ENVVEST
Semiannual Progress Report

31 October 2001

Prepared By:

U.S. Air Force
30 CES/CEV
806 13th Street, Suite 116
Vandenberg AFB, California 93437-5242

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

1.0 INTRODUCTION

On 16 March 1995, President Clinton and Vice President Gore announced an initiative titled *Reinventing Environmental Regulations,* which proposed 10 principles on regulatory reform and directed the U.S. Environmental Protection Agency (U.S. EPA) to implement 25 high priority actions. One of these was aimed at achieving regulatory reform within the Department of Defense (DoD) through a program called ENVVEST (Environmental Investment).

On 2 November 1995, the DoD and U.S. EPA signed a Memorandum of Agreement (MOA) on Regulatory Reinvention Pilot Projects, which formally established the ENVVEST program. The MOA established a framework for developing pilot programs at three to five selected DoD facilities. Vandenberg Air Force Base (AFB) has been selected as the prototype facility to pilot the ENVVEST program and implement common-sense and cost-effective environmental protection. The ENVVEST program emphasizes regulatory compliance through pollution prevention and provides an alternative strategy to prescriptive command-and-control regulatory requirements in the form of a performance-based environmental management system.

2.0 ENVVEST INITIATIVE

2.1 FPA AGREEMENT

On 3 November 1997, Vandenberg AFB, U.S. EPA, and the Santa Barbara County Air Pollution Control District (SBCAPCD) signed the first ENVVEST Final Project Agreement (FPA) within the DoD; since then, only one other such agreement has been signed. The FPA states the intentions of the aforementioned parties to carry out a pilot program pursuant to the 1995 MOA by testing innovative approaches to environmental protection. Under the FPA, the Vandenberg AFB Air Quality Project XL/ENVVEST Initiative is aimed at improving air quality beyond that achieved through federal, state, and local permit programs. This multi-year implementation strategy is aimed at achieving sustainable long-term projects meeting criteria specified in the FPA.

2.2 ENVVEST PROGRAM MILESTONES

Five milestones were established that provide the framework for monitoring progress of the program. The milestone requirements were specified in the FPA and incorporated into SBCAPCD Rules and Regulations, *Rule 1301 Plan*, thus making the milestones and the strategy to achieve each milestone enforceable. As stated in *Rule 1301*, a stationary source is defined as any structure, facility, or installation which emits or may emit any regulated pollutant or any pollutant listed pursuant to the Clean Air Act (CAA). In the case of ENVVEST, the rule defines the requirements of the Vandenberg AFB ENVVEST program in the Rule.

The five milestones are:

- Milestone 1: Completion of the initial assessment and cost feasibility study within 30 days of execution of the FPA;
- Milestone 2: Retrofitting 30 percent of candidate boilers identified in Milestone 1 by 30 April 1999;
- Milestone 3: Emission reductions of two tons per year by 30 April 2000;

- Milestone 4: Retrofitting 70 percent of candidate boilers identified in Milestone 1 by 30 April 2001; and

- Milestone 5: Reduction in annual emissions of ozone precursors by 10 tons or more by 30 November 2002.

2.2.1 Milestone Summary

Achieving Milestones 1 through 5 requires emission reductions from both mobile and stationary sources beyond traditional technologies and beyond agreed-upon measures identified in the FPA. Both public and private agreements were made to foster partnering and technology advancement in support of FPA goals and objectives.

To date, Vandenberg AFB has met Milestones 1 through 4. In order to meet Milestone 5, Vandenberg AFB applied 12 tons of purchased and registered emission reduction credits (ERCs). The ERCs were purchased from Grefco Minerals, Inc., located in Santa Barbara County and within the same north county air basin. As a result, the purchased ERCs are permanently removed from Santa Barbara County's emission bank, given up for the benefit of clean air, and credited to the ENVVEST program. The application of purchased and ENVVEST-achieved ERCs provides a net air quality benefit of 17.8 tons per year.[1] Approximately 14.2 tons per year are considered surplus.[2]

Even though all milestones have been met, Vandenberg AFB has obligated the balance of the ENVVEST funds (approximately $1,000,000) to implement a Mobile Source Reduction Program. This revised approach to the program was approved by SBCAPCD in November 1999. As a result, Vandenberg AFB implemented a series of Mobile Source Reduction initiatives.

2.2.2 Previous Program Progress

In addition to the milestones, the FPA identified the need for a program plan. Source selection criteria, baseline emission protocols, technology options, emission measurement protocols, and emission reduction reporting protocols were to be included in the plan. An initial plan was submitted to SBCAPCD on 26 November 1997. The Plan[3] was partially approved[4] with the understanding that it would be revised and resubmitted to demonstrate compliance with Milestone 5. The document was completed on 31 October 2001, and will demonstrate that the conditions of all milestones were met.

2.2.3 Program Milestone Progress

The milestone completion date, SBCAPCD approval date, and program accomplishments are summarized in Table 1.

---

[1] Details of 16.2 tons of emission reductions are identified in the ENVVEST Semiannual Progress Report, Section 3, Stationary Source Emission Reduction Technical Approach, Apr. 28, 2000. An additional 1.6 tons of emission reductions are attributed to implementation of the Electric Vehicle Pilot Program.

[2] Surplus emission reductions consist of the 12 tons of purchased ERCs and approximately 2.2 tons from the Boiler Retrofit and Replacement Program.

[3] Memorandum from Scott W. Westfall, Lt Col, Commander Environmental Flight, Vandenberg AFB, "ENVVEST/Rule 1301 Emission Reduction Plan," Nov. 26, 1997.

[4] Letter from Douglas W. Allard, Air Pollution Control Officer, SBCAPCD, "ENVVEST Program Emission Reduction Proposals for Boilers and Lawnmowers," Feb. 20, 1998.

2.3 ENVVEST PROGRAM TRANSITION

Although the ENVVEST program milestones were met with a surplus of funds, Vandenberg AFB continued the ENVVEST efforts by reallocating the remaining funds to an electric vehicle (EV) program. The concluding portion of this document summarizes EV program developments and highlights the importance of the programs to the overall technology development, air quality benefit, and economic importance to continuing the development of these types of programs.

2.3.1 Electric Vehicle Program

In 1999, Vandenberg AFB, with Tetra Tech's technical assistance, initiated a mobile source emissions reduction program in addition to the existing stationary source emission reduction program to further reduce air emissions. A transportation demand management study was conducted in the beginning of the program to fully understand commute and transportation characteristics and demand, as well as to access the program potential. The study results indicate that a high percentage of base commuters are alternate fuel vehicle (AFV) program candidates.

Based on this study, Vandenberg AFB initiated a pilot project to evaluate the feasibility of an AFV program on base.

Vandenberg AFB worked to devise an innovative approach to the AFV program by establishing key partnerships, identifying funding sources and mechanisms, and obtaining vendor's technical support and services to assure the success and sustainability of the project.

Recognizing that the EVs and other AFVs would be used more efficiently if they were shared with other users and organizations, Vandenberg AFB set out to develop a Shared Use Vehicle Management System (SUVMS).

Table 1
Summary of Program Milestone Progress

Milestone	Compliance Date	Completion Date	Approval Date	Accomplishments
1. Initial assessment and cost feasibility study	2 Dec 97	26 Nov 97	20 Feb 98	Boiler Emission Reduction Implementation and Cost Feasibility (ERI&CF) Study[5] Lawn Mower ERI&CF Study[6]
2. Retrofit or replace 30 percent of ENVVEST candidate boilers	30 Apr 99	May 1998	Not applicable	4 of the 10 candidate boiler projects retrofitted or replaced with low NOX burner technology
3. Achieve 2 ton per year emission reduction	30 Apr 00	28 Apr 00	Not applicable	Vandenberg AFB submitted the first annual ENVVEST Summary Report[7] 2.29 tons of real, quantifiable, surplus and enforceable emission reductions
4. Retrofit or replace 70 percent of ENVVEST candidate boilers	30 Apr 01	May 1999	Not applicable	10 candidate boiler projects retrofitted or replaced with low NO_x burner technology
5. Achieve 10 ton per year emission reduction	30 Nov 02	16 Sep 99	Awaiting SBCAPCD & U.S. EPA approval of Final Plan	Purchased 12 tons of registered NO_x emission reduction credits, implemented EV Pilot Program, and developed Shared Use Vehicle Management System.

Notes: EV - Electric vehicle
NO_x – Oxides of nitrogen
SBCAPCD – Santa Barbara County Air Pollution Control District
U.S. EPA – U.S. Environmental Protection Agency

[5] Tetra Tech, Inc., Final ENVVEST Boiler ERI & CF Study, November 25, 1997.
[6] Tetra Tech, Inc., Final Lawn Mower ERI & CF Study, November 25, 1997.
[7] Tetra Tech, Inc., ENVVEST Summary Report, April 28, 2000.

The goal of the SUVMS was to provide Vandenberg AFB with overall cost savings through resource sharing of vehicles to maximize use of AFVs. Additionally, the system automates vehicle reservation, billing, and maintenance scheduling. The benefits include reduction of fleet size, use of an environmentally friendly mode of transportation, and facilitating the California Air Resources Board's low emission vehicle II (LEVII) goals and objectives.

2.3.2 Shared Use Vehicle Management System

Procedures for using shared vehicles consist simply of:

1. Reserving a vehicle though a web page-based system;
2. Entering the reservation time and travel itinerary; and
3. Returning the vehicle at the end of the use period.

The system automatically matches the user needs with an appropriate AFV and assigns the selected vehicle to the user. The user then swipes a contactless card and enters a personal identification number (PIN) to enable vehicle operation. Data collected during vehicle use are stored in a central data system and used for automated accounting, billing, and fleet maintenance services.

Inherent benefits of the SUVMS are cost-effective fleet management, reduced emissions through the use of AFVs, and reduced fuel costs. In its current application at Vandenberg AFB, it is the Air Force that receives the benefits of SUVMS technology, however, the same benefits could also be made available to companies and public sector organizations that use a fleet of vehicles.

The ultimate goal in demonstrating SUVMS technology lies in the ability to cost-effectively automate vehicle checkout, manage fleet maintenance, increase AFV use and efficiency, and reduce mobile source emissions. AFVs are an integral part of energy and environmental management plans for both private and public organizations managing fuel and energy use, air pollution emissions, and fleet management costs. By installing the SUVMS technology, business growth is possible through realized emission credits, and cost savings are gained from reduced fuel use and optimized fleet management. The benefits of this technology make it an integral element of an air quality and energy management plan.

2.3.3 Technology Overview

The system consists of three primary components: an on-board vehicle system, vehicle registration, and a management center. The on-board vehicle system consists of radio frequency (RF) communication equipment, card reader, vehicle systems interface, user display, and a microcontroller. Configuration of the vehicle systems interface is dependent upon vehicle components and vehicle types.

The fleet management server provides the interface for maintaining several databases and properly allocating vehicles to users. The vehicle management system maintains the real-time and historical database of vehicle, user, and operational data. A graphical vehicle location-mapping interface provides real-time vehicle status (e.g., location, state-of-charge).

Several system modules operate in conjunction with the real-time databases. An accounting module controls automated debits for vehicle use. Billing summaries can be viewed through the accounting

module by system staff. Users who wish to coordinate a reservation will interface with the registration module running on the management server through an internet application (web page). A similar process occurs for on-demand vehicle acquisition. A user wishing to obtain a vehicle approaches a vehicle access terminal, swipes their contactless card, and enters pertinent information on the touchscreen display. The information is then transmitted to the registration module, which interfaces with the vehicle management system to assign a vehicle to the user.

For a user to acquire a vehicle, the system must transmit user data to the vehicle where it can be processed by the on-board vehicle system. The data transmitted to the vehicle will allow the user to access the vehicle and enable the ignition. The transmission of data occurs by an established communications channel (e.g., RF transceiver and/or cellular based). The vehicle electronic unit receives and processes the data. The user swipes their contactless card to gain access to the vehicle/user interface. Once the user swipes the card, they enter an identification number on the vehicle/user interface within the vehicle. This enables the vehicle ignition. Throughout the trip, the on-board vehicle system monitors vehicle parameters such as duration, length, speed, and battery state of charge. When RF communications are used, the processor within the vehicle access terminal serves as the conduit for sending/receiving data between vehicles and the fleet management center.

The vehicle is returned at the end of the use period. Data collected during vehicle use are stored in a central data system and used for automated accounting, billing, and fleet maintenance services. The user's organization is billed based on the time, distance, and fuel used during the reservation. Additionally, the maintenance needs for each vehicle are managed through a network interface that notifies the maintenance center if the vehicle needs servicing.

2.3.4 Technology Installation

The technology installation was accomplished in four tasks as follows:

- Program Infrastructure Design;
- Vehicle Management System (VMS) Development;
- Equipment and Infrastructure Installation; and
- SUVMS Assessment.

Each task is described in more detail in the following sections.

2.4 PROGRAM INFRASTRUCTURE DESIGN

The infrastructure design for the program was accomplished in two subtasks. A collaborative effort among the partners was made to determine the infrastructure and design requirements, and develop infrastructure and equipment engineering drawings (initial design drawings). A conceptual rendering for the SUVMS system was created and used as a pattern to initiate discussion on the system.

2.4.1 Identify Infrastructure and Design Requirements

Location, vehicle parking layout, SUVMS equipment, and structural and utility requirements were identified in this subtask. Infrastructure specifications included kiosk equipment and enclosure, power

supply and distribution equipment and enclosure, and charging station equipment and placement. The base facility excellence standards for architectural design were incorporated into the preliminary design.

2.4.2 Develop Infrastructure and Equipment Engineering Drawings

With Vandenberg AFB as the technical lead, infrastructure and equipment engineering drawings were developed. The integration of equipment and software was identified and specifications were incorporated in the overall design of the SUVMS program. The following preliminary design elements were developed based on performance and cost data:

- Parking island and charging station layout;
- Electrical equipment enclosure (north end of parking island);
- Communication equipment enclosure (south end of parking island); and
- VMS design and equipment layout.

The designs for SUVMS program were finalized prior to the start of construction and were incorporated into engineering design specifications and requirements.

2.4.3 VMS Development

The VMS design requirements were finalized by evaluating user needs and available technology to develop and enhance this type of system.

The VMS development was accomplished through seven subtasks, each of which is discussed below.

- Vehicle communication development;
- Vehicle access terminal development;
- Vehicle and system interface development;
- Fleet manager module and server development;
- Vehicle reservation module development;
- Vehicle maintenance module development;
- Accounting system module development; and
- Durability testing.

2.4.4 Vehicle Communication Development

Each vehicle is equipped with an input/output unit that can communicate with the system to link the management system and perform sensing and monitoring of vehicle status. The modifications will vary for each vehicle and will only be completed upon the approval from Ford Motor Company

representatives. The following equipment was installed to integrate vehicle operation and communication with the SUVMS:

- Door locks;
- Battery state-of-charge / fuel level;
- Odometer;
- Card reader;
- Microcontroller power and ground; and
- Ignition circuit.

2.4.5 Vehicle Access Terminal Design and System Integration

The vehicle access terminal is located at the parking island. The system uses an electronic vehicle access terminal (i.e., kiosk) to gain access to vehicle information. An example of the vehicle access terminal design and system integration is shown in Figure 1. To access vehicle information, the user will provide identification (e.g., using a smartcard) and enter trip information. The system will respond by providing the best vehicle (in terms of fuel and type) available. This component of the system is equipped with "on-demand reservation," and allows the user to reserve a vehicle at the station site. By automating the reservation service and allowing the registration to occur simultaneously with the vehicle acquisition, vehicle use will be optimized.

The kiosk is designed to interface with the server and transmit pertinent information to the designated vehicle using an RF data link. The kiosk is located at the south end of the SUVMS parking island.

2.4.6 Vehicle and Systems Interface Development

An on-board communication system, consisting of multiple components serving various functions, was developed. The system consists of radio frequency communication equipment, card reader, vehicle systems interface, user display, and a microcontroller. The system interface depends greatly on the vehicle types used in the system. The four vehicle types that have been selected for this system are:

- Ford Th!nk City electric vehicle;
- Ford Crown Victoria Compressed Natural Gas sedan;
- Ford Econoline Compressed Natural Gas van; and
- Ford Ranger electric truck.

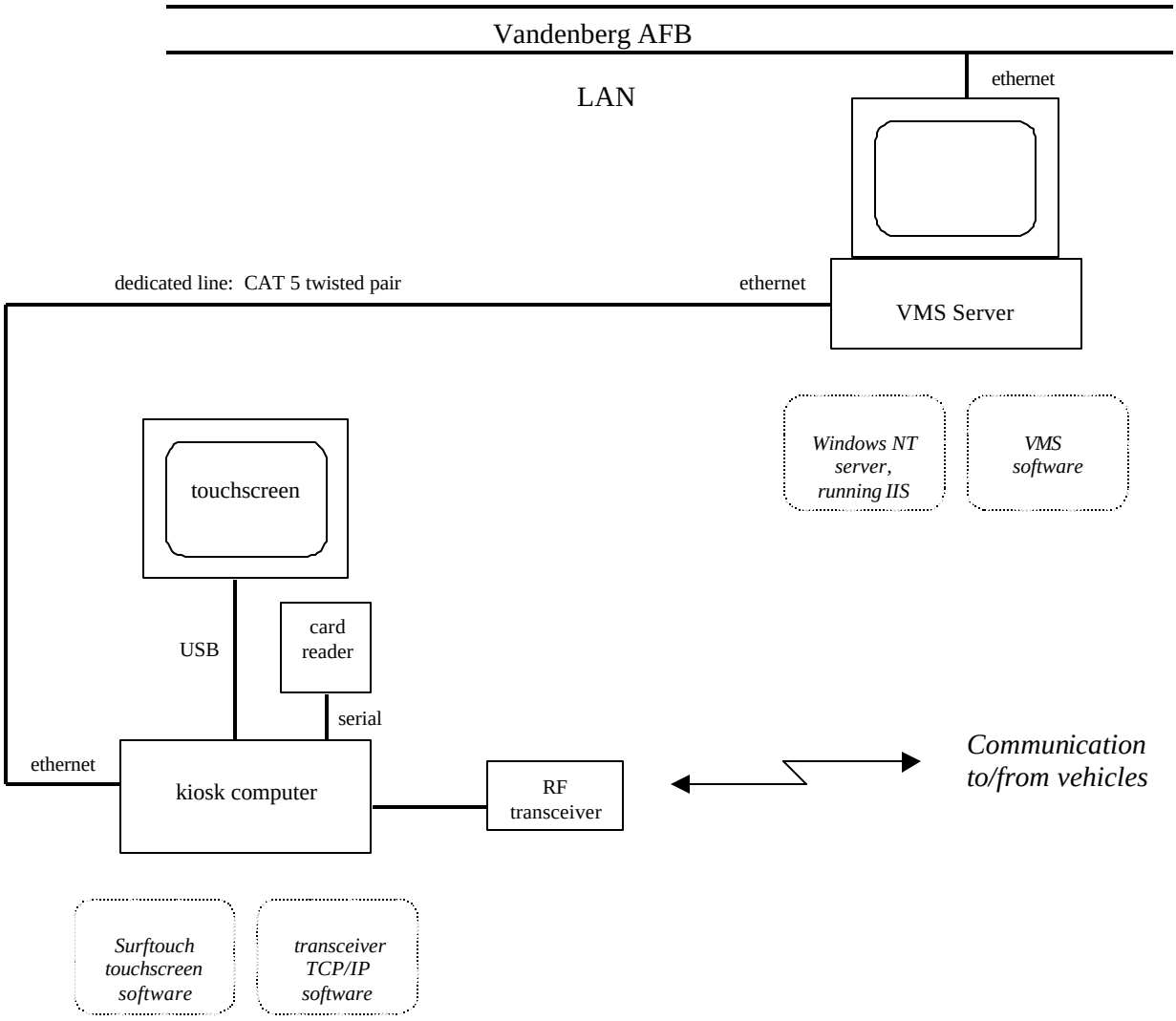

Figure 1 Vehicle Access and Systems Integration

2.4.7 Fleet Management Server Development

The fleet management server links the system components with communication hardware and software. When a user initially requests a vehicle through a reservation, the management server determines the availability and reserves a vehicle. Once a user arrives at a vehicle access terminal, the management server will interface with the reservation process to ensure proper vehicle allocation. Trip information will be displayed at the start of each use cycle and will include vehicle location and state-of-charge.

2.4.8 Vehicle Reservation Module Development

The vehicle reservation module facilitates the vehicle check-out process and records use and trip information to the vehicle management system. This system allows vehicle reservations to be made in

advance or on demand. The system at Vandenberg AFB uses the base local area network (LAN) to access the intranet-based web reservation system to record user and trip destination information during the vehicle reservation process. The process information will be recorded and sent to the fleet management server, allowing the system to assign the proper vehicle type for the requested travel.

2.4.9 Vehicle Maintenance Module Development

Based on the planned fleet mix and vehicle types, a maintenance module was developed and incorporated into the system. This module is capable of electronically notifying the base Ford Warranty Service Center (Vehicle Maintenance Flight [30 TRNS/LGTM]) when a vehicle is due for routine servicing based on accumulated mileage or vehicle operational failure. Maintenance account information will be provided by the service center and entered into the system when services are rendered. The maintenance module provides the service center with access to the vehicle when maintenance is due and deactivates user reservations until maintenance services are complete. Additionally, the system provides maintenance history reports that can be used to evaluate each vehicle's performance.

2.4.10 Accounting System Module Development

The VMS provides participating organizations billing for vehicle use through an automated accounting system. During the reservation process, the user provides a unique identification number (during log-on to the LAN system or by swipe card during on-demand reservation). By doing so, the system automatically enters the user's account information (user name, location, organization, and billing summary) prior to each trip. The system will look up the vehicle usage logs and determine the debit amounts relating to each trip by the user. The amount billed to the organization is based on usage time and vehicle miles traveled.

2.4.11 Durability Testing

Durability testing was performed to determine the number of usage cycles prior to failure. Testing also included an on-board system evaluation to determine response to temperature and engineering modifications. The performance testing determined usage cycles, temperature, and vibration failure modes and will be modified if failure modes are not acceptable. Acceptable failure modes are based on a minimum expected 3-year use of the system (corresponding to a 3-year vehicle lease period).

2.5 EQUIPMENT AND INFRASTRUCTURE INSTALLATION

The equipment and infrastructure that were installed included:

- Parking island and charging stations;
- Electrical equipment enclosure (north end of parking island);
- Communication equipment enclosure (south end of parking island);
- EV system interface; and
- VMS and equipment.

2.5.1 Parking Island and Charging Stations

As shown in Figure 2, a parking island was constructed to accommodate 30 AFVs at the Western Range operation complex. Dual mounted charging stations were installed to support the 20 EVs. A center sidewalk will provide access to the SUVMS.

Figure 2 SUVMS Parking Island

2.5.2 Electrical Equipment Enclosure

The electrical equipment enclosure was constructed on the north end of the parking island and is shown in Figure 3. The enclosure houses a transformer, electrical panels, and electrical distribution equipment that provide power to the SUVMS and EV charging stations.

Figure 3 SUVMS Electrical Equipment Enclosure

2.5.3 Communication Equipment Enclosure

The communication equipment enclosure was constructed on the south end of the parking island and is shown in Figure 4. The enclosure houses the communication and kiosk equipment to operate the SUVMS.

Figure 4 SUVMS Communications Equipment Enclosure

2.5.4 EV System Interface Equipment

Thirty AFVs were leased by Vandenberg AFB on 30 September 2001 and are scheduled to be retrofitted with communication software and equipment upon delivery in January 2002. The equipment installation and modifications will generally take place in the dashboard area of the vehicle. The software and equipment will interface with the on-board vehicle system and will not compromise the warranty, lease agreement, vehicle integrity, or passenger safety. Diagrams of the hardware for the battery electric and internal combustion engine vehicle are shown in Figures 5 and 6, respectively.

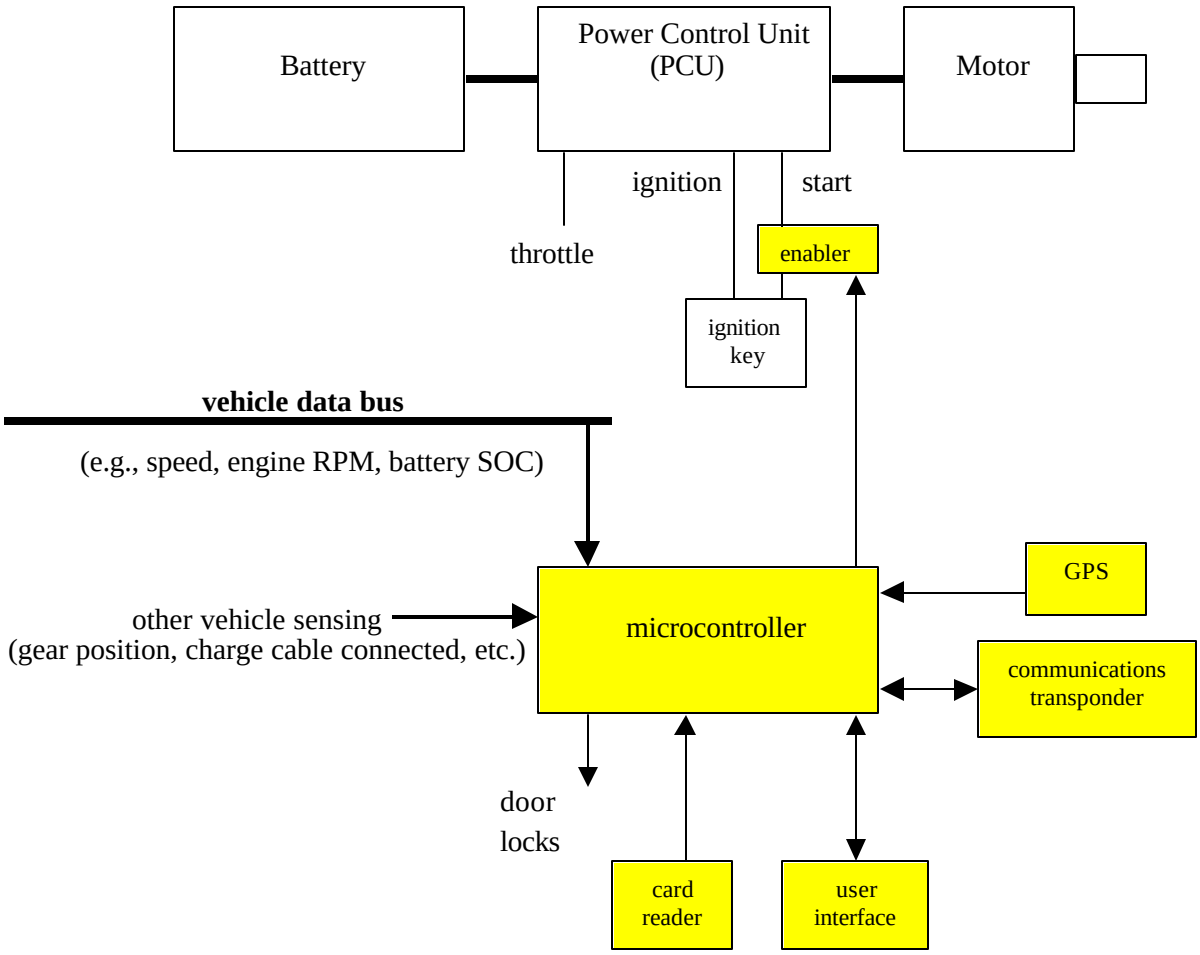

Figure 5 Hardware for Battery Electric Vehicle

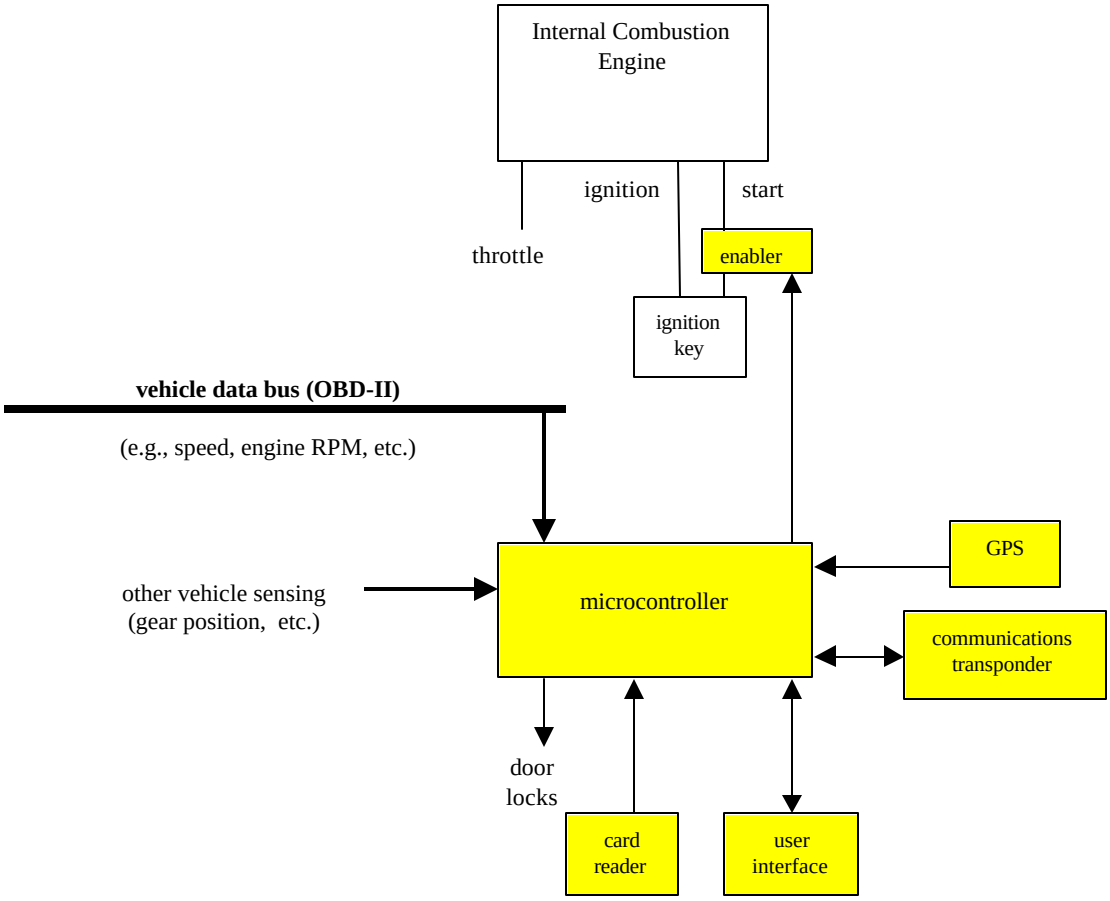

Figure 6 Hardware for Internal Combustion Engine Vehicle

2.5.5 VMS and System Equipment

A fully functional and integrated SUVMS will be installed and will include a central management server, vehicle access terminal, and station-to-vehicle communications. The management center equipment will be set up in Building 11439 that has appropriate power and network connections. The kiosk will be installed in a facility located on the south end of the parking island. A network connection to interface between the SUVMS and the vehicles will be housed in this facility.

2.6 SUVMS ASSESSMENT

Performance and operational data will be collected to evaluate the operation of the SUVMS. Data that will be collected will include:

- User identification;
- Organization;
- Date/time of use;
- Frequency of use;
- Trip length;
- Number of trips/day;
- Comments;
- Maintenance log; and
- Accounting log.

The average use rate will be monitored to determine the number of users needed to optimize the SUVMS fleet.

2.6.1 Program and SUVMS Assessment

Both SUVMS and vehicle user training will be provided to ensure proper vehicle acquisition and use. Training will be performed as user organizations are enrolled into the system.

The evaluation period for the system will be 12 weeks. A set of evaluation criteria will be established so the program's success can be measured. A final report will be prepared to document the program success and will include a cost/benefit analysis to determine the technology transfer potential of the system to government and industry applications.

2.7 PRELIMINARY RESULTS FOR THE SUVMS

The SUVMS application utilizing AFVs under the mobile source reduction program is the final planned project for the Vandenberg AFB ENVVEST program. This technology provided the basis to improve on vehicle management, meet Energy Policy Act of 1992, and support Greening the Government requirements while saving the Air Force money. Vandenberg AFB anticipates cost savings associated with operation and maintenance (O&M) for vehicles in the SUVMS by reducing the overall fleet size; the O&M cost savings for the EV fleet is estimated at over $177,000.

Finally, it is important to note that the ENVVEST Program has provided Vandenberg AFB the opportunity to demonstrate how AFVs can be used in a shared-use setting at a military installation. The lessons learned from the SUVMS will be shared throughout government and private fleet communities and will be showcased as a way of implementing state-of-the art technology at a reduced cost. The results and lessons learned will provide future projects the basic program concept, design and development,

project schedule and ramp-up time, and recommended partnerships and co-funding sources. It is important to note that cost-shared research and co-funding programs will be essential for implementing future AFV programs until the distinction between AFVs and conventional vehicles fades as cars, trucks, and buses adopt characteristics of today's "clean vehicles."

3.0 CONCLUSION

As this juncture of the ENVVEST program comes to a close, the stakeholders of the program believe it provides inherent flexibility to go beyond meeting the intended environmental regulations. ENVVEST provides the legal framework to effectively shift the focus from investing funds to comply with regulatory requirements ("end-of-pipe" approach) to exceeding these requirements through implementing pollution prevention solutions. The estimated Title V program costs, ENVVEST program costs, and overall cost savings to Vandenberg AFB are presented in Table 2. The financial offsets during the past five years are difficult to measure, however, it is estimated that over $1,000,000 was saved. Vandenberg AFB has reduced recordkeeping and reporting, monitoring, and management costs associated with Title V compliance by approximately 30 percent. In return, $2,500,000 was reinvested into this program.

Table 2
Estimated Title V Program Costs, ENVVEST Program Costs, and Overall Cost Savings to Vandenberg AFB

Title V Program Requirement	Cost	Cost Element
Prepare Permit Application	$300,000	Environmental Consultant Cost
Permit & Fee Administration	$160,000	Regulatory Cost Reimbursement
Compliance Monitoring	$100,000	Regulatory Inspection Cost
Total First Year Title V Cost =	**$560,000**	
Permit Administration		
• Permit & Fee Administration	$125,000	Regulatory Cost Reimbursement
• Environmental Contractor Support	$250,000	Consultant Cost
Compliance Monitoring		
• Regulatory Compliance Oversight	$100,000	Regulatory Inspection Cost
• Source Testing	$150,000	Environmental Contractor
• Parametric Monitoring	$125,000	Equipment Cost
Annual Title V O&M Cost =	**$750,000**	
Title V Program Cost =	$3,560,000	Compliance Cost Over Five-Year Period
ENVVEST Program Cost =	$2,500,000	P2 Cost Over Five-Year Period
Vandenberg AFB Cost Savings =	**$1,060,000**	