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VANDENBERG AIR FORCE BASE INTEGRATED RESOURCE ASSESSMENT

VOLUME 2: BASELINE DETAIL

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MASTER

ABSTRACT

The U.S. Air Force Space Command (SPACECOM) has tasked the Pacific Northwest Laboratory (PNL),[a] as the lead laboratory supporting the U.S. Department of Energy (DOE) Federal Energy Management Program (FEMP), to identify, evaluate, and assist in acquiring all cost-effective energy projects at Vandenberg Air Force Base (VAFB). This is a model program PNL is designing for federal customers served by the Pacific Gas and Electric Company (PG&E). The primary goal of the VAFB project is to identify all electric energy efficiency opportunities, and to negotiate with PG&E to acquire those resources through a customized demand-side management (DSM) program for its federal clients. That customized program should have three major characteristics: 1) 100% up-front financing; 2) substantial utility cost-sharing; and 3) utility implementation through energy service companies under contract to the utility. A similar arrangement will be pursued with Southern California Gas for non-electric resource opportunities if that is deemed desirable by the site and if the gas utility seems open to such an approach.

This report documents the assessment of baseline energy use at VAFB located near Lompoc, California. It is a companion report to Volume 1, Executive Summary, and Volume 3, Resource Assessment. This analysis examines the characteristics of electric, natural gas, fuel oil, and propane use for fiscal year 1991. It records energy-use intensities for the facilities at VAFB by building type and energy end use. It also breaks down building energy consumption by fuel type, energy end use, and building type. A more complete energy consumption reconciliation is presented that includes the accounting of all energy use among buildings, utilities, and applicable losses.

(a) Pacific Northwest Laboratory is operated for the U.S. Department of Energy by Battelle Memorial Institute under Contract DE-AC06-76RLO 1830.

SUMMARY

The U.S. Air Force Space Command (SPACECOM) has tasked the Pacific Northwest Laboratory (PNL), as the lead laboratory supporting the U.S. Department of Energy (DOE) Federal Energy Management Program (FEMP), to identify, evaluate, and assist in acquiring all cost-effective energy projects at Vandenberg Air Force Base (VAFB). This is a model program PNL is designing for federal customers served by the Pacific Gas and Electric Company (PG&E). The primary goal of the VAFB project is to identify all electric energy efficiency opportunities, and to negotiate with PG&E to acquire those resources through a customized demand-side management (DSM) program for its federal clients. That customized program should have three major characteristics: 1) 100% up-front financing; 2) substantial utility cost-sharing; and 3) utility implementation through energy service companies under contract to the utility. A similar arrangement will be pursued with Southern California Gas for non-electric resource opportunities if that is deemed desirable by the site and if the gas utility seems open to such an approach.

This report documents the assessment of baseline energy use at one of PG&E's primary federal facilities, the SPACECOM Vandenberg Air Force Base in California. The analysis herein examines the characteristics of electric, natural gas, fuel oil, and propane use for fiscal year 1991. It records energy-use intensities for the facilities at VAFB by building type and energy end use. It also breaks down building energy consumption by fuel type, energy end use, and building type. A more complete energy consumption reconciliation is presented that includes the accounting of all energy use among buildings, utilities, and applicable losses.

Vandenberg Air Force Base is a 98,400-acre (154-square-mile) SPACECOM facility situated along the Pacific coast east of Lompoc, California, and southwest of Santa Maria, California, at 34°N latitude and 120°W longitude. The primary mission of VAFB is to launch and track polar-orbiting space satellites and intercontinental ballistic missiles.

Table S.1 shows a summation of the typical yearly energy consumption and cost for all facilities at VAFB. For each energy type, the yearly total is shown in units appropriate to the energy type and in a common unit as a basis for comparison. The total consumption values represent the typical current yearly usage, from the last complete year of data available during this analysis – 1991. The yearly energy consumption was 1,464,000 MBtu at a cost of $15,794,000.

There are more than 40 Department of Defense (DoD) and non-DoD government organizations located at VAFB, along with more than 60 civilian aerospace contractors. The base population includes between 5,000 and 7,000 full-time residents and a varying number of contractor employees. Contractor employment has been as high as 8,600 people, giving a "total" base population approaching 15,000. Roughly 920 commercial buildings with an area of 8,122,000 ft^2 are

TABLE S.1. Yearly Energy Consumption and Energy Cost at VAFB

	Energy Consumption			Energy Cost	
Energy Type	Yearly Total	Yearly Total (MBtu)[a]	Percent of Total	Yearly Total (1991$)	Percent of Total
Electricity	199,810 MWh	681,787 [b]	46.5	10,960,446	69.4
Natural Gas	6,840 ktherm	684,000 [c]	46.7	4,078,990 (est)	25.8
#2 Fuel Oil	343 kgallon	47,600 [d]	3.3	353,290	2.3
Propane	531 kgallon	50,452 [e]	3.5	401,436	2.5
Totals		1,463,998	100.0	15,794,162	100.0

(a) 1 MBtu = 1,000,000 Btu.
(b) 3,413 Btu/kWh.
(c) 100,000 Btu/therm.
(d) 0.1387 MBtu/gal.
(e) 0.095 MBtu/gal.

reported in the VAFB Real Property Data Base. There are an additional 1913 housing units with a reported area of 2,774,000 ft^2, for a total building area of 10,896,000 ft^2. Table S.2 records the fuel type, number, total square feet, average square feet, and percent of the VAFB total square footage for each of the building types at VAFB.

Table S.3 breaks down the energy consumption by fuel type and sector. Overall, total building energy consumption at VAFB is estimated to be 1,420,198 MBtu/year, with electricity accounting for 48% of the usage, natural gas 45%, #2 fuel oil 3.5%, and propane 3.6%. Opportunities for energy savings will be greatest for electricity and natural gas usage. These opportunities are the subject of a companion report to this document, entitled Vandenberg Air Force Base Integrated Resource Assessment – Volume 3: Resource Assessment.

TABLE S.2. Vandenberg Air Force Base Building Characterization

Building Type	Energy Type	Number of Buildings	Total Floorspace(ft^2)	Average Floorspace(ft^2)	Percent of Base Total Floorspace
ADMIN	E/G/O/P	73	748,232	10,250	6.9
BRK/ADM	E/G	68	553,421	8,139	5.1
CHAPEL	E/G	2	19,666	9,833	0.2
CLUB	E/G/P	5	23,000	4,600	0.2
COMCATN	E/G/P	83	371,840	4,480	3.4
CONFMT	E/G	2	10,850	5,425	0.1
DET-RR	E/G	5	1,369	274	0.0
DGR	E/G	11	98,594	8,963	0.9
DINING	E/G	6	103,162	17,194	0.9
FUELDSP	E/G	6	1,991	332	0.0
GROCERY	E/G	1	83,287	83,287	0.8
HANGAR	E/G	2	48,136	24,068	0.4
HOSPITL	E/G	1	118,651	118,651	1.1
HOTEL	E/G	1	9,872	9,872	0.1
HSG-FAM	E/G	1,913	2,773,765	1,450	25.4
HUT	-	5	4,352	870	0.0
KENNEL	E/G/P	3	5,288	1,763	0.0
LAB-MED	E/G/P	11	106,616	9,692	1.0
MTRPOOL	E/G	22	96,093	4,368	0.9
MWR	E/G	37	159,102	4,300	1.5
OTHER	E/G	7	6,009	858	0.1
PLT-BLDG	E/G/P	58	92,040	1,587	0.8
POOL-OT	G	1	5,778	5,778	0.1
PRDCTN	E/G	1	62,517	62,517	0.6
PUMP	E	44	35,589	809	0.3
R&D	E/G/O/P	136	2,780,446	20,444	25.5
REC	E/G	5	57,555	11,511	0.5
SECURTY	E/G/O/P	51	95,089	1,864	0.9
SHOP	E/G/P	16	127,952	7,997	1.2
SHOP-HVY	E/G	3	11,903	3,968	0.1
SHOP-WPN	E/G/P	12	67,486	5,624	0.6
STOR-HZ	E/G	24	15,969	665	0.1
STOR-UH	E/P	2,179	857,234	393	7.9
TERMINL	E/G	1	6,971	6,971	0.1
TRAING	E/G	37	205,856	5,564	1.9
UTL-VLT	-	34	38,400	1,129	0.4
WHS	E/G/O/P	144	1,083,196	7,522	9.9
WHS-CLD	E/G	2	8,858	4,429	0.1
TOTALS		5,012	10,896,135		100.0

Notes: E: Electricity G: Natural Gas
O: Oil P: Propane

TABLE S.3. Energy Consumption by Sector (MBtu/year)

Fuel Type/Sector	Consumption (MBtu/year)	Percent of Consumption
Electricity:		
Buildings	456,171	66.9
Water Supply	12,249	1.8
Sewage Treatment	1,201	0.2
Transformer Losses	23,734	3.5
Street/Lot Lighting	2,966	0.4
Non-Building Process 1 (Tracking)	105,803	15.5
Non-Building Process 2 (Launch Support)	38,908	5.7
Reimbursables	40,755	6.0
Totals	681,787	100.0
Natural Gas:		
Buildings	569,056	89.2
South Vandenberg Power Plant	54,607	8.6
Other Power Plants	10,921	1.7
Non Reimbursables	3,403	0.5
Totals	637,987	100.0
#2 Fuel Oil:		
Buildings	43,152	92.0
South Vandenberg Power Plant	4,043	2.0
Other Power Plants	2,327	5.0
Emergency Power Plants	450	1.0
Totals	49,972	100.0
Propane:		
Buildings	49,276	97.7
Non-Building Process	1,176	2.3
Totals	50,452	100.0

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1.0 PHYSICAL CHARACTERISTICS

1.1 SITE PROFILE

Vandenberg Air Force Base (VAFB) is a 98,400-acre (154-square-mile) United States Air Force Space Command (SPACECOM) facility situated along the Pacific Coast east of Lompoc, California, and southwest of Santa Maria, California, at 34°N latitude and 120°W longitude. The primary mission of VAFB is to launch and track polar-orbiting space satellites and intercontinental ballistic missiles. Figure 1.1 is a map of VAFB.

There are more than 40 Department of Defense (DoD) and non-DoD government organizations located at VAFB, along with more than 60 civilian aerospace contractors. The base population includes between 5,000 and 7,000 full-time residents and a varying number of contractor employees. Contractor employment has been as high as 8,600 people, giving a "total" base population approaching 15,000.

Roughly 920 commercial buildings with an area of 8,122,000 ft^2 are reported in the VAFB Real Property Data Base. There are an additional 1,913 housing units with a reported area of 2,774,000 ft^2, for a total building area of 10,896,000 ft^2. More detailed characterization of the VAFB building stock is included in Section 1.2.1, Buildings Characterization.

The climate at VAFB is moderated greatly by the proximity of the Pacific Ocean, which keeps daily maximum temperatures around 60°F (range 59-67°F) and daily minimum temperatures at about 48°F (range 43-53°F) all year long. Heating degree days (base 65°F) are about 3,450, with cooling degree days (base 50°F) about 25.

1.2 BUILDING AND FACILITY PROFILE

This section includes a characterization of the types of facilities at VAFB, including buildings, family housing, and utilities. For the characterization of buildings, energy type used, age, building count, and floorspace are described. The concept of process energy usage as it applies to VAFB is

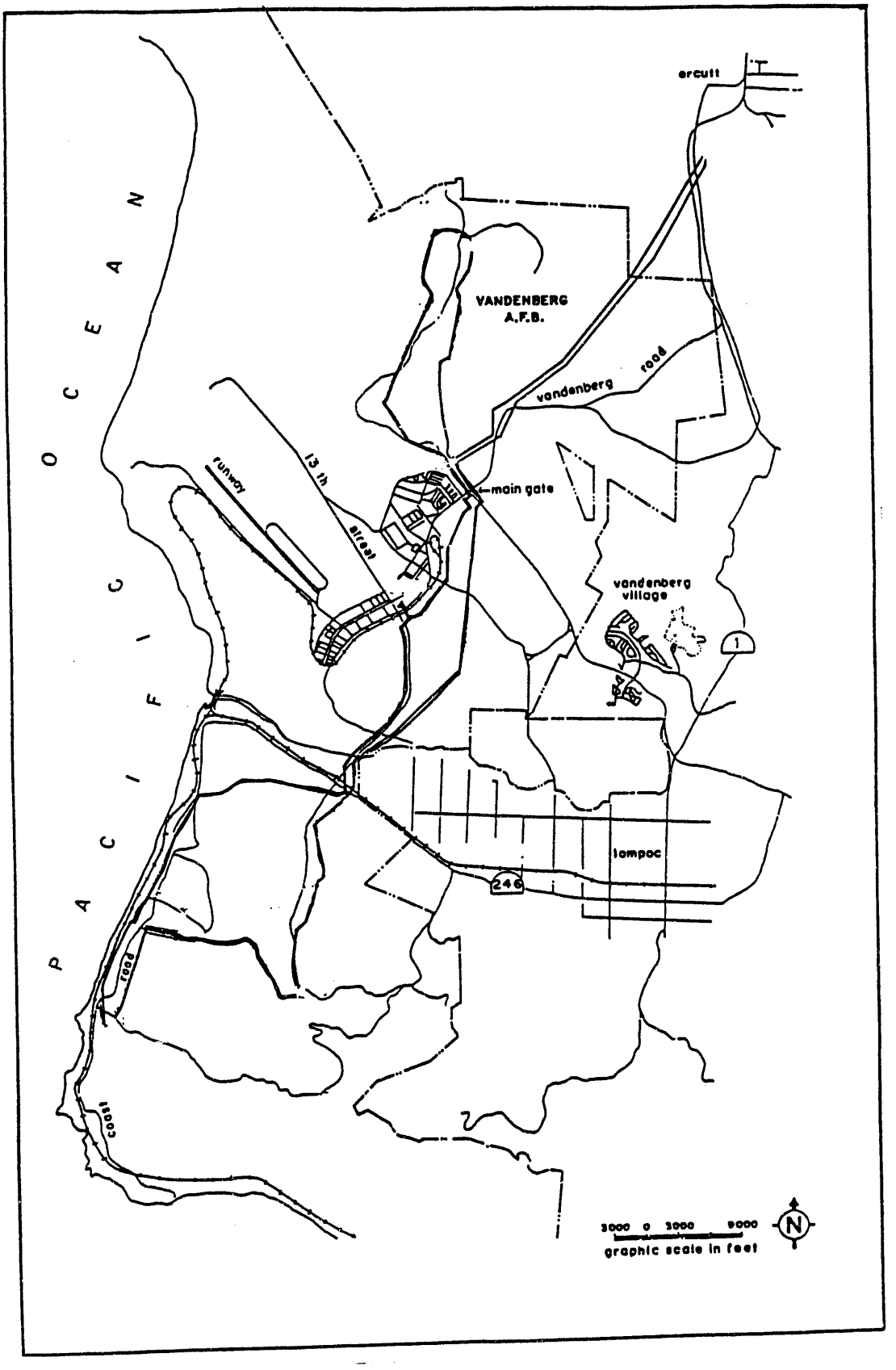

FIGURE 1.1. Map of Vandenberg Air Force Base

discussed. The electrical distribution, water and sewage systems and streetlights are also described.

1.2.1 Buildings Characterization

Based on the Real Property Data Base supplied by VAFB, the facilities at VAFB may be divided into 38 building types. These building types are created by combining facilities of different facility description codes (as provided in the Real Property Data Base) into larger categories with similar energy usage. The idea is to minimize the number of building types while preserving any unique or unusual building types.

The building types codes in Table 1.1 describe the building types at VAFB. In Table 1.2, the building types are applied to the VAFB Real Property Data Base to describe each building type in terms of energy type, building count, total floorspace, and percent of total floor space. Table 1.3 characterizes the average age of the various building types, as determined from the Real Property Data Base.

The assignment of a building to a particular building type is based on the Air Force Facility Code assigned to the building in the Real Property Data Base. These facility codes have been combined to produce the building types used here. Buildings with similar facility codes are assigned to particular building types based on similar energy use intensities (EUIs). (See Section 3 for more detail on the concept of EUIs.) This categorization of buildings is only as good as the data in the Real Property Data Base. As buildings are vacated and occupied by new tenants, the numbers of buildings and square footage associated with each category may change. Similarly, the assigned category codes are taken to be correct and representative of actual function. One small group of buildings that is purposely not included in the building reconciliation (also not found in the Real Property Data Base) is that of the reimbursable facilities at VAFB that are beyond consideration for any VAFB-initiated energy improvements. (Note that these facilities are still responsible for meeting energy conservation goals but that VAFB is not responsible for funding improvements at these facilities.) These are typically commercial enterprises such as a bank, restaurant, or phone service that

TABLE 1.1. VAFB Building Type Descriptions

Bldg Type	Description
ADMIN	Administration Building
BRK/ADM	Barracks (enlisted & BOQ)
CHAPEL	Chapel
CLUB	Club (NCO, Officers, etc.)
COMCATN	Communications
CONFMT	Confinement Facility
DET-RR	Detached Restrooms, Latrines, Shower Houses, etc.
DGR	Dry Goods/Retail
DINING	Enlisted Dining Facility
FUELDSP	Fuel Dispensing Bldgs.
GROCERY	Grocery
HANGAR	Hangar
HOSPITL	Hospital
HOTEL	Hotel/Motel/Guesthouse
HSG-FAM	Family Housing
HUT	Misc. Small Bldgs. and Shelters (not security)
KENNEL	Kennel or kennel support facilities
LAB-MED	Laboratory/Vet. Facility
MTRPOOL	Maint. Shops for Cars, Trucks, Tanks - Land Vehicles
MWR	Morale, Welfare, & Recreation (Non-Physical Rec)
OTHER	Other (non ECO bldgs.)
PLT-BLDG°	Heating/Cooling/Power Plant, Elec. Distribution Buildings
POOL-OT	Outdoor Swimming Pools
PRDCTN	Production/Assembly Facilities
PUMP	Pump Bldgs. - Sewer, Wells, Wash Platforms, etc
R&D	Research and Development Buildings
REC	Physical Recreation (gym, bowling alley, etc)
SECURTY	Security Operations (police, fire)
SHOP	General Maint. Shops, inc. DEH/Base Eng.
SHOP-HVY	Maint. Shops with Heavy Eqp.- Plating, Welding, Railroad
SHOP-WPN	Maint. Shops for Weapons, from Pistols to ICBMs
STOR-HZ	Hazardous materials storage
STOR-UH	Unheated Storage (vehicles, ammo, residential sheds)
TERMINL	Airport, Bus, Train Terminal
TRAING	Training/Classrooms (not simulator)
UTL-VLT	Utility Vault (primarily electrical controls)
WHS	Warehouse
WHS-CLD	Cold Storage Warehouse

TABLE 1.2. Vandenberg Air Force Base Building Characterization

Building Type	Energy Type	Number of Buildings	Total Floorspace(ft^2)	Average Floorspace(ft^2)	Percent of Base Total Floorspace
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KENNEL	E/G/P	3	5,288	1,763	0.0
LAB-MED	E/G/P	11	106,616	9,692	1.0
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WHS	E/G/O/P	144	1,083,196	7,522	9.9
WHS-CLD	E/G	2	8,858	4,429	0.1
TOTALS		5,012	10,896,135		100.0

Notes: E: Electricity G: Natural Gas
O: Oil P: Propane

TABLE 1.3. Vandenberg Air Force Base Building Age Characterization

Building Type	Oldest Date	Newest Date	Average Age (Years)
ADMIN	1942	1990	35
BRK/ADM	1942	1987	33
CHAPEL	1942	1968	37
CLUB	1960	1970	28
COMCATN	1942	1990	24
CONFMT	1942	1960	41
DET-RR	1942	1982	28
DGR	1942	1990	26
DINING	1942	1971	33
FUELDSP	1959	1982	20
GROCERY	1986	1986	6
HANGAR	1942	1959	42
HOSPITL	1967	1967	25
HOTEL	1990	1990	2
HSG-FAM	1959	1969	32
HUT	1959	1988	21
KENNEL	1942	1986	30
LAB-MED	1928	1982	41
MTRPOOL	1942	1984	30
MWR	1942	1987	32
OTHER	1960	1983	19
PLT-BLD	1942	1989	21
POOL-OT	1959	1959	33
PRDCTN	1958	1958	34
PUMP	1937	1984	29
R&D	1942	1990	29
REC	1942	1987	23
RESTRNT	1989	1989	3
SECURTY	1942	1990	23
SHOP	1942	1984	36
SHOP-HVY	1942	1968	41
SHOP-WPN	1942	1987	30
STOR-HZ	1942	1989	22
STOR-UH	1937	1991	31
TERMINL	1959	1959	33
TRAING	1942	1991	41
UTL-VLT	1959	1986	17
WHS	1942	1991	35
WHS-CLD	1969	1974	21

reimburse VAFB for utility costs. These facilities are typically not available for VAFB-sponsored energy-related projects. The 38 types shown below represent the best estimate of VAFB building types at this time.

Table 1.4 shows the list of building types at VAFB ranked by square footage. Only building types with more than 1% of total VAFB floorspace are broken out. R&D is the single largest category by square footage at VAFB, followed by family housing, warehouses, unheated storage, administration buildings, barracks, and communications. These building types account for 84.1% of the total building stock at VAFB. Because of the different EUIs in each building type, building types with greater square footage do not necessarily consume more energy. Section 3 discusses the concept of EUIs in greater detail and Sections 4 through 7 discuss the total energy usage by the various building types.

TABLE 1.4. Ranked List of Building Types at VAFB

Building Type	Total Area (ft^2)	Percent Area	Cumulative Percent Area
R&D	2,780,446	25.5	25.5
HSG-FAM	2,773,765	25.4	50.9
WHS	1,083,196	9.9	60.9
STOR-UH	857,234	7.9	68.7
ADMIN	748,232	6.9	75.6
BRK/ADM	553,421	5.1	80.7
COMCATN	371,840	3.4	84.1
TRAING	205,856	1.9	86.0
MWR	159,102	1.5	87.5
SHOP	127,952	1.2	88.6
HOSPITL	118,651	1.1	89.7
LAB-MED	106,616	1.0	90.7
Other Types	1,013,364	9.3	100.0
Totals	10,899,675	100.0	100.0

Commercial buildings are a mix of older wood frame construction and newer metal frame and curtain wall construction, with some stone/brick construction. Family housing is primarily wood frame construction with little or no insulation in the walls or ceilings.

1.2.2 Equipment Energy Use Characterization

In addition to energy used for space conditioning, water heating, lighting, and other standard building equipment, a significant amount of energy is used to operate large or unusual equipment items or systems. Equipment such as overhead cranes, large pumps, alarm systems, and cathodic protection systems are examples of what this report characterizes as equipment loads. Significant pieces of equipment are tracked in the Real Property Data Base in much the same way as buildings. The equipment items identified in the Real Property Data Base have been grouped into 18 categories defined below in Table 1.5.

In addition to the equipment categories defined above, there are a number of entries in the Real Property Data Base listed as "buildings" but having no square footage. These were found in the COMCATN, FUELDSP, PUMP,

TABLE 1.5. Equipment Category Definitions

ALARM	Fire and Security Alarm Systems
CATH-PRO	Cathodic Protection system
COM-OUT	Outdoor Communications - Antenna, Phone Lines, etc.
CRANE	Crane or Crane Structure
EMCS	Energy Management Control System Equipment
FIRE-PR	Fire Protection/Sprinkler Systems
FUEL-OUT	Fuel Dispensing Equipment
LTG-SYS	Lighting Systems (mainly Airfield, some Ext. Lights)
PLT-A/C	Air Conditioning Plant
PLT-AIR	Air Compression Equipment
PLT-CLG	Cooling Plant
PLT-GEN	Electricity Generation Equipment
PLT-H2O	Water Treatment Equipment (Fresh Water)
PLT-HET	Heating Plant
PLT-SOL	Solar Technology Equipment
PLT-WST	Waste Treatment Equipment (Liquid Waste)
SCALE	Large Truck or Equipment Scale
STA-UTL	Substation or Switching Station

R&D, and SHOP-HVY building categories and are generally equipment items associated with particular building type functions. They include such things as isolated pumps, transformers, and pad-mounted communication equipment that are identified by a facility or building number in the Real Property Data Base but are treated as "equipment" in this report. The distinction between building and equipment is based solely on the presence or absence of square footage. Energy use without accompanying square footage is classified as equipment. Items listed as equipment, including those building category items with no square footage are summarized by age and count in Table 1.6. Sewage and water pumps, streetlighting, and the electrical distribution system are considered in greater detail in later sections.

The primary interest with equipment loads occurs during the resource assessment portion of this analysis. Equipment that may be old and inefficient may be considered for replacement.

TABLE 1.6. Vandenberg Air Force Base Equipment Description

Equipment Category	Oldest Date	Newest Date	Average Age (year)	Equipment Number
ALARM	1942	1991	15	2,536
CATH-PRO	1962	1989	23	41
COM-OUT	1958	1990	21	156
CRANE	1971	1981	16	2
EMCS	1961	1991	14	146
FIRE-PR	1942	1990	17	173
FUEL-OUT	1959	1980	25	6
LTG-SYS	1942	1991	23	242
PLT-A/C	1951	1991	21	272
PLT-AIR	1958	1991	20	83
PLT-CLG	NA	NA	NA	3
PLT-GEN	1958	1989	20	80
PLT-H2O	1942	1989	18	13
PLT-HET	1942	1991	22	121
PLT-SOL	1984	1985	7	5
PLT-WST	1938	1985	27	150
SCALE	NA	NA	NA	2
STA-UTL	1960	1991	8	173
COMCATN	1938	1988	21	85
FUELDSP	1965	1967	26	2
PUMP	1959	1979	22	14
R&D	1959	1986	28	39
SHOP-HVY	1963	1963	29	1

1.2.3 Process Energy Use Characterization

Section 1.1 focused on discussions of building stock, with the ultimate goal of predicting the energy usage of each building type. The energy use most commonly associated with buildings are those end uses associated with occupant comfort (such as lighting, heating, and cooling) and amenities (such as computers, copiers, and refrigerators). There is another set of energy end uses associated with process loads. For purposes of this energy assessment, the term "process energy" was defined to encompass end uses which are largely unique to VAFB's mission. VAFB's mission is launching and tracking missiles. Thus, the definition of process energy was restricted to those end uses which were directly related and specific to launch and tracking activities. Specific examples of VAFB process energy end uses are shown below.

- HVAC units to cool large computer rooms used during launch tracking.
- Water pumping stations for damping the acoustic wave produced by the boosters.
- Nitrogen (and other) gas pumping stations used for the launch vehicles.
- HVAC units used to keep positive pressure and humidity control for clean rooms and launch towers.
- Radar and other communications transmitters.
- HVAC units to provide temperature and humidity control for missile fuel storage.
- Hydrazine vapor incinerators.

The VAFB Real Property Data Base was used to make a distinction between process and non-process facilities and end uses. The list of category codes was examined for both equipment and building codes that seemed to indicate process loads. Building categories which seem to best fit the VAFB process energy definition are listed below in Table 1.7. The column labeled "PNL BUILDING TYPE" refers to the categories defined in Table 1.1.

TABLE 1.7. Vandenberg Air Force Base Process Building Types

Building Description	PNL Building Type
Missile Guidance Station	COMCATN
Missile Command Station	COMCATN
Missile Guidance Facility	COMCATN
Missile Instrumentation Station	COMCATN
Missile Radar Station	COMCATN
Missile Theodolite Station	COMCATN
Satellite Communication Ground Terminal	COMCATN
Satellite Control Station	COMCATN
Test Range Complex	COMCATN
Propulsion Engineer Test Fuel System	COMCATN
Shop, Missile Assembly	PRDCTN
Storage, Demineralized Water	PUMP
Electronics Research Laboratory	R&D
Electronics Research Test	R&D
Equipment Research Laboratory	R&D
Equipment Research Test	R&D
Materials Research Test Laboratory	R&D
Missile Launch Test Facility	R&D
Missile Space Research Engineering	R&D
Missile Space Research Laboratory	R&D
Missile Space Research Test	R&D
Propulsion Engine Test Stand	R&D
Propulsion Research Laboratory Fuel and Lubricants	R&D
Chemistry Science Laboratories	R&D
Prototype Model Construction and Assembly	SHOP
Transporter/Erector Test Facility	SHOP-HVY
Shop Missile Battery	SHOP-WPN
Shop Missile Service	SHOP-WPN
Shop Missile Warhead Assembly and Maintenance	SHOP-WPN
Shop, Surveillance and Inspection	SHOP-WPN
Missile Transfer Building	WHS
Re-Entry Vehicle Building	WHS
Research Equipment Storage	WHS
Test Track Building	WHS
Water Pumping Station	PUMP

Equipment codes which indicated the likely presence of process equipment which was not necessarily associated with a process building are listed below:

- Foam Fire System
- Halon 1301 Fire System
- CO_2 Fire System
- Heating Plant 750-3500 MBtu
- Heating Plant Over 3500 MBtu
- A/C Plant 25-100 Tons
- A/C Plant Over 100 Tons
- Heating Fuel Oil Storage
- Load and Unload Gantry Crane
- Compressed Air Plant
- Transmissometer
- Antenna Support Structure
- Missile Storage Fuel
- Operating Storage, Diesel Fuel

Process loads at VAFB were estimated based on listings of equipment provided in the Real Property Data Base and short-time metering of specific facilities provided in the Vandenberg Telemetry Receiving Station (VTRS) Site Survey report (Stearns-Rogers 1990; see Bibliography). The results of the Real Property Data Base equipment count for "process" equipment are shown in Table 1.8. The equipment is listed by the actual description used in the Real Property Data Base.

The VTRS Site Survey provided by VAFB contained "one-time" metering records for specific instrumentation sites and other facilities. Much of the metered data could not be directly related to specific identifiable pieces of equipment as listed in the Real Property Data Base. Several of the readings were associated with missile tracking equipment and other monitoring equipment

TABLE 1.8. Vandenberg Air Force Process Equipment Counts

Equipment	Number	Equipment	Number
A/C FR CEN PLT	2	A/C PLT 5 TO 25 TN	5
A/C PLT, LS 5 TN	9	A/C WINDOW UNITS	22
ANT SPT STRU	100	CEILOMETER ANGMQ13	3
CMPRS AIR PLT	5	IND WST FL-SP COLL	1
IND WST TRMT&DSPL	5	LF FIL STD, TRK	1
LF STD UNLOAD	2	MSL COMM STN	9
MSL INSTM STN	40	MSL LCH TST FCLTY	31
MSL RDR STN	2	MSL THODLIT STN	14
OPN HD DELUGE SYS	2	PRPLN ENG T/FL SYS	1
PRPLN ENG T/STD	1	RDR MET SET C-BAND	1
T/ERCTR TST FCLTY	1	TEM/HUM MEA SET	1
TRANSMSTR, ANGMQ10	5	TST RG COMPLX	7
TWR, RDR	8	WD MEA SET ANGMQ20	3
WIND DIR INDCTR	1		

that comprises a large portion of the non-building process equipment loads at VAFB. These readings were used to derive estimates of yearly energy use for various non-building process-type equipment. Based on these estimate, additional estimates were derived for similar process-type equipment found within buildings. These additional estimates provided the basis for the process EUI and consumption values within buildings.

1.2.4 Electrical Utility Energy Use Characterization

Electrical service is provided by Pacific Gas and Electric Company with most of the base consumption delivered via two 69-kV transmission lines from the PG&E Divide substation to VAFB substation A. (The remaining 1% is delivered at lower voltage to two remote sites. See Section 2.1 for additional detail.) Distribution on the Base consists of two 69-kV transmission lines, connected at substation A. The North Loop, approximately 9.75 miles long, provides power to substations D and E. The South Loop, 30.5 miles long, provides power to the remaining substations: B, C, J, K, L, M, and N. Current plans call for consolidating substations J, K, and L into a

single substation where substation K is located in 1993. Each of the 10 major substations has transformers to provide distribution voltage, mainly 12 kV with some 4,160-V feeders.

Both the transmission and distribution systems are overhead line systems. Due to common and heavy ocean fogs which tend to corrode electrical contact surfaces, all overhead lines use insulators rated at twice the operating voltage to minimize flashovers and provide a margin of safety. The 69-kV lines therefore use 115-kV insulators and the 12-kV lines use insulators rated at 24 kV.

There are approximately 1,403 transformers at VAFB, with 16 three-phase transmission voltage step-down transformers located at the substations, for a total nameplate capacity of 92,500 kVA. There are about 1,378 distribution stepdown transformers, for a total nameplate capacity of 180,650 kVA, with 84% of the single-phase transformers representing 29% of the capacity. The remaining transformers are utilization voltage transformers with an overall capacity of 590 kVA. Details of the methodology for calculating transmission and distribution system losses are found in Appendix A of this report.

1.2.5 Water Distribution Energy Use

Water is provided to VAFB by nine operating wells and three booster pumps. Two of the wells are located in south Vandenberg, with the remainder in central and north Vandenberg. The aggregate capacity of the well pumps is reported to be 9,536 gpm with an aggregated load of 695 horsepower. Booster pumps are also in operation with each of the well systems at a total effective load of approximately 625 horsepower. The current typical water supply provided by this well system is approximately 1.2 billion gallons per year.

VAFB is currently exploring water supply options. One option being considered would bring water from northern California to the central California coast via a new pipeline through Kern, San Luis Obispo, and Santa Barbara counties. If state water is used at VAFB, future electrical usage for well pumps can be expected to drop dramatically.

Table 1.9 provides an inventory of the various water wells at VAFB, their capacities (in gpm), and estimated consumption (in MWh) for a typical operating year. Consumption data are based on capacity and use information supplied by VAFB personnel.

The installation dates for the pumps indicate that they are late-1970s, early 1980s for all pumps except for SV1 and SV3, which are circa 1960 and 1969, respectively.

TABLE 1.9. Water Well Inventory

Well #	Capacity (gpm)	Rated Pump Horsepower	Yearly Estimated Consumption (MWh)
SY3	1,500	75	63
SY5	1,266	60	72
SY6	1,950	75	<1
SA4	950	75	227
SA5	900	60	300
SA6	1,100	75	171
SA7	970	75	198
SV1	300	100	62
SV3	400	100	65
SY Booster	4,900	750	424
SA Booster	6,600	1,000	1,927
SV Booster	*	*	79*
Total	21,036	2,445	3,589

* Actual capacity values unknown; [illegible] value based on ratio of water supply of other well areas.

1.2.6 Sewage Treatment Energy Use

Sewage treatment for VAFB is provided by the city of Lompoc sewage treatment system. This includes the treatment of sewage for the central VAFB facilities and family housing. Additional sewage treatment for outlying areas is provided by nine package treatment stations. These stations are located

throughout north and south Vandenberg for service of the many launch facility sites. These stations are operated on a continuous basis at a total rated power level of approximately 55 horsepower.

Table 1.10 provides an inventory of the various package sewage treatment stations at VAFB, their capacities, and estimated consumption (in kWh) for a typical operating year (based on 1991 and 1992 available data provided by VAFB personnel).

TABLE 1.10. Package Sewage Treatment Inventory

Building #	Rated Pump Horsepower	Yearly Estimated Consumption (MWh)
393	10	65
488	6	39
535	1.3	9
743	17	111
769	3	20
896	7.5	49
1801	1	7
21150	2	13
23260	6	39
Total	53.8	352

1.2.7 Streetlight Energy Use

An estimate of 1,950 amps attributable to street lighting was provided by VAFB staff. Of this total amperage, 99% was estimated to be 120 V, 0.5% 208 V, and 0.5% 480 V. The total streetlighting demand was calculated to be 238 kW. Assuming 10 hours of operation per day, this is equivalent to a total of 869 MWh per year. Streetlighting uses primarily high-pressure and low-pressure sodium technologies, with some mercury vapor technology. Streetlighting ages range from 1942 to 1991, with the majority being installed in the mid-1960s to early 1980s.

2.0 ENERGY SOURCE CHARACTERISTICS

Energy sources used by Vandenberg Air Force Base (VAFB) include electricity, natural gas, fuel oil, and propane. Table 2.1 shows a summation of the typical yearly energy consumption and cost at VAFB for all facilities, including family housing and space launch complexes (SLCs). For each energy type, the yearly total is shown in units appropriate to the energy as well as a common unit as a basis of comparison. The total consumption values are based on the usage values chosen for analysis in this report as typical current yearly usage. This typical year is based on the best available data gathered from 1991 and 1992 consumption levels. These are aggregations of various billing consumption amounts and are considered representative of normal VAFB operational energy consumption.

TABLE 2.1. Yearly Energy Consumption and Energy Cost at VAFB

	Energy Consumption			Energy Cost	
Energy Type	Yearly Total	Yearly Total (MBtu)[a]	Percent of Total	Yearly Total (1991$)	Percent of Total
Electricity	199,810 MWh	681,787 [b]	46.5	10,960,446	69.4
Natural Gas	6,840 ktherm	684,000 [c]	46.7	4,078,990 (est)	25.8
#2 Fuel Oil	343 kgallon	47,600 [d]	3.3	353,290	2.3
Propane	531 kgallon	50,452 [e]	3.5	401,436	2.5
Totals		1,463,998	100.0	15,794,162	100.0

(a) 1 MBtu = 1,000,000 Btu.
(b) 3,413 Btu/kWh.
(c) 100,000 Btu/therm.
(d) 0.1387 MBtu/gal.
(e) 0.095 MBtu/gal.

2.1 ELECTRIC SUPPLY SOURCE DESCRIPTION

Electricity is supplied to VAFB by PG&E through main 69-kV lines and two smaller remote feeds. The three electric metering points are the Main Base, Oak Mountain-Miguelito Canyon, and Honda Canyon. Because over 99% of the total cost is associated with the Main Base meter, the two minor meters will not be considered here. Electricity is delivered to the Main Meter at PGE's transmission line voltage of 69 kV, qualifying for the lowest rates on PGE's schedule E-20. The rate structure (as of April 1991) is shown in Table 2.2. The rate structure has changed as of January 1, 1992, and is shown in Table 2.3. The April 1991 rates were in use during the time period used for billing data comparisons and are presented here for completeness. Any PNL-recommended energy conservation opportunities (EROs) should use the January 1, 1992, electrical rate structure.

TABLE 2.2. VAFB Electrical Rate Structure (April 1991)

Charge	Summer	Winter
Demand Charges (per kW)		
Maximum Peak Period Demand	$8.60	----
Maximum Demand	$0.60	$0.60
Energy Charges (per kWh)		
Peak Period	$0.08351	----
Partial Peak Period	$0.05668	$0.04846
Off-Peak Period	$0.04327	$0.04198
Peak Period Rate Limiter (per kWh)	$0.62907	----
Customer Charge (per meter per month)	$510.00	$510.00

Period	Summary	Winter
	(May 1 through October 31)	(November 1 through April 30)
Peak	12:00 noon to 6:00 PM (M-F)	----
Partial Peak	8:30 AM to 12:00 noon (M-F)	8:30 AM to 9:30 PM (M-F)
	6:00 PM to 9:30 PM (M-F)	
Off-Peak	9:30 PM to 8:30 AM (M-F)	9:30 PM to 8:30 AM (M-F)
	all day weekends and holidays	

TABLE 2.3. VAFB Electrical Rate Structure (January 1992)

Charge	Summer	Winter
Demand Charges (per kW)		
Maximum Peak Period Demand	$9.00	----
Maximum Demand	$0.60	$0.60
Energy Charges (per kWh)		
Peak Period	$0.08485	----
Partial Peak Period	$0.05759	$0.04924
Off-Peak Period	$0.04397	$0.04265
Standby Charge (per kWh)	$0.60	$0.60
Customer Charge (per meter per month)	$510.00	$510.00

Period	Summary	Winter
	(May 1 through October 31)	(November 1 through April 30)
Peak	12:00 noon to 6:00 PM (M-F)	----
Partial Peak	8:30 AM to 12:00 noon (M-F)	8:30 AM to 9:30 PM (M-F)
	6:00 PM to 9:30 PM (M-F)	
Off-Peak	9:30 PM to 8:30 AM (M-F)	9:30 PM to 8:30 AM (M-F)
	all day weekends and holidays	

In addition to the utility electricity supply, VAFB generates its own electric power to support launch activities and supply backup power to other critical loads. The largest on-site electricity producer is the South Vandenberg Power Plant (SVPP), which support Atlas, Titan, and Scout missile launches at SLCs 3, 4 and 5, respectively. Currently, the SVPP's mission is to provide primary and backup power for missile operation support requirements (MOSR) at the SLCs. A change in this mission is being considered by VAFB personnel and is analyzed in a PNL document entitled Economic Analysis of Operating Alternatives for the South Vandenberg Power Plant at Vandenberg Air Force Base, California (PNL-8556, Daellenbach et al. 1993; see Bibliography).

Another 105 smaller supplemental power supplies and backup generators using #2 fuel oil provide the remainder of the on-site power production. During the 12-month period between February 1991 and January 1992, the SVPP consumed 546,068 therms (54,606.8 MBtu) of natural gas during 2,012.5 turbine-hours of operation and 7,164 gallons (994.3 MBtu) of #2 fuel oil during 62.3 turbine-hours of operation. The total electricity generated during this time was 2,568 MWh.

2.2 GAS SUPPLY SOURCE DESCRIPTION

Natural gas is supplied to VAFB by the Southern California Gas Company. The supply to VAFB is metered at four locations. Natural gas lines supply central VAFB and the airstrip, as well as the family housing area. Additional lines are run to the SVPP and some of the general launch facilities in South Vandenberg. Gas is not supplied directly to most of the actual launch facilities at each SLC.

Natural gas is supplied to VAFB based on four rate schedules assigned to groups of facilities at the site. The four rate structures and the facility areas they serve are as follows:

GM-E	basis for family housing charges based on estimated consumption of 52% of main metering covering family housing and the contonment area
GN-20I	basis for commercial facility charges based on estimated consumption of 48% of main metering covering family housing and the contonment area
GN-10	basis for charges at hospital, adult education center, and new tracking station
GN-32	basis for charges of estimated use at the South Vandenberg Power Plant (SVPP)

The net effect of blending these four rate schedules was that natural gas was supplied to VAFB during the 1991 baseline year at an average rate of 53.681 cents per therm (summer) and 57.682 cents per therm (winter).

2.3 OIL SUPPLY SOURCE DESCRIPTION

Diesel fuel oil is used throughout VAFB at various facilities for space and water heating as well as electricity generation and backup emergency power. The oil is supplied to VAFB as #2 fuel oil (diesel or distillate fuel oil), 2% sulfur diesel, and motor vehicle diesel. The 2% sulfur diesel and motor vehicle diesel use are beyond the scope of this assessment and are therefore not included in the totals.

The fuel oil is supplied by companies who win competitive bidding process to maintain tank levels during the contract period. In addition to the various individual building supply tanks there are three fuel distribution facilities that receive #2 fuel oil and motor vehicle diesel. The oil is distributed from these points for use in smaller building heating systems and emergency generators. During the 1991 baseline year, #2 fuel oil was supplied at the rate of $1.03 per gallon. The current 1992 rate is $0.67 per gallon.

2.4 PROPANE SUPPLY SOURCE DESCRIPTION

Propane is supplied to VAFB through a competitive contract bidding process to dedicated building locations. These facilities are primarily remote launch sites, dining halls, and clubs. The propane is used for heating, cooking, water heating and some process functions such as fume incineration at the SLCs. The 1991 baseline year propane rate was approximately 75.6 cents per gallon. The current 1992 rate is 62.5 cents per gallon.

3.0 ENERGY-USE INTENSITIES

Energy-use intensities (EUIs) are defined as energy-use per unit floor area, per unit time and are commonly expressed as thousands of Btu per square foot per year (kBtu/ft^2-year), or kilowatt hours per square foot per year (kWh/ft^2-year). These EUI values are used to help develop baseline consumption for various building types when actual consumption data are not available. This section describes the EUI information that was used in the energy assessment at Vandenberg Air Force Base.

The specific EUI values used in the VAFB integrated resource assessment are derived from three primary data sources. The first is regional information collected from local utilities and other energy organizations that have prepared EUI data for their own and public use. The second is the PNL experience gained from analyzing EUI data at other federal sites, including military facilities. The similarity of military facilities from site to site, coupled with appropriate adjustments for climate and operational differences between the sites, provides valuable EUI information. These two sources make up the initial set of EUI values that are used as a starting point for determining appropriate EUI values.

The third and most accurate source of EUI data is actual metered and\or billing information obtained at the site itself. Since this information is usually scarce for a large sample of facilities at the site, the regional and previous site EUI values are relied upon for much of the assessment. Adjusting the data from these three data sources provides the means to derive a specific set of EUI values for the various buildings types and end uses at VAFB.

3.1 INITIAL ENERGY-USE DATA SOURCES

Initial EUI values are used as a starting point to determine appropriate EUI values in the absence of specific data. The regional and local EUI data make up part of the initial EUI values and were collected from six sources that include Pacific Gas & Electric (PG&E), Southern California Edison (SCED), Los Angeles Department of Water & Power (LADWP), California Energy Commission

data for Burbank, Glendale, and Pasadena (BGP), data from the Environmental Protection Agency Western Systems Coordinating Council (EPA/WSCC), and the Energy Information Administration's Commercial Buildings Energy Consumption Survey (CBECS). (Complete references are included in the Bibliography, Section 8 of this report.)

Tables B.1 through B.24 (located in Appendix B) break out energy-use by facility type, building type, fuel type, and fuel end use by data source. The two major building type categories are residential and commercial. Energy-use is expressed in kWh/ft²-year for electric EUIs and kBtu/ft²-year for fossil fuel EUIs. Energy-use data are reported for the following end-use categories: space heating, cooling, domestic hot water (DHW), cooking, refrigeration, interior and exterior lighting, office equipment, and other. The other category includes miscellaneous end uses like electrical appliances, motors, and water/steam heating for laundry or food preparation.

In the residential category, data were available only as unit energy consumption (UEC) values, given in units of kWh/year per dwelling unit. To convert a UEC to an EUI, an average residential square foot value must be assumed. For this assessment, values of 1,500 ft^2 for a single family residence and 1,000 ft^2 for a multi-family residential unit were assumed based on CBECS data.

While some of the EUI values correlate well from source to source for a given building type, fuel type, and end use, others do not. There are a number of reasons for discrepancies, including: data were derived from different service areas, differences in building size and shape, and poorly defined or ambiguous building types.

The second data source of initial EUI values is that derived from other federal site analysis efforts where similar building types were considered. Values derived for the assessment of Fort Drum in New York were applied to VAFB because many of the building types were similar in function and construction (see Dixon et al. 1992a, 1992b in the Bibliography). Since the cooling load at Fort Drum is similar to that at VAFB (very low, except in process applications), no adjustments for cooling load weather conditions were needed to apply the Fort Drum values to VAFB. The heating load EUI values at Fort

ratio between Fort Drum, New York, and VAFB, California, to develop EUI values appropriate to VAFB climate. This adjustment was necessary only for the fossil fuel EUI values since virtually all heating at Fort Drum was generated from fossil fuels. Tables B.25 and B.26 (in Appendix B) contain the fossil and electric EUI values derived by applying a climate adjustment to the Fort Drum EUI values. These adjusted EUI values were used as a starting point for the analysis of VAFB.

3.2 ENERGY-USE VALUES

A primary product of the energy baseline analysis for VAFB are the site-specific EUI values for various building types and end uses that make up the energy consumption at VAFB. These EUI values are considered reasonable representations of the magnitude of energy consumption among various end uses, buildings, and areas of VAFB.

The initial step in the development of these values was to assess all available regional and published EUI data that might be applicable to VAFB (Tables B.1-B.26). After reviewing various sources and matching existing data generated from PNL measurements at other facilities with VAFB building types, a set of EUI values was derived. This set of values provides a reasonable EUI value to be used in assigning site-specific EUI values to VAFB facilities.

The final step in EUI development was completed as part of allocating energy use in developing the baseline. This process incorporates various factors that influence the EUI values and energy consumption among buildings, including: weather, occupancy, construction, age, operation, and function. Any available actual metered or other billing data are applied in this iterative process. In the case of VAFB, metered electrical substation data, electric bills, natural gas bills, and fuel oil and propane delivery records were all used.

The energy allocation process uses actual consumption information when available and relies on the initial EUI values in all other cases. This procedure accounts for all energy use at VAFB while apportioning it as accurately as possible among the building types and other uses. A result of this process is a set of EUI values that is considered representative of VAFB.

Tables 3.1 and 3.2 detail the EUI values for the end uses and building types represented at VAFB. The EUI values are shown for building types that use particular fuels for a specific end use. For example, heating in the administration building category is known to be provided by several different fuels and is represented by EUI values in each fuel type.

3.3 PROCESS ENERGY-USE VALUES

One of the unique characteristics of VAFB's energy use is its large process-driven loads. These are generally found as mission-related operations within buildings and process-driven equipment. This includes launch facilities and launch/tracking support equipment such as gas processing for instrument purge, tracking of launch vehicles, communications, and payload and launch vehicle processing.

Since metered data are not available for these functions, some estimate of energy use is required. The processes at VAFB are divided into three primary components for estimation purposes. These are building process loads, non-building loads associated with tracking functions, and all other non-building process functions such as gas processing, payload heating, ventilation, and air conditioning.

Initially an estimate was made of the non-building tracking load. This estimate was based on one-time meter readings taken as part of the VTRS Site Survey. Readings of tracking equipment were used along with estimates of operational hours to derive an estimate of tracking equipment energy consumption. This energy consumption value was extrapolated based on using the number of pieces of process-related equipment at VAFB.

This tracking consumption estimate was used to derive a building process value for those facilities that are considered to provide similar functions to the tracking equipment. The remaining electricity consumption at VAFB was assigned to the non-building processes. This was verified to be reasonable based on an estimate of the consumption of the cooling and other miscellaneous loads in the non-building process category.

TABLE 3.1. Vandenberg Air Force Base Fossil Fuel Energy-Use Intensities (kBtu/ft^2/year) by End Use and Building Type

	NATURAL GAS					FUEL OIL			PROPANE			
BLDG-TYPE	TOTAL	HEAT	DHW	COOK	OTHER	TOTAL	HEAT	DHW	TOTAL	HEAT	DHW	COOK
ADMIN	170,940	113,960	56,980	0	0	1,894	1,527	367	1,940	1,293	647	0
BRK/ADM	50,000	25,000	25,000	0	0	0	0	0	0	0	0	0
CHAPEL	46,000	30,000	16,000	0	0	0	0	0	0	0	0	0
CLUB	30,151	10,660	10,400	9,091	0	0	0	0	10,700	3,782	3,690	3,228
COMCATN	36,564	26,592	9,972	0	0	0	0	0	2,229	1,621	608	0
CONFMT	47,000	25,000	22,000	0	0	0	0	0	0	0	0	0
DET-RR	15,000	15,000	0	0	0	0	0	0	0	0	0	0
DGR	44,656	42,877	1,779	0	0	0	0	0	0	0	0	0
DINING	114,028	40,303	39,320	34,405	0	0	0	0	41	0	0	41
FUELDSP	1,000	1,000	0	0	0	0	0	0	0	0	0	0
GROCERY	5,7000	47,000	10,000	0	0	0	0	0	0	0	0	0
HANGAR	2,0000	15,000	5,000	0	0	0	0	0	0	0	0	0
HOSPITL	8,4550	43,791	39,299	1,460	0	0	0	0	0	0	0	0
HOTEL	7,0000	35,000	35,000	0	0	0	0	0	0	0	0	0
HSG-FAM	5,0000	25,000	20,000	5,000	0	0	0	0	0	0	0	0
HUT	0	0	0	0	0	0	0	0	0	0	0	0
KENNEL	14,850	14,850	0	0	0	0	0	0	7,250	7,250	0	0
LAB-MED	48,464	29,824	18,640	0	0	0	0	0	10,187	6,269	3,918	0
MTRPOOL	20,000	15,000	5,000	0	0	0	0	0	0	0	0	0
MWR	36,600	30,500	6,100	0	0	0	0	0	0	0	0	0
OTHER	36,600	36,600	0	0	0	0	0	0	0	0	0	0
PLT-BLDG	21,630	14,420	7,210	0	0	0	0	0	35,300	23,533	11,767	0
POOL-OT	1,185,000	0	0	0	1,185,000	0	0	0	0	0	0	0
PRDCTN	30,000	20,000	10,000	0	0	0	0	0	0	0	0	0
PUMP	0	0	0	0	0	0	0	0	0	0	0	0
R&D	60,000	38,400	21,600	0	0	9,440	7,613	1,827	12,714	8,137	4,577	0
REC	36,600	30,500	6,100	0	0	0	0	0	0	0	0	0
SECURTY	16,500	12,375	4,125	0	0	1,804	1,455	349	9,278	6,958	2,319	0
SHOP	18,470	13,845	4,625	0	0	0	0	0	2,379	1,784	595	0
SHOP-ELC	17,160	12,870	4,290	0	0	13,788	11,490	2,298	0	0	0	0
SHOP-HVY	20,000	15,000	5,000	0	0	0	0	0	0	0	0	0
SHOP-WPN	18,600	13,950	4,650	0	0	0	0	0	8,269	6,202	2,067	0
STOR-HZ	10,000	10,000	0	0	0	0	0	0	0	0	0	0
STOR-UH	0	0	0	0	0	0	0	0	226	170	57	0
TERMINL	20,000	15,000	5,000	0	0	0	0	0	0	0	0	0
TRAING	48,000	32,000	16,000	0	0	0	0	0	0	0	0	0
UTL-VLT	0	0	0	0	0	0	0	0	0	0	0	0
WHS	16,500	16,500	0	0	0	14,140	14,140	0	4,692	3,519	1,173	0
WHS-CLD	15,000	15,000	0	0	0	0	0	0	0	0	0	0

TABLE 3.2. Vandenberg Air Force Base Electric Energy-Use Intensities (kWh/ft^2/year) by End Use and Building Type

BLDG-TYPE	TOTAL	HEAT	COOL	VENT	DWH	COOK	LIGHTS	REF	OTHER	PROCESS
ADMIN	16.93	0.61	0.10	3.00	0.45	0.00	6.25	0.02	2.50	4.00
BRK/ADM	8.12	0.40	0.00	3.00	0.24	0.00	3.40	0.08	1.00	0.00
CHAPEL	6.15	0.00	0.00	1.00	0.00	0.00	3.15	0.00	2.00	0.00
CLUB	32.98	0.30	6.14	5.00	2.99	0.10	9.45	8.00	1.00	0.00
COMCATN	22.92	0.50	0.75	0.75	0.03	0.00	6.29	0.00	2.52	12.07
CONFMT	6.65	0.00	0.00	3.00	0.00	0.00	3.15	0.00	0.50	0.00
DET-RR	0.55	0.00	0.00	0.00	0.00	0.00	0.55	0.00	0.00	0.00
DGR	11.49	0.00	2.40	2.74	0.00	0.00	4.80	0.17	1.37	0.00
DINING	36.55	0.00	0.00	6.00	0.00	0.10	9.45	8.00	13.00	0.00
FUELDSP	5.60	0.00	0.00	0.00	0.00	0.00	0.50	0.00	0.05	5.05
GROCERY	51.02	0.00	2.00	4.00	0.00	0.02	12.00	24.00	9.00	0.00
HANGAR	3.60	0.00	0.00	0.50	0.00	0.00	2.10	0.00	1.00	0.00
HOSPITL	26.00	0.00	5.82	4.48	0.00	0.02	8.51	0.90	6.27	0.00
HOTEL	7.65	0.00	0.00	3.00	0.00	0.00	3.15	0.00	1.50	0.00
HSG-FAM	5.02	0.00	0.00	0.10	0.00	0.02	1.30	1.30	2.30	0.00
HUT	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
KENNEL	1.05	0.00	0.00	0.05	0.00	0.00	1.00	0.00	0.00	0.00
LAB-MED	8.55	0.00	0.75	1.00	0.00	0.00	2.80	0.00	2.00	2.00
MTRPOOL	6.55	0.00	0.00	1.13	0.00	0.00	3.16	0.00	2.26	0.00
MWR	9.92	0.93	0.00	0.00	0.16	0.00	6.63	0.04	2.15	0.00
OTHER	17.42	0.00	0.00	0.00	0.00	0.00	13.15	0.00	4.27	0.00
PLT-BLDG	7.88	0.00	0.08	1.00	0.00	0.00	2.80	0.00	2.00	2.00
POOL-OT	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
PRDCTN	10.80	0.00	0.00	1.23	0.00	0.00	3.44	0.00	2.45	3.68
PUMP	0.55	0.00	0.00	0.00	0.00	0.00	0.55	0.00	0.00	0.00
R&D	22.79	0.72	0.25	3.00	0.05	0.00	6.25	0.02	2.50	10.00
REC	17.42	0.00	0.00	0.00	0.00	0.00	13.15	0.00	4.27	0.00
SECURTY	18.90	0.00	0.38	3.00	0.00	0.00	8.00	0.02	2.50	5.00
SHOP	8.55	0.00	0.00	1.10	0.00	0.00	3.07	0.00	2.19	2.19
SHOP-ELC	6.55	0.00	0.00	1.13	0.00	0.00	3.16	0.00	2.26	0.00
SHOP-HVY	11.55	0.00	0.00	1.07	0.00	0.00	2.99	0.00	2.14	5.35
SHOP-WPN	11.80	0.00	0.00	1.09	0.00	0.00	3.06	0.00	2.19	5.46
STOR-HZ	5.00	0.00	0.00	1.00	0.00	0.00	1.00	0.00	0.00	3.00
STOR-UH	2.00	0.00	0.00	0.00	0.00	0.00	2.00	0.00	0.00	0.00
TERMINL	12.01	0.00	0.08	3.05	0.00	0.00	6.35	0.00	2.54	0.00
TRAING	12.29	0.30	0.19	3.00	0.03	0.00	6.25	0.02	2.50	0.00
UTL-VLT	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
WHS	2.97	0.22	0.00	0.25	0.00	0.00	2.00	0.00	0.50	0.00
WHS-CLD	13.00	0.00	0.00	1.00	0.00	0.00	1.00	10.00	1.00	0.00

4.0 ELECTRICAL CONSUMPTION

4.1 METERING AND DATA SUMMARY

There are four sources of electric metering and consumption data at Vandenberg Air Force Base: utility meter readings, on-base metering for base reimbursable facilities, metering by the contracting firm of Keller and Gannon (San Francisco, California), and PNL substation metering.

Utility meter readings are available for three separate feeds to VAFB: the Main Base meter, the Oak Mountain-Miguelito Canyon meter, and the Honda Canyon meter. Approximately 99% of the VAFB electric charges stem from the Main Base, with the remainder for Oak Mountain-Miguelito Canyon and Honda Canyon. To provide appropriate billing data to various Air Force organizations, the total VAFB bill is divided up using engineering judgment into bills for Housing, the VAFB hospital, and the Main Base. A typical month (July 1991) attributes 1.7% of the electricity cost to the Hospital, 5.7% of the cost to Housing, and the remaining 92.6% of the cost to the Main Base. This split is based on a monthly estimate for the Capehart 3, 4 and 5 family housing units (provided by VAFB personnel), and a monthly meter reading for the Hospital. The calculation of total electricity cost is based on the average kWh cost for VAFB (found by dividing the total electric bill by the total kWh used). The blended cost for July 1991 was $0.0707 per kWh.

Table 4.1 shows the electrical demand and consumption for the Main Base meter for the last three years. The primary purpose of Table 4.1 is to identify trends in demand and consumption at VAFB. Billed monthly peak demand has been relatively constant in the range of 27,000 to 29,000 kW for the last two years, and was slightly lower at about 26,000 kW in 1989. Consumption over the same period has ranged from 14,462,000 to 18,144,000 kWh per month, with 1991 showing a higher average consumption than the two previous years. The average consumption for this three-year period was approximately 188,617,008 kWh, for a total cost of $10,485,297. This indicates a blended electrical rate of $0.0556/kWh.

TABLE 4.1. VAFB Electrical Demand and Consumption - 1989 to 1991

Month	Total kWh Consumed	Peak Demand (kW)	Cost	
OCT	15,820,000	27,000	$959,916	
NOV	14,560,000	26,800	$697,936	
DEC	15,302,000	26,900	$670,528	
JAN	15,232,000	26,675	$689,041	FY 1989
FEB	15,414,000	27,150	$711,809	
MAR	15,050,000	27,100	$693,048	
APR	14,896,000	26,250	$691,851	
MAY	14,462,000	26,475	$919,537	
JUN	14,924,000	26,525	$960,118	
JUL	14,854,000	26,875	$975,139	
AUG	14,938,000	27,650	$989,226	
SEP	16,436,000	27,250	$1,051,287	
FY89 TOT	181,888,000		$10,009,441	
OCT	15,624,000	27,425	$1,027,133	
NOV	16,590,000	15,450	$795,429	
DEC	14,812,000	27,150	$684,925	
JAN	15,078,000	28,600	$668,565	FY 1990
FEB	16,856,000	28,325	$736,572	
MAR	15,134,000	27,500	$665,355	
APR	14,560,000	26,975	$639,976	
MAY	15,512,000	28,350	$967,592	
JUN	16,366,000	27,550	$1,040,308	
JUL	16,170,000	28,650	$1,053,790	
AUG	15,162,000	27,600	$996,792	
SEP	16,632,000	27,375	$1,058,297	
FY90 TOT	188,496,000		$10,334,739	
OCT	15,386,000	28,375	$1,012,020	
NOV	17,752,000	27,600	$853,658	
DEC	16,240,000	28,900	$712,133	
JAN	15,372,000	28,475	$707,271	FY1991
FEB	18,144,000	29,575	$842,426	
MAR	15,750,000	28,900	$737,900	
APR	16,226,000	28,600	$759,071	
MAY	15,414,000	28,350	$1,033,396	
JUN	16,450,000	27,625	$1,136,834	
JUL	15,148,000	27,425	$1,071,747	
AUG	17,052,000	28,675	$1,190,956	
FY91 TOT	178,934,000		$10,057,417 (11 months)	

VAFB also meters facilities that are required to reimburse the base for electricity consumed. These facilities are typically occupied by private companies or other federal agencies. A list of these facilities is provided below in Table 4.2.

Including reimbursable metered facilities in the baseline estimate ensures that all electrical consumption is accounted for at VAFB. Those reimbursable facilities that are included on VAFB's Real Property Data Base will be included in both the Baseline report and the following Resource Assessment report. Facilities that are not in the Real Property Data Base will be included only in the Baseline report. This will ensure that any ERO estimates are based solely on facilities and property that are under the control of VAFB.

As a major part of a study upgrading the VAFB electrical system, Keller and Gannon metered every feeder at each substation for a period of about a week. Their metered data were used to provide estimates of transformer and electric distribution system power losses, and also to supplement PNL metered data at substations where PNL was unable to obtain data for long periods of time.

TABLE 4.2. Electric Meters for VAFB Reimbursables

Buiding Name	Electricity Consumption (kWh)
General Telephone	323,850
Southern California Gas Co	2,620
Crestview School	85,600
Los Padres School	146,280
Maple School	74,400
Lake Canyon Trailer Park	360,000
Credit Union	1,590
Middle School	335,160
Lompoc Prison	10606,520
Bank Bldg	1,590
Burger King	195,840
U.S. Sprint	5,020
Total	12,136,890

As part of the overall assessment process at VAFB, PNL metered a number of substations at the base for extended periods of time. At the time of this writing, about 5 months of data are available for substations A, B, C, E, J and L. By examining Keller and Gannon metered data, it was determined that substations D, K, and M exhibited small loads relative to the whole base and therefore PNL did not monitor them. Substation N was monitored by PNL, but no phone line was available at the substation building for data transmission. Therefore, no data are available from Substation N.

The substations were monitored by connecting PNL-developed Field Data Acquisition Systems (FDAS) units to existing kW and KVAR transducers in each substation. Data were collected as hourly averages from all metering points.

The areas served by the various substations at VAFB are listed below in Table 4.3.

TABLE 4.3. Areas Served by Various Substations at VAFB

Substation	Areas Served
	North Vandenberg
A	Hospital, Air Field, and Washington Areas, Capehart Residential Areas, Thor Area, and Tracking Station
B	7000 and 8500 Building Complexes, Nevada, New Mexico, and California Areas, and MX Area
C	RV Area, Water Plant, Federal Correctional Institute
D	Minuteman Launch Complex, Vandenberg Tracking Station technical power, and Peacekeeper Garrison
E	Alternate Feed to Tracking Station
	South Vandenberg
J	Santa Ynez, Lompoc Canyon, and Coast Road
K	SLC-3 (non-critical power)
L	Telemetry and operations radar and industrial areas
M	SLC-4 backup
N	SLC-3 and SLC-4 (critical power)

4.2 ENERGY-USE BREAKDOWN

The electrical consumption at VAFB is shown in Table 4.3. The table includes consumption for all facilities served by the Main Base meter (99% of the total base load), with the exception of the reimbursable facilities listed in the previous section. (These facilities are considered in Table 4.6.) Consumption is apportioned by building type and by primary end use in each building type. Table 4.4 accounts for electrical consumption associated with buildings only. (Table 4.4 does include process loads associated with buildings.)

Table 4.5 breaks down the lighting use shown in Table 4.4 into various lighting technologies such as interior and exterior incandescent, fluorescent, and high intensity discharge. Table 4.6 shows the total electrical usage for buildings (from Table 4.4) along with an accounting of all electrical usage not directly associated with buildings (such as process loads not connected with buildings, transmission and distribution losses, water supply and sewage treatment).

The electrical consumption in Table 4.5 accounts for approximately 99% of the total use for the 1991 typical base year at VAFB. Major components such as streetlighting, water pumping, transmission and distribution losses, and process loads are itemized separately. The non-building process loads are split into two process functions. The first (TRACKING) includes energy use for all functions related to the monitoring and tracking of launched vehicles. The second (LAUNCH SUPPORT) applies to energy used in preparing for and launching a vehicle.

These process loads are important at VAFB as they account for a major portion of energy use that is not associated with other specific buildings. These components are generally targeted for specific energy-use improvements and it is necessary to identify their contribution to the base total. Finally, the energy consumed by the reimbursable account facilities (non-military support facilities) is identified for purposes of completeness. The energy use by these facilities is not typically available for energy improvements funded by VAFB or utility cost sharing because they are controlled by non-military organizations.

TABLE 4.4. Typical VAFB Buildings Electrical Usage (MWh/year)

BLDG TYPE	AREA (ft^2)	TOTAL	LIGHTING	HEATING	COOLING	VENTIL	DHW	COOKING	REFRIG	OTHER	PROCESS
ADMIN	748,232	12,665	4,676	453	75	2,245	337	0	15	1,871	2,993
BRK/ADM	553,421	4,494	1,882	221	0	1,660	133	0	44	553	0
CHAPEL	19,666	121	62	0	0	20	0	0	0	39	0
CLUB	23,000	759	217	7	141	115	69	2	184	23	0
COMCATN	371,840	8,523	2,339	187	281	281	11	0	0	935	4,490
CONFMT	10,850	72	34	0	0	33	0	0	0	5	0
DET-RR	1,369	1	1	0	0	0	0	0	0	0	0
DGR	98,594	1,132	473	0	237	270	0	0	17	135	0
DINING	103,162	3,771	975	0	0	619	0	10	825	1,341	0
FUELDSP	1,991	11	1	0	0	0	0	0	0	0	10
GROCERY	83,287	4,249	999	0	167	333	0	2	1,999	750	0
HANGAR	48,136	173	101	0	0	24	0	0	0	48	0
HOSPITL	118,651	3,085	1,010	0	691	532	0	2	106	744	0
HOTEL	9,872	76	31	0	0	30	0	0	0	15	0
HSG-FAM	2,773,765	13,924	3,606	0	0	277	0	55	3,606	6,380	0
HUT	4,352	0	0	0	0	0	0	0	0	0	0
KENNEL	5,288	6	5	0	0	0	0	0	0	0	0
LAB-MED	106,616	912	299	0	80	107	0	0	0	213	213
MTRPOOL	96,093	629	304	0	0	109	0	0	0	217	0
MWR	159,102	1,578	1,055	148	0	0	26	0	7	342	0
OTHER	6,009	105	79	0	0	0	0	0	0	26	0
PLT-BLDG	92,040	725	258	0	7	92	0	0	0	184	184
POOL-OT	5,778	0	0	0	0	0	0	0	0	0	0
PRDCTN	62,517	675	215	0	0	77	0	0	0	153	230
PUMP	35,589	20	20	0	0	0	0	0	0	0	0
R&D	2,780,446	63,380	17,378	2,004	695	8,341	150	0	56	6,951	27,804
REC	57,555	1,003	757	0	0	0	0	0	0	246	0
SECURTY	95,089	1,797	761	0	36	285	0	0	2	238	475
SHOP	127,952	1,094	393	0	0	140	0	0	0	281	281
SHOP-HVY	11,903	137	36	0	0	13	0	0	0	25	64
SHOP-WPN	67,486	796	206	0	0	74	0	0	0	147	369
STOR-HZ	15,969	80	16	0	0	16	0	0	0	0	48
STOR-UH	857,234	1,714	1,714	0	0	0	0	0	0	0	0
TERMINL	6,971	84	44	0	1	21	0	0	0	18	0
TRAING	205,856	2,529	1,287	62	39	618	6	0	4	515	0
UTL-VLT	38,400	0	0	0	0	0	0	0	0	0	0
WHS	1,083,196	3,222	2,166	244	0	271	0	0	0	542	0
WHS-CLD	8,858	115	9	0	0	9	0	0	89	9	0
TOTAL	10,896,135	133,657	43,408	3,326	2,448	16,610	732	72	6,954	22,946	37,161
PERCENT OF TOTAL	---	100.0%	32.5%	2.5%	1.8%	12.4%	0.6%	0.1%	5.2%	17.1%	27.8%

TABLE 4.5. Buildings Electrical Lighting Usage by Lighting Type (MWh/year)

BLDG TYPE	AREA (ft^2)	TOTAL	INT.INCAN	EXT.INCAN	FLUOR	INT.HID	EXT.HID
ADMIN	748,232	4,676	655	47	3,788	0	187
BRK/ADM	553,421	1,882	282	0	1,524	0	75
CHAPEL	19,666	62	9	1	50	0	2
CLUB	23,000	217	28	4	176	0	9
COMCATN	371,840	2,339	327	23	1,894	0	94
CONFMT	10,850	34	5	0	28	0	1
DET-RR	1,369	1	1	0	0	0	0
DGR	98,594	473	66	5	383	0	19
DINING	103,162	975	136	10	790	0	39
FUELDSP	1,991	1	0	0	1	0	0
GROCERY	83,287	999	140	10	560	250	40
HANGAR	48,136	101	15	0	57	25	4
HOSPITL	118,651	1,010	151	0	818	0	40
HOTEL	9,872	31	4	0	25	0	1
HSG-FAM	2,773,765	3,606	3,245	361	0	0	0
HUT	4,352	0	0	0	0	0	0
KENNEL	5,288	5	1	0	3	1	0
LAB-MED	106,616	299	45	0	242	0	12
MTRPOOL	96,093	304	43	3	170	76	12
MWR	159,102	1,055	158	0	855	0	42
OTHER	6,009	79	12	0	64	0	3
PLT-BLDG	92,040	258	39	0	209	0	10
POOL-OT	5,778	0	0	0	0	0	0
PRDCTN	62,517	215	32	0	120	54	9
PUMP	35,589	20	3	0	16	0	1
R&D	2,780,446	17,378	2,607	0	14,076	0	695
REC	57,555	757	106	8	613	0	30
SECURTY	95,089	761	106	8	616	0	30
SHOP	127,952	393	55	4	220	98	16
SHOP-HVY	11,903	36	5	0	20	9	1
SHOP-WPN	67,486	206	29	2	116	52	8
STOR-HZ	15,969	16	2	0	9	4	1
STOR-UH	857,234	1,714	240	17	960	429	69
TERMINL	6,971	44	7	0	36	0	2
TRAING	205,856	1,287	193	0	1,042	0	51
UTL-VLT	38,400	0	0	0	0	0	0
WHS	1,083,196	2,166	303	22	1,213	542	87
WHS-CLD	8,858	9	1	0	5	2	0
TOTAL	10,896,135	43,408	9,052	524	30,698	1,541	1,592
PERCENT OF TOTAL	---	100.0%	20.9%	1.1%	70.7%	3.6%	3.7%

TABLE 4.6. Overall VAFB Electric Consumption (MWh/year)

Sector	Consumption (MWh/year)	Percent of Consumption
Buildings	133,657	66.9%
Water Supply	3,589	1.8%
Sewage Treatment	352	0.2%
Transformer Losses	6,954	3.5%
Street/Lot Lighting	869	0.4%
Non-Building Process 1 (Tracking)	31,000	15.5%
Non-Building Process 2 (Launch Support)	11,400	5.7%
Reimbursables	11,941	6.0%
Total	199,762	100.0%

A further check of the reasonableness of the building electric EUI values involved the accounting of electrical use on a feeder or substation basis. This requires the accounting of estimated use for all facilities on a particular feeder or substation with its actual metered use. The VAFB electrical system creates a challenge to this form of analysis due to its built-in redundancy capability. This makes it difficult to assure the exact feeder serving various facilities during a year of electrical consumption.

Roughly three months of data available from the metered feeders were first extrapolated for use over a full year. The buildings associated with each feeder were also identified according to data supplied by VAFB personnel. Based on this information an estimate of the building energy use was made for each feeder based on the EUI and square footage values of the associated buildings. The energy accounting for the feeders varied from 10% to 200%. It is thought that this wide variance is due mainly to the use of alternate feeders.

At the substation level, complete metering data was available for the major substation A as well as two smaller stations (C and J). The accounting of building energy use associated with the main commercial area feeders of substation A came to 69% of the total. This compares well with the VAFB building energy use accounting of 67% (see Table 4.5). These feeders serve a

large portion of the base (over 40% of the total consumption) and are considered to present a good representation of VAFB facilities and operations.

The accounting within the two smaller substations was mixed. Substation C accounting was only 10% while that of substation J was 75%. Since these substations serve relatively small areas, the building mix cannot be considered representative of VAFB as a whole, and therefore the data are not as valuable. The total consumption supplied by both substations is also very small, accounting for only 4% of VAFB's total consumption.

This substation level accounting at VAFB (at any substation other than A) is not considered an accurate method for determining baseline energy use since many alternate feeder lines are active. However, the accounting for substation A does provide a reasonable verification of the whole site accounting used in this analysis.

4.3 ELECTRICAL DEMAND SUMMARY

Time-of-use data are available from two sources at VAFB. One source is the metering performed by Keller and Gannon and the other is the metering performed by PNL. Keller and Gannon's metering, while limited to measurements over the course of a single month, covers the entire VAFB transmission and distribution system. The PNL metering used in this report covers a longer time period (5 months), but does not include any data from substation N. (Data were not collected due to the unavailability of a phone line in the substation). Also, PNL's metering does not include substations D, K, or M due to their relatively small contribution to electrical consumption.

The peak system load metered by Keller and Gannon (K&G) was 30.42 MW, occurring on Tuesday, October 22, 1992. A composite weekday load determined from PNL metered data for substations A, B, C, E, J, and L for all weekdays in each month from March 1992 through June 23, 1992 is shown in Figure 4.1. A typical weekday profile can be described as having a baseline of about 21 MW with a peak of about 30 MW occurring in the afternoon and another smaller peak of about 27 MW in the early evening. This profile is reasonably consistent for the first three weeks of Keller and Gannon's metering (although some decrease in consumption is seen on Fridays). The week of November 9 shows

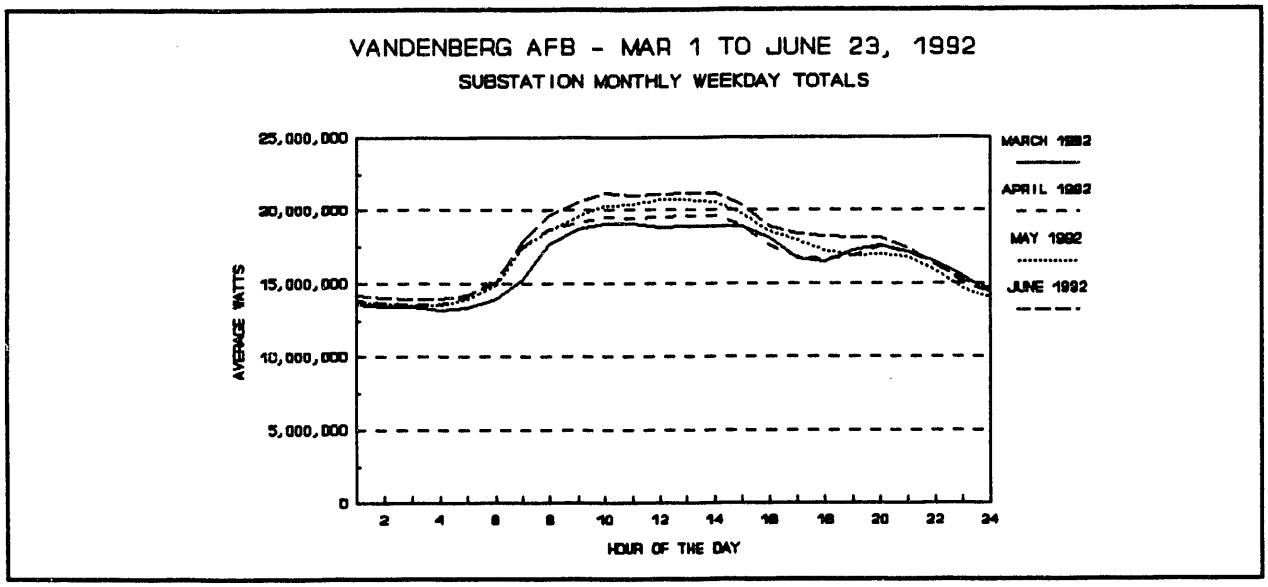

FIGURE 4.1. PNL Metered Substations - Typical Weekday by Month

lower peaks but with a similar baseline. The weekend load can be characterized as having a baseline consumption of 23 MW and a peak consumption of 25 MW with an evening peak very similar to the weekday peak.

The weekday load is very similar for all four months, indicating very little monthly variation. This is to be expected given the very moderate climate at VAFB. A similar plot for the composite weekend load for the substations and months listed above and for the same time period is shown in Figure 4.2. Note that the peak and baseline consumption are lower than that shown by Keller and Gannon. This is due primarily to the lack of substation N data for the period of PNL metering.

Figure 4.3 presents the average weekday and weekend consumption results. This figure shows the average weekday and weekend profiles for the period of March 1 through June 23, 1992.

Analysis of individual substation data indicate the contributions listed below in Table 4.7. Also shown is the estimated totals from the Keller and Gannon metered data. Comparing the PNL and Keller and Gannon totals gives an

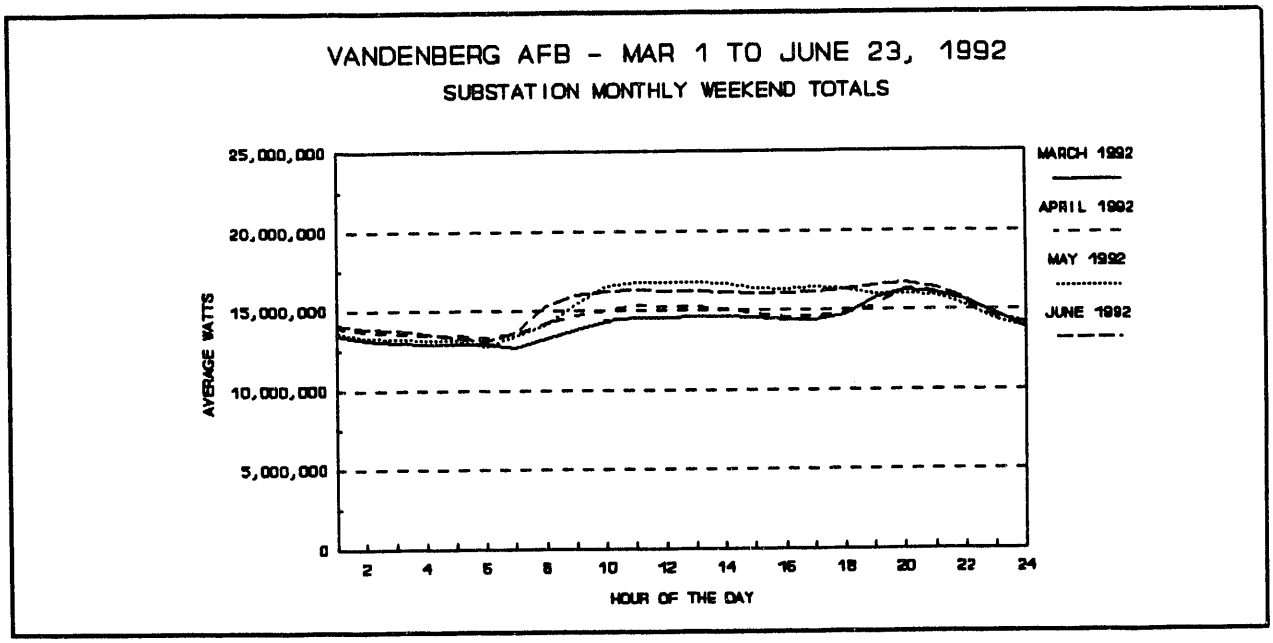

FIGURE 4.2. PNL Metered Substations - Typical Weekend by Month

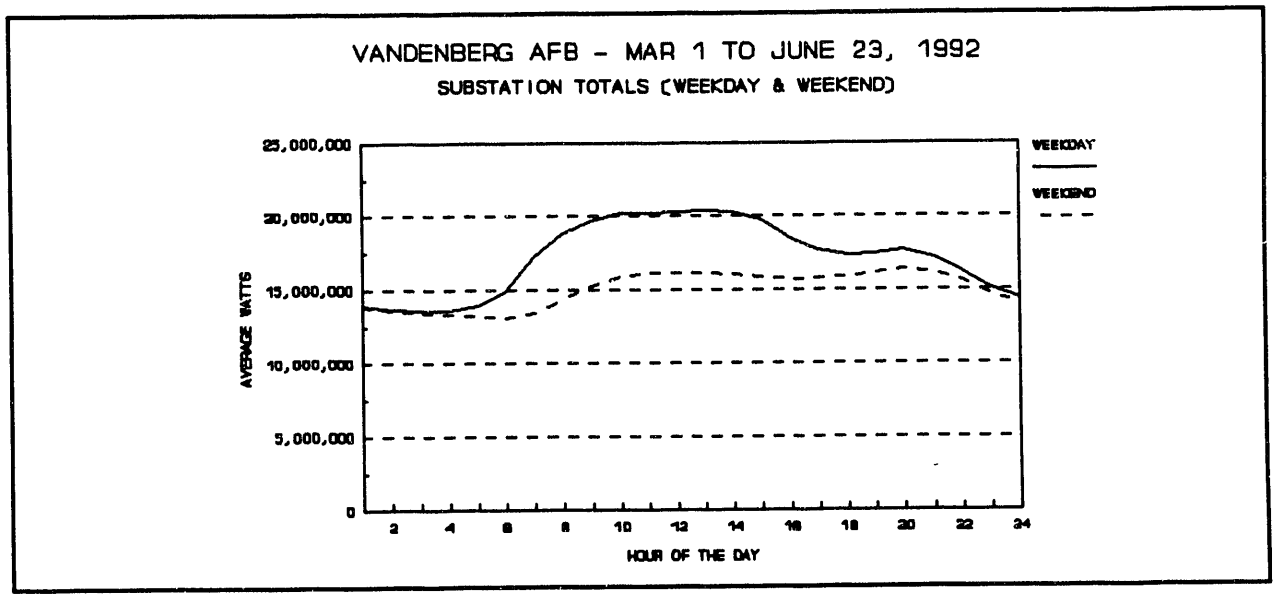

FIGURE 4.3. PNL Metered Substation Totals - Average Weekday and Weekend

estimate of the total load for the three substations that PNL did or could not meter. The majority of the non-metered load is associated with substation N.

TABLE 4.7. VAFB Substation VAFB Weekday Profile (PNL metered)

Substation	Baseload	Afternoon Peak	Evening Peak
A	4.5 MW	6.5 MW	7.0 MW
B	6.0 MW	9.0 MW	6.5 MW
C	2.0 MW	2.5 MW	2.0 MW
D	not metered by PNL (low load)		
E	0.5 MW	0.5 MW	0.5 MW
J	1.0 MW	1.5 MW	1.0 MW
K	not metered by PNL (low load)		
L	0.5 MW	0.5 MW	0.5 MW
M	not metered by PNL (low load)		
N	not metered by PNL (no phone)		
Total	14.5 MW	20.5 MW	17.5 MW

Comparing the PNL metered total with the Keller and Gannon metered total results in an estimate of the combined load of substations D, K, M, and N, as shown in Table 4.8.

Using the estimated substation D, K, M, and N load, a typical weekday profile for VAFB may be created. This profile is shown in Figure 4.4. A similar procedure could be used to derive a weekend profile, but the weekend profile is much lower than the weekday profile and therefore not as important in demand or time-of-use analysis.

TABLE 4.8. Estimate of Load for Substations D, K, M and N.

PNL Metered Total	14.5 MW	20.5 MW	17.5 MW
K&G Metered Total	21.0 MW	30.0 MW	27.5 MW
Difference	6.5 MW	9.5 MW	10.0 MW

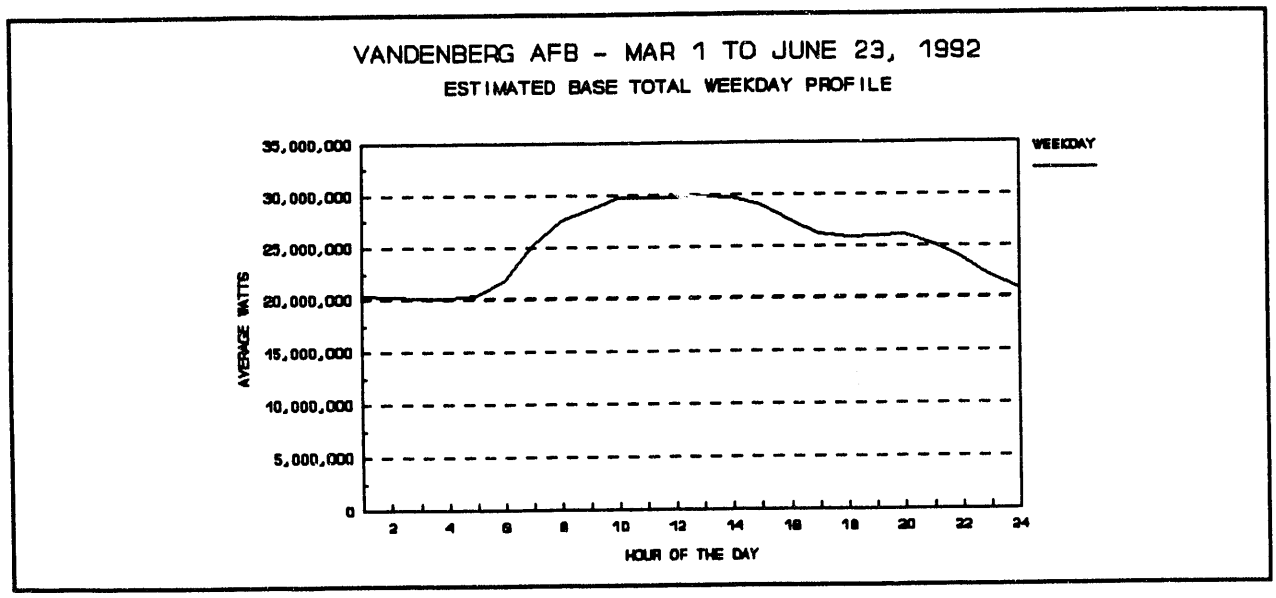

FIGURE 4.4. Estimated VAFB Average Weekday Profile

Because of the low variability in the climate at VAFB, the profile shown in Figure 4.4 is appropriate for use in both summer and winter months at VAFB. It can be seen from Figure 4.4 that VAFB has its peak demand during the PGE summer peak hours of 12:00 noon to 6:00 PM. VAFB's smaller evening peak occurs during PGE summer partial peak hours. Approximately 30% of VAFB's electrical consumption occurs during the six-hour peak period, with another 33% occurring during the seven-hour partial-peak period, and the remaining 37% occurring during off-peak period.

Analysis of individual feeders of substation A indicates that the smaller peak in the evening is due primarily to an increase in loads on the two feeders serving Family Housing. A significant evening peak is also shown on substation C loads. This substation includes both the recreational vehicle (RV) area and the Federal Correctional Institute. The peak here is probably due to residential loads in the RV area.

The baseload electrical demand of VAFB is about 21 MW, compared with the peak demand of 30 MW. This indicates that considerable amounts of electrical equipment is left on at all times. The energy use breakdown for VAFB indicates that close to 50% of the total electrical consumption is due to

process-related loads (Non-Building Process 1 and Non-Building Process 2 in Table 4.5, and the Building Related Process End Use totals in Table 4.3). Because a significant number of these process loads are operational 24 hours a day, it is not surprising that the baseload electrical consumption is such a large fraction of the peak. Other loads undoubtedly contributing to a high baseload consumption include lighting and plug loads left on 24 hours a day in Administration and R&D facilities.

The main peak in the VAFB demand profile is a broad peak between 10:00 AM and 2:00 PM corresponding to the heart of the working hours at the base. Demand begins to rise at about 6:00 AM and reaches a broad plateau by 8:00 AM. Demand peaks in early afternoon and begins to drop off by about 3:00 PM. The drop continues until early evening, when the smaller peak at 7:30 PM forms.

5.0 NATURAL GAS CONSUMPTION

5.1 METERING AND DATA SUMMARY

Natural gas is consumed at Vandenberg Air Force Base in all family housing areas, many of the central VAFB facilities and reimbursable account buildings, as well as several launch and tracking site facilities. Reasonably complete gas metering data provided by VAFB included readings for 1990, 1991, and part of 1992 at 11 specific locations. These locations included reimbursable account facilities such as the U.S. Penitentiary, phone service, credit union, Burger King restaurant and other non-military support services that will not be considered for EROs in the Resource Assessment report. The metered data from calendar year 1991 was used in reconciling the baseline. Gas consumption at the South Vandenberg Power Plant was included in the determination of VAFB consumption.

5.2 ENERGY-USE BREAKDOWN

Natural gas consumption for VAFB is accounted for in Table 5.1. The consumption of gas within buildings is apportioned within each building type to each of its primary end uses. Table 5.2 accounts for the overall natural gas consumption at VAFB. All natural gas consumption for the central VAFB area, launch and tracking sites, family housing, power generation, and other uses is included.

The consumption within each building type has been estimated from metered and regional gas EUI data. The cooking values shown are derived for only those building types that are known or assumed to have significant gas use for food production. The one gas end use in the "other" column of Table 5.1 represents the estimate of gas use for heating swimming pool water and is based on metered data.

The South Vandenberg Power Plant (SVPP) value is directly based on metered data from log sheets (VAFB Form 1167) for the period of February 1991 through January 1992. The reimbursable consumption includes a metered value for the fast food commercial facility as well as estimated consumption for the four public schools at VAFB. (See Table 4.2.) These are the primary gas

users that are unavailable for any proposed energy projects to install EROs and are therefore accounted for separately. The value for other power plants is a rough estimate considered to be approximately 20% of the South Vandenberg Power Plant.

The total base Natural gas consumption shown in Table 5.2 accounts for 92% of the typical yearly use. The 92% accounting is considered within the level of accuracy generally achievable in this type of analysis and any further adjustments were considered unnecessary. The gas use by the SVPP and other power plants is identified as a major use. Specific energy saving analysis associated with power plant use will make use of this information. Again the reimbursable gas use is accounted for as use that is not typically available for VAFB sponsored improvements.

TABLE 5.1. Typical VAFB Natural Gas Consumption By Building Type (MBtu/year)

Bldg Type	Area (ft^2)	Total	Heating	DHW	Cooking	Other
ADMIN	748,232	127,903	85,269	42,634	0	0
BRK/ADM	553,421	27,671	13,836	13,836	0	0
CHAPEL	19,666	905	590	315	0	0
CLUB	23,000	693	245	239	209	0
COMCATN	371,840	13,596	9,888	3,708	0	0
CONFMT	10,850	510	271	239	0	0
DET-RR	1,369	21	21	0	0	0
DGR	98,594	4,403	4,227	175	0	0
DINING	103,162	11,763	4,158	4,056	3,549	0
FUELDSP	1,991	2	2	0	0	0
GROCERY	83,287	4,747	3,914	833	0	0
HANGAR	48,136	963	722	241	0	0
HOSPITL	118,651	10,032	5,196	4,663	173	0
HOTEL	9,872	691	346	346	0	0
HSG-FAM	2,773,765	138,688	69,344	55,475	13,869	0
HUT	4,352	0	0	0	0	0
KENNEL	5,288	79	79	0	0	0
LAB-MED	106,616	5,167	3,180	1,987	0	0
MTRPOOL	96,093	1,922	1,441	480	0	0
MWR	159,102	5,823	4,853	971	0	0
OTHER	6,009	220	220	0	0	0
PLT-BLDG	92,040	1,991	1,327	664	0	0
POOL-OT	5,778	6,847	0	0	0	6,847
PRDCTN	62,517	1,876	1,250	625	0	0
PUMP	35,589	0	0	0	0	0
R&D	2,780,446	166,827	106,769	60,058	0	0
REC	57,555	2,107	1,755	351	0	0
SECURTY	95,089	1,569	1,177	392	0	0
SHOP	127,952	2,363	1,771	592	0	0
SHOP-HVY	11,903	238	179	60	0	0
SHOP-WPN	67,486	1,255	941	314	0	0
STOR-HZ	15,969	160	160	0	0	0
STOR-UH	857,234	0	0	0	0	0
TERMINL	6,971	139	105	35	0	0
TRAING	205,856	9,881	6,587	3,294	0	0
UTL-VLT	38,400	0	0	0	0	0
WHS	1,083,196	17,873	17,873	0	0	0
WHS-CLD	8,858	133	133	0	0	0
TOTAL	10,896,135	569,056	347,828	196,581	17,800	6,847
PERCENT OF TOTAL	---	100.0%	61.1%	34.6%	3.1%	1.2%

TABLE 5.2. Overall VAFB Natural Gas Consumption (MBtu/year)

Sector	Consumption (MBtu/year)	Percent of Consumption
Buildings	569,056	89.2%
South Vandenberg Power Plant	54,607	8.6%
Other Power Plants	10,921	1.7%
Non Reimbursables	3,403	0.5%
Total	637,987	100.0%

6.0 OIL CONSUMPTION

6.1 METERING AND DATA SUMMARY

Oil delivery records for over 40 buildings were provided by Vandenberg Air Force Base personnel that included the 18-month period between October 1990 through March 1992. As the latest complete year of records, the consumption for April 1991 to March 1992 was chosen as representative of yearly use. These data were used to derive EUI values for administration, R&D, shop, and warehouse facilities. Much of the fuel delivered to VAFB was 2% sulphur diesel and motor vehicle diesel (686,000 gallons in 1991). This fuel was not considered in this analysis. Of the remaining fuel, approximately 32% (107,000 gallons) was delivered to three fuel distribution buildings and further distributed to VAFB facilities. This fuel is accounted for within buildings based on estimated EUI values and as part of the power production of emergency backup generators.

6.2 ENERGY-USE BREAKDOWN

Consumption of #2 fuel oil at VAFB is accounted for in Table 6.1. All non-vehicle fuel oil consumption for VAFB is included. The consumption by building type is divided between primary end uses. Since data were not available concerning the exact location of use for all fuel oil, all fuel was assumed to be used within the building types that also had actual delivery records of fuel oil. Table 6.2 provides an overall accounting of #2 fuel oil use at VAFB. Some of this dispensed fuel oil use was also allocated to emergency backup generators. The consumption by the SVPP and the other power plants was derived directly from delivery records.

The fuel oil values in Table 6.2 account for 99% of the non-vehicle oil use at VAFB. All oil deliveries associated with vehicle diesel fuel were excluded from this analysis.

TABLE 6.1. Typical VAFB Fuel Oil Consumption (MBtu/year)

Bldg Type	Area (ft^2)	Total	Heating	DHW
ADMIN	748,232	1,417	1,143	274
BRK/ADM	553,421	0	0	0
CHAPEL	19,666	0	0	0
CLUB	23,000	0	0	0
COMCATN	371,840	0	0	0
CONFMT	10,850	0	0	0
DET-RR	1,369	0	0	0
DGR	98,594	0	0	0
DINING	103,162	0	0	0
FUELDSP	1,991	0	0	0
GROCERY	83,287	0	0	0
HANGAR	48,136	0	0	0
HOSPITL	118,651	0	0	0
HOTEL	9,872	0	0	0
HSG-FAM	2,773,765	0	0	0
HUT	4,352	0	0	0
KENNEL	5,288	0	0	0
LAB-MED	106,616	0	0	0
MTRPOOL	96,093	0	0	0
MWR	159,102	0	0	0
OTHER	6,009	0	0	0
PLT-BLDG	92,040	0	0	0
POOL-OT	5,778	0	0	0
PRDCTN	62,517	0	0	0
PUMP	35,589	0	0	0
R&D	2,780,446	26,247	21,167	5,080
REC	57,555	0	0	0
SECURTY	95,089	172	138	33
SHOP	127,952	0	0	0
SHOP-HVY	11,903	0	0	0
SHOP-WPN	67,486	0	0	0
STOR-HZ	15,969	0	0	0
STOR-UH	857,234	0	0	0
TERMINL	6,971	0	0	0
TRAING	205,856	0	0	0
UTL-VLT	38,400	0	0	0
WHS	1,083,196	15,316	15,316	0
WHS-CLD	8,858	0	0	0
TOTAL	10,896,135	43,152	37,765	5,388
PERCENT OF TOTAL	---	100.0%	87.5%	12.5%

TABLE 6.2. Overall VAFB #2 Fuel Oil Consumption (MBtu/year)

Sector	Consumption (MBtu/year)	Percent of Consumption
Buildings	43,152	92.0%
South Vandenberg Power Plant	4,043	2.0%
Other Power Plants	2,327	5.0%
Emergency Power Plants	450	1.0%
Total	49,972	100.0%

7.0 PROPANE CONSUMPTION

7.1 METERING AND DATA SUMMARY

Propane delivery data was provided by Vandenberg Air Force Base for 54 buildings during the 18-month period from October 1990 through March 1992. As the last complete year of records, the consumption for April 1991 through March 1992 was chosen as representative of yearly use. A majority of the propane use is found in the outlying launch and tracking areas where natural gas pipelines are not available to transport natural gas to the facilities. These data were used to derive EUI values for use in the baseline energy consumption calculations.

7.2 ENERGY-USE BREAKDOWN

Propane consumption for VAFB is shown in Table 7.1. All propane consumption is included. The consumption is apportioned within each building type for each of its primary end uses. In addition, a small estimated amount is allocated to known process-related uses in the launch areas.

All of the propane use at VAFB is accounted for in Table 7.2. According to delivery records, most of the propane is consumed by specific buildings. A small estimated amount is used for launch-related processes.

TABLE 7.1. Typical VAFB Propane Consumption (MBtu/year)

Bldg Type	Area (ft^2)	Total	Heating	DHW	Cooking
ADMIN	748,232	1,452	968	484	0
BRK/ADM	553,421	0	0	0	0
CHAPEL	19,666	0	0	0	0
CLUB	23,000	246	87	85	74
COMCATN	371,840	829	603	226	0
CONFMT	10,850	0	0	0	0
DET-RR	1,369	0	0	0	0
DGR	98,594	0	0	0	0
DINING	103,162	4	0	0	4
FUELDSP	1,991	0	0	0	0
GROCERY	83,287	0	0	0	0
HANGAR	48,136	0	0	0	0
HOSPITL	118,651	0	0	0	0
HOTEL	9,872	0	0	0	0
HSG-FAM	2,773,765	0	0	0	0
HUT	4,352	0	0	0	0
KENNEL	5,288	38	38	0	0
LAB-MED	106,616	1,086	668	418	0
MTRPOOL	96,093	0	0	0	0
MWR	159,102	0	0	0	0
OTHER	6,009	0	0	0	0
PLT-BLDG	92,040	3,249	2,166	1,083	0
POOL-OT	5,778	0	0	0	0
PRDCTN	62,517	0	0	0	0
PUMP	35,589	0	0	0	0
R&D	2,780,446	35,351	22,625	12,726	0
REC	57,555	0	0	0	0
SECURTY	95,089	882	662	221	0
SHOP	127,952	304	228	76	0
SHOP-HVY	11,903	0	0	0	0
SHOP-WPN	67,486	558	419	140	0
STOR-HZ	15,969	0	0	0	0
STOR-UH	857,234	194	145	48	0
TERMINL	6,971	0	0	0	0
TRAING	205,856	0	0	0	0
UTL-VLT	38,400	0	0	0	0
WHS	1,083,196	5,082	3,812	1,271	0
WHS-CLD	8,858	0	0	0	0
TOTAL	10,896,135	49,276	32,420	16,777	79
PERCENT OF TOTAL --		100.0%	65.8%	34.0%	0.2%

TABLE 7.2. Overall VAFB Propane Consumption (MBtu/year)

Sector	Consumption (MBtu/year)	Percent of Consumption
Buildings	49,276	97.7%
Non-Building Process	1,176	2.3%
Total	50,452	100.0%

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APPENDIX A

TRANSMISSION AND DISTRIBUTION SYSTEM

APPENDIX A

TRANSMISSION AND DISTRIBUTION SYSTEM

Most of the transmission and distribution system energy losses are due to transformer losses. Transformers are necessary to convert high voltage distribution power to low voltage utilization power. The total combined losses for the approximately 1,400 distribution transformers at Vandenberg Air Force Base account for about 7.3 million kWh of annual energy losses, contributing over 1000 kW to the peak demand. The methodology for calculating this consumption is given in this appendix.

A.1 TRANSFORMER LOSS METHODOLOGY

Transformer energy loss consists of no-load and load power losses. No-load loss is the energy consumed by the transformer's magnetic field during periods when the transformer is energized. It is dependant on the configuration and design of the device, materials used, and the voltage and frequency of the power. These characteristics remain constant during the loading cycle and, therefore, do not change with transformer load (typically measured in kVA).

Load losses, on the other hand, are produced from resistance in the conductor windings. These losses are a function of the total transformer current, and vary as a function of the transformer load squared.

A.2 TRANSFORMER LOSS CHARACTERISTICS

Table A.1 lists typical no-load and load losses for transformer sizes at VAFB. These data were extrapolated from data contained in Gönen (1986), with interpolation and extrapolation for those sizes not included in Gönen. The load loss given in the table represents operation at full nameplate capacity, as measured in kVA.

TABLE A.1. Individual Transformer Losses by Size

No. of Phases	Voltage (Volts) Primary	Voltage (Volts) Secondary	Capacity (KVA)	Loss (Watts) No-Load	Loss (Watts) Load
1	480	240	5	34	103
1	480	240	10	68	129
1	2400	240	5	34	103
1	2400	240	10	68	129
1	4160	240	5	34	103
1	4160	240	10	68	129
1	4160	480	100	355	835
1	4160	480	225	577	2394
1	4160	480	750	1282	5692
1	4160	480	1500	2351	9887
1	12000	240	5	41	103
1	12000	240	10	68	136
1	12000	240	15	84	198
1	12000	240	25	118	304
1	12000	240	37.5	166	404
1	12000	240	45	177	483
1	12000	240	50	185	535
1	12000	240	75	285	700
1	12000	240	100	355	920
1	12000	240	167	500	1600
1	12000	240	300	749	3202
1	12000	240	333	840	3415
1	12000	240	750	1282	7269
1	12000	277	10	68	141
1	12000	277	100	355	935
1	12000	480	10	68	141
1	12000	480	15	84	203
1	12000	480	25	118	309
1	12000	480	37.5	166	409
1	12000	480	50	185	540
1	12000	480	75	285	715
1	12000	480	100	355	935
1	12000	480	167	500	1500
1	12000	480	250	610	2640
1	12000	480	333	840	2850
3	480	208	75	360	990
3	480	208	225	880	2420
3	600	208	15	106	280
3	600	208	30	173	653
3	600	208	150	560	1690
3	12000	208	15	106	280
3	12000	208	25	149	430
3	12000	208	30	173	486
3	12000	208	45	223	683
3	12000	208	75	360	990
3	12000	208	112.5	530	1270

TABLE A.1. (contd)

No. of Phases	Voltage (Volts) Primary	Voltage (Volts) Secondary	Capacity (KVA)	Loss (Watts) No-Load	Loss (Watts) Load
3	12000	208	150	560	1690
3	12000	208	225	880	2420
3	12000	208	230	1005	3028
3	12000	208	300	1050	3250
3	12000	208	500	1600	5200
3	12000	208	750	1800	8400
3	12000	208	1000	2100	10400
3	12000	480	30	173	483
3	12000	480	50	234	748
3	12000	480	75	360	990
3	12000	480	100	473	1177
3	12000	480	112.5	530	1270
3	12000	480	150	560	1690
3	12000	480	225	880	2420
3	12000	480	300	1050	3050
3	12000	480	500	1600	4900
3	12000	480	750	1800	7600
3	12000	480	1000	2100	8800
3	12000	480	1500	3300	13200
3	12000	480	2000	4050	17500
3	12000	480	2500	4800	21800
3	12000	2400	750	2094	7804
3	12000	2400	1000	2443	9037
3	12000	4160	50	215	465
3	12000	4160	300	1221	2132
3	12000	4160	1800	3905	14054
3	12000	4160	2000	4205	15250
3	12000	4160	5000	8800	33325
3	69000	4160	3750	6500	29000
3	69000	12000	2500	4800	21800
3	69000	12000	2500	4800	21800
3	69000	12000	2500	4800	21800
3	69000	12000	3750	6500	29000
3	69000	12000	3750	6500	29000
3	69000	12000	3750	6500	29000
3	69000	12000	3750	6500	29000
3	69000	12000	3750	6500	29000
3	69000	12000	7500	11600	50600
3	69000	12000	7500	11600	50600
3	69000	12000	7500	11600	50600
3	69000	12000	10000	15000	65000
3	69000	12000	10000	15000	65000
3	69000	12000	10000	15000	65000
3	69000	12000	10000	15000	65000

A.2.1 Peak Power Loss

Transformer loss calculations include both the peak power demand and the annual energy consumption. This distinction is particularly important to assess the impact to the overall electrical consumption, since both demand and energy are billed separately.

The peak transformer demand includes the no-load and load losses. Since transformer loss is a function of load, the maximum transformer loss is coincident with the peak load consumed by VAFB.

The transformer load loss given in Table A.1 represents the loss at nameplate capacity. Since the peak load is normally quite different than the transformer capacity, the actual loss must be adjusted accordingly. Equation (A.1) gives the formula for calculating the demand loss factor (F_{DLS}), used to adjust the transformer loss during peak loading as opposed to nameplate capacity operation. Since the load loss is primarily resistive losses in the windings, this equation is based on the I^2R nature of resistive loss.

$$F_{DLS} = \left(\frac{\text{Peak Load (kVA)}}{\text{Nameplate Capacity (kVA)}}\right)^2 \qquad \text{(A.1)}$$

A.2.2 Annual Energy Loss

To calculate the total annual energy loss of the transformers, both the no-load and load contributions must be properly accounted for. The no-load energy consumption is simply the no-load loss multiplied by the number of hours in the year. The load loss contribution must include the variations in the load. Since seasonal variations in electrical consumption are minimal at VAFB, the difference in load is mainly due to hourly variations in the daily loadshape.

An equation based on empirical data, developed in Gönen (1986), correlates the average transformer loss with the average and peak loads of the system. This formula takes into consideration the I^2R nature of the resistive loss and typical characteristics of daily load variations. The equation is

then modified to account for the difference between the peak load and the nameplate capacity. The energy loss factor (F_{ELS}) is given in Equation (A.2).

$$F_{ELS} = F_{DLS}\left(0.3F_{LD} + 0.7F_{LD}2\right) \tag{A.2}$$

A.3 VAFB TRANSFORMER LOSSES

For the 16 main substation transformers, average and peak loads were obtained from Keller and Gannon (1992) and PNL metered data. A power factor correction multiplier of 1.2 was applied to the peak load, corresponding to a power factor of about 0.85. A load factor of 0.5 was used in cases where the average load on a specific transformer was not available. The demand and energy loss factors are given in Table A.2.

TABLE A.2. Loss Factors for Substation Transformers

Transformer Identity	Peak Load (MVA)	Capacity (MVA)	Demand Loss Factor	Load Factor	Energy Loss Factor
A1	5.899	7.50	0.6187	0.736	0.3712
A2	2.827	10.00	0.0799	0.736	0.0480
B1	5.640	7.50	0.5655	0.665	0.2879
B2	2.564	7.50	0.1169	0.665	0.0595
B3	4.386	10.00	0.1924	0.665	0.0979
C	2.742	3.75	0.5347	0.630	0.2496
D1	0.946	3.75	0.0636	0.500	0.0207
D2	0.211	3.75	0.0032	0.500	0.0010
D3	0.810	3.75	0.0467	0.500	0.0152
E	1.411	2.50	0.3186	0.306	0.0501
J	1.331	3.75	0.1259	0.529	0.0447
K	0.562	3.75	0.0224	0.500	0.0073
L	1.012	2.50	0.1637	0.305	0.0256
M	0.000	2.50	0.0000	0.000	0.0000
N1	2.857	10.00	0.0816	0.500	0.0265
N2	2.927	10.00	0.0857	0.500	0.0278

For the remaining distribution transformers, a diversity factor of 2.0 was applied to the transformers. Diversity is the ratio between the individual maximum demands and the coincident maximum demand. The National Electric Code diversity factor allowances were used in making this estimate (Earley et al. 1989). These transformers have a 30 MVA peak coincident load, and 177 MVA of overall capacity. This yields a demand loss factor of 0.115. Assuming a load factor of 0.6, the energy loss factor is 0.050.

The equations for calculating the overall contribution of transformer losses on the VAFB peak power demand and annual energy consumption are given below in Equations (A.3) and (A.4).

$$\text{Peak Power Loss} = NLL + F_{DLS}\ LL \qquad \text{Watts} \qquad (A.3)$$

$$\text{Annual Energy Loss} = 8.76\ (\ NLL + F_{ELS}\ LL\ ) \qquad \text{kWh/year} \qquad (A.4)$$

where NLL = Transformer no-load loss (watts)
LL = Transformer load loss (watts)

The total transformer power and energy consumption for VAFB, aggregated by transformer size, is given in Table A.3.

TABLE A.3. VAFB Transformer Power Consumption by Size

No. Phases	Voltage (Volts) Primary	Voltage (Volts) Secondary	Capacity (KVA)	No. Units	Per Transformer Peak Demand (kW)	Per Transformer Annual Energy (kWh)	Category Total Peak Demand (kW)	Category Total Annual Energy (kWh)
1	480	240	5	2	0.0	343	0.1	685
1	480	240	10	1	0.1	652	0.1	652
1	2400	240	5	4	0.0	343	0.2	1371
1	2400	240	10	2	0.1	652	0.2	1304
1	4160	240	5	1	0.0	343	0.0	343
1	4160	240	10	1	0.1	652	0.1	652
1	4160	480	100	4	0.5	3473	1.8	13893
1	4160	480	225	2	0.9	6096	1.7	12193
1	4160	480	750	1	1.9	13707	1.9	13707
1	4160	480	1500	1	3.5	24898	3.5	24898

TABLE A.3. (contd)

No. Phases	Voltage (Volts) Primary	Voltage (Volts) Secondary	Capacity (KVA)	No. Units	Per Transformer Peak Demand (kW)	Per Transformer Annual Energy (kWh)	Category Total Peak Demand (kW)	Category Total Annual Energy (kWh)
1	12000	240	5	19	0.1	404	1.0	7676
1	12000	240	10	152	0.1	655	12.7	99540
1	12000	240	15	116	0.1	822	12.4	95353
1	12000	240	25	230	0.2	1166	35.2	268175
1	12000	240	37.5	229	0.2	1630	48.7	373265
1	12000	240	45	1	0.2	1761	0.2	1761
1	12000	240	50	99	0.2	1853	24.4	183490
1	12000	240	75	30	0.4	2801	11.0	84037
1	12000	240	100	33	0.5	3510	15.2	115836
1	12000	240	167	12	0.7	5076	8.2	60916
1	12000	240	300	1	1.1	7955	1.1	7955
1	12000	240	333	3	1.2	8845	3.7	26534
1	12000	240	750	2	2.1	14394	4.2	28788
1	12000	277	10	3	0.1	657	0.3	1971
1	12000	277	100	3	0.5	3517	1.4	10550
1	12000	480	10	22	0.1	657	1.9	14455
1	12000	480	15	3	0.1	824	0.3	2473
1	12000	480	25	50	0.2	1168	7.7	58408
1	12000	480	37.5	36	0.2	1632	7.7	58758
1	12000	480	50	20	0.2	1856	4.9	37112
1	12000	480	75	20	0.4	2808	7.3	56155
1	12000	480	100	12	0.5	3517	5.6	42201
1	12000	480	167	18	0.7	5033	12.1	90590
1	12000	480	250	14	0.9	6493	12.8	90895
1	12000	480	333	9	1.2	8599	10.5	77388
3	480	208	75	2	0.5	3584	0.9	7169
3	480	208	225	1	1.2	8762	1.2	8762
3	600	208	15	1	0.1	1050	0.1	1050
3	600	208	30	1	0.2	1800	0.2	1800
3	600	208	150	1	0.8	5641	0.8	5641
3	12000	208	15	1	0.1	1050	0.1	1050
3	12000	208	25	1	0.2	1492	0.2	1492
3	12000	208	30	2	0.2	1727	0.5	3454
3	12000	208	45	1	0.3	2251	0.3	2251
3	12000	208	75	6	0.5	3584	2.8	21507
3	12000	208	112.5	11	0.7	5195	7.4	57150
3	12000	208	150	11	0.8	5641	8.3	62052
3	12000	208	225	11	1.2	8762	12.7	96382
3	12000	208	280	1	1.4	10122	1.4	10122
3	12000	208	300	10	1.4	10612	14.2	106124
3	12000	208	500	8	2.2	16279	17.6	130232
3	12000	208	750	8	2.8	19424	22.1	155389
3	12000	208	1000	2	3.3	22922	6.6	45844
3	12000	480	30	1	0.2	1726	0.2	1726

TABLE A.3. (contd)

No. Phases	Voltage (Volts) Primary	Voltage (Volts) Secondary	Capacity (KVA)	No. Units	Per Transformer Peak Demand (kW)	Per Transformer Annual Energy (kWh)	Category Total Peak Demand (kW)	Category Total Annual Energy (kWh)
3	12000	480	50	3	0.3	2375	1.0	7126
3	12000	480	75	3	0.5	3584	1.4	10753
3	12000	480	100	6	0.6	4656	3.7	27934
3	12000	480	112.5	1	0.7	5195	0.7	5195
3	12000	480	150	10	0.8	5641	7.5	56411
3	12000	480	225	16	1.2	8762	18.5	140192
3	12000	480	300	19	1.4	10525	26.6	199982
3	12000	480	500	42	2.2	16148	90.9	678236
3	12000	480	750	12	2.7	19075	32.1	228906
3	12000	480	1000	8	3.1	22226	24.9	177806
3	12000	480	1500	6	4.8	34653	28.9	207916
3	12000	480	2000	12	6.1	43094	72.8	517127
3	12000	480	2500	2	7.3	51535	14.6	103071
3	12000	2400	750	1	3.0	21740	3.0	21740
3	12000	2400	1000	1	3.5	25334	3.5	25334
3	12000	4160	50	1	0.3	2086	0.3	2086
3	12000	4160	300	1	1.5	11624	1.5	11624
3	12000	4160	1800	1	5.5	40324	5.5	40324
3	12000	4160	2000	5	6.0	43473	29.8	217363
3	12000	4160	5000	1	12.6	91591	12.6	91591
3	69000	4160	3750	1	6.6	57194	6.6	57194
3	69000	12000	2500	1	4.8	42048	4.8	42048
3	69000	12000	2500	1	8.4	46937	8.4	46937
3	69000	12000	2500	1	11.7	51615	11.7	51615
3	69000	12000	3750	1	10.2	68296	10.2	68296
3	69000	12000	3750	1	7.1	58794	7.1	58794
3	69000	12000	3750	1	7.9	60801	7.9	60801
3	69000	12000	3750	1	22.0	120348	22.0	120348
3	69000	12000	3750	1	8.3	62199	8.3	62199
3	69000	12000	7500	1	17.5	127990	17.5	127990
3	69000	12000	7500	1	40.2	229229	40.2	229229
3	69000	12000	7500	1	42.9	266153	42.9	266153
3	69000	12000	10000	1	20.3	146489	20.3	146489
3	69000	12000	10000	1	20.6	147229	20.6	147229
3	69000	12000	10000	1	20.2	158731	20.2	158731
3	69000	12000	10000	1	27.5	187144	27.5	187144
TOTALS:				1403			1013.7	7285087

A.4 REFERENCES

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Gönen, T. 1986. Electric Power Distribution System Engineering, McGraw-Hill Book Company, New York, New York.

Keller and Gannon 1992. Base Electrical System Upgrade Study of Vandenberg Air Force Base: Pre-Final Report, Keller and Gannon Engineers and Architects, San Francisco, California.

APPENDIX B

EUI DATA SOURCES

APPENDIX B

EUI DATA SOURCES

Tables B.1 through B.24 show the various energy-use intensity values obtained from a number of sources.[a] Tables B.25 and B.26 show the EUI values obtained by climate-adjusting the EUI values used for PNL's assessment of Fort Drum, New York.

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[a] Sources abbreviations in Tables B.1 through B.24: PG&E = Pacific Gas and Electric Company; SCED = Southern California Edison; LADWP = Los Angeles Department of Water and Power; BGP = Burbank, Glendale, Pasadena; EPA/WSCC = Environmental Protection Agency/Western Systems Coordinating Council; CBECS = Commercial Buildings Energy Consumption Survey.

TABLE B.1. Small Office - Electric (kWh/ft^2-yr)

	Heat	Cool	Vent	DHW	Cook	Ref	Int Lgt	Ext Lgt	Office Equip	Other[a]	Total
PG&E	.07	3.67	1.39	.19	.2	.21	4.47	1.0	3.14	3.19	17.53
SCED	.03	3.52	.87	.2	.26	.26	4.83	.93	2.82	2.48	16.20
LADWP	.05	3.72	.94	.21	.27	.28	5.06	1.04	3.24	3.61	18.42
BGP	.1	4.64	1.12	.22	.27	.27	4.93	2.75	2.46	1.2	17.96
EPA/ WSCC	9.3	6.7	1.8	1.3	.6	.2	8.6[b]	-	-	3.1	31.6
CBECS	-	-	-	-	-	-	-	-	-	-	-

(a) Defined as miscellaneous/other EUI.
(b) Number includes interior and exterior lighting.

TABLE B.2. Large Office - Electric (kWh/ft^2-yr)

	Heat	Cool	Vent	DHW	Cook	Ref	Int Lgt	Ext Lgt	Office Equip	Other[a]	Total
PG&E	3.41	3.7	3.74	.31	.09	.1	7.79	1.21	3.2	2.66	26.21
SCED	3.14	5.5	3.01	.33	.1	.11	8.08	.93	2.25	1.82	25.27
LADWP	2.88	5.77	3.22	.33	.11	.11	8.25	1.91	3.44	3.0	28.3
BGP	3.14	5.32	3.19	.34	.1	.11	8.21	1.57	1.97	2.48	26.43
EPA/ WSCC	5.2	6.8	2.8	1.4	.5	.3	7.5[b]	-	-	4.1	28.6
CBECS	-	-	-	-	-	-	-	-	-	-	22.7

(a) Defined as miscellaneous/other EUI.
(b) Number includes interior and exterior lighting.

TABLE B.3. Restaurant - Electric (kWh/ft^2-yr)

	Heat	Cool	Vent	DHW	Cook	Ref	Int Lgt	Ext Lgt	Office Equip	Other[a]	Total
PG&E	3.02	4.32	7.66	1.0	4.24	9.94	6.95	2.56	.05	4.45	44.19
SCED	1.63	6.2	5.7	.41	4.58	10.7	6.94	2.1	.05	3.3	41.61
LADWP	1.7	6.84	5.94	.88	4.67	10.93	7.34	1.91	.06	4.14	44.14
BGP	1.67	6.39	5.97	1.72	4.89	10.59	7.32	4.09	.01	5.13	47.78
EPA/ WSCC	10.3	6.1	2.2	12.8	21.7	6.4	6.1[b]	-	-	2.4	68.0
CBECS	-	-	-	-	-	-	-	-	-	-	30.2

(a) Defined as miscellaneous/other EUI.
(b) Number includes interior and exterior lighting.

TABLE B.4. Retail - Electric (kWh/ft^2-yr)

	Heat	Cool	Vent	DHW	Cook	Ref	Int Lgt	Ext Lgt	Office Equip	Other[a]	Total
PG&E	.28	1.77	1.86	.07	.12	.78	5.29	.92	.33	.89	12.31
SCED	.17	2.75	1.46	.1	.16	.88	5.78	.91	.21	.75	13.17
LADWP	.11	2.38	1.49	.09	.16	.9	5.57	.82	.32	.94	12.78
BGP	.12	2.94	1.54	.11	.16	.88	5.84	1.24	.6	.87	14.3
EPA/ WSCC	4.1	1.0	1.3	.7	1.2	.7	5.4[b]		-	1.3	15.7
CBECS	-	-	-	-	-	-	-	-	-	-	12.2

(a) Defined as miscellaneous/other EUI.
(b) Number includes interior and exterior lighting.

TABLE B.5. Food Store - Electric (kWh/ft^2-yr)

	Heat	Cool	Vent	DHW	Cook	Ref	Int Lgt	Ext Lgt	Office Equip	Other[a]	Total
PG&E	1.29	1.11	2.31	.14	.62	17.49	9.91	1.44	.36	1.79	36.46
SCED	.79	1.06	1.92	.18	.8	21.12	10.88	1.43	.33	1.51	40.02
LADWP	.74	1.08	1.94	.19	.81	21.8	11.11	1.27	.35	1.91	41.2
BGP	.62	1.7	1.87	.2	.84	20.41	10.86	1.92	.65	1.78	40.85
EPA/ WSCC	13.3	3.8	3.2	2.9	12.1	23.7	12.6[b]	-	-	1.9	73.5
CBECS	-	-	-	-	-	-	-	-	-	-	-

(a) Defined as miscellaneous/other EUI.
(b) Number includes interior and exterior lighting.

TABLE B.6. Warehouse - Electric (kWh/ft^2-yr)

	Heat	Cool	Vent	DHW	Cook	Ref	Int Lgt	Ext Lgt	Office Equip	Other[a]	Total
PG&E	.25	.7	.69	.05	-	1.43	3.07	.17	.26	1.46	8.08
SCED	.19	.83	.56	.06	-	1.55	3.2	.16	.14	1.16	7.85
LADWP	.19	.84	.57	.06	-	1.44	3.25	.2	.24	1.78	8.57
BGP	.12	.95	.6	.06	-	1.57	3.24	.21	.46	1.3	8.51
EPA/ WSCC	1.5	1.4	1.0	.7	-	6.1	2.7[b]	-	-	.9	14.3
CBECS	-	-	-	-	-	-	-	-	-	-	7.7

(a) Defined as miscellaneous/other EUI.
(b) Number includes interior and exterior lighting.

TABLE B.7. Elementary School - Electric (kWh/ft^2-yr)

	Heat	Cool	Vent	DHW	Cook	Ref	Int Lgt	Ext Lgt	Office Equip	Other[a]	Total
PG&E	1.21	2.15	1.13	.58	.3	.17	2.88	.75	.48	.41	10.06
SCED	1.27	2.0	.75	.57	.29	.18	2.77	.41	.4	.21	8.85
LADWP	1.0	2.26	.81	.55	.32	.19	2.87	.52	.65	.36	9.53
BGP	.98	2.03	.87	.42	.32	.18	2.86	1.12	.28	.44	9.5
EPA/ WSCC	7.2	1.7	.6	2.9	1.9	.4	4.3[b]	-	.6	19.6	
CBECS	-	-	-	-	-	-	-	-	-	-	8.23

(a) Defined as miscellaneous/other EUI.
(b) Number includes interior and exterior lighting.

TABLE B.8. University/College - Electric (kWh/ft^2-yr)

	Heat	Cool	Vent	DHW	Cook	Ref	Int Lgt	Ext Lgt	Office Equip	Other[a]	Total
PG&E	8.94	3.28	2.38	2.19	.28	.93	2.93	.17	1.36	1.68	24.14
SCED	4.14	4.3	1.75	2.41	.3	1.04	2.89	.1	1.68	.9	19.51
LADWP	1.31	3.99	1.85	2.07	.32	1.06	2.65	.11	1.92	1.32	16.6
BGP	3.11	3.81	1.84	1.84	.32	.97	2.96	.24	.26	1.73	17.08
EPA/ WSCC	4.6	1.9	1.1	3.3	2.1	.4	3.4[b]	-	1.0	17.8	
CBECS	-	-	-	-	-	-	-	-	-	-	-

(a) Defined as miscellaneous/other EUI.
(b) Number includes interior and exterior lighting.

TABLE B.9. Hospital - Electric (kWh/ft^2-yr)

	Heat	Cool	Vent	DHW	Cook	Ref	Int Lgt	Ext Lgt	Office Equip	Other[a]	Total
PG&E	4.56	7.07	2.78	7.05	.26	.54	9.13	.26	3.79	7.74	43.18
SCED	3.46	9.55	2.3	7.94	.31	.6	9.94	.26	2.88	6.63	43.87
LADWP	1.33	11.25	2.31	8.23	.31	.61	9.45	.16	4.73	5.8	44.18
BGP	3.24	9.9	2.35	8.06	.31	.58	9.83	.33	1.72	7.21	43.53
EPA/ WSCC	6.6	4.3	1.9	4.4	7.1	.5	4.5[b]	-	-	1.9	31.2
CBECS	-	-	-	-	-	-	-	-	-	-	13.24

(a) Defined as miscellaneous/other EUI.
(b) Number includes interior and exterior lighting.

TABLE B.10. Hotel/Motel - Electric (kWh/ft^2-yr)

	Heat	Cool	Vent	DHW	Cook	Ref	Int Lgt	Ext Lgt	Office Equip	Other[a]	Total
PG&E	7.15	3.75	1.33	2.24	.5	1.82	3.73	.05	.02	2.34	22.93
SCED	5.49	4.9	.98	2.56	.53	1.95	3.84	.46	.02	1.82	22.55
LADWP	5.01	4.91	1.03	2.59	.55	1.97	3.75	.44	.02	2.43	22.70
BGP	4.27	5.43	1.08	2.62	.56	1.92	3.87	.64	.03	2.14	22.56
EPA/ WSCC	2.7	5.4	1.1	5.2	16.0	.9	4.0[b]	-	-	1.8	37.1
CBECS	-	-	-	-	-	-	-	-	-	-	13.54

(a) Defined as miscellaneous/other EUI.
(b) Number includes interior and exterior lighting.

TABLE B.11. Miscellaneous - Electric (kWh/ft^2-yr)

	Heat	Cool	Vent	DHW	Cook	Ref	Int Lgt	Ext Lgt	Office Equip	Other[a]	Total
PG&E	4.51	4.76	2.02	.73	.09	.11	3.69	.79	.37	.98	18.05
SCED	3.29	5.1	1.56	.79	.1	.12	3.68	.61	.15	.68	16.08
LADWP	3.27	5.59	1.52	.8	.1	.12	3.75	.69	.45	1.04	17.43
BGP	3.0	6.66	1.7	.8	.11	.13	3.79	1.12	.21	1.0	18.52
EPA/ WSCC	8.4	4.3	1.4	.7	1.0	1.0	3.3[b]	-	-	1.4	21.5
CBECS	-	-	-	-	-	-	-	-	-	-	15.67

(a) Defined as miscellaneous/other EUI.
(b) Number includes interior and exterior lighting.

TABLE B.12. Single-Family Residence - Electric (kWh/ft^2-yr)

	Heat	Cool	Vent	DHW	Cook	Ref	Int Lgt	Ext Lgt	Office Equip	Other[a]	Total
EPA/ WSCC	4.18	.67	-	2.44	.58	-	-	-	-	2.63	10.5
RECS[b]	-	-	-	-	-	-	-	-	-	-	9.36

All data available only as UEC (unit energy consumption). EUI calculated assumes 1500-ft^2/single-family residence.

(a) Other category includes refrigeration, lighting, and residual appliances
(b) RECS data are for the West Region.

TABLE B.13. Small Office (kBtu/ft^2-yr)

	Heat	Cool	DHW	Cook	Ref	Other[a]	Total
PG&E	.5	82.58	1.67	5.98	-	13.55	104.28
SCED	.18	82.66	1.18	5.19	-	12.66	101.87
LADWP	.27	75.33	.73	4.94	-	12.83	94.1
BGP	.72	106.07	1.73	5.91	.52	13.36	128.31
EPA/ WSCC	48.9	13	5.9	1.3	-	.5	69.6
CBECS	-	-	-	-	-	-	-

(a) Defined as miscellaneous/other EUI.

TABLE B.14. Large Office (kBtu/ft^2-yr)

	Heat	Cool	DHW	Cook	Ref	Other[a]	Total
PG&E	38.12	98.3	6.4	.52	-	10.74	154.08
SCED	20.36	140.55	5.72	.47	1.47	9.78	178.35
LADWP	18.35	152.2	5.93	.48	1.45	10.16	188.57
BGP	23.84	142.56	6.35	.52	1.46	10.67	185.4
EPA/ WSCC	36.1	59.1	8.9	2.0	-	.7	106.8
CBECS	-	-	-	-	-	-	33.3

(a) Defined as miscellaneous/other EUI.

TABLE B.15. Restaurant (kBtu/ft^2-yr)

	Heat	Cool	DHW	Cook	Ref	Other[a]	Total
PG&E	15.87	95.55	15.79	110.58	-	16.44	254.23
SCED	7.61	145.8	13.97	98.43	33.14	14.99	313.94
LADWP	3.36	153.84	12.96	102.61	33.29	15.27	321.33
BGP	9.89	152.57	16.64	112.55	33.33	16.69	341.67
EPA/ WSCC	101.7	60.0	92.0	141.8	-	-	395.5
CBECS	-	-	-	-	-	-	189.4

(a) Defined as miscellaneous/other EUI.

TABLE B.16. Retail (kBtu/ft^2-yr)

	Heat	Cool	DHW	Cook	Ref	Other[a]	Total
PG&E	1.59	33.64	.51	.22	-	8.54	44.5
SCED	1.01	61.85	.43	.17	7.39	7.97	78.82
LADWP	.54	59.93	.4	.14	7.39	7.94	76.34
BGP	.86	67.08	.52	.22	7.43	8.48	84.59
EPA/ WSCC	33.5	100.8	9.7	4.5	-	-	148.5
CBECS	-	-	-	-	-	-	26.2

(a) Defined as miscellaneous/other EUI.

TABLE B.17. Food Store (kBtu/ft^2-yr)

	Heat	Cool	DHW	Cook	Ref	Other[a]	Total
PG&E	14.89	22.22	1.05	6.25	105.65	27.25	177.31
SCED	7.54	23.2	.88	5.48	-	25.65	62.75
LADWP	5.88	21.89	.55	4.81	-	25.81	58.94
BGP	8.34	33.89	1.05	6.29	-	27.03	76.6
EPA/ WSCC	60.7	-	8.4	3.4	-	-	72.5
CBECS	-	-	-	-	-	-	-

(a) Defined as miscellaneous/other EUI.

TABLE B.18. Warehouse (kBtu/ft^2-yr)

	Heat	Cool	DHW	Cook	Ref	Other[a]	Total
PG&E	1.35	12.36	1.01	.09	-	38.06	52.87
SCED	16.16	15.19	.9	.08	4.7	35.94	72.97
LADWP	15.34	17.72	.61	.09	4.7	37.14	75.6
BGP	.72	18.67	.98	.09	4.73	37.74	62.93
EPA/ WSCC	19.5	2.8	2.1	-	-	1.4	25.8
CBECS	-	-	-	-	-	-	13.2

(a) Defined as miscellaneous/other EUI.

TABLE B.19. Elementary School (kBtu/ft^2-yr)

	Heat	Cool	DHW	Cook	Ref	Other[a]	Total
PG&E	16.2	25.61	2.27	.17	-	19.64	63.89
SCED	10.03	23.45	2.05	.13	-	17.57	53.23
LADWP	7.62	25.37	2.12	.13	-	18.09	53.33
BGP	10.06	32.34	2.45	.17	1.6	19.59	66.21
EPA/ WSCC	58	29.7	17.2	11.1	-	3.0	119
CBECS	-	-	-	-	-	-	46.7

(a) Defined as miscellaneous/other EUI.

TABLE B.20. University/College (kBtu/ft^2-yr)

	Heat	Cool	DHW	Cook	Ref	Other[a]	Total
PG&E	92.32	81.35	10.23	.16	-	14.45	198.51
SCED	46.44	121.48	9.02	.12	-	12.39	189.45
LADWP	46.8	161.5	8.62	.08	-	11.27	228.27
BGP	57.0	138.46	10.91	.18	1.67	15.06	223.28
EPA/ WSCC	51.3	50.6	15.1	14.3	-	5.4	136.7
CBECS	-	-	-	-	-	-	-

(a) Defined as miscellaneous/other EUI.

TABLE B.21. Hospital (kBtu/ft^2-yr)

	Heat	Cool	DHW	Cook	Ref	Other[a]	Total
PG&E	23.34	92.91	30.26	1.31	-	33.97	181.79
SCED	16.56	151.74	29.31	1.24	-	33.32	232.17
LADWP	5.62	109.11	26.41	1.08	-	26.61	168.83
BGP	14.93	183.47	29.6	1.28	7.47	33.31	270.06
EPA/ WSCC	166.1	21.8	35.1	2.7	-	11.9	237.6
CBECS	-	-	-	-	-	-	133.6

(a) Defined as miscellaneous/other EUI.

TABLE B.22. Hotel/Motel (kBtu/ft^2-yr)

	Heat	Cool	DHW	Cook	Ref	Other[a]	Total
PG&E	51.42	34.27	9.75	3.15	-	23.53	122.12
SCED	34.43	-	9.23	2.87	-	22.2	68.73
LADWP	28.24	-	7.94	2.84	-	21.57	60.59
BGP	30.76	-	10.06	3.11	-	23.86	67.79
EPA/ WSCC	172.8	68.1	28.8	13.4	-	6.0	289.1
CBECS	-	-	-	-	-	-	69.4

(a) Defined as miscellaneous/other EUI.

TABLE B.23. Miscellaneous (kBtu/ft^2-yr)

	Heat	Cool	DHW	Cook	Ref	Other[a]	Total
PG&E	38.37	74.94	6.54	.61	-	53.66	174.12
SCED	22.57	89.81	5.61	.52	1.98	48.92	169.41
LADWP	19.46	96.17	5.44	.51	1.99	50.72	174.29
BGP	24.14	112.4	6.71	.61	1.99	53.8	199.65
EPA/ WSCC	45.0	20.8	4.8	1.4	-	3.5	75.5
CBECS	-	-	-	-	-	-	60.7

(a) Defined as miscellaneous/other EUI.

TABLE B.24. Single-Family Residence (kBtu/ft^2-yr)

	Heat	Cool	Vent	DHW	Cook	Ref	Int Lgt	Ext Lgt	Office Equip	Other[a]	Total
EPA/ WSCC	26.91	-	-	.16	.06	-	-	-	-	-	27.13
RECS[a]	-	-	-	-	-	-	-	-	-	-	55.9

All data available only as UEC (unit energy consumption). EUI calculated assumes 1500-ft^2/single-family residence.

(a) RECS data are for the West Region.

TABLE B.25. VAFB Initial Natural Gas EUI's (MBtu/ft^2-yr) (From HDD-Adjusted Fort Drum EUIs)

Building Type	Space Heating	DHW	Cooking	Total
ADMIN	0.032	0.016	0.000	0.048
BRK/ADM	0.025	0.025	0.000	0.050
CHAPEL	0.030	0.016	0.000	0.046
CLUB	0.030	0.040	0.000	0.070
COMCATN	0.032	0.012	0.000	0.044
CONFMT	0.025	0.022	0.000	0.047
DET-RR	0.015	0.000	0.000	0.015
DGR	0.047	0.010	0.000	0.057
DINING	0.041	0.040	0.035	0.116
FUELDSP	0.015	0.005	0.000	0.020
GROCERY	0.047	0.010	0.000	0.057
HANGAR	0.015	0.005	0.000	0.020
HOSPITAL	0.039	0.035	0.000	0.074
HOTEL	0.035	0.035	0.000	0.070
HSG-FAM	0.025	0.020	0.005	0.050
HUT	0.000	0.000	0.000	0.000
KENNEL	0.000	0.000	0.000	0.000
LAB-MED	0.032	0.020	0.000	0.052
MTRPOOL	0.015	0.005	0.000	0.020
MWR	0.300	0.030	0.005	0.335
OTHER	0.025	0.015	0.000	0.040
PLT-BLD	0.020	0.010	0.000	0.030
POOL-OT	0.000	0.050	0.000	0.050
PRDCTN	0.020	0.010	0.000	0.030
PUMP	0.000	0.000	0.000	0.000
R&D	0.032	0.016	0.000	0.048
REC	0.030	0.033	0.000	0.063
RESTRNT	0.041	0.040	0.035	0.116
SECURTY	0.015	0.005	0.000	0.020
SHOP	0.015	0.005	0.000	0.020
SHOP-ELC	0.015	0.005	0.000	0.020
SHOP-HVY	0.015	0.005	0.000	0.020
SHOP-WPN	0.015	0.005	0.000	0.020
STOR-HZ	0.015	0.005	0.000	0.020
STOR-UH	0.015	0.005	0.000	0.020
TERMINL	0.015	0.005	0.000	0.020
TRAING	0.032	0.016	0.000	0.048
UTL-VLT	0.000	0.000	0.000	0.000
WHS	0.015	0.005	0.000	0.020
WHS-CLD	0.015	0.000	0.000	0.015

TABLE B.26. VAFB Initial Electric EUI (kWh/ft^2-year) (from Adjusted Fort Drum EUIs)

Building Type	Fans/Pumps	Lighting	Cooling	Food Prep	Refrigeration	Other	Total
OFF POST HOUSING:							
HGAC	0.070	1.050	0.700	0	0.900	1.995	4.715
HGAR	0.070	1.050	0.700	0	0.900	2.048	4.768
HGEB	0.070	1.050	0.700	0	0.900	2.238	4.958
HGCA	0.070	1.050	0.700	0.450	0.900	1.572	4.742
HGCB	0.070	1.050	0.700	0.450	0.900	1.572	4.742
HGCR	0.070	1.050	0.700	0	0.900	1.648	4.368
HGWC	0.070	1.050	0.700	0	0.900	1.747	4.467
HGCL	0.070	1.050	0.700	0	0.900	1.830	4.550
HGCO	0.070	1.050	0.700	0	0.900	1.991	4.711
HGGN	0.070	1.050	0.700	0	0.900	1.544	4.264
HGGC	0.070	1.050	0.700	0	0.900	1.351	4.071
HGEM	0.070	1.050	0.700	0	0.900	1.830	4.550
HGLO	0.070	1.050	0.700	0	0.900	1.520	4.240
HGPH	0.070	1.050	0.700	0	0.900	1.830	4.550
NEW POST COMMERCIAL:							
NADM	3.000	6.250	0.738	0	0.200	2.500	12.688
NASS	1.000	3.150	0	0	0	2.000	6.150
NBAR	3.000	3.360	0	0	0.800	1.000	8.160
NCLB	5.000	9.450	6.140	0	8.000	11.000	39.590
NCOM	0.100	5.250	14.085	0	0	5.000	24.435
NDGR	4.000	7.000	3.502	0	1.000	2.000	17.502
NGRO	4.000	12.000	1.123	2.500	24.000	7.500	51.123
NHOT	3.000	3.150	0	0	0	1.500	7.650
NMED	5.000	9.400	2.525	0	0.500	4.500	21.925
NMES	6.000	9.450	0	0	8.000	13.000	36.450
NMTH	0.050	0.100	0	0	0	0	0.150
NOTH	0.500	3.150	1.720	0	0	0.500	5.870
NREC	3.000	4.200	1.363	0	0	1.000	9.563
NSHP	1.000	2.835	0.766	0	0	2.000	6.601
NSMA	1.000	2.835	0.298	0	0	2.000	6.133
NWAR	0.100	2.000	0	0	0	0.500	2.600
BRKG	6.000	9.450	0	0	12.000	30.000	57.450

TABLE B.26. (contd)

Building Type	Fans/Pumps	Lighting	Cooling	Food Prep	Refrigeration	Other	Total
ON POST HOUSING:							
HGLE	0.070	1.103	0.700	0.600	0.900	2.000	7.800
HGRA	0.070	1.103	0.700	0.600	0.900	6.900	10.973
HGRH	0.070	1.103	0.700	0.500	0.900	2.200	5.200
HGRE	0.070	1.103	0.700	0.500	0.900	2.200	5.200
HGBO	0.070	1.103	0.700	0.500	0.900	2.200	5.200
HGLI	0.070	1.103	0.700	0.500	0.900	2.200	5.200
HGCL	0.070	1.103	0.700	0.500	0.900	2.200	5.200
HGSL	0.070	1.103	0.700	0.500	0.900	2.200	5.200
HGAD	0.070	1.103	0.700	0.500	0.900	2.200	5.200
HGSU	0.070	1.103	0.700	0.500	0.900	2.200	5.200
HGYO	0.070	1.103	0.700	0.500	0.900	2.200	5.200
HGWI	0.070	1.103	0.700	0.500	0.900	2.200	5.200
HGCA	0.070	1.103	0.700	0.500	0.900	2.200	5.200
HGPA	0.070	1.103	0.700	0.500	0.900	2.200	5.200
HGSA	0.070	1.103	0.700	0.500	0.900	2.200	5.200
OLD POST COMMERCIAL:							
ADM	0.100	5.000	0.231	0	0.200	0.500	6.531
OASS	0.100	3.150	4.069	0	0	0.500	7.819
OBAM	0.100	3.150	0	0	5.000	0.800	10.250
OBAR	1.200	2.100	2.390	0	0	1.000	6.490
OCLB	0.100	9.450	1.223	0	8.000	7.000	25.773
OCLD	0.100	1.050	0	0	10.000	1.000	12.150
OCOM	0.100	5.200	3.001	0	0	2.500	12.301
ODGR	1.000	8.400	1.780	0	0.500	0.500	12.180
OHAN	0.500	2.100	0	0	0	1.000	3.600
OHOT	0.100	3.465	0	0	0.500	2.500	6.565
OHSP	0.100	8.400	5.212	0	0.500	5.500	21.712
OLAU	0.100	4.150	0	0	0	1.000	5.250
OMED	3.037	9.153	4.714	0	0.500	5.500	22.904
OMES	0.100	7.250	0	0	8.000	12.000	35.350
OMTH	0.100	1.050	0	0	0	0.500	1.650
OOTH	0.100	3.150	5.303	0	0	1.000	9.553
OREC	1.000	6.200	10.600	0	0	1.000	26.539
OSHP	2.000	2.835	0.982	0	0	1.000	6.817
OSIM	1.500	7.250	4.572	0	0	15.000	31.322
OWAR	0.100	2.100	0.475	0	0	0.500	3.175
OFF POST COMMERCIAL:							
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