suited for wall mounting
AC and DC circuit breakers: Allows disconnection of all AC and DC power from the inverter for servicing

Part Number	Inverter	Max Power Output	Grid Required	AC and DC Disconnects	Efficiency > 90%
UT-SW3048EPV	SW3048EPV	3.3 kVA	230 VAC / 50 Hz	35 amp (AC) 110 amp (DC)	.2 to 2.0 kVA
UT-SW4048PV	SW4048PV	4.0 kVA	120 VAC / 60 Hz	60 amp (AC) 110 amp (DC)	.2 to 2.5 kVA
UT-SW4048UPV	SW4048UPV	4.0 kVA	240 VAC / 60 Hz	35 amp (AC) 110 amp (DC)	.2 to 2.5 kVA
UT-SW4548EPV	SW454EPV	4.5 kVA	230 VAC / 50 Hz	35 amp (AC) 110 amp (DC)	.2 to 3.3 kVA
UT-SW5548PV	SW5548PV	5.5 kVA	120 VAC / 60 Hz	60 amp (AC) 110 amp (DC)	.2 to 4.0 kVA
UT-SW5548UPV	SW5548UPV	5.5 kVA	240 VAC / 60 Hz	35 amp (AC) 110 amp (DC)	.2 to 4.0 kVA

Option: GFP - Ground Fault Protection may be ordered as an option with the utility tie system.

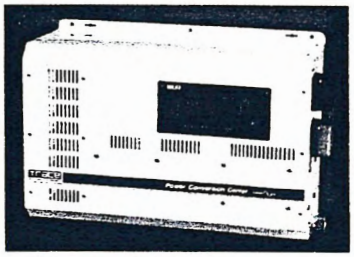
SW (PV1) SERIES UTILITY TIE INVERTER

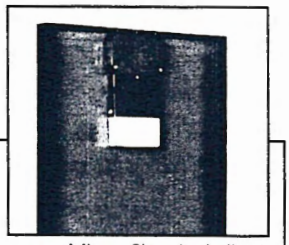
Available for indoor installation only, includes:

SW (PV) Series, high efficiency Utility Tie Inverter - *includes all inverter features described above*
Inverter dimensions: 9" (22.8cm) deep x 22.5" (57.2cm) wide x 15.1" (38.3cm) high

SWCB1 - Conduit Box (SWCB) with DC input filter capacitor mounted inside.
The SWCB1 adds 9 lbs. and another 6" (15cm) to end of inverter.

Note: GFP, AC or DC disconnects, which may be required by local Utility / Building inspectors, are not included. (GFP can not be purchased individually at this time.)


SW, PV Series Inverter


Micro Sine installed on solar module

MICROSINE PV MODULE INVERTER: Designed specifically to "sell back" power into a utility grid (no battery back-up available), mounts directly to the back of a solar PV module. This weatherproof, modular inverter includes MPPT and islanding protection system built to meet Utility Tie standards. *UL/ETL listing, NEC and Utility requirements are pending.* (Dim:5.4" x 4.2" x 1.2" @ 1.5 lbs.)

MS100	100 watts DC, 24-50 VDC input, 120 VAC/60 Hz output, efficiency: 89% average, 92.5% peak - *MSCA not included*
MS100U	100 watts DC, 24-50 VDC input, 230 VAC/60 Hz output, efficiency: 89% average, 92.5% peak - *MSCA not included*
MS100E	100 watts DC, 24-50 VDC input, 230 VAC/50 Hz output, efficiency: 89% average, 92.5% peak - *MSCA not included*
MSJB	Optional Microsine Junction Box provides easy mounting & wire termination point for most solar module brands.
MSCA	Optional Communications Adapter for MicroSine inverters: required to change the voltage and frequency limits, also allows up to 127 Microsine inverters to be connected to a PC computer. Includes RS485-232 adapter and DOS based software. *(required twisted pair two wire cable not included).*

5 year limited warranty / All specifications are subject to change without notice.

AVAILABLE FROM:

THE POWER COMPANY
TRACE ENGINEERING
Arlington • WA • USA • Phone: 360-435-8[illegible] • Fax: 360-435-2229
http: www.traceengineering[illegible]

Model SW 5548PV

UTILITY INTERACTIVE PHOTOVOLTAIC INVERTER

For *Battery-less* Photovoltaic Power Systems

Trace Engineering now offers a DC to AC power inverter for utility-interactive photovoltaic applications where utility back-up ability is not required. This allows the SW series inverter to be used in applications where batteries are not easily accommodated, such as in retrofit installations by utilities on residences.
ETL listed to UL 1741 Photovoltaic Power Systems.

Standard Features

- Allows direct conversion of the solar energy to AC without a battery storage system
- 5500 watts continuous AC output @ 25°C, over 90% efficient from 300 to 400 watts AC output
- Includes automatic tracking of the solar array's maximum power operating voltage (MPPT)
- Built-in islanding protection with under / over voltage & frequency shutdown and disconnection
- DC input operating range of 44 to 75 VDC (peak power point tracking range of 44 to 64 VDC)
- Designed to operate with three PV modules in series solar arrays (108 to 120 PV cells in series)
- LCD display with back lighting provides status, input & output voltages, AC currents and wattage
- Automatic morning wake up and evening shutdown (less than 1 watt draw at night or when off)
- Automatic fault condition reset for loss of grid, over & under voltage and frequency

Optional Outdoor Enclosure

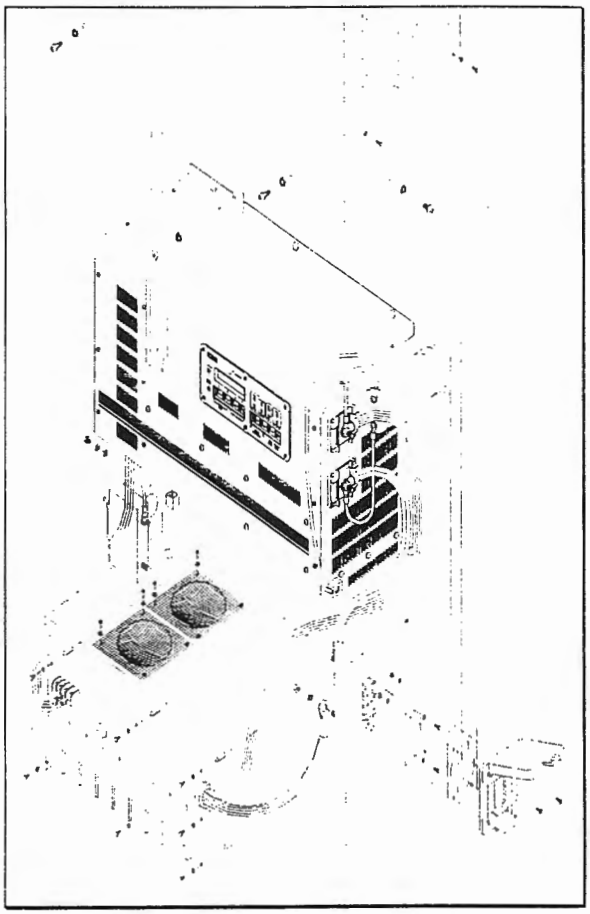
- Allows installation of the inverter on an exterior wall as required by many utility project specifications.
- Cabinet includes ventilation louvers with internal baffles and provisions for additional cooling fan for high ambient environments.
- Lift off cover makes installation easy
- Includes padlock provision for cover

Optional Ground Fault Protection

- Shuts down the system if a ground fault occurs in the PV array wiring system
- Disconnects and short circuits the solar array when a ground condition fault occurs
- Designed to accommodate up to 8 sub-array inputs up to 16 amps short circuit each
- Includes 20 amp DC UL listed supplementary fuses for each sub-array input to protect small wiring - eliminates roof top combiner boxes
- Built-in test switch creates an actual ½ amp "ground fault" for acceptance testing
- Accommodates up to #6 AWG wire (13.3mm2) from each sub-array

Optional AC and DC Disconnects

- 60 amp AC circuit breaker with outdoor flip-up type lockable cover for AC output wiring
- 110 amp DC circuit breaker with outdoor flip-up type lockable cover for DC input wiring
- Allows disconnection of all AC and DC power from the inverter to allow servicing



Shown with optional outdoor enclosure, DC and AC disconnects and ground fault protection

5916 195th St. N.E. Arlington, WA USA 98223 Phone (360) 435-8826 Fax (360) 435-2229

THE POWER COMPANY

ENGINEERING

Islanding Protection

All of the SW series inverter/chargers include the following protective systems. These systems are used to protect the inverter and the installer/operator/utility personnel from hazardous conditions. The standard protection is as follows:

- **Grid shorted-** Normally, when the utility power fails, the inverter momentarily tries to power the entire neighborhood. This condition looks like a short circuit to the inverter and causes it to reach the overcurrent protection setting and shuts off. It then opens its internal relay and disconnects from the utility grid. This protective system operates instantly. (Under four milliseconds)

- **Grid open-** The inverter can tell when there is no current being delivered to the grid and it will disconnect. This is used when a disconnected switch is opened or the power line which feeds the installation is cut. This protective system may require up to one second to respond.

- **Islanding-**This occurs when the grid has failed and the "neighborhood" that the inverter is powering requires the same amount of power that the inverter can supply. This balanced condition is often called "islanding". The islanding detection circuit checks the grid condition on each cycle. The inverter watches the utility grid and waits for it to rise a couple of volts before it begins to invert again. This is done on each cycle when SELL mode is activated. Typically, disconnection is achieved in a few cycles after the utility has failed. If a large electric motor is connected, it may provide enough generator capacity that the inverter thinks the grid is still connected. This can fool this protective system. Two additional protective systems are provided to then handle this condition over/under frequency and over/under voltage detection.

- **Over/Under Frequency-** Since the inverter is locked onto the frequency of the "Islanded" utility grid, the frequency of the system will drift out of regulation in a short amount of time during and islanding condition. This protective system may require up to one second to respond. The inverter will shut off disconnect after the frequency exceeds +/- 1 hertz of the nominal frequency.

- **Over/Under Voltage-**Since the inverter does not regulate the voltage of the utility grid while selling power into it , the AC voltage will drift out of regulation in short amount of time during an islanding condition. This protective system may require up to one second to respond. The inverter will shut off and disconnect after the voltage exceeds +/- 10% of the nominal AC voltage

Each SW series inverter/charger is individually tested to ensure operation of the islanding protection system. A signed certificate by the test technician of the test results are included with each unit.

THE POWER COMPANY
TRACE ENGINEERING

5916 195th St. NE, Arlington, WA 98223 PH: 360/435-8826 FAX: 360/435-2229
http://www.traceengineering.com

UTILITY TIE PRICE LIST (Revision 1.3) Effective: August 1, 1998

UTILITY TIE SYSTEMS / INVERTERS

TRACE ENGINEERING now offers Utility Tie Systems/Inverters for utility interactive photovoltaic applications where utility back-up ability is not required. They allow direct conversion of photovoltaic (solar) energy to Utility Power **without a battery storage system**. The TRACE ENGINEERING Utility Tie Systems/Inverters are designed to meet or exceed utility power company requirements.

UTILITY TIE SYSTEM: Available for *indoor or outdoor installation*, shipped pre-wired as a complete packaged system, includes:

- **SW (PV) Series, high efficiency Utility Tie power inverter, *featuring*:**
  - Built in islanding protection with automatic fault condition reset for loss of grid, over/under voltage, and over/under frequency
  - Back-lit LCD display provides status, input and output voltages, AC currents, and status
  - Maximum Power Point Tracking (MPPT) software which automatically tracks the solar array's maximum power operating voltage
  - Automatic morning wake-up and evening shutdown (less than 1 watt draw at night)
  - Designed to operate with three 12 VDC photovoltaic (PV) solar modules in series (108 to 120 PV cells in series)
  - DC operating range between 34 to 75 VDC (peak power point tracking range of 44 to 64 VDC)

  NOTE: OPEN CIRCUIT VOLTAGE OF PV ARRAY MUST NOT EXCEED 75 VDC AT LOWEST TEMPERATURE
- **SWODE*:** Outdoor Enclosure with DC input capacitor, suited for wall mounting
  - Lift off cover makes installation easy, includes a padlock provision. Dim: 11.5" (29.2 cm) deep x 28" (71.1 cm) wide x 30" (76.2 cm) high
- **AC and DC circuit breakers*:** Allows disconnection of all AC and DC power from the inverter for servicing
  - Includes outdoor, lockable covers for AC output and DC input wiring

* The SWODE and AC/DC breakers are **only** included with the Utility Tie System

Part Number	Inverter	Max Power Output	Grid Required	AC and DC Disconnects		Efficiency >90%	List Price
UT-SW3048EPV	SW3048EPV	3300 VA	230 VAC / 50 Hz	35 amp (AC)	110 amp (DC)	.2 to 2.0 kVA	$ 4315.00
UT-SW4048PV	SW4048PV	4000 VA	120 VAC / 60 Hz	60 amp (AC)	110 amp (DC)	.2 to 2.5 kVA	$ 4315.00
UT-SW4048UPV	SW4048UPV	4000 VA	240 VAC / 60 Hz	35 amp (AC)	110 amp (DC)	.2 to 2.5 kVA	$ 4315.00
UT-SW4548EPV	SW4548EPV	4500 VA	230 VAC / 50 Hz	35 amp (AC)	110 amp (DC)	.2 to 3.3 kVA	$ 4835.00
UT-SW5548PV	SW5548PV	5500 VA	120 VAC / 60 Hz	60 amp (AC)	110 amp (DC)	.2 to 4.0 kVA	$ 4835.00
UT-SW5548UPV	SW5548UPV	5500 VA	240 VAC / 60 Hz	35 amp (AC)	110 amp (DC)	.2 to 4.0 kVA	$ 4835.00

UTILITY TIE SYSTEM OPTIONS (pre-installed):
(UTO- options are ONLY available at the time of the Utility Tie System purchase, the GFP cannot be purchased individually at this time)**

Part Number	*Ground Fault Protection – Required for residential photovoltaic rooftop installation on homes in the United States.*	Add Price
PVGFP1	Ground Fault Protection Device, One pole for one solar-array. (100 amp Max) UL listed	$ 275.00
PVGFP2	Ground Fault Protection Device, Two pole for two solar-arrays. (100 amp Max) UL listed	$ 325.00
PVGFP3	Ground Fault Protection Device, Three pole for three solar-arrays. (100 amp Max) UL listed	$ 375.00
PVGFP4	Ground Fault Protection Device, Four pole for four solar-arrays. (100 amp Max) UL listed	$ 425.00
UTO-VLC40	Voltage Limiting Controller (40 amps) - necessary for solar arrays with DC voltages that exceed 75 VDC open circuit.	$ 225.00
SWCA-UT	Communications Adapter - allows PC control and monitoring of the SW (PV) Series inverter.	$ 175.00

SW (PV1) SERIES UTILITY TIE INVERTER: Available for *indoor installation* only, includes:

- **SW (PV) Series, high efficiency Utility Tie Inverter** - includes all inverter features described above

  Inverter dimensions: 9" (22.8 cm) deep x 22.5" (57.2 cm) wide x 15.1" (38.3 cm) high
- **SWCB1** - Conduit Box (SWCB) with DC input filter capacitor mounted inside.

  The SWCB1 adds 9 lbs. and another 6" (15 cm) to end of inverter.

Note: No GFP, AC or DC disconnects are included, these items may be required by local utility/building inspectors

Part Number	Inverter	Max Power Output	Grid Required	Efficiency > 90%	Weight	List Price
SW3048EPV1	SW3048EPV	3300 VA	230 VAC / 50 Hz	.2 to 2.0 kVA	117 lbs	$ 3560.00
SW4048PV1	SW4048PV	4000 VA	120 VAC / 60 Hz	.2 to 2.5 kVA	117 lbs	$ 3560.00
SW4048UPV1	SW4048UPV	4000 VA	240 VAC / 60 Hz	.2 to 2.5 kVA	117 lbs	$ 3560.00
SW4548EPV1	SW4548EPV	4500 VA	230 VAC / 50 Hz	.2 to 3.3 kVA	145 lbs	$ 4130.00
SW5548PV1	SW5548PV	5500 VA	120 VAC / 60 Hz	.2 to 4.0 kVA	145 lbs	$ 4130.00
SW5548UPV1	SW5548UPV	5500 VA	240 VAC / 60 Hz	.2 to 4.0 kVA	145 lbs	$ 4130.00

SW (PV) SERIES UTILITY TIE INVERTER OPTIONS (field installable):

SWCA-UT	Communications Adapter - allows PC control and monitoring of the SW (PV) Series inverter.	$ 175.00
VLC40	Voltage Limiting Controller (40 amps) - necessary for solar arrays with DC voltages that exceed 75 VDC open circuit.	$ 235.00
CD110	110 amp DC circuit breaker for disconnection of DC power from the inverter to allow servicing.	$ 60.00

MICROSINE PV MODULE INVERTER: Designed specifically to "sell back" power into a utility grid (no battery back-up available), mounts directly to the back of a solar PV module. This *weatherproof*, modular inverter includes MPPT and islanding protection system built to meet Utility Tie standards. *UL/ETL listing, NEC and Utility requirements are pending.* (Dim: 5.4" x 4.2" x 1.2", weight: 1.5 lbs.)

MS100	100 watts DC, 24-50 VDC input, 120 VAC/60 Hz output, efficiency: 89% average, 92.5% peak - *MSCA not included*	$ 345.00
MS100U	100 watts DC, 24-50 VDC input, 230 VAC/60 Hz output, efficiency: 89% average, 92.5% peak - *MSCA not included*	$ 345.00
MS100E	100 watts DC, 24-50 VDC input, 230 VAC/50 Hz output, efficiency: 89% average, 92.5% peak - *MSCA not included*	$ 345.00
MSCA	**Optional Communications Adapter for MicroSine inverters: required to change the voltage and frequency limits, also allows up to 127 MicroSine inverters to be connected to a PC computer. Includes RS485-232 adapter and DOS based software (required twisted pair, two wire cable not included).**	**$ 145.00**

All prices and specifications are subject to change without notice. Prices are F.O.B. Trace Engineering Inc., Arlington, WA 98223

TOP-OF-POLE MOUNTS

DP&W Top-of-Pole Mounts are available in several sizes ranging from 1-module through 24-modules. The rack design is determined by the area of module to be mounted; not necessarily the number of modules. This sheet describes our standard line of mounts. DP&W specializes in custom design and fabrication and can build mounts to meet your exact needs.

SPECIFICATIONS

MATERIALS

Strongbacks, Elevation Pivots and Mounting Sleeves are made of heavy gauge steel flat bar, square tubing and pipe or mechanical tubing conforming to ASTM A36 and ASTM A500-Grade B. All parts are mig-welded, burrs are removed, corners are coped and edges are sanded. Steel parts are coated with a minimum of two coats of industrial urethane enamel.

Module Rails are made of mill-finish 6061-T6 structural aluminum angle. All holes are deburred and edges are coped and sanded.

Stainless steel module mounting hardware is provided with each rack. Standard rack assembly hardware is zinc-plated Grade 5.

ELEVATION ANGLE ADJUSTMENT

Standard Top-of-Pole Mounts have six tilt-angle settings. These positions are positive locking to avoid the possibility of slippage. The racks are balanced about the pivot bolt to make adjustment easy. Other tilt combinations and racks welded at fixed angles are offered as options.

WINDLOADING CAPABILITY

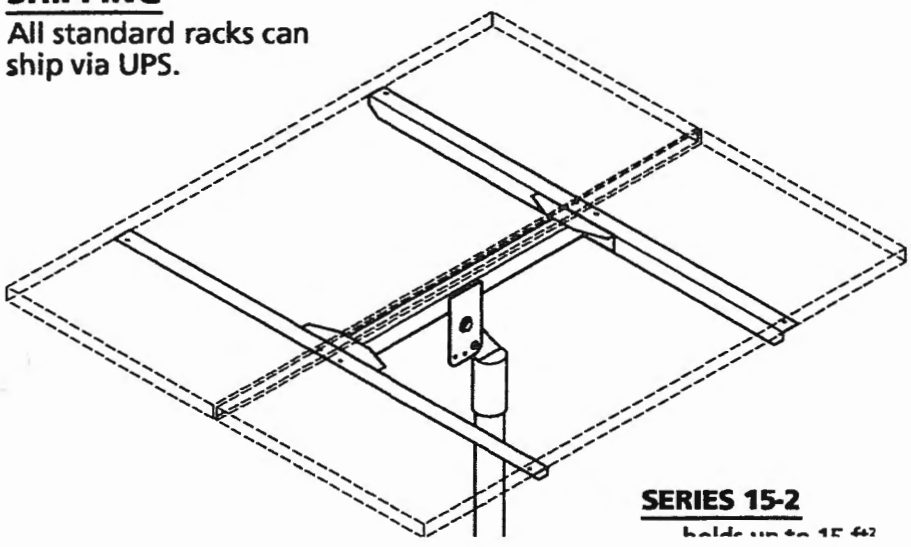
Standard models are designed and warranteed to withstand windloads of 30 lbs./ft² (approximately 90 mph). Designs capable of withstanding greater loads are available for high-wind areas.

MOUNTING

All racks have sleeves sized to slip over readily-available standard sizes of installer-supplied SCH40 steel pipe. The mounting sleeves have set bolts spaced 90° apart to firmly secure the rack to the pole.

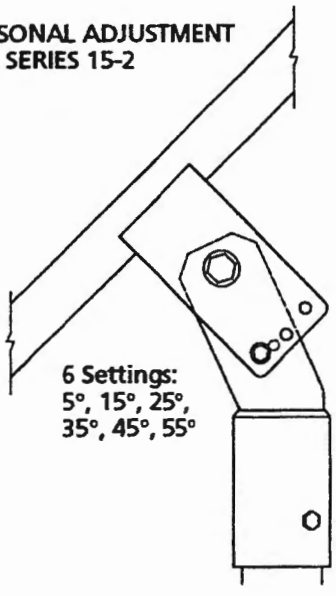
SHIPPING

All standard racks can ship via UPS.

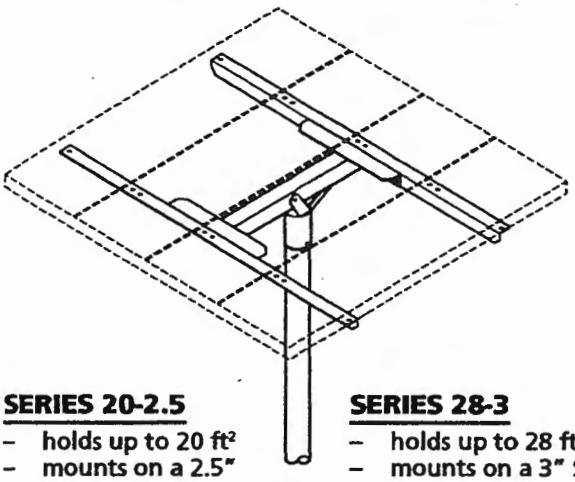


SERIES 15-2

SEASONAL ADJUSTMENT FOR SERIES 15-2

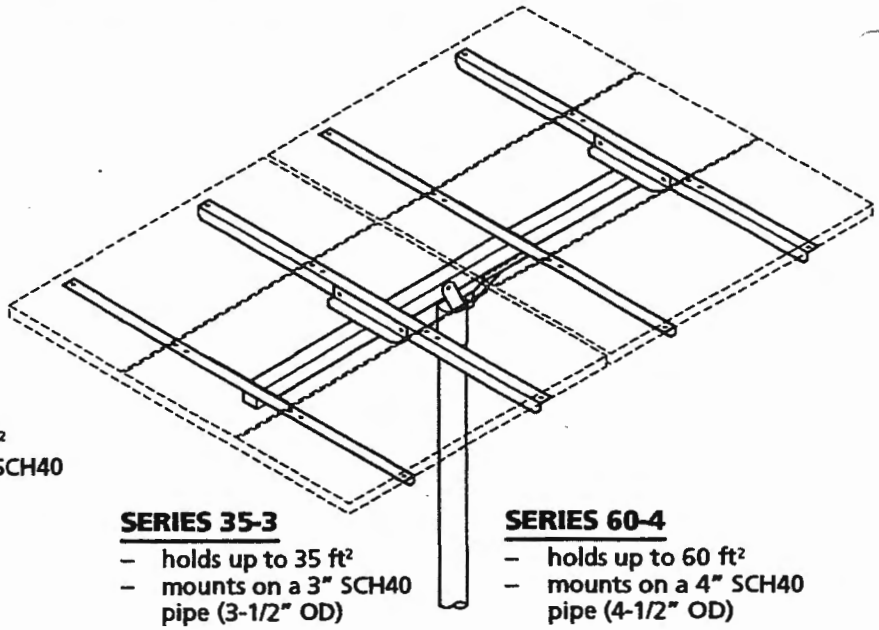


TOP-OF-POLE MOUNTS *(continued)*



SERIES 20-2.5
- holds up to 20 ft²
- mounts on a 2.5" SCH40 pipe (2-7/8" OD)

SERIES 28-3
- holds up to 28 ft²
- mounts on a 3" SCH40 pipe (3-1/2" OD)

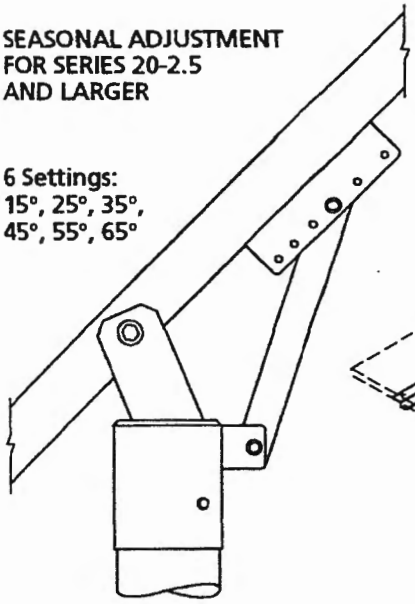


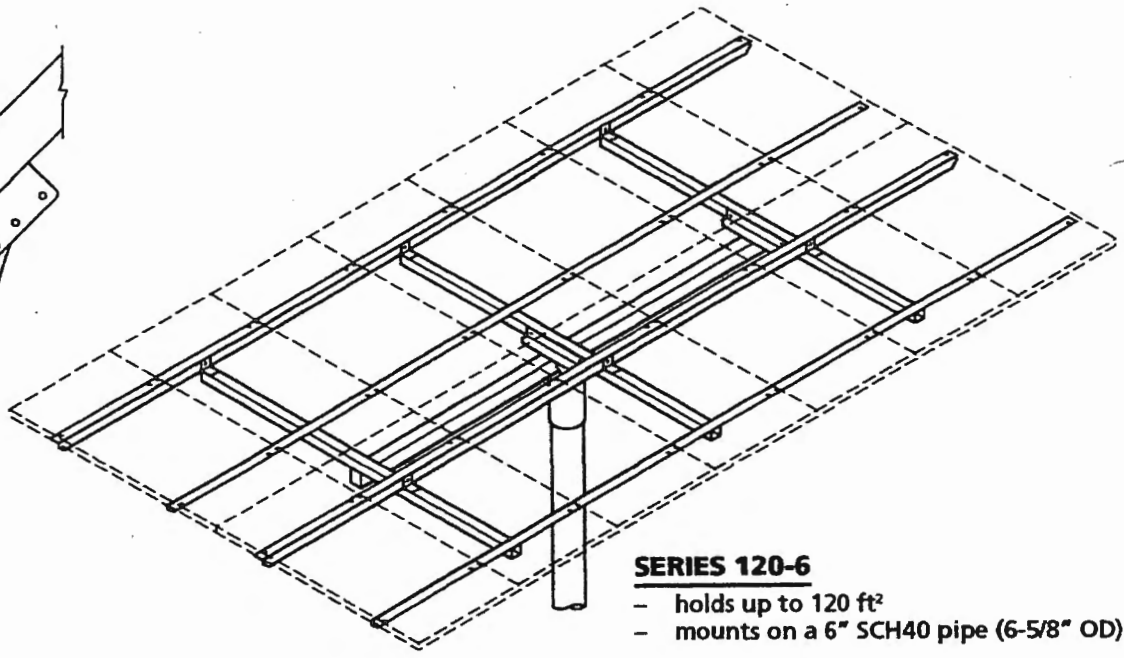
SERIES 35-3
- holds up to 35 ft²
- mounts on a 3" SCH40 pipe (3-1/2" OD)

SERIES 60-4
- holds up to 60 ft²
- mounts on a 4" SCH40 pipe (4-1/2" OD)

SEASONAL ADJUSTMENT FOR SERIES 20-2.5 AND LARGER

6 Settings:
15°, 25°, 35°,
45°, 55°, 65°





SERIES 120-6
- holds up to 120 ft²
- mounts on a 6" SCH40 pipe (6-5/8" OD)

OPTIONS

- Hot-dip galvanized steel with anodized aluminum rails
- Combiner box mounting plates
- Custom sleeve sizes
- Custom elevation angle settings
- Tamper-resistant hardware
- All stainless hardware
- Wire holes in cap
- All-welded racks
- Powder coating

REPRESENTED BY:

Appendix

List of Exhibitors

ALAMEDA

INTERNATIONAL
ELECTRIC VEHICLE
EXPOSITION

Co-Sponsored by:
Chrysler Corporation
Toyota Motor Sales, U.S.A.
American Honda Motor Co.

with the support of
Sillicon Valley Power
& Bay Area AQMD

Co-hosts:
Alameda Bureau of Electricity
and CALSTART

American Honda Motor Co., Inc.
1919 Torrance Blvd.
Torrance, CA 90501
310-781-4450
www.honda.com

Honda is a world leader in environmental automobiles. The EV PLUS is the first and only advanced-battery EV passenger car marketed to consumers and fleet customers in California. The purpose-built EV PLUS seats four adults comfortably, has flexible cargo space, and has an EPA city driving range-to-empty of 125 miles (60 to 80 "real world" miles). Honda also makes the Civic GX, a natural gas powered Civic, and the cleanest internal combustion engine car ever built.

Bay Area Air Quality Management District
939 Ellis Street
San Francisco, CA 94109
415-749-4641
www.baaqmd.gov

The Bay Area Air Quality Management District is working to introduce electric vehicles to the San Francisco Bay Area. The District has provided over $5 million in funding to public agencies through its Transportation Fund for Clean Air (TFCA) program to subsidize the cost of electric vehicles and EV infrastructure. To date, the TFCA has funded 300 light duty EVs, as well as three electric buses. For information on the District's EV programs, call David Burch at 415-749-4641, or visit the District's web page at www.baaqmd.gov.

California Air Resources Board
2020 L. Street
Sacramento, CA 95812
916-322-2990
www.arb.ca.gov

The Air Resources Board was established in 1967 to attain and maintain healthy air quality, conduct research into the causes of and solutions to air pollution, and systematically attack the se3rious problem caused by motor vehicles, the major contributor of air pollution in the state. Working with industry and the public, the ARB seeks cost-effective approaches that improve air quality. The goal is cleaner air for better public health, a sound economy, and improved quality of life.

CALSTART
2701 Monarch
Hangar 20
Alameda Point
Alameda, CA 94501
510-864-3000
www.calstart.org

CALSTART is a private, non-profit consortium of more than 200 public and private organizations developing and implementing advanced transportation technologies. Its mission is to help develop and bring advanced transportation systems and vehicles to market in order to clean the air, increase energy efficiency and create high-quality jobs.

City of Alameda Bureau of Electricity
2000 Grand Street
Alameda, CA 94501
510-748-3944
JimBaak@compuserve.com

Through the Alameda EV Model City Program, the Bureau of Electricity is taking a leadership role in promoting the development and use of electric vehicles. With promotional events, demonstrations, an EV Loaner Program, an electric transit system, public charging facilities and fleet conversion programs, the EV Model City Program is designed to promote the use of EVs and the development of the EV industry in Alameda.

Chrysler Corporation
27777 Franklin Rd.
Southfield, MI 48034
248-948-3644
www.chryslercorp.com

Chrysler is firmly behind the development and advancement of electric vehicles. We were the first major auto manufacturer to introduce a fully certified production electric vehicle that meets California's Zero Emission Vehicle (ZEV) standard. Our "TEVan" was marketed to electric utility fleet customers from 1993 – 1995. Our current challe3nge is to develop a battery that will allow EVs to offer the range, performance and utility of gasoline counterparts.

Edison EV
6040 Irwindale Ave.
Irwindale, CA 91706
1-888-890-GOV
www.edisonev.com

CI Enterprises
1410 Martin Ave.
Santa Clara, CA 95050
408-986-9505
www.cielectric.com

Edison EV, a subsidiary of Edison International, is the nation's largest provider of electric vehicle infrastructure. The company provides a complete menu of services for residential, fleet and public charging customers, including charging equipment, installation, warranty and repair services. CI Enterprises has been providing construction and electric services to Bay Area businesses since 1983. CI is Edison EV's Authorized Contractor for Northern California and has installed EV charging at more than 100 locations.

Electrifying Times
63600 Deschutes Market Road
Bend, Oregon 97701
541-388-1908
www.teleport.com/~etimes

Electrifying Times, an international magazine on the emergence of electric vehicles, hybrid electric vehicles, batteries, fuel cells, microturbines, ultracapacitors and other new clean zero emission or near zero emission technology announces the launch of "Preview 2000". Printed in full color, glossy print, it features 35 EVs, HEVs, produced or soon to be produced by major and minor companies worldwide for the new millennium. With the ever-increasing auto population, congestion and increased air pollution in most cities worldwide, the announcement of this environmentally friendly transportation technology is welcomed by all frustrated urban dwellers. "Preview 2000" will be available at some Barnes & Noble and Tower Book Stores nationwide or contact us or our web site for details on how to order "Preview 2000". It is available separately or with a yearly subscription to Electrifying Times.

General Motors EVI
Electric Vehicle Marketing Svcs./Saturn Corp.
3952 Harrison St. #302
Oakland, CA 94611
1-800-25-ELECTRIC
www.gmev.com

Perfect for commuting, the General Motors Ev1 is a sporty, two-door, purpose-built electric vehicle. EV1's advanced technologies make it the world's most energy-efficient vehicle platform. Ev1 is currently available for lease at 33 Saturn retailers in California and Arizona.

It's Electric
540 Irwin St.
San Rafael, CA 94901
415-456-7211
www.greenkeys.com

Located in San Rafael, California, It's Electric! Is the first and only all-electric auto dealership in the country. Our purpose is to provide individuals, private companies, and public agencies with a means to contribute, in a personal and direct way, to a solution to the problems of air pollution and global warming; by the purchase and use of high quality, zero-emission electric vehicles. Come drive the future today at It's Electric!

Lithia Sun Valley Ford
2285 Diamond Blvd.
Concord, CA 94520
800-582-2275 or 925-686-5000 ext. 387]
SunValleyFord@Juno.com

Lithia Sun Valley Ford is California's premier OEM electrical vehicle dealer. Located in the heart of Contra Costa County, in the city of Concord, Sun Valley Ford is one of only ten Ford Dealers in the state offering the Ford EV Ranger pick up for both sale and for lease. Sun Valley offers this exciting new electrical vehicle to private industry, government, and to the private owner. Sun Valley Ford is a member of the EAA.

Neighborhood Electric Vehicle Co.
435 Lincoln Street
Eugene, OR 97401
541-687-5939
gizmo@nevco.com or www.nevco.com

Neighborhood Electric Vehicle Company makes the Gizmo, a one passenger affordable NEV capable of meting the needs of most local trips. The first Gizmo was completed in July of 1995 and since then NEVCO has completed a test fleet in use in real world application. Customers include Eugene Water and Electric Board (meter reading and site inspection), businesses for delivery and short local travel, and commuters. Delivery is projected to start second quarter of 1999.

Nissan North America
18501 South Figueroa Street
Gardena, CA 90248
800-239-8810
www.nissan-na.com

Nissan in North America employ more than 20,000 people in the United States, Canada and Mexico and generates more than 70,000 jobs through more than 1,500 Nissan and Infiniti retailers across the continent. More information about Nissan in North America and the complete line of Nissan and Infiniti vehicles can be found on-line at www.nissan-na.com and www.nissan-usa.com.

P G & E
P. O. Box 770000 Mail Code H28L
San Francisco, CA 94177
800-684-4648
www.pge.com/cleanair

Pacific Gas & Electric Company has been supporting EV development and use for many years, and is available to help their customers with current information about electric vehicles. Customers who purchase EVs at the Alameda International Electric Vehicle Expo can visit P G & E's booth to arrange for electric service under PG & E's special rate schedule for EV charging.

S-LEMNA, Inc.
2420 NE 61st Avenue
Portland, OR 97213
503-249-8621
www.S-LEM.ch

S-LEMNA, Inc. is the US and Canadian distributor of the Swiss-Light Electric Mobiles (S-LEM) Active, which will be displayed at the Alameda Expo. The Active features:

- NHTSA Certification
- 1.5 hour 120 volt charging with only 2kWhr
- 50 mile range at 30 mph or 30 miles at 50mph
- load capacity of 365 pounds
- top speed of 85 km/hr (53 mph)
- crash cage protection
- Availability for purchase.

Silicon Valley Power
City of Santa Clara
1500 Warburton Ave.
Santa Clara, CA 95050
408-261-5348
www.Siliconvalleypower.com

Silicon Valley Power, the City of Santa Clara's Electric Department, is preparing for the new era of energy services. As we are all aware, traffic congestion and related problems are on the increase in Santa Clara Valley. The City of Santa Clara supports several programs that are aimed at finding alternatives to driving a vehicle. To this end, SVP is planning to support an electric shuttle rail-line service in late Spring 1999 by introducing electric shuttle buses.

SVP continues to seek innovative ways to use cleaner transportation technologies, and to serving its customers as well as potential new markets.

Toyota Motor Sales
19001 S. Western Ave.
Torrance, CA 90509
1-800-GO-TOYOTA
www.toyota.com

Toyota has long held the view that if the automobile is to continue as a form of transportation, it must function more in harmony with the environment. That's why Toyota is committed to reducing CO2 and other harmful emissions. Toyota is hard at work developing new sources of vehicle power and technologies to conserve fossil fuels. Toyota also is committed to enriching your life with vehicles that are fun to drive and do less harm to our environment.

Ultimate Motroller Corporation
21352 Nordhoff St.
Chatsworth, CA 91311
818-998-0722

UMC produces a revolutionary, patented, brushless DC motor/controller. It is an ideal traction motor system, providing variable and high speed, high torque, high efficiency over a broad range of speed at low voltage in a small and low cost package. It has no complicated AC vector control, no brushes, no expensive rare earth magnets, no intricate and expensive rotor or stator, and best of all, no shutdown from a single phase component failure.

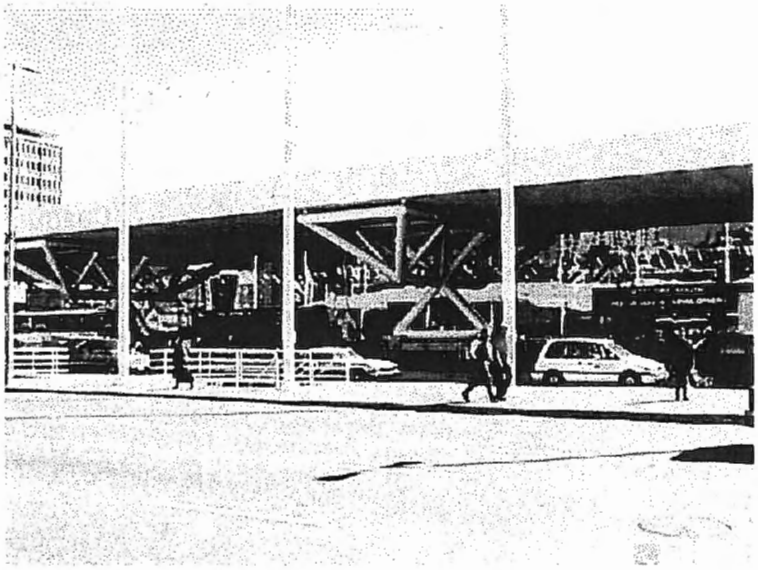
U. S. Dept. of Energy
Office of Advanced Automotive Technologies
EE-32
1000 Independence Ave., SW
Washington, D.C. 20585
202-586-8055
www.ott.doe.gov/oaat

Under the Partnership for a New Generation of Vehicles program, the U.S. DOE's Office of Advanced Automotive Technologies, along with national labs, universities, U.S. automakers, and suppliers, are leading the way in the research and development of technologies for your 21st Century Vehicle.

Wu's Ltd. Co.
1851 Flickinger Ave.
San Jose, CA 95131
408-929-5942
yiyi-Wu@hotmail.com

Established in 1967, Wu's is a pioneer in inventing and manufacturing special automobiles, and has become the major supplies for this industry in Taiwan. Ten years ago, we initiated the development of electric vehicles in Taiwan and have gained great success and experience in this field. We are now entering the world market and seeking suitable partnerships in this interest. We also offer the benefit of OEM by providing the best prices and guaranteed quality.

EV Report 1998 San Francisco Auto Show Nov.21 - Nov.28 1998



More than 500 vehicles were on display at the Moscone Center during the San Francisco International Auto Show. Special attractions include "dream cars of tomorrow," **alternative-fuel vehicles,** motorcycles, Sears Point and Laguna Seca race car exhibits, classic roadsters from Danville's Blackhawk Automotive Museum, and the Mercedes Benz 360 degree Circle Scope Movie Theater, where they screened "Fortune Teller," a 14-minute film on the past, present, and future of Mercedes.

As a part of the special attractions for the environmentally minded show goers the car show featured **Electric Vehicle Spectrum**, a display of "no-tail pipe" Evs available. EV manufacturers include Toyota Motors, Ford Motor Company, Chrysler Corporation, Honda America, Zebra Motors, Toyota Industrial, Powerboss, Par Car, Zap bikes and Corbin Pacific.

Because all countries are facing air pollution issues this show was an international display that included clean air vehicle representatives from America, Japan and England. The California consulting firm Synergy EV, Inc. organized 16 symposiums on the "ABC's of Electric Vehicles" with PG & E as its premiere sponsor. For more info contact:

Synergy EV, Inc.
15520 Quito Road
Los Gatos, CA 95030

Peter Senkowsky of EVTRANSPORT was a staff member in one of the Electric Vehicle booth during the duration of the show. Please click here to read his report. **Peter's Auto Show Report**

.



The following Evs were sighted at the Auto Show:
(Click on icons to view details)

Chrysler Epic Minivan

Honda EV Plus

Ford Ranger

Solectria Force

Corbin Sparrow

Toyota Rav4-EV

Zap Electric Bikes

Zebra

Saturn EV1

This report was prepared for REDI
By Devi Senkowsky of EVTRANSPORT

The **1998 San Francisco Auto Show** opened with the traditional fanfare of the press opening night on Thursday before the show opened to the public.

The Automotive crowd donned their party clothes that night and amidst the ever-flowing champagne, conversed, analyzed, and criticized the industry's best of 1998.

To the average motor-head and automotive consumer there were more of the same themes around our "best friend" the automobile. Mainly more luxury, extravagance, engineering finesse, higher performance, and more proliferation of even bigger SUVs. For people with technical background and understanding, it was very visible that it takes even more computers and related complex systems to meet more demanding air quality requirements. These complexities will ultimately cost the consumer a larger portion of their hard-earned dollars to keep up.

For the duration of the show, the writer had a very special assignment. Of all places I was involved in the introduction and promotion of a California built fully electric commuter vehicle. This placed me in a spot where people with interests in the alternative scene can naturally be found.
After the 10 days of the show we had confirmation from the show's management that this EV booth had four times the visitor traffic than all the other booths in the entire show. Which leads me to believe that almost all users of automobiles in the current form are waiting for a solution that improves our environment and contributes to a friendlier face of our neighborhoods.

I observed that people are intrigued by the idea of less air and noise pollution, and smaller vehicles that are easier to maneuver around congested urban areas. The same people are delighted with the idea of less operating cost, minimum service, and maintenance .

The general crowd of which over 80 percent are users of automobiles on a daily basis, salute an obvious reversal from the rising complexities of the modern cars to simpler and more logical engineering solutions in a coming generation of electric vehicles.

While the presence of EVs at the auto show has grown, I observed that the unique presentation of this particular electric vehicle was an extreme crowd magnet. The unusual and attractive appearance of the EV itself plus a proper product introduction by our staff changed people's opinion about the practicality of today's available electric cars. This induced interest led to endless discussions, questions and more specific interest on other Electric Vehicles presented at the show.

I personally talked to well over 3,000 people in the 10 days of the show specifically about Electric Vehicles, I believe that more public awareness of alternative fuel vehicles need to be promoted in a more intensive manner.
The public reaction indicates that small personal urban commuters could very well be the largest growing markets in this new emerging industry of Electric Vehicles.

Peter W. Senkowsky
President
EVTRANSPORT
2575 Trinity Road
Glen Ellen, CA 95442



Back to home

NAEVI Network — Proceedings



The NAEVI 98 proceedings are a compilation of papers from NAEVI 98 speakers representing all three tracks of the conference's concurrent sessions: infrastructure, technology, and marketing.

The spiral bound publication is available for $125 and will soon be able to be **purchased on-line**, or by calling EVAA at 415.249.2690.

NAEVI 98: North American EV & Infrastructure Conference and Exposition; December 3-4, 1998; Phoenix, Arizona. © Copyright 1997 EVAA, Inc. All rights reserved.

Basic Information | **NAEVI 98 Proceedings** | Other Products

Media Information -- Media Day

Products Launched, Projects Announced at NAEVI

EVAA kicked off Media Day at NAEVI '98 with a demonstration of its new CD ROM titled EVs Are Here -- Are You Ready? An Orientation to Electric Vehicles. The first-ever comprehensive CD ROM on electric vehicles, the "new media" product is aimed at providing basic information on electric vehicles and supporting infrastructure to broad audiences, including the public and media. It is available for purchase on-line at www.evaa.org.

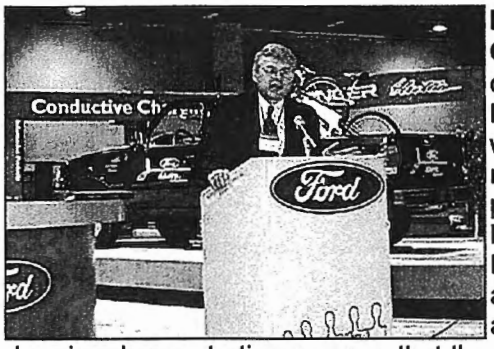
DaimlerChrysler showed off its 1999 Electric Powered Interurban Commuter (EPIC), powered by nickel-metal hydride (NiMH) batteries, and described the company's plans to market the vehicle. "We are targeting government and commercial fleets in California," said Mike Clement, manager of alternative fuel vehicle sales and marketing for the company. DaimlerChrysler will not be waiting for customers to come to them. They have launched a three-part mailing campaign targeted at 10,000 selected fleet customers in five markets - San Diego, San Francisco, Los Angeles, San Jose and Sacramento. Eleven dealers in California will receive special service training along with a total of 120 EPICs. Each dealership's demonstration vehicle will be emblazoned with graphics proclaiming, "yes, it's electric!"



Edison EV described its new solar-powered "chargeports" for charging EVs. Each charging station is covered by a canopy of photovoltaic panels, creating a carport that covers eight parking spaces and can power two cars daily. When not being used to charge EVs, the system is tied into the power grid to help offset the electricity costs of the host site.

Southern California Edison is doubling the size of its EV Technical Center, a comprehensive EV testing center recognized by the U. S. Department of Energy. The new 6,700-square-foot facility in Pomona will enable SCE to expand the scope of its testing projects, according to Ed Kjaer, SCE's director of electric transportation. At NAEVI, the EV Tech Center received special recognition from the Boeing Company's reusable space system division of Downey, California, with which SCE shares electric transportation technology advances of possible application to the space shuttle program. Boeing's Sam Hwangbo, electric auxiliary

power unit project manager, said, "I continue to be impressed with SCE's technical excellence and prompt service at the EV Tech Center."



Ford Motor Company showed off its 1999 Ford Ranger EV equipped with NiMH batteries, reduced the lease price on its lead-acid battery-powered Ranger EV to $349 a month, and announced a fast-charging demonstration program that the company will launch in the spring to assess customer satisfaction with fast charging and vehicle performance. The company also announced its participation in a program to offer a conductive charging wall box for as little as $295.

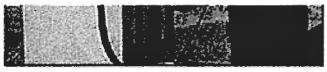
The EVC3 (Electric Vehicle Conductive Charging Coalition) picked up where Ford left off in describing the low costs and safe, accessible technology involved with conductive charging. EVC3 is comprised of American Honda Motor Company, DaimlerChrysler, Ford Motor Company, Mazda Motor Company, Solectria Corporation, Electric Vehicle Infrastructure, SCI Systems, Avcon Corporation, Norvik Traction, AeroVironment and Lockheed Martin Control Systems.

General Motors announced major technological improvements in its 1999 EV1 model, including advanced NiMH batteries, improved performance lead-acid batteries and a Generation II electric drive system that, according to GM, represents half the cost, half the size and one-third fewer parts than the Generation I design. The company's 1999 Chevrolet S-10 Electric Pickup will also be available with NiMH batteries. Batteries for both vehicles are being supplied by GM Ovonic, a joint venture with Energy Conversion Devices' Ovonic Battery Company. GM also reinforced its commitment to inductive charging.

AeroVironment plans to produce a fuel cell test station called the FC-100 that will improve the capability for testing modern fuel cells for automotive and stationary power applications. The company says its decision to develop a product for the fuel cell market was driven by customer demand and a belief that fuel cells will be the next significant advancement in energy storage.



eXtend Computer & Instrument announced it has combined a set of its Battery Management Sensors with a stand-alone electronic controller to produce an Active Battery Management upgrade kit that can improve vehicle maintenance, battery life



and reliability of electric and hybrid electric vehicles. Battery Management Sensors are small electronic sensors that, when attached to groups of batteries or fuel cells, can improve the usable range and life of the battery pack or fuel cell stack by measuring its condition and improving control.

SCAT (Southern Coalition for Advanced Transportation) revealed the results of a study it commissioned, indicating that southern states are a promising location for advanced transportation markets and manufacturing. SCAT President and CEO John Wilson also described educational efforts it supports such as the 1998 EV International Challenge taking place in conjunction with NAEVI.

NAEVI 98: North American EV & Infrastructure Conference and Exposition; December 3-4, 1998; Phoenix, Arizona. © Copyright 1997 EVAA, Inc. All rights reserved.

Basic Information News Releases Media Day

Conference Information -- Highlights

Ask the Experts



- Opening General Session
- Concurrent Sessions
- Networking
- "Ask the Experts"

Following the NAEVI 98 closing reception luncheon, a series of questions were posed to "experts" in the electric vehicle industry. The questions were submitted by NAEVI attendees and directed toward a particular person, company, or group. New to the NAEVI agenda, the "Ask the Experts" Closing Session received overwhelmingly positive reviews. A few of the questions and excerpts of the responses follow:

Q: (To Mike Clement, DaimlerChrysler) Will your merger with Daimler slow your EV/HEV program in favor of more emphasis on fuel cells, or will the MOA requirement mean the current U.S. program continues? Will Daimler consider the EPIC van for central Europe city use?

A: We don't have plans to export the EPIC. The U.S. team was ahead of the Germany team, which, to my knowledge hadn't sold any EVs. Whether it's fuel cell, battery EVs, or hybrid, they all use electric technology. The lead on fuel cells will be in Germany. My feeling is both programs will be accelerated, which is good news for the industry.

Q: (To Ken Dircks, Ballard Power Systems) What source of hydrogen does Ballard prefer for its fuel cells: pure hydrogen stored as a gas or solid, hydrogen from methanol, or hydrogen from gasoline?

A: Ballard is a fuel cell stack and system company. We do not make the fuel decision — the manufacturers do. We have a system for all three fuel types. We're fuel neutral.

Q: (To all automakers) How will the new CARB rules affect EV development?

A: (Mark Amstock, Toyota) Even with the addition of natural gas, hybrids and fuel cells, 4 percent must still be battery electrics. That hovers around 8,000 units a year. The challenge is still there to produce battery electric vehicles, and the incentives are encouraging us to keep production going.

Q: (To Chris Reilly, Lockheed Martin) It seems unusual for an aircraft company to be involved in hybrid vehicle manufacturing. Will this become another core business for Lockheed Martin?

A: It will be a while before we can call EV technology "core." We've been able to do what we've done because our management believes there are real markets out there. We continue to lose money on these programs, but we believe that will turn around.

Q: (To Frank Pereira, GM) You mentioned yesterday that EV1 customers love their cars. Will your 1999 advertising campaign be more informative about the ease of use, low operating cost and advantages...?

A: We've done lots of work looking at how to reach early adopters. Our advertising has been quite controversial, but we've had a successful program. We know who our customers are and how to reach them. We hope our controversial program continues to be controversial.

NAEVI 98: North American EV & Infrastructure Conference and Exposition; December 3-4, 1998; Phoenix, Arizona. © Copyright 1997 EVAA, Inc. All rights reserved.

« Basic Information Agenda Program »

ZEV

THE CLEAN CAR ADVOCATE

VOLUME 3, NUMBER 1 JUNE 1999

Gearing up for More ARB Hearings in 2000

Historically, the auto industry has opposed regulations. It will likely happen again in coming months as the ARB gears up for the 2000 Biennial Review.

◆

Since the California Air Resources Board (ARB) voted in 1996 to revise the original Zero-Emission Vehicle (ZEV) mandate, which called for 2 percent ZEVs in 1998 and 10 percent ZEVs in 2003, major auto makers have offered for sale or lease a small number of electric vehicles in limited markets. These demonstration programs are part of the auto makers' Memoranda of Agreement with ARB. Auto makers also have advanced hybrid and fuel cell technologies. Two hybrid vehicles should be available within a year, while DaimlerChrysler has announced that its fuel cell vehicle should be commercially available in 2004.

In November 1998, the ARB further revised the California Low-Emission Vehicle regulation, of which the ZEV mandate is a part, in an effort to build in flexibility for auto makers and in recognition that the industry has made progress developing other alternative fuel technologies.

The ARB reduced from 10 percent to 4 percent the annual new vehicle production required to be ZEVs beginning in 2003. Four percent of new vehicles sold in California equates to more than 40,000 ZEVs. Battery electric vehicles or stored hydrogen fuel cell vehicles are the only technologies that currently qualify as ZEVs, and only battery-electric vehicles are available today. Of the remaining 6 percent, auto makers have a choice: they can make and market pure ZEVs or they can produce a much larger number of certain advanced technology vehicles, such as hybrids, under a system where these vehicles may receive partial credit toward their ZEV requirements. Hybrids that can travel in zero-emission mode will receive graduated credits, for example, and auto makers that introduce advanced battery EVs early, or EVs capable of accepting fast-charging technology, receive multiple credits toward their ZEV requirement.

"This plan gives auto makers a way to ramp up to high-volume production in 2003, and get credit for doing so. For this reason, PCL Foundation supported the ARB's thoughtful revision," explains Executive Director Jerry Meral.

Known as LEV-II, the revision also tightened emission and exhaust standards for internal combustion cars. The most controversial part of the revision, which gained most of the media attention, was the requirement that light trucks and medium-duty vehicles, such as the popular and ubiquitous sport utility vehicles, meet the same emission standards as passenger cars. This requirement will be phased in beginning in 2004. The U.S. EPA has proposed similar rules for the rest of the country, fashioned after California's groundbreaking regulation.

The one major LEV-II amendment that the PCL Foundation, other environmental groups including the Sierra Club, the Union of Concerned Scientists,

Continued on page 2 ➤ ➤ ➤

About ZEVolutions

ZEVolutions is published periodically by the Planning and Conservation League Foundation, a nonprofit organization dedicated to the preservation of California's natural environment. Launched initially in 1995, when the ZEV mandate underwent its first revision, ZEVolutions has been parked to recharge.

Its purpose is to provide activists and interested citizens with information about clean air regulations and technology issues that relate to zero-emission and alternative fuel vehicles to help them become effective and involved in the regulatory process.

This issue reviews the status of regulations and provides a summary of related legislation.

In coming months, ZEVolutions will examine the alternative fuel vehicle market, available vehicles and the various clean car technologies existing today and on the horizon. ◆

ZEVolutions
THE CLEAN CAR ADVOCATE
is published periodically by the
PLANNING AND CONSERVATION LEAGUE FOUNDATION

926 J Street, Suite 612, Sacramento, CA 95814
916-444-8726
pclmail@pcl.org www.pcl.org

Executive Director: Gerald H. Meral, Ph.D.
Editor: Tim McRae tmcrae@pcl.org

More ARB Hearings in 2000

Continued on page 1

CalPIRG, and the Natural Resources Defense Council, and EV industry supporters opposed, provides partial ZEV credit for new gasoline-powered cars that qualify as "Super-Ultra-Low-Emission Vehicles," or SULEVs.

"PCLF strongly opposes the proposal to offer partial ZEV credit to low-emitting gasoline vehicles. These gasoline vehicles would not have the ZEV-like characteristics that should be required to received ZEV credit," said PCLF's Jennifer Jennings, in testimony before the board. Despite our opposition, that provision also passed.

Where does that leave us now?

The ZEV mandate comes up for its Biennial Review in Year 2000. Over the coming year, ARB will likely sponsor a series of workshops to collect information and input from industry experts to help the agency evaluate the mandate's continued feasibility. The workshops likely will examine factors such as battery development, advances in fast-charging for EVs, cost of components and battery production. The status of hybrids and fuel cells will play a substantial role as ARB examines the available and future vehicle and fuel options that will help the state attain health-based air quality standards.

The auto industry's historic opposition to regulations will likely occur again, as well, as the ARB gears up for the 2000 Biennial Review.

As we approach the review process, one substantially different political factor has come into play. Gov. Gray Davis, the first Democratic governor in 16 years, supports electric and alternative fuel vehicles; during his campaign, he stated his support for the ZEV mandate, within technological and economic reason. The PCL Foundation is hopeful that the governor will stay this course, and applauds his appointment of Alan Lloyd as chairman of the ARB (see story page 3). PCLF applauds the ARB for its regulatory decisions that continue to push for advanced technology vehicles of all kinds. ◆

Examples of Partial ZEV Allowance Calculations

Technology	Baseline allowance	Zero-emission VMT[1] allowance	Low fuel-cycle allowance	Partial ZEV allowance[2]
Gasoline SULEV[3]	0.2	0.0	0	**0.2**
Hybrid gasoline SULEV with no AER[4], equipped with advanced batteries, electric powertrain	0.2	0.1	0	**0.3**
CNG[5] SULEV	0.2	0.0	0.2	**0.4**
Gasoline Hybrid SULEV w/ 20-mile AER, off-vehicle recharging	0.2	0.3	0.1	**0.6**
On-board methanol reformer Fuel Cell (FC[6]) vehicle	0.2	0.3[7]	0.2[8]	**0.7**
Hybrid SULEV with NiMH[9] battery (60 whr/kg[10]) and 100-mile range.	0.2	0.6	0.2	**1.0**
Onboard hydrogen FC vehicle w/ off-board partial oxidation reforming of hydrogen using fuel with low fuel-cycle emissions.	0.2	0.6	0.2	**1.0**

Source: California Air Resources Board LEV-II Staff Proposal, presented to and approved by the board, November 1998. The numbers represent the partial credit each vehicle technology may receive toward the ZEV requirement. For example, a manufacturer of the first technology listed (gasoline SULEV), would receive 0.2 credit toward the ZEV requirement for each vehicle it sells. Thus a manufacturer could sell five SULEVs and receive credit for the sale of one ZEV.

[1] VMT = Vehicle Miles Traveled [2] Partial ZEV allowance = Baseline allowance + Zero-emission VMT allowance + Low fuel-cycle allowance [3] SULEV = Super-Ultra-Low-Emission Vehicle [4] AER = All Electric Range [5] CNG = Compressed Natural Gas [6] FC = Fuel Cell [7] Assumes on-board methanol reformer produces virtually no NOx (oxides of nitrogen, a precursor to smog) emissions [8] Assumes methanol has very low fuel-cycle emissions [9] NiMH = Nickel-Metal Hydride [10] whr/kg = watt-hours per kilogram, a measure of a battery's specific energy, an indicator of range

Alan Lloyd Appointed Chairman of ARB



The PCL Foundation applauds Gov. Gray Davis' appointment of Alan C. Lloyd, Ph.D. as chairman of the California Air Resources Board. As chairman, Dr. Lloyd has significant decision-making power; he is well equipped to lead the state's air quality regulatory agency.

Dr. Lloyd, a widely recognized alternative fuels expert, has said that CARB must commit itself and California to a transition to zero and near-zero emission technology across the board.

Environmentalists welcome his enthusiasm. "For the first time, we have a chair who understands the technical opportunities to help chart the path to a clean transportation future," said PCLF Executive Director Jerry Meral. "We have an opportunity to change the way the state does business, and to recognize that air pollution is not acceptable for business, public health or the environment."

Current Air Resources Board Members: Joseph C. Calhoun, P.E., Automotive Engineering Member; Mark J. DeSaulnier, Supervisor, Contra Costa County Bay Area AQMD Member; Lynne T. Edgerton, Law Member; C. Hugh Friedman, Public Member; William F. Friedman, M.D., Physician and Surgeon Member; Barbara Patrick, Supervisor, Kern County, San Joaquin Valley Unified APCD Member; Sally Rakow, Public Member; Mrs. Barbara Riordan, Public Member, Mojave Desert AQMD.

Other District Members: Ron Roberts, Supervisor, San Diego County, San Diego APCD Member; Vacant, South Coast AQMD Member.

Contact: Pat Hutchens, Clerk of the Board, P.O. Box 2815, Sacramento, CA 95812, (916) 322-5594. ◆

ZEV Bills Pending in California Legislature

Several pieces of legislation pending in the California Legislature involve ZEVs. As ZEVolutions goes to press, we've made every effort to present the most current status of the bills listed below. Because the legislative process changes quickly from day to day, however, we recommend readers visit the PCL website to obtain the most up-to-date status on these important bills. Point your browser to www.pcl.org.

AB 71: Sponsored by Assembly Member Jim Cunneen (R-Cupertino), AB 71 would allow "inherently low-emission vehicles," (ILEVs) to use carpool lanes regardless of occupancy. The bill also would create a special license plate for qualifying vehicles so law enforcement can recognize them. ILEV is a fuel-neutral federal designation for vehicles that meet certain low-emission (LEV) and ultra-low-emission (ULEV) standards and have no hydrocarbon evaporative emissions. Currently, only EVs and natural gas vehicles qualify as ILEVs. This represents a powerful non-monetary incentive to encourage the development and commercialization of EVs and extremely clean vehicles in California.

Status: Senate Transportation Committee.

AB 1571: Sponsored by Assembly Member Antonio Villaraigosa (D-Los Angeles) and Senator Jim Brulte (R-Cucamonga), AB 1571 creates the Carl Moyer Memorial Air Quality Standards Attainment Program, administered by the California Air Resources Board. The program would authorize the ARB to make available grants to purchase and retrofit low-emission, heavy-duty engines such as grounds maintenance, airport ground support and similar equipment and to develop infrastructure.

Status: Assembly Appropriations Committee. Suspense File.

SB 280: Sponsored by Senator Debra Bowen (D-Marina del Rey), and known as the "Green Buildings" bill, the measure requires the use of environmentally sound building materials where feasible, and applies energy efficiency standards in new construction or renovation of all publicly funded buildings and schools. It includes accommodating future installation of EV recharging systems and designated parking for alternative fuel vehicles.

Status: Assembly Consumer Protection, Government Efficiency and Economic Development Committee.

AB 38/SB 98: Sponsored by Assembly Member Carl Washington (D-Paramount) and Senator Richard Alarcon (D-San Fernando Valley), these companion bills extend funding authorization for clean fuels and technology advancement programs in the South Coast Air Quality Management District through 2004. The current funding authorization expires in August. The money comes from a $1 surcharge on vehicle registrations in the district.

Status: AB 38 in Senate Transportation Committee. SB 98 in Assembly Appropriations Committee.

SB 448: Sponsored by Senator Deborah Ortiz (D-Sacramento), this measure exempts certain experimental diesel fuels, including the fuel known as A55, from the existing diesel fuel tax for the first two years of their use and experimentation in the state. These fuels show promise because they are thought to significantly reduce NOx and PM emissions.

Status: Senate Appropriations Committee. ◆

Online Info...

Looking for more information about ZEVs? Here's a list of government agencies and business, individual or public interest organization web sites to get you started. In the next issue of ZEVolutions, we'll focus on manufacturers and technology resources. Happy surfing!

California Energy Commission: State government agency: www.energy.ca.gov/

California Air Resources Board: State government agency: www.arb.ca.gov/homepage.htm

California Fuel Cell Partnership: Public/private entity formed to demonstrate fuel cell EVs in California between 2000 and 2003: www.drivingthefuture.org/

California Legislature: Assembly home page and bill tracking site: www.assembly.ca.gov www.assembly.ca.gov/acs/acsframeset2text.htm

California Legislature: Senate home page and bill tracking site: www.senate.ca.gov www.senate.ca.gov/~newsen/legislation/legislation.htp

CalETC: Advocacy organization promoting EVs and electric drive technologies in California: www.caletc.org

Calstart: Advanced transportation business consortium: www.calstart.org/

Dept. of Energy: Hybrid electric vehicle program: www.hev.doe.gov/

EAA: Electric Auto Association, representing do-it-yourself EV enthusiasts and conversions: www.eaaev.org/

EPRI: Collaborative science and technology organization for the energy provider (utility) industry: www.epri.com

EV Information Network: Independent resource for EV enthusiasts: www.radix.net/~futurev/welcome.html

EV World: Online EV trade publication: www.evworld.com/

EV1 Club: Resource for owners of General Motors' EV1 electric car: http://ev1-club.power.net/

EVAA: Electric Vehicle Association of the Americas; national trade association for EV industry: www.evaa.org/

EVRN: Electric Vehicle Research Network, independent general information source, a project of EPRI: www.epri.com/csg/trans/evrn

Fleets & Fuels: Web site of alternative fuel biweekly trade newsletter: www.augustpacific.com

Global EAA and EV News: Global Electric Auto Association, trade publication serving industry and independent EV conversion enthusiasts: www.ariz.com/gleaa/

ITS UC Davis: Institute of Transportation Studies, UC Davis: www.engr.ucdavis.edu/~its/

Los Angeles EAA: Listing of EV links - comprehensive list of everything EV: www.geocities.com/MotorCity/Downs/4214/links.html

NESEA: Northeast Sustainable Energy Association: www.nesea.org/

Planning and Conservation League and PCL Foundation: Nonprofit environmental organization addressing California environmental issues, and publisher of ZEVolutions: www.pcl.org

Union of Concerned Scientists (UCS): Nonprofit scientific research organization: www.ucsusa.org/transportation/index.html

UCS Consumer Center: Advanced technology vehicle purchasing options: www.ucsusa.org/less/index.html ◆

PLANNING AND CONSERVATION LEAGUE
FOUNDATION

926 J Street, Suite 612
Sacramento, California
95814

NON PROFIT ORG.
US POSTAGE
PAID
PERMIT #2066
SACRAMENTO, CA

Recycled paper/printed in soy ink

Bibliography

BIBLIOGRAPHY
Sources of More Information

Vehicles Manufacturers and Dealerships

General Motors
100 Saturn Parkway, Mail Drop S24, Spring Hill, TN 37174
www:http//www.saturncars.com/EV1/

Toyota Motor Sales, USA, Inc.
19001 South Western Avenue, Torrance, CA 90509
www:http://www.toyota.com/inside toyota/rav4ev/

Ford Motor Company
Alternative Fuels Vehicle Center
2044 Loreto Place
Placentia, CA 92870
www:http://www.ford.com/electricvehicle

Sales Department
Solectria Corporation
33 Industrial Way, Wilmington, MA 01887
www:solectria.com

It's Electric! Inc.
540 Irwin Street, San Rafael, CA 94901
www.greenkeys.com

Daimler - Chrysler Corp.
27777 Franklin Road, 19th Floor, Southfield, MI 48034
www.chrysler.com

Associations and Organizations

CalETC - California Electric Transportation Coalition, Sacramento, CA

CALSTART Cooperatives, Alameda, CA
www.calstart.org
www.cleanfleets.com

Current EVents
A publication of the Electric Auto Association, Alameda, CA
www.eaaev.org

Nucleus
The Magazine of the Union of Concerned Scientists, Cambridge, MA
www.ucsusa.org

BIBLIOGRAPHY
Sources of More Information

Electric Power Research Institute (EPRI), Palo Alto, CA
www.epri.com
(A research consortium created by electric utilities in 1973)

Electric Vehicle Association of the Americas (EVAA)
www.evaa.org
NAEVI 98 Conference

Government Agencies

U.S. Dept. of Energy - Fleet Buyers Guide
www.fleets.doe.gov

U.S. Dept. of Energy publication Alternative Fuel News
www.ccities.doe.gov
www.afdc.doe.gov

California Energy Commission
Emerging Renewables Buydown Program
Sacramento, CA 95814
www.energy.ca.gov/renewables

California Air Resources Board
www.arb.ca.gov

Publications

ZEVolutions
A publication of the Planning & Conservation League, Sacramento, CA
www.pcl.org

Electrifying Times, Bend, OR
www.teleport.com/~etimes

"A Study of Air Quality Conditions, Including Emissions Inventory, Ozone Formation, PM10 Generation and Mitigation Measures, for Mendocino County, California" prepared for the County of Mendocino Air Quality Management District by Sonoma Technologies, Inc., January 1999