Contra Costa Community College District
pathways to success

Chancellor
Helen Benjamin, Ph.D.

College Presidents
Contra Costa College Denise Noldon, Ph.D.
Diablo Valley College Peter Garcia
Los Medanos College Bob Kratochvil

September 25, 2012

Marc Hamaji, Grand Jury Foreman
Michael Smith, Special Districts/Education Chair
Contra Costa County Grand Jury
P.O. Box 431
Martinez, CA 94553

RE: Information Request of September 13, 2012
Installation of Solar Panels

Honorable Marc Hamaji, Foreman, and Honorable Michael Smith, Special District/Education Chair:

This letter and its attachments are in response to the request for information received from you on September 13, 2012, in regard to our decision to install solar panels to replace grid-delivered electric power at our three college sites. In your request you asked for all documents that were pertinent to the decision made to undertake this energy conservation project, including cash flow analyses, assumptions used for those cash flow models, as well as any information on the sources of capital financing for the project, debt service, and any subsidies that could be received on the project(s).

The full summary and proposal that we received from Chevron in response to our request for a comprehensive energy analysis to assist us with the implementation of numerous energy conservation measures, including solar panel installation on our college sites, are enclosed for your review. As noted, this was a multi-faceted project, so the cost and savings analyses that are included are inclusive of all potential costs, energy reductions, or cost savings from all recommended changes from our facility improvements; they are not limited solely to solar panel installation costs or savings.

Beginning in late 2005, the District began exploring a comprehensive energy conservation plan. We have attached the minutes from the December 14, 2005, Governing Board meeting regarding the discussion on a Districtwide energy conservation and infrastructure plan. It is provided as Exhibit 1. Subsequently, on April 26, 2006, the Governing Board approved a resolution regarding the approval of an energy service contract to explore potential energy savings conservation measures. The pertinent Governing Board documents are attached as Exhibit 2. On May 31, 2006, the Governing Board received a report on comprehensive Districtwide energy conservation measures and services. This report is attached as Exhibit 3.

The following month, the District received a report titled "Contra Costa Community Colleges Comprehensive Energy Analysis" dated June 22, 2006. This report is attached as Exhibit 4. This report provided the District with a comprehensive approach to energy conservation measures Districtwide and included various energy conservation savings projects. A solar power project at each college campus was one element of the analysis. In order to provide context, the entire report is provided, and is summarized in the executive summary beginning on page 1-1. Section 4 of Exhibit 4 describes the details of the energy conservation measures, including a section on solar power for each campus. Solar power for Contra Costa College begins on page 4-2; Diablo Valley College, page 4-26; and Los Medanos College, page 4-63. Section 5 of Exhibit 4 includes the financial analysis for the energy conservation program. Please note that at this stage of the analysis, the pro-forma for the project assumed that a portion of the work would be financed.

On June 28, 2006, the Governing Board approved a contract to design and build various energy conservation measures. At that time, the District was still considering various types of financing to fully fund the project. The Governing Board report from this meeting is attached as Exhibit 5. Once the project was initiated, it was decided that no financing would be included with these projects. The energy conservation savings projects were fully funded using the 2006 Measure A bond. Thus, no finance payments were required.

Exhibit 6 indicates the cost savings analysis of the entire program, and includes a section solely on the projected solar panel savings. This analysis assisted the District in making its decision to fully fund select energy conservation measures, including the solar installation, from the 2006 Measure A bond, thus saving the District any costs associated with financing these projects. To date, the District has received over $8M of the rebates noted in the cost savings projections.

Pursuant to your request, all of the documents associated with your request are included with this letter. If you have any additional questions, please call me at (925) 229-6820 or email me at hbenjamin@4cd.edu.

Sincerely yours,

Helen Benjamin, Chancellor

cc: CCCCD Governing Board
Vice Chancellor, Administrative Services John al-Amin
Chief Facilities Planner Ray Pyle

MINUTES OF THE GOVERNING BOARD OF THE CONTRA COSTA COMMUNITY COLLEGE DISTRICT

Regular Meeting

Date: December 14, 2005

Time: 5:00 p.m. - Closed Session
7:00 p.m. - Regular Session

Place: George R. Gordon Education Center
Board Room
500 Court Street
Martinez, California

Presiding Officer: Sheila A. Grilli, President

ROLL CALL

Present	Absent
Sheila A. Grilli, President	None
John T. Nejedly, Vice President	
David N. MacDiarmid, Secretary	
Jo Ann Cookman	
Tomi Van de Brooke	
Valentin Lorien, Student Trustee	

Those present constituted a quorum.

CALL TO ORDER

The meeting was called to order at 5:00 p.m. The Board immediately recessed to closed session to:

- discuss public employee discipline/dismissal/release;
- discuss public employee performance evaluation - Chancellor;
- discuss liability claim; and
- conference with labor negotiator

RECONVENE PUBLIC SESSION

Board President Grilli reconvened the public session at 7:08 p.m., leading the Pledge of Allegiance to the U.S. flag. President Grilli announced that the Board denied a claim in closed session.

Minutes of December 14, 2005

ENERGY CONSERVATION AND INFRASTRUCTURE PLAN

The attached Energy Conservation and Infrastructure Plan was presented to the Board for information.

ENERGY CONSERVATION AND INFRASTRUCTURE PLAN

Background

In our continuing effort to reduce the consumption and cost of energy and utilities across the colleges, a high-level Feasibility Energy Analysis (FEA) of our District facilities was conducted. These reports provide the District facilities department with the information necessary to address cost-saving energy conservation and energy infrastructure capital projects to be included in a more comprehensive approach to planning and developing the infrastructure necessary to improve future energy conservation measures. These surveys prepare us to identify/prioritize projects, identify/understand funding sources and to focus on energy/cost reduction measures necessary to mitigate the inevitable future costs to operating our colleges. These surveys may also assist us with our decisions regarding our current bond-funded facility infrastructure improvements.

Analysis

Specifically, these energy surveys consist of preliminary energy audits of Diablo Valley College, Contra Costa College and Los Medanos College and have identified energy-efficiency and energy-infrastructure projects that will help save the colleges thousands of dollars per year in energy costs. The measures identified in this report and additional measures that can be identified in more detailed Comprehensive Energy Analysis can be implemented under California Government Code Section 4217.10-18, which governs energy services contracts. This Government Code allows public entities like Contra Costa Community College District to implement energy projects under a design/build scenario and without requiring the construction portion of the project to be publicly bid. As a result, this will expedite the process by which the District can implement energy-conservation and energy-infrastructure projects from inception to design and construction, allowing the District to quickly achieve the cost-saving benefits of such projects.

As an example, below is a typical financial program the District could achieve based on the Energy Conservation Opportunities identified in the audits:

Total Project Cost:	$3,200,000
Less Rebates and Incentives:	$ 300,000
Less Capital Contribution:	$ 300,000
Net Financed Amount:	$2,600,000
Annual Energy and Other Savings:	$ 340,000
Annual Debt Payment: (amortized over 15 yrs at 4.5%)	$ 243,000
Simple Payback:	7.6 years

The FEA is the first phase of a systematic approach to implementing energy infrastructure and cost-saving projects with positive or neutral cash flow to the District. The second phase of the process is to explore all the FEA measures identified in more detail by performing the necessary engineering in order to finalize the scope, savings, schedule, financing, rebates, grants, and costs for the overall project (the Comprehensive Energy Analysis). The Comprehensive Energy Analysis is a firm fixed-price energy project that is ready to proceed to construction. The third phase is construction and commissioning of the project.

The energy solutions are vendor neutral and can include a wide range of services, including analyzing and interpreting energy usage patterns, upgrading inefficient equipment or installing new equipment, improving the quality and reliability of the power that drives operations, and developing specific strategic energy plans.

Conclusion

The Board and District should consider the following:

- hiring a firm to assist us in moving forward with design, development, management, and construction of a wide variety of energy systems;
- delivering these systems turnkey to provide immediate and long-term financial and operational benefits;
- developing central plant solutions, on-site generation, cogeneration and distributed generation projects;
- identifying specific areas of opportunity for operational cost savings through energy efficiency upgrades and energy (and other resource) conservation measures;
- demonstrating there exists sufficient economic justification for moving forward with a Comprehensive Energy Analysis and a program of projects and initiatives clearly identified and fully analyzed therein; and
- taking more sustainable approaches to our energy management as the right thing to do for the environment and the District.

GOVERNING BOARD

CONTRA COSTA COMMUNITY COLLEGE DISTRICT

OF
CONTRA COSTA COUNTY
MARTINEZ, CALIFORNIA

PUBLIC HEARING **DATE** April 26, 2006

PURPOSE Pursuant to Government Code Section 4217.10 through 4217.18, the Contra Costa Community College District (CCCCD) will hold a Public Hearing to Receive Public Comment Relative to Adoption of Findings Identifying Benefits to the CCCCD of an Energy Service Contract, and Approval of an Energy Service Contract at No Cost to the CCCCD for Energy Related Improvements to District Facilities

TO MEMBERS OF THE GOVERNING BOARD

RECOMMENDATION

Review, evaluation and selection of the most qualified energy service contracting firm based on written responses to a Contra Costa Community College District (CCCCD) Request for Qualifications (RFQ) will occur on April 24, 2006.

The CCCCD recommends adoption of the attached resolution identifying the benefits to the CCCCD of an energy service contract and requiring that such contracts be performed at no cost to the CCCCD, and recommends award of an energy service contract to the most qualified firm responding to the RFQ as presented in Board Report No. 80-D.

FUNDING SOURCE

Project costs will be funded entirely from energy cost savings and state and utility company incentive and grant programs.

BACKGROUND

Government Code Sections 4217.10 through 4217.18 require a public hearing at a regularly scheduled public agency governing board meeting to assess and declare by resolution the benefits to the public agency of an energy services contract, and prior to award of a contract for energy services contracting. The notice of this public hearing was posted on April 12, 2006.

Disposition **APPROVED** Governing Board Date APR 2 6 2006 JoAnn Cookman Secretary

CONTRA COSTA COMMUNITY COLLEGE DISTRICT RESOLUTION TO APPROVE AN ENERGY SERVICE CONTRACT

WHEREAS, California Government Code Section 4217.10 to 4217.18, authorizes the Contra Costa Community College District (CCCCD) Governing Board to enter into an energy service contract for the implementation of energy related improvements if the CCCCD Governing Board finds that it is in the best interest of the CCCCD to enter into such energy service contract and that the anticipated cost to the CCCCD for thermal or electrical energy or conservation services provided by the energy conservation facility under the contract will be less than the anticipated marginal cost to the CCCCD of thermal, electrical, or other energy that would have been consumed by the CCCCD in absence of those purchases; and

WHEREAS, the cost to the CCCCD for the energy service contract by and between the CCCCD and the best qualified respondent to a Request for Qualifications (RFQ) for the implementation of certain energy measures for thermal or electrical energy or conservation services will be less than the anticipated marginal cost to the CCCCD of thermal, electrical, or other energy that would have been consumed by the CCCCD in absence of the implementation of the improvements under the energy service contract.

NOW, THEREFORE, BE IT RESOLVED, that the CCCCD Governing Board adopts the following resolution:

"The Contra Costa Community College District (CCCCD) Governing Board finds that (1) it is in the best interest of the CCCCD to enter into an energy service contract with the best qualified respondent to a Request for Qualifications (RFQ) for the implementation of certain energy related improvements to the CCCCD facilities, and (2) the anticipated cost to the CCCCD for thermal or electrical energy or conservation services provided by the energy conservation facility under the contract will be less than the anticipated marginal cost to the CCCCD of thermal, electrical, or other energy that would have been consumed by the CCCCD in absence of those purchases. Therefore, the CCCCD Governing Board hereby authorizes the CCCCD to execute the energy service contract by and between the CCCCD and the best qualified respondent to an RFQ for the implementation of certain energy related improvements to the CCCCD facilities in accordance with these findings and California Government Code Section 4217.10 to 4217.18."

PASSED AND APPROVED by the Governing Board of the Contra Costa Community College District of Contra Costa County, California, this 26th day of April, 2006, by the following vote:

AYES - John T. Nejedly, David N. MacDiarmid, Jo Ann Cookman, Tomi Van de Brooke, Sheila Grilli,
NOES -
ABSENT -

I hereby certify that the foregoing is a full, true, and correct copy of a resolution passed and adopted by the Governing Board of the Contra Costa Community College District at its regular meeting of the Governing Board held on the 26th day of April, 2006.

Jo Ann Cookman

Secretary of the Governing Board
Contra Costa Community College District

April 12, 2006

PUBLIC NOTICE

Subject: ENERGY SERVICES CONSERVATION CONTRACT
Public Hearing on April 26, 2006
Los Medanos College
2700 E. Leland Rd., Pittsburg, CA 94565
Meeting Time: 5:00 p.m.

The Contra Costa Community College District will convene a public hearing regarding its consideration of an energy service contract, in accordance with Chapter 3.2, section 4217 of the California State Government Code, with the best qualified respondent to a Request for Qualifications (RFQ).

GOVERNING BOARD

CONTRA COSTA COMMUNITY COLLEGE DISTRICT

OF
CONTRA COSTA COUNTY
MARTINEZ, CALIFORNIA

REPORT NO. 80-D **DATE:** April 26, 2006

PURPOSE Adopt Findings Relative to the Benefits to the District of an Energy Service Contract, and Approve an Energy Service Contract at No Cost to the District for Energy Related Improvements to District Facilities.

TO MEMBERS OF THE GOVERNING BOARD

RECOMMENDATION

Review, evaluation and selection of the most qualified firm based on written responses to a District Request for Qualifications (RFQ) will occur on Monday, April 24, 2006.

A resolution identifying the benefits to the District of energy service contracts and requiring that such contracts be performed at no cost to the District along with a recommendation to award the contract to the most qualified firm responding to the RFQ will be distributed the evening of the Board meeting.

FUNDING SOURCE

Project costs will be funded entirely from energy cost savings and state and utility company incentive and grant programs.

BACKGROUND

This project implements a comprehensive energy savings program Districtwide by consolidating implementation of quantified energy savings measures with state and public utility incentive and grant programs for energy consumption reduction.

Disposition **APPROVED** Date APR 26 2006 Jo Ann Cookman
Governing Board Secretary

Minutes of April 26, 2006

Board Report No. 80-C – Change and Correction to Contract No. 6164 with John Plane Construction, Inc., for Liberal Arts Building heating, ventilating and air conditioning and roof replacement at Diablo Valley College. Correction to Change Order No. 2R adds $71,388.64 to the contract amount for owner-requested contract changes to replace water tanks required to complete work, construction drawing clarifications for fascia/platform transition and HVAC mounting, and differing field site conditions to replace dry rotten lumber, re-route electrical conduits and modify shaft walls. Project costs will be funded by State Capital Schedule Maintenance Construction Program and Local (Measure A) bond funds.

On motion of Mr. MacDiarmid, seconded by Ms. Grilli, by unanimous vote, (Student Trustee Advisory Vote – aye), the Governing Board authorized the Assistant Secretary to execute Correction to Change Order No. 2 to Contract No. 6164 with John Plane Construction, Inc., for Liberal Arts Building heating, ventilating, and air conditioning and roof replacement at Diablo Valley College.

Original Contract Amount	$1,488,508.00
Change Order No. 1	109,392.15
Change Order No. 2R	71,388.64
Total Adjusted Contract Amount	$1,669,288.79

John Plane Construction, Inc. has completed all work in connection with the heating, ventilating, and air conditioning and roof replacement at Diablo Valley College in accordance with plans and specifications prepared by Interactive Resources, Richmond, California.

Further, the Assistant Secretary was authorized to pay $83,464.44, which is fifty percent of the total amount in retention, and that authorization be given to pay the remaining fifty percent, which is $83,464.43, at the expiration of the 35-day lien period, providing no liens are filed and all punch list items are completed and as-builts are submitted.

Board Report No. 80-D – Adopt Findings Relative to the Benefits to the District of an Energy Service Contract, and Approve an Energy Service Contract at no Cost to the District for Energy Related Improvements to District Facilities. This project implements a comprehensive energy savings program Districtwide by consolidating implementation of quantified energy savings measures with state and public utility incentive and grant programs for energy consumption reduction. Project costs will be funded entirely from energy cost savings and state and utility company incentive and grant programs.

On motion of Mr. MacDiarmid, seconded by Ms. Van de Brooke, by unanimous vote, (Student Trustee Advisory Vote – aye), the Governing Board authorized the Assistant Secretary to review, evaluate and select the most qualified firm based on written responses to a District Request for Qualifications that occurred on April 24, 2006. The resolution identifying the benefits to the District of energy service contracts and requiring that such contracts be performed at no cost to the District was discussed and approved earlier during the Public Hearing.

MINUTES OF BOARD FINANCE COMMITTEE MEETING – MARCH 28, 2006

The attached Minutes of the March 28, 2006, Board Finance Committee meeting of the Contra Costa Community College District were presented to the Board for information.

Minutes of May 31, 2006

PUBLIC COMMENT

Bernadette Green, Local One President, introduced Jason Cueva who will fill in for Carl Doolittle, Local One Business Agent, during his leave of absence. Terry Simpson, retired Chief of Police, Pleasant Hill, spoke on behalf of the District police services and commended the force for their service to the District. He also thanked Police Chief Charles Gibson and Jeffrey Kingston, Vice Chancellor, Facilities and Operations, for overseeing the department and managing it so well. Kristen Martinez, a police aide and student at Los Medanos College (LMC) spoke of the many opportunities she has had as a result of working for police services. She praised the department for their service to students and the District.

Terrence Elliott praised the Contra Costa College (CCC) speech team. Together with President McKinley Williams and speech/debate instructor Connie Anderson, four of the students who helped the CCC team win 11 awards at a national competition were introduced and congratulated. James Simmons congratulated Valentin Lorien for his year of service and commitment to students Districtwide.

EDUCATIONAL REPORTS

Energy Services Program

David Baldwin, P.E., Director, Energy Management and Bruce Dickinson, Regional Manager, Chevron employees, presented the attached report on a proposed Districtwide Energy Services Program. Ms. Van de Brooke asked why the energy consumption for LMC and Diablo Valley College (DVC) were so much higher than that of CCC. Mr. Baldwin said a differential exists because of the location of LMC and DVC and the vast differences in temperatures in West County and Central and East County. Ms. Van de Brooke asked about the lifespan for new facilities. Mr. Kingston said electrical can last for 40 or more years; air conditioning can last between 15 to 20 years; and buildings can last between 20 to 30 years. In response to Ms. Van de Brooke's question on the use or recycled water, Mr. Kingston stated that DVC and LMC use recycled water, the former from the Central Sanitary District.

Mr. Kingston further added that the electrical consumption at the colleges is decreasing. Mr. Baldwin said he would meet with Mr. Kingston and his staff in mid-June to go over a final energy savings plan for the District. This report will be presented at the June 28, 2006, Board meeting. Mr. Nejedly thanked Mr. Baldwin and Mr. Dickinson for their presentation.

Chevron

Contra Costa Community College District

Comprehensive Energy Analysis, Renewable Energy & Utility Master Plan
Program Summary

Chevron Energy Solutions
San Francisco, CA

May 31, 2006

Overview

- District-wide Energy Program Goals
- Utility Expense Comparison
- Process / Timeline
- Key Findings
- Measure Selection Criteria
- Energy Program Impacts

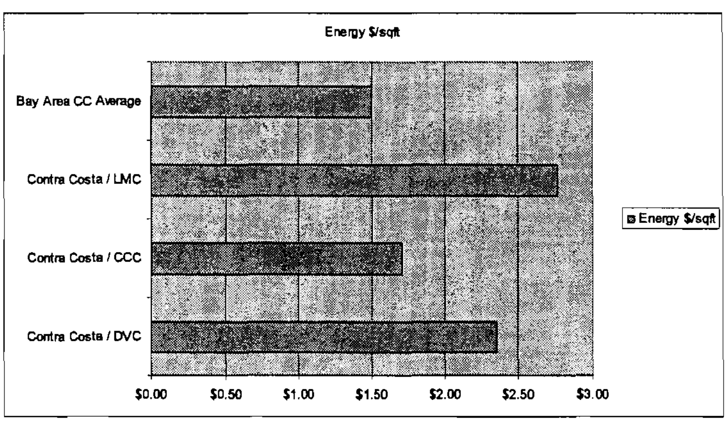
2

Program Goals

- Reduce Utility Expenses
- Improve Energy Efficiency
- Expand Use of Renewable Energy
- Implement Water Conservation
- Decrease Exposure to Price Volatility
- Increase Operational Control & Reliability

3

Utility Expenses – N.California Comparison



4

Multi-phase Turn-key Program Approach

Feasibility Study → **Comprehensive Analysis** → **Design/Build Implementation**

•FEA Report
•Partnership Program Rebate Application

•Campus Community Meetings/Town Hall
•PV Design/Siting/Procurement Recommendations
•Identify Program Financing Options
•Identify Other Rebates, Grants, Incentives
•Deliver CEA Report
•*Proposal for Infrastructure Master Planning Services*

•Construction of Phase 1 Projects
•Commissioning of Projects
•Obtain available rebate/grant monies
•*Deliver Utility Infrastructure Master Plan*

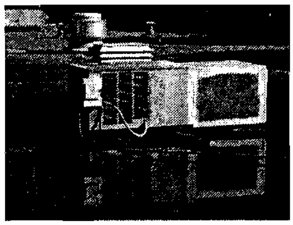
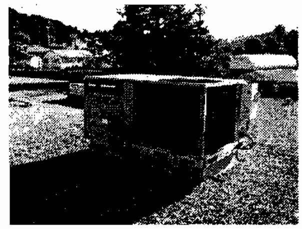
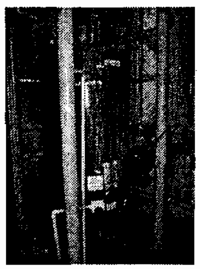
5

Comprehensive Energy Audit
The Process

- Survey & Physical Analysis of Systems
  - Mechanical / HVAC
  - Lighting and Environmental Controls
  - Electrical, Natural Gas and Water Systems
- Interview Staff (usage/habits/needs)
- Review Energy & Operations Data
  - Monthly/Annual Expenditures & Usage
- Scope Development & Constructability Review
- Preliminary Report - Energy Efficiency & Water Upgrades in Phases (60 Energy Saving Measures)

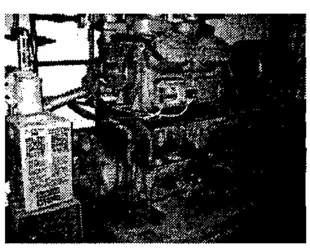
6

Comprehensive Energy Audit Key Findings


7

Comprehensive Energy Audit Key Findings



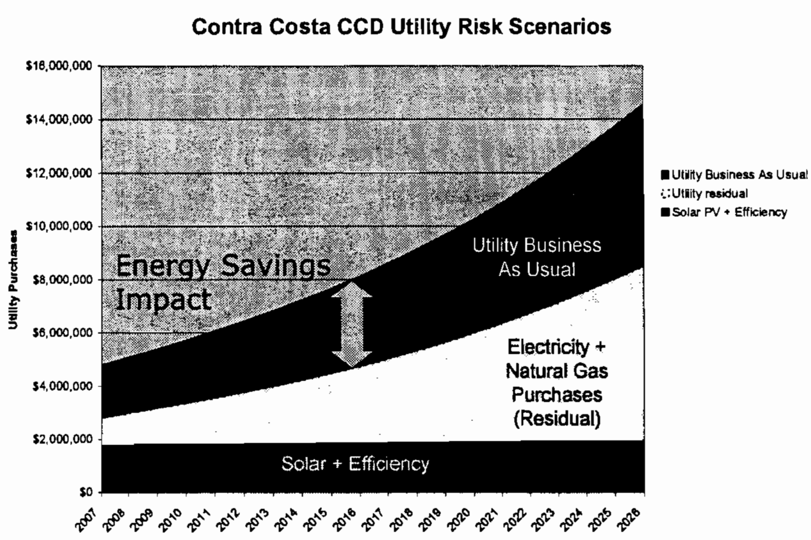

8

Energy and Water Measures Selection Criteria

- Reduce Utility Expenses
- Decrease Equipment Failure Rate/Improve Performance
- Reduce Overall Maintenance Expenses
- Integrate with Bond Master Plan Phases
- Increase Operational Control
- Improve Learning & Workplace Environment
- Increase Reliability of Service
- Increase Use of Renewable Energy
- Decrease Exposure to Volatility
- Return on Investment/Life Cycle Savings

9

Utility Portfolio - Scenarios



10

Table of Contents

Section 1

Executive Summary

Chevron Energy Solutions (ES) is pleased to provide this comprehensive energy analysis (CEA) to the Contra Costa Community College District (CCCCD) staff in support of the district's goals of improving the efficiency and management of energy and water utilization while reducing utility expenditures.

Overview

This CEA for the Phase 1 Energy Conservation Program includes energy, water and maintenance cost reductions for the District Office (DO) in Martinez and for three college campuses:

- Diablo Valley College (DVC)
- Contra Costa College (CCC)
- Los Medanos College (LMC)

The CEA report explores in more detail the energy measures of interest to CCCCD, including solar photovoltaic systems, energy management measures submitted as part of the statewide partnership program, and additional measures that were identified during the comprehensive study.

The CEA report summarizes the results of Chevron ES's evaluation of energy utility data, survey of the energy systems and equipment, and analyses of the energy savings and installation costs for a range of energy conservation measures (ECMs) at each facility.

A summary of the conservation and facility improvement measures that are recommended are presented in Table 1-1. **The total first-year utility and operational savings to be realized from implementation of the measures is approximately $1.45 million.** Chevron ES's objective in this effort has been to maximize the savings potential and provide a program in which the savings fund the energy measures. We look forward to implementing a successful savings program.

This CEA provides an extensive program for reducing energy costs and recommends further study in two main areas:

- Infrastructure master planning services
- Central chilled water plants

Table 1-1: Phase 1, Recommended Measures

Site	ECO	Task Description	1st Year Utility Savings	Maint. Savings	Rebates	kW savings	kWh savings	Therms savings	HCF Water Savings
Contra Costa College									
CCC	PV1	Photovoltaic System -	$ 228,067	$ (2,000)	$ 2,580,000	394	1,267,040		
CCC	L1	Lighting Retrofit	$ 53,244	$ 8,085	$ 63,893	116	425,953		
CCC	EMS1	PC Energy Mgmt software	$ 15,270		$ 18,324		129,795		
CCC	EMS2	Compressor Controllers	$ 2,022	$ -	$ 2,426	-	16,176		
CCC		**subtotal**	**$ 298,603**	**$ 6,085**	**$ 2,664,643**	**510**	**1,838,964**		
Diablo Valley College									
DVC	PV1	Photovoltaic System -	$ 246,459	$ (2,000)	$ 2,700,000	412	1,332,210		
DVC	L1	Lighting Retrofit	$ 183,457	$ 15,770	$ 179,860	382	1,199,065		
DVC	EMS1	PC Energy Mgmt software	$ 35,045		$ 34,358		229,050		
DVC	EMS2	Compressor Controllers	$ 7,965		$ 7,809	-	52,059		
DVC	H2O	Water Conservation	$ 11,449						4,506
DVC	TX1	Primary Tx Upgrade	$ 118,757	$ (5,000)					
DVC	UMP	Utility Master Plan							
DVC		**subtotal**	**$ 603,132**	**$ 8,770**	**$ 2,922,027**	**794**	**2,812,384**		
Los Medanos College									
LMC	PV1	Photovoltaic System -	$ 243,798	$ (2,000)	$ 2,745,000	419	1,354,600		
LMC	L1	Lighting Retrofit	$ 40,838	$ 4,796	$ 64,000	77	277,812		
LMC	POOL	New Pool Filtration Systen	$ 8,920	$ 30,000	$ -	0.90	60,792		
LMC	EMS1	PC Energy Mgmt software	$ 13,468		$ 13,468		91,620		
LMC	EMS2	Compressor Controllers	$ 2,375		$ 2,423	-	16,156		
LMC	TX1	Primary Tx Upgrade	$ 95,282	$ (5,000)					
LMC	H2O	Water Conservation	$ 2,426						927
LMC		**subtotal**	**$ 407,107**	**$ 27,796**	**$ 2,824,891**	**497**	**1,800,980**		
District Office									
DO	L1	Lighting Retrofit	$ 11,084	$ 864	$ 53,000	16	81,502		
DO	EMS1	PC Energy Mgmt software	$ 7,788		$ 11,650		84,000		
DO	EMS3	New Energy Mgt Controls	$ 12,544	$ 10,000	$ 21,364	-	64,714	3,151	
DO	HVAC1	New Boiler, Chiller, Coolin	$ 12,598	$ 30,000	$ 13,934	47	68,371	2,801	
DO		**subtotal**	**$ 44,014**	**$ 40,864**	**$ 99,948**	**63**	**298,587**	**5,951**	
All		**total**	**$ 1,352,856**	**$ 83,515**	**$ 8,511,510**	**1,864**	**6,750,915**	**5,951**	**5,433**

Implementation of the recommended measures will provide CCCCD with a reduced exposure to future energy price escalation. Projected energy costs are illustrated in Figure 1-1.

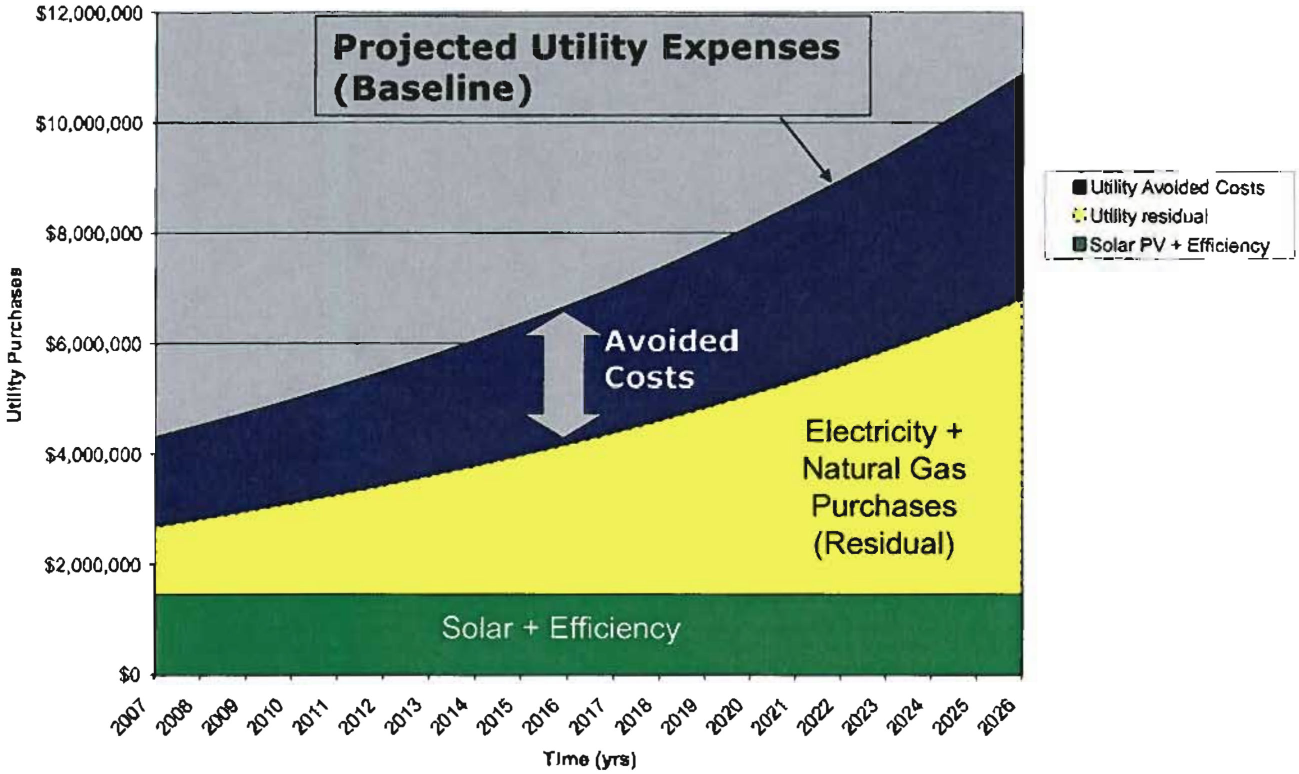


Figure 1-1: Contra Costa CCD Utility Risk Scenarios

Benefits

Implementation of the recommended measures will provide the following key benefits:

- Economic leadership
- Utility and state grants and incentives
- Environmental stewardship
- Integration with CCCCD facility operations processes
- Improved workplace environment and operations
- State-of-the-art energy infrastructure upgrades
- Infrastructure master planning services and central chilled water plants

Economic Leadership

CCCCD will maintain economic leadership by:

- Generating approximately $1.45 million in annual utility and operating cost avoidance and more than $50 million in cost avoidance over the project's useful lifetime.
- Forming a hedge against future electricity price volatility.
- Potentially financing the project through energy savings and incentives, requiring no capital contribution from district finances.

Utility and State Grants and Incentives

The total cost for Phase 1 can be reduced through grants and incentives totaling over $8.5 million.

Environmental Stewardship

CCCCD will advance its environmental stewardship because:

- Energy conservation and efficiency reduces annual electric grid consumption by about 6.75 million kilowatt-hours, which is the equivalent of approximately 1,125 residences.
- Total natural gas savings is estimated to be 5,590 therms per year.
- Carbon dioxide (CO_2) emissions are reduced by 5.89 million pounds per year.

Integration with CCCCD Facility Operations Processes

Throughout the CEA program, Chevron Energy Solutions will coordinate project schedules with CCCCD staff and will implement key facility renovation activities with site-specific work and class schedules. Our construction management personnel will be onsite to manage the contractors and construction activity and handle inquiries, deliveries, and project/construction meetings.

Improved Workplace Environment and Operations

Implementing the recommended measures:

- Delivers more effective lighting systems, lighting controls and energy management system (EMS) controls in offices, classrooms and common-use areas.
- Provides improved environmental controls and indoor air quality by repairing, replacing, and/or installing modern heating, cooling, ventilation and energy management equipment.

State-of-the-Art Energy Infrastructure Upgrades

Chevron ES can upgrade the district's energy infrastructure by:

- Making needed repairs and upgrades to the heating, ventilation and air conditioning (HVAC) systems, EMS controls and roofing.
- Installing new electrical infrastructure at DVC and LMC, which improves the reliability of the electrical equipment.

Infrastructure Master Planning Services and Central Chilled Water Plants

CCCCD would benefit from the following:

- Chevron ES proposes to develop a comprehensive infrastructure master plan for DVC.
- Chevron ES has identified the potential for a centralized chilled water plant and proposes to develop an expandable approach at DVC.

Work Performed

Chevron ES performed the preliminary work under contract to CCCCD according to the Energy Audit Agreement. Chevron ES staff met with maintenance, administration and finance representatives, attended meetings, and discussed numerous energy measures. After gathering the necessary information, Chevron ES was able to produce a Feasibility Energy Assessment (FEA) report and a comprehensive energy analysis.

FEA and Partnership Program

The first step in the planning effort was to complete the Feasibility Energy Assessment report for DVC. This report identified a list of potential measures and provided a good basis for identifying cost-effective measures at the other campuses. From this list of measures, CCCCD submitted Forms 1 and 2 for the statewide partnership program, enabling the district to secure substantial incentives for project funding. CCCCD also secured approximately $9.5 million in incentive funding for three megawatts of solar photovoltaic systems at the campuses. Chevron Energy Solutions focused its CEA effort on these specific measures.

Comprehensive Energy Analysis

For the CEA report, Chevron Energy Solutions performed the following tasks:

- Reviewed and copied (where appropriate) existing documentation, including drawings, utility bills, operating logs, utility company invoices and metering logs.
- Conducted onsite data gathering as part of a thorough field survey of the facility.
- Installed data loggers and interviewed site and plant operations personnel about facility operations.
- Analyzed data gathered onsite and elsewhere, and identified potential ECMs (energy conservation measures).
- Contacted contractor personnel to assist in identifying potential ECMs and to provide budgetary and bid-level quotes for implementing the ECMs.
- Computed energy and demand savings of potential ECMs.
- Developed measure selection criteria in conjunction with CCCCD staff.
- Conducted financial analyses for potential energy system repairs and ECMs.
- Prepared this technical report, and submitted it to CCCCD staff.

Per the guidance provided by the facilities staff, this report presents an analysis of energy system improvements and energy conservation measures that appear to be both technically and economically feasible based on Chevron ES's experience. Other measures were considered and were either rejected as uneconomical or are in consideration for future energy program phases, but they were not included in this report due to time limitations. For the selected ECMs, detailed analyses with assumptions and costing are provided.

Key Findings

Over the course of the technical surveys and analyses, the Chevron ES Engineering Team, along with the CCCCD staff, has reviewed the utility and operational characteristics of numerous district buildings and identified areas for energy conservation, improved operations, comfort and safety, and reduced incidences of equipment failure.

The key findings of the energy audit are:

- Higher-than-category-average utility expenses
- Higher-than-average maintenance for aging equipment
- Average efficiency lighting systems suitable for upgrade to premium efficiency systems
- HVAC systems beyond usable life expectancies
- Incomplete roofing projects and roofing in need of replacement
- Significant opportunities to reduce energy and water consumption and to provide environmental benefits

Utility Expenses

The three campuses in the CCCCD have a total annual electricity and natural gas expenditure of approximately $2.30 per gross square foot of facility area (energy ratio). Chevron ES compared the district's energy ratio with other area colleges that have implemented a comprehensive energy program, and found that it exceeded their average energy ratio by 50 percent (Figure 1-2).

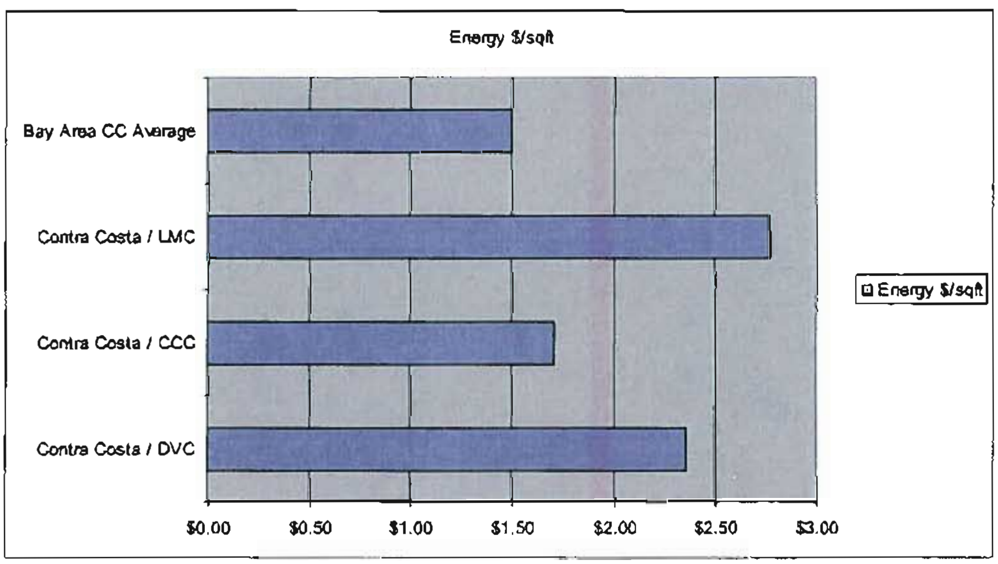


Figure 1-2: Comparison of Utility Expenditures at Northern California Colleges

In addition, the uncertainty surrounding the retail electricity market combined with the volatility of the natural gas market in the past few years has exposed CCCCD to added risks in its ability to control utility expenses. An illustration of the electricity and natural gas retail price volatility is shown in Figure 1-3 and Figure 1-4.

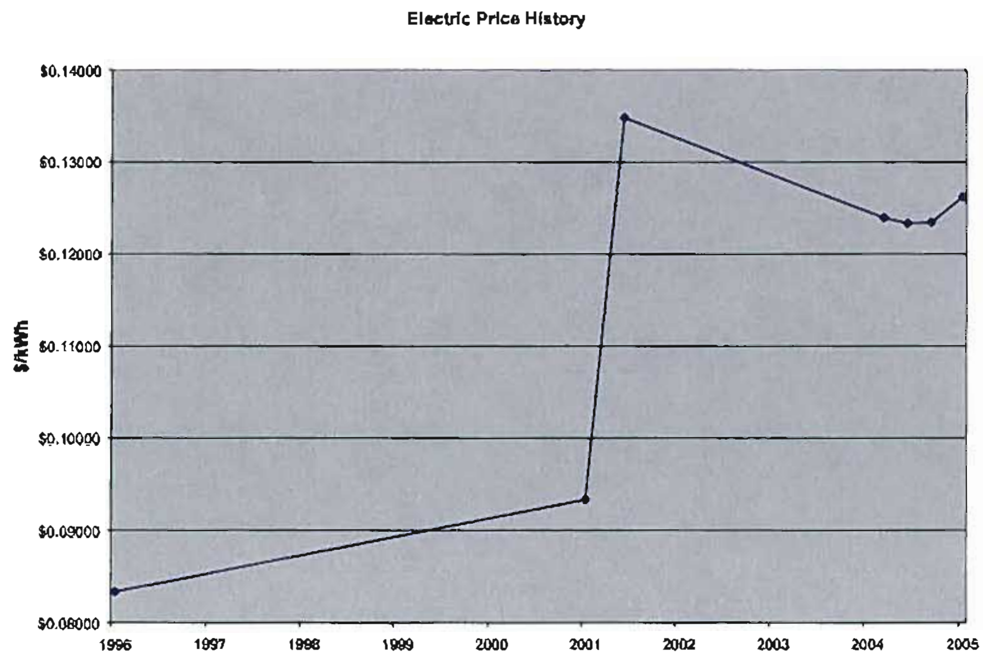


Figure 1-3: PG&E Historic Electric Commodity (E20S) to Commercial Customers

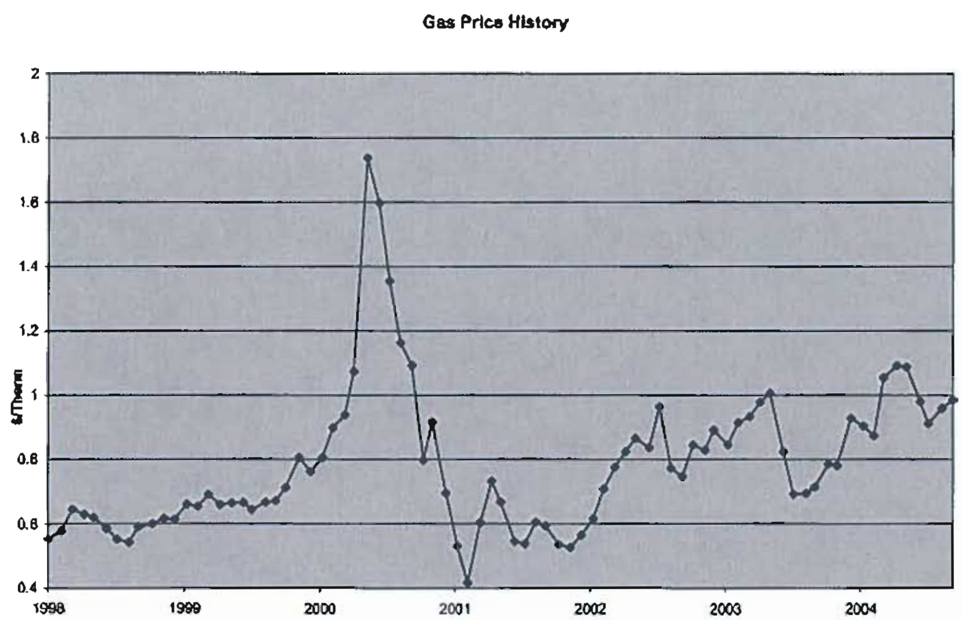


Figure 1-4: PG&E Historic Gas Commodity Price (GNR1) to Commercial Customers

Aging Equipment

Based on a detailed building-by-building energy survey, and based on actual maintenance records supplied by CCCCD staff, Chevron ES has documented a broad range of maintenance needs; inoperable, aging or inefficient equipment; and equipment repairs that are necessary to sustain facility operations and control operating expenses. In some instances, controllers, valves and filtration systems are in need of repair or replacement.

Lighting Systems

Based on a detailed building-by-building energy survey, and based on measured light levels and energy use, Chevron ES has documented the broad range of lighting systems in use at the facilities. Many of these systems were retrofitted approximately 10 years ago. Based on the many improvements in lighting and control technologies, Chevron ES finds that CCCCD will benefit greatly from a campus-wide lighting retrofit and fixture upgrade.

HVAC Systems

The detailed building-by-building energy survey has revealed that many of the heating, ventilation and air conditioning systems are operating beyond their usable life span. The maintenance department has done an excellent job of keeping these systems running, but the systems should be replaced soon because their failure is imminent.

Roofing

The roofing is in poor condition at many of the buildings. At one facility only half of a needed roofing project was completed due to budgeting constraints. The roofing should be replaced where needed.

Energy Consumption and Environmental Benefits

Energy savings of over 6.75 million kilowatt-hours of electricity per year and 5,950 therms of natural gas per year are projected for the Phase 1 Energy Conservation Program. In addition, over 1,864 kilowatts of peak electric demand reduction has been projected due to the various solar PV and energy efficiency measures. The estimated reduction in electricity purchases is 35 to 40 percent of the districtwide electricity use.

From the overall project summary information, an analysis of the Phase 1 Energy Conservation Program's environmental benefits shows significant positive impacts. The additional environmental benefits are due to the offset of direct-fired natural gas equipment used on campus and the fossil-fuel-based electricity generation offsets provided by implementation of the ECMs that reduce electricity use. Direct reduction in water use can also be achieved through the proposed water conservation measures.

The global warming mitigation benefit, or CO_2 emissions reduction, due to the project is estimated to be the equivalent of planting almost 800 acres of trees.

Technical Proposal Organization

This report is presented in seven sections, including the appendix. Sections 2 through 6 contain the completed analyses, as well as the detailed descriptions of each recommendation, including:

- Energy and water savings
- Operating cost impacts
- Implementation cost estimates for the ECMs

On behalf of the Chevron Energy Solutions Engineering Team, who completed this comprehensive energy analysis for the Phase 1 Energy Conservation Program, we would like to thank the staff at each of the CCCCD campuses who assisted us in our work. We look forward to great success on this project.

Section 2

Utility Usage and Evaluation Methods

This section consists of three subsections that discuss the following:

Utility Data: This subsection explains how utility data is analyzed and used to establish baseline operations. The subsection also gives specific details on how the cost of energy is calculated for each specific site, and displays tables that list the existing use and cost for each site.

Baseline Energy Consumption: An important step in calculating savings is to accurately model the existing operation of the facility. The details of Chevron Energy Solutions' (Chevron ES's) methodologies appear in this subsection.

Savings Calculation Methods: This subsection explains how savings are calculated for each type of energy project and offers equations, methods, assumptions and a general explanation of how the project works.

Utility Data

The energy usage and costs have been gathered and reviewed for each of the facilities. This data is derived from PG&E downloads, commodity supplier data, actual utility bills, and information supplied by the district. This information is then analyzed to determine the following:

- The monthly usage profile
- The cost of energy and water (kilowatt-hours [kWh], therms and 100 cubic feet [HCF]) at each site

The *monthly usage profile* is used to establish a *baseline usage profile* for all energy-using equipment at the site. The cost of energy is evaluated based on the utility type. Three years of historic energy usage data has been reviewed for completeness, normalized by month, and placed in a succinct format. The electric rate is a blended rate, averaging the past 12 months of total electric costs, including demand charges where applicable, transmission costs, taxes, and all other costs associated with electricity use. Similarly the gas and water rates represent the average overall cost over the past 12 months. This method provides conservative savings numbers, given that utility costs are on the rise. Because energy rates have been rising in recent months, an escalation factor is applied to these rates to illustrate anticipated future savings based on anticipated future rates. The blended rate baseline is not used to calculate savings for the photovoltaic generation measure or the electric transformer installation. Instead, time-of-day weighted demand schedules are used for these measures.

The data illustrated in this section of the report is focused on:

- Contra Costa College (CCC)
- Diablo Valley College (DVC)
- Los Medanos College (LMC)
- District Business Office (DO)

Data from the Brentwood, San Ramon and Walnut Creek facilities has been excluded from this analysis.

Energy Service Data

The district participates in a utility purchasing consortium for the commodities of electricity and natural gas at each facility. The delivery and billing services for these utilities is provided by Pacific Gas & Electric Company (PG&E). The small electric services at DVC serving outdoor lighting and sprinkler controllers have energy and delivery provided by PG&E. A variety of commodity providers serve the facilities included in this report. The electrical and natural gas services for each campus with account numbers, meter numbers, rate schedules and commodity providers are shown in Table 2-1.

Table 2-1: Energy Service Information

Campus	Utility	Account #	Meter #	Rate Schedule	Commodity Provider
Contra Costa College	Ele	1355937005	5012R7	E19P	Constellation
Contra Costa College	Ele	6861830005	6985R9	A6	Constellation
Contra Costa College	Ele	6986830005	692T66	A1	Constellation
Contra Costa College	Ele	7028496005	569R53	A6	Constellation
Diablo Valley College	Ele	9991320005	00826R	E20S	Constellation
Diablo Valley College	Ele	5695860005		A1F	PG&E
Diablo Valley College	Ele	3253480005		OL1	PG&E
Diablo Valley College	Ele	3430592005		OL1	PG&E
Los Medanos	Ele	6189251005	M07590	E19S	Constellation
District Office	Ele	6845508020	X45843	A10S	Constellation
Contra Costa College	Gas	6903496005	10022001		Accent
Contra Costa College	Gas	6945163005	36106092		Accent
Contra Costa College	Gas	7070163005	56155671		Accent
Contra Costa College	Gas	7111830005	51460860		Accent
Contra Costa College	Gas	7153496005	43799162		Accent
Contra Costa College	Gas	7195163005	36885409		Accent
Contra Costa College	Gas	7236830005	37416093		Accent
Contra Costa College	Gas	7278496005	31822329		Accent
Contra Costa College	Gas	9601281005	51466536		Accent
Contra Costa College	Gas	9642947005	25966028		Accent
Diablo Valley College	Gas	8241327005	000083A		Energy Mgmt.
Los Medanos	Gas	5322620005	47853036		Accent
Los Medanos	Gas	5364287005	000544A		Accent
Los Medanos	Gas	5405953005	30708403		Accent
District Office	Gas	4459691005	45588477		Accent

The major electrical services at CCC, DVC, LMC and the DO are E19P, E20S, E19S and A10S respectively. The 19 in E19P represents a service rate based on electrical energy demand of less than 1000 kW; the 20 in E20S represents a demand in excess of 1000 kW. The P and S at the end of the rate identifier represent the voltage at which the power is delivered (metered):

- P is for *primary voltage*, or voltage in excess of 2,400 volts.
- S is for *secondary voltage*, or voltage less than 2,400 volts.

The rate tariff is based on the demand and voltage.

Energy Service Rates

Energy indices are helpful to determine the operational efficiency when compared to other similar facilities. Table 2-2 and Figure 2-1 illustrate the energy cost per facility square footage and actual blended utility rates for each facility. Note that no adjustment has been made for the differences in local climates. The values shown include commodity, service and delivery charges.

Table 2-2: Energy Rate Information

College	Sq. Ft.	Electric kWh/Yr	Demand kW	Gas Thm/yr	Total $/kWh	Total $/Therm	Load Factor	Energy $/Sq. Ft.
CCC	385,312	3,713,079	797	167,817	$0.125	$1.16	53%	$1.71
DVC	669,024	8,544,300	2,040	293,391	$0.153	$0.911	48%	$2.35
LMC	267,060	3,922,437	809	147,208	$0.147	$1.11	55%	$2.77
DO	34,363	1,110,660	214	26,450	$0.136	$1.18	59%	$5.32

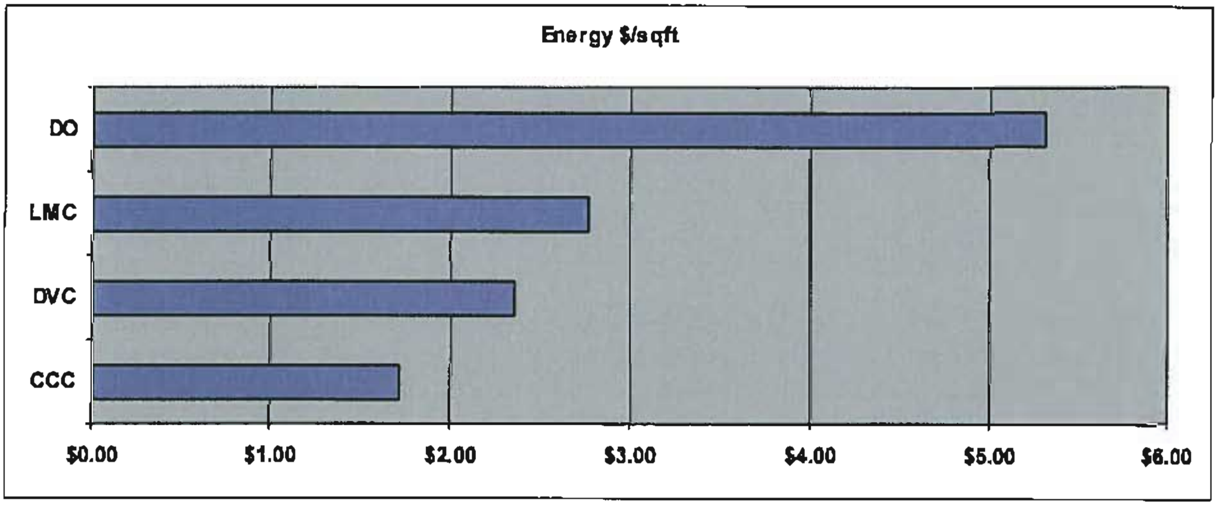


Figure 2-1: Energy Usage Comparison

Electrical Load Factors

Load factor is defined as the ratio of the energy that would have been used had energy been consumed at a uniform level equal to the maximum demand throughout the billing period to the energy actually consumed during the billing period. A load factor of 1, or unity, is ideal. Typical office buildings in Northern California, for example, have a load factor of around 40 to 60 percent. Load factor is important for design and sizing considerations that must be applied to onsite generation equipment analysis. The average campus load factors are:

- CCC – 53 percent
- DVC – 48 percent
- LMC – 55 percent
- DO – 59 percent

Historical Energy Use

The tables and figures shown on the following pages illustrate the facilities' normalized energy use by month.

Table 2-3: Electricity Usage by Month in Kilowatt-Hours

Month	CCC	DVC	LMC	DO
Jan	283,287	570,745	278,410	82,460
Feb	336,837	627,581	278,141	79,925
Mar	356,853	695,257	311,514	94,753
Apr	328,081	658,626	302,539	91,057
May	323,398	720,376	318,520	104,806
Jun	264,439	705,014	316,082	107,601
Jul	263,295	818,139	350,661	109,085
Aug	298,347	796,579	377,210	98,872
Sep	335,278	831,693	380,473	92,004
Oct	341,970	821,556	381,935	90,097
Nov	320,013	685,312	344,019	80,000
Dec	261,281	613,422	282,933	80,000
Totals	**3,713,079**	**8,544,300**	**3,922,437**	**1,110,660**

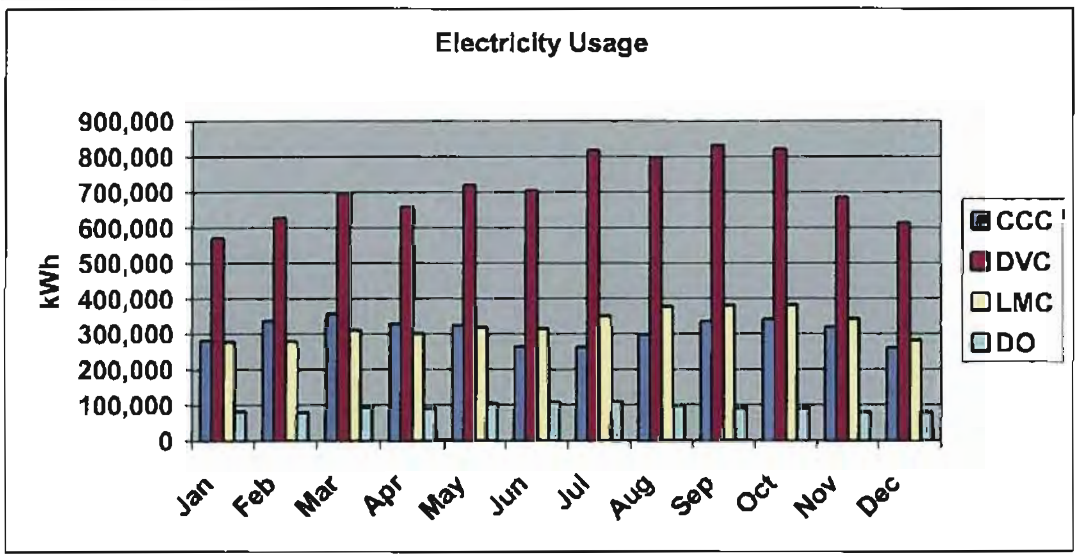


Figure 2-2: Bar Chart of Monthly Electricity Usage

Table 2-4: Electricity Demand by Month in Kilowatt-Hours

Month	CCC	DVC	LMC	DO
Jan	706	1,590	682	163
Feb	810	1,644	771	224
Mar	880	1,922	771	232
Apr	826	1,766	768	223
May	830	2,066	768	249
Jun	794	2,110	934	235
Jul	730	2,538	880	236
Aug	642	2,364	934	224
Sep	866	2,522	931	240
Oct	808	2,410	835	219
Nov	910	1,832	803	161
Dec	758	1,710	627	161
Average	**797**	**2,040**	**809**	**214**

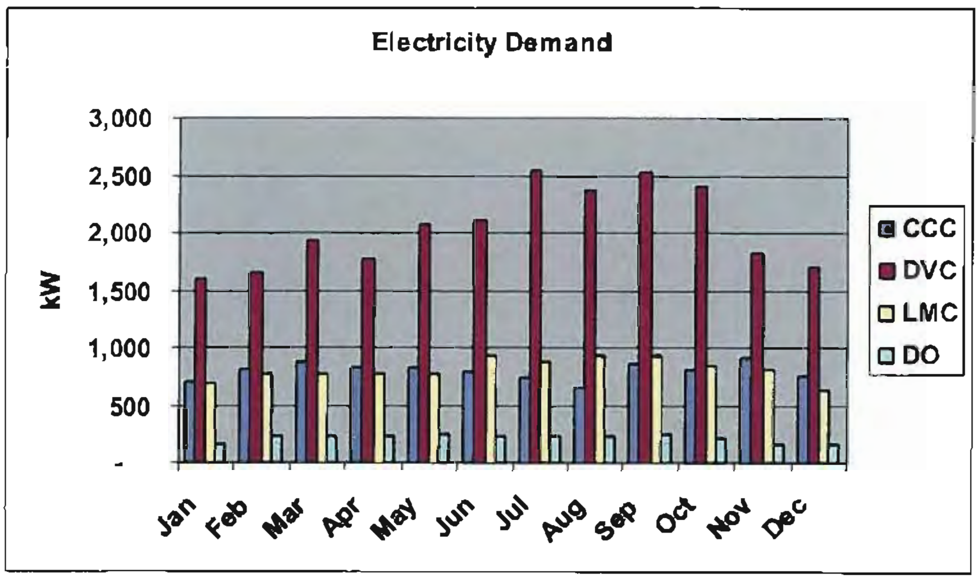


Figure 2.3: Bar Chart of Monthly Electricity Demand

Table 2.5: Electricity Cost by Month in Dollars

Month	CCC	DVC	LMC	DO
Jan	$34,656	$87,950	$44,168	$11,020
Feb	$36,804	$84,504	$35,946	$10,788
Mar	$40,121	$94,827	$40,944	$12,315
Apr	$38,829	$93,030	$40,718	$11,594
May	$40,456	$108,536	$45,748	$13,715
Jun	$35,187	$113,663	$48,812	$13,991
Jul	$36,035	$135,388	$54,897	$14,751
Aug	$39,626	$132,277	$58,621	$14,192
Sep	$45,365	$137,208	$59,453	$13,486
Oct	$43,466	$131,200	$57,327	$13,193
Nov	$39,113	$99,753	$48,444	$11,382
Dec	$33,229	$89,640	$40,441	$11,172
Totals	**$462,887**	**$1,307,976**	**$575,519**	**$151,599**

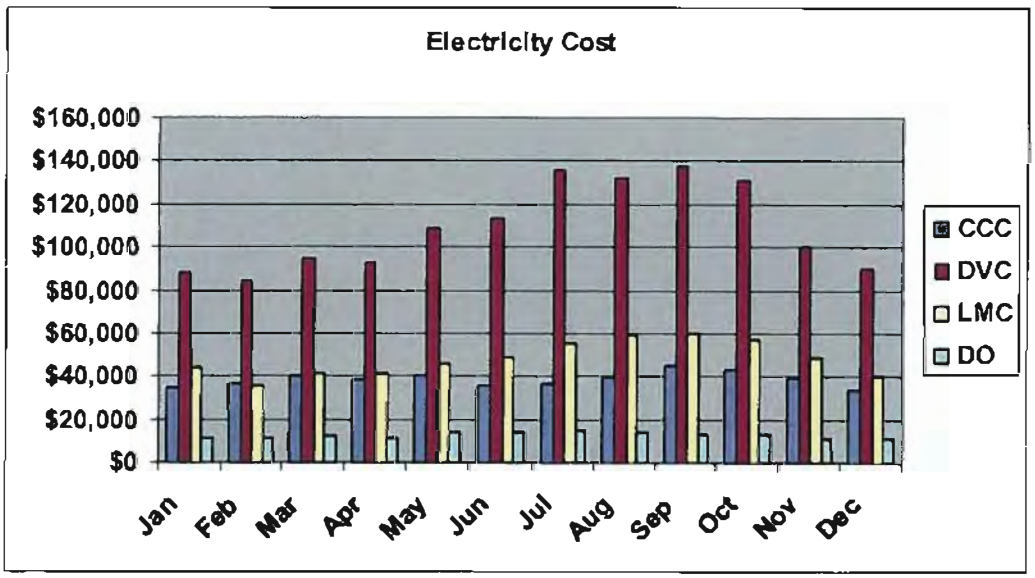


Figure 2-4: Bar Chart of Monthly Electricity Cost

Table 2-6: Natural Gas Usage by Month in Therms

Month	CCC	DVC	LMC	DO
Jan	28,558	56,216	23,830	3,460
Feb	20,974	35,235	16,724	2,619
Mar	24,876	28,227	14,614	2,419
Apr	20,768	23,200	13,589	2,034
May	15,208	15,392	9,271	1,521
Jun	11,872	8,866	5,834	1,528
Jul	5,215	6,492	3,962	1,255
Aug	4,448	6,555	4,991	1,552
Sep	4,613	14,785	7,456	1,803
Oct	10,719	24,698	11,604	2,112
Nov	8,118	35,833	15,333	2,847
Dec	12,448	37,892	20,000	3,300
Totals	**167,817**	**293,391**	**147,208**	**26,450**

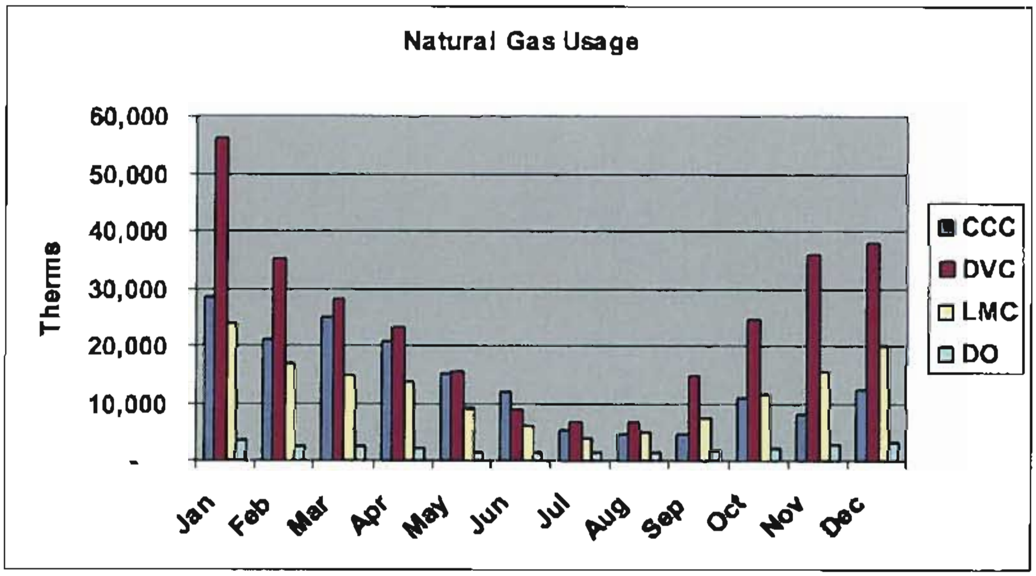


Figure 2-5: Bar Chart of Monthly Natural Gas Usage

Table 2-7: Natural Gas Cost by Month in Dollars

Month	CCC	DVC	LMC	DO
Jan	$24,681	$43,220	$23,898	$3,779
Feb	$20,997	$36,557	$17,747	$2,748
Mar	$20,903	$34,874	$13,912	$2,505
Apr	$17,083	$19,990	$13,213	$2,081
May	$10,693	$11,261	$8,827	$1,628
Jun	$6,329	$6,621	$5,159	$1,369
Jul	$5,080	$4,908	$3,641	$1,181
Aug	$7,642	$4,957	$5,639	$1,743
Sep	$11,299	$13,556	$9,510	$2,373
Oct	$14,738	$22,434	$15,525	$3,002
Nov	$23,766	$33,185	$17,614	$3,665
Dec	$31,513	$35,576	$29,187	$5,078
Totals	**$194,725**	**$267,139**	**$163,872**	**$31,152**

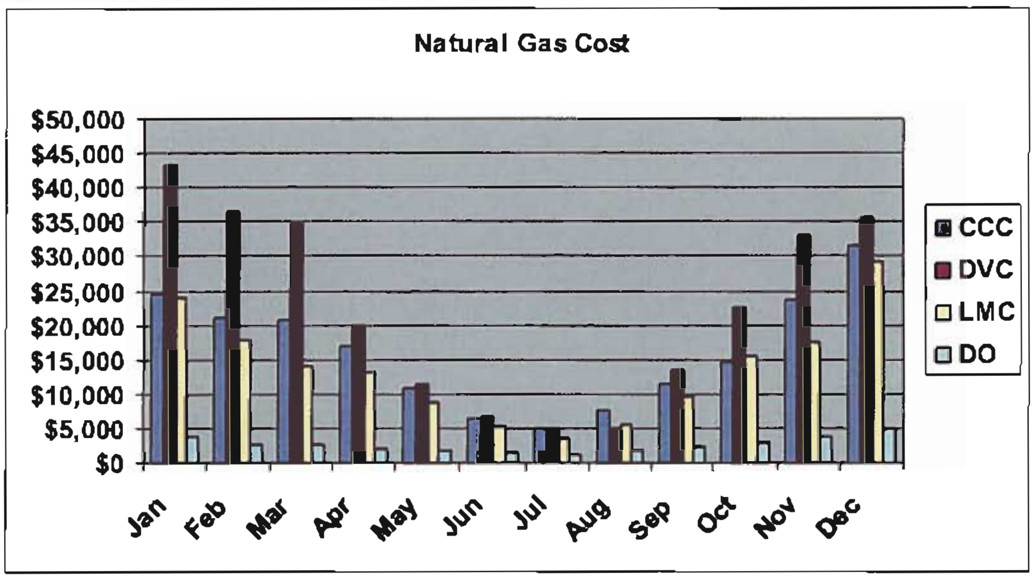


Figure 2-6: Bar Chart of Monthly Natural Gas Cost

Energy Use by Equipment Type

The energy use at the facilities has been measured, modeled or estimated for each of the equipment types shown in this subsection. The remaining of the energy use falls into the Miscellaneous category. The energy use by equipment type for each campus is shown in the following tables and charts. Note the higher energy content of natural gas when compared to electricity; gas-consuming equipment may show a higher usage than expected when shown using this methodology. Similar charts by costs are shown following this section.

Table 2-8: Electricity Use by Location and Equipment Type in Kilowatt-Hours

College	HVAC	Lighting	Computers	Pools	Misc	Totals	kW
CCC	1,299,578	1,309,477	297,046	185,654	621,324	3,713,079	797
DVC	4,699,365	2,544,236	683,544	256,329	360,826	8,544,300	2,040
LMC	1,372,853	914,728	313,795	196,122	1,124,939	3,922,437	809
DO	499,797	250,073	199,919	-	160,871	1,110,660	219

Table 2-9: Natural Gas Use by Location and Equipment Type in Therms

College	HVAC	Lighting	Hot Water	Pools	Misc	Totals
CCC	125,863	-	13,425	23,130	5,399	167,817
DVC	220,043	-	23,471	33,758	16,118	293,391
LMC	110,406	-	11,777	15,452	9,574	147,208
DO	23,805	-	2,116	-	529	26,450

Table 2-10: Total Energy Use by Location and Equipment Type in Million BTUs

College	HVAC	Lighting	Computers	Pools	Misc	Totals
CCC-Energy	17,020	4,468	1,014	2,946	4,006	29,454
DVC-Energy	38,039	8,681	2,332	4,250	5,199	58,501
LMC-Energy	15,725	3,121	1,071	2,214	5,977	28,108
DO-Energy	4,086	853	682	-	815	6,436

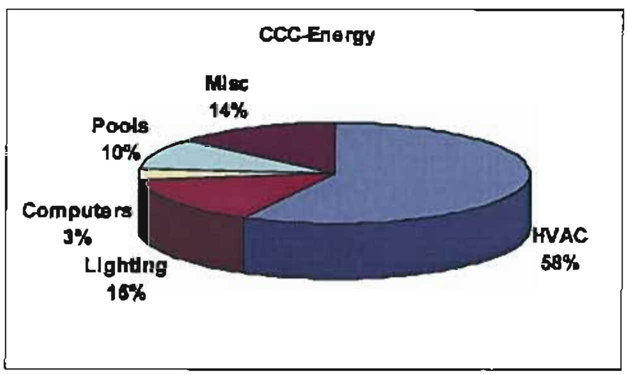


Figure 2-7: Pie Chart of CCC Energy Use by Equipment Type in Percentages

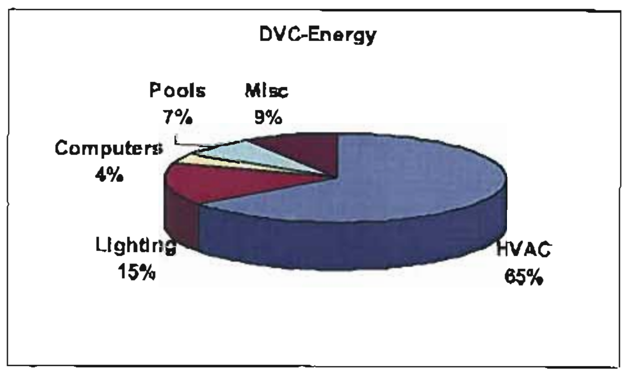


Figure 2-8: Pie Chart of DVC Energy Use by Equipment Type in Percentages

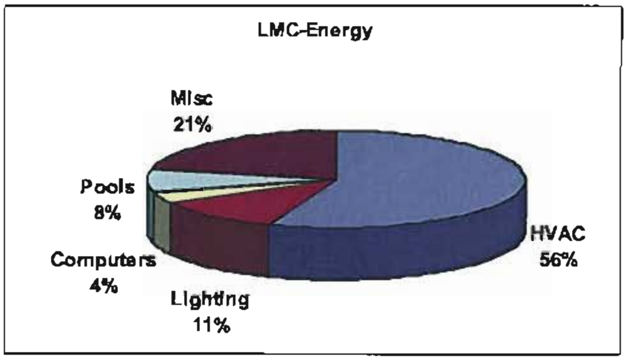


Figure 2-9: Pie Chart of LMC Energy Use by Equipment Type in Percentages

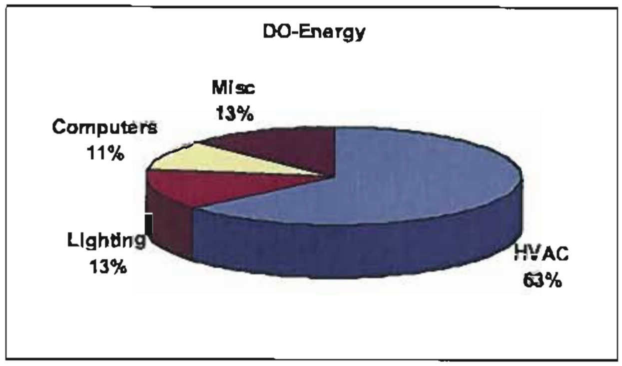


Figure 2-10: Pie Chart of DO Energy Use by Equipment Type in Percentages

Energy Cost by Equipment Type

The following tables and charts illustrate the energy cost by equipment type. The cost per unit of energy difference makes a comparison of these charts versus the energy usage charts quite interesting.

Table 2-11: Electricity Cost by Location and Equipment Type in Dollars

College	HVAC	Lighting	Computers	Pools	Misc	Totals
CCC	$162,010	$163,245	$37,031	$23,144	$77,457	$462,887
DVC	$719,387	$389,476	$104,638	$39,239	$55,236	$1,307,976
LMC	$201,432	$134,213	$46,042	$28,776	$165,057	$575,519
DO	$68,220	$34,134	$27,288	$0	$21,958	$151,599

Table 2-12: Natural Gas Cost by Location and Equipment Type in Dollars

College	HVAC	Lighting	Computers	Pools	Misc	Totals
CCC	$146,044	$0	$15,578	$26,838	$6,265	$194,725
DVC	$200,354	$0	$21,371	$30,738	$14,676	$267,139
LMC	$122,904	$0	$13,110	$17,201	$10,657	$163,872
DO	$28,037	$0	$2,492	$0	$623	$31,152

Table 2-13: Total Energy Cost by Location and Equipment Type in Dollars

College	HVAC	Lighting	Computers	Pools	Misc	Totals
CCC $	$308,000	$163,000	$53,000	$50,000	$84,000	$657,612
DVC $	$920,000	$389,000	$126,000	$70,000	$70,000	$1,575,115
LMC $	$324,000	$134,000	$59,000	$46,000	$176,000	$739,391
DO $	$96,000	$34,000	$30,000	$0	$23,000	$182,751

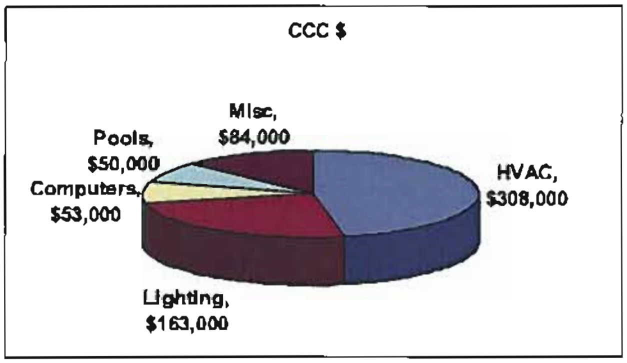


Figure 2-11: Pie Chart of CCC Energy Cost by Equipment Type

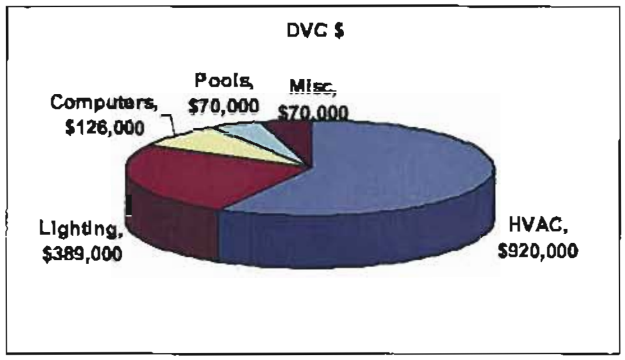


Figure 2-12: Pie Chart of DVC Energy Cost by Equipment Type

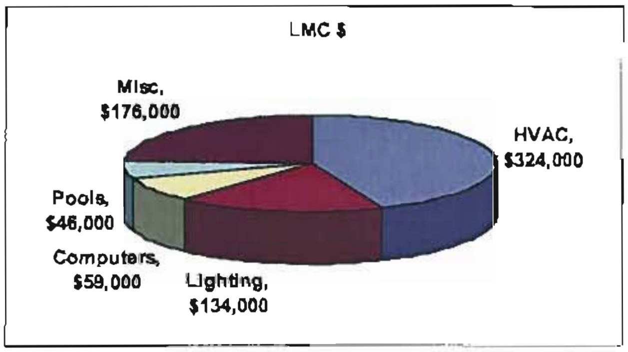


Figure 2-13: Pie Chart of LMC Energy Cost by Equipment Type

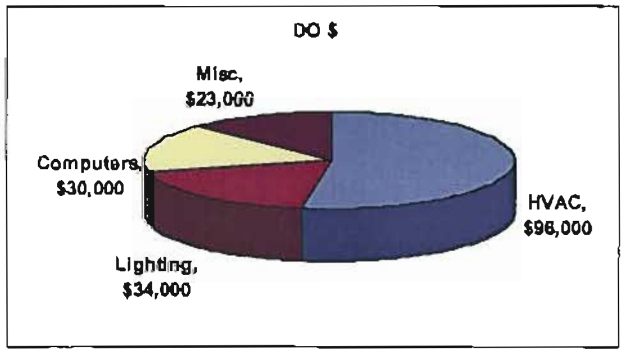


Figure 2-14: Pie Chart of DO Energy Cost by Equipment Type

Water Utilities

The water service providers (domestic water, irrigation and sewer) are shown by campus in Table 2-14.

Table 2-14: Water Services

College	Provider	Service
CCC	EBMUD	Domestic
CCC	EBMUD	Irrigation
DVC	EBMUD	Domestic
DVC	CCCSD	Irrigation (reclaimed)
DVC	CCCSD	Sewer
LMC	City of Pittsburg	Domestic
LMC	City of Pittsburg	Sewer
LMC	Contra Costa Canal	Irrigation

Water Use and Cost by Campus

The following table and charts illustrate the water use and cost by campus.

Table 2-15: Water Use and Cost by Campus

College	Sq. Ft.	Domestic Water Use, HCF	Domestic Water HCF/Sq. Ft.	Domestic Water Cost	Domestic Water $/ Sq. Ft.	Sewer Cost	Reclaimed Water Use, gallons	Reclaimed Water Cost	Water & Sewer $/HCF
CCC	385,312	30,301	0.0786	$80,501	$0.21				$2.657
DVC	669,024	20,080	0.0300	$73,778	$0.11	$36,568	31,714,322	$37,361	$5.495
LMC	267,060	6,927	0.0259	$33,425	$0.13	$12,644	canal		$4.825
DO	88,000								

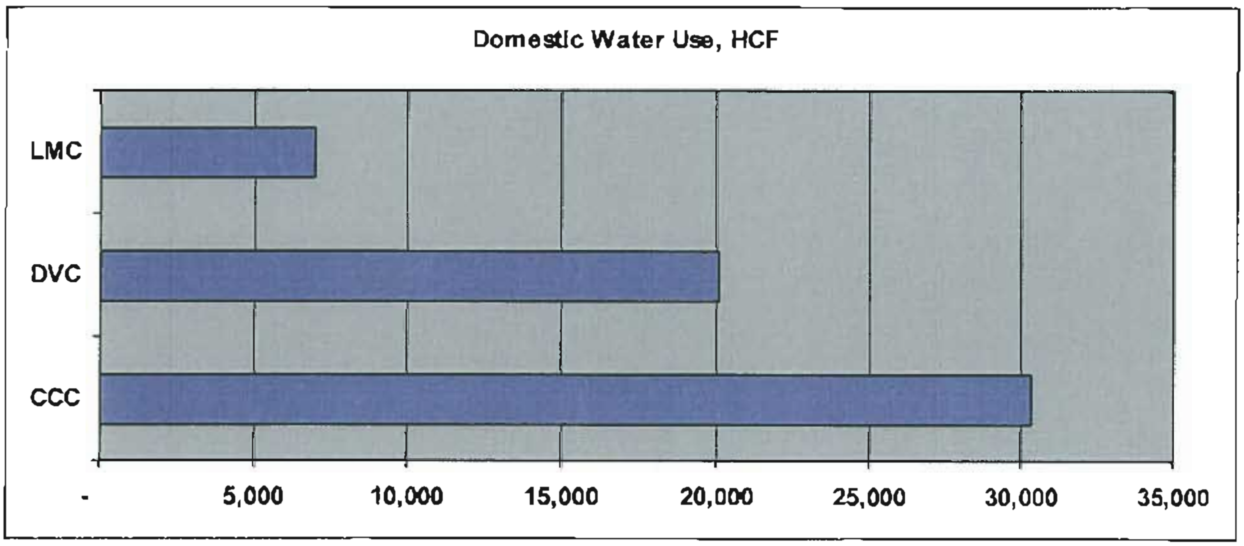


Figure 2-15: Domestic Water Use In Hundreds of Cubic Feet

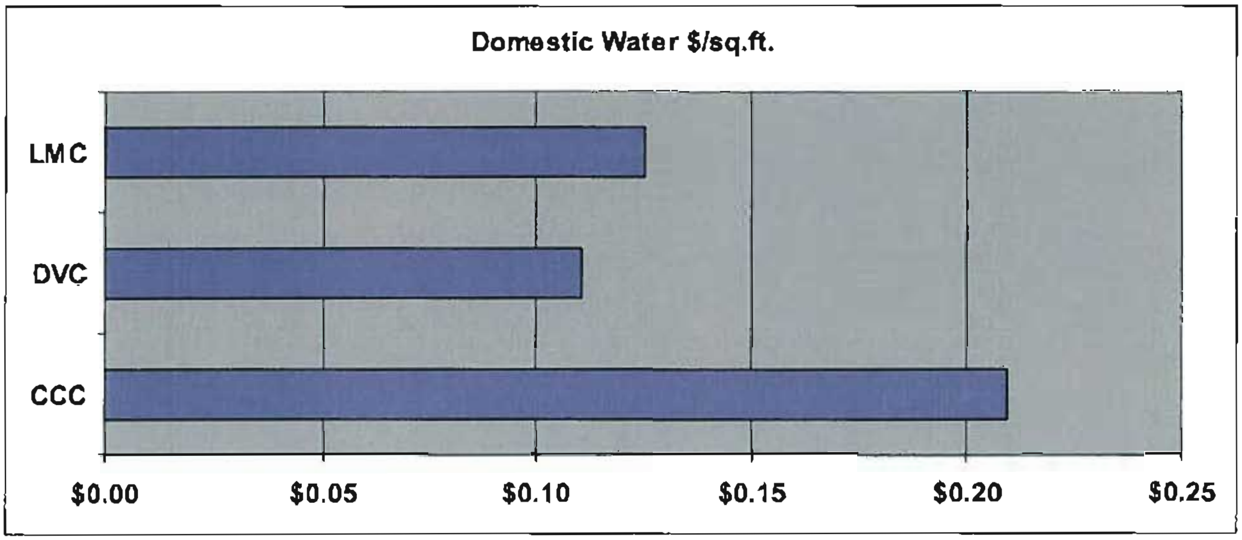


Figure 2-16: Domestic Water Use in Dollars per Square Foot

Baseline Energy Consumption

Before the energy savings can be established for each energy conservation opportunity (ECO), a baseline must be established for each fuel type (gas and electric). Using monthly utility data, Chevron Energy Solutions (Chevron ES) developed a historical *energy usage profile*, or *baseline usage profile* (or just *baseline*), for each site. The baseline is sometimes called an *energy balance*. All of these terms are used interchangeably in this report.

The billed energy usage for each facility does not necessarily fall in a convenient first-of-month to end-of-month format. To allow for ease of comparison to computer models, and among the facilities, the billed energy usage values and costs were normalized from the billed dates to fit a beginning-to-end-of-month format. This was done for each meter on each site, and the values were summed to yield a total kilowatt-hour, kilowatt and therm usage for each calendar month of each year.

Electric usage typically experiences a phenomenon called *creep* where the usage rises each year due to the addition of computers, processing equipment and other miscellaneous equipment. For example, several of the sites in this project have had one or more large sorting machines added to the facility in the past year. In addition to adding to the electrical load due to their operation, the addition of the sorting machines also adds to the cooling load due to the extra heat they generate.

On a year-to-year basis, natural gas usage is typically more weather-dependent than electric usage because it is typically used primarily for heating.

The assumed operation, or calculated baseline, is then compared with each site's energy bills to verify energy use assumptions. The historical energy usage baseline for each site is located in Section 3 under each respective site's section. A detailed electric and natural gas usage, cost, and baseline breakdown for each facility is located in the appendix.

Electric Baseline Calculation Methods

Electric consumption at each facility can be broken down into the following usage categories:

- **HVAC**: Heating and cooling fans or pump motors, controls, chillers, boilers, cooling towers, and the like.
- **Lighting**: Indoor, outdoor, task lighting, and such.
- **Computers**: PCs only
- **Pools**: Filtration pumping and heating
- **Miscellaneous**: Copiers, snack or soda machines, space heaters, small water heaters, computer servers and the like.

The HVAC electrical baseline use is established using two main methods: spreadsheet based analysis tools and building computer modeling software.

The historical electrical use due to lighting is derived from spreadsheets that list the quantity, type and size of all light fixtures, multiplied by the hours of annual operation as determined through:

- Data logging
- Information provided by site personnel

- Known usage patterns from similar facilities

Spreadsheet Analysis

Weather data displayed in a bin format is used to create a heating and cooling profile for the site being assessed. This data, combined with the facilities operating schedule, sequence of controls and system configuration, can simulate the existing electricity, natural gas and demand use required to heat and cool the facility.

A benefit to this method is for straightforward applications, the user can better tailor the calculation to that site's unique operating characteristics, and the formulas used are easily accessible and viewable. Drawbacks to this method are that:

- It does not easily yield a month-by-month profile of energy consumption
- It is inadequate to simulate multiple, complex systems and conservation measures

Computer Modeling

The computer modeling software used was Trane TRACE 700. Entries made to the program include:

- Building construction types
- Equipment types
- Occupancy and operating schedules
- Internal loads

The software contains a database of yearly weather data for locations throughout the U.S.

A benefit to this method is it has better capabilities when analyzing multiple measures of great complexity, such as a combination of water-side and air-side measures. Computer models also enable the user to view month-by-month energy usage, and it outputs building loads for equipment sizing without requiring additional calculations. Drawbacks to this method are that the modeling software was originally designed to model buildings to be constructed, not ones that were built years ago. Modeling the existing building system's inefficiencies and operational issues can sometimes present a challenge with software not geared for that purpose.

Calculation Assumptions

The following data were used in the analysis.

- Heating and cooling set points
- Building internal load, including occupancy, plug loads such as computers and printers, and lighting
- Existing equipment nameplate for chillers, cooling towers, boilers, air handlers, pumps and packaged units
- Existing equipment condition, such as damper positions, outside air settings, type and condition of controls, age of equipment

- Logger data, including power loggers installed on large equipment, temperature loggers installed in the building spaces, and power measurements performed on select motors
- Scheduled operation of all equipment, based on the information gathered during the site survey, from facility personnel, available drawings, and existing energy management system (EMS)
- Efficiency: boiler combustion efficiency (heating equipment), chiller and packaged unit efficiency in kilowatts per ton (cooling equipment), and motor efficiency values for pumps and fans
- Appropriate diversity and usage factors for equipment operation and building occupancy

The following physical data and calculated values are used in the computer model only and are based on survey data and available drawings.

- Room information, including dimensions; orientation; and window size, direction and shading
- The different U-values (measures of heat transmission) are input based on the building construction types.
  - **Floor**: The U-value ranges from 0.124 Btu/h×ft^2×°F for 8″ LW concrete to 0.181 Btu/h×ft^2×°F for 5″ LW concrete.
  - **Roof**: The U-value ranges from 0.045 Btu/h×ft^2×°F for built-up roof to 0.214 Btu/h×ft^2×°F for 4″ LW concrete roof.
  - **Wall**: The U-value ranges from 0.115 Btu/h×ft^2×°F for 9″ concrete panel to 0.295 Btu/h×ft^2×°F for 8″ LW concrete block.
  - **Window**: The U-value ranges from 1.0 Btu/h×ft^2×°F for single-pane coated ¼″ glass to 0.5 Btu/h×ft^2×°F for double-pane coated ¼″ glass.

Note: *Btu/h×ft^2×°F for 8″ LW concrete* means "British thermal units per hour, multiplied by square footage, multiplied by degrees Fahrenheit for 8-inch lightweight concrete." Lower U-values indicate better insulation.

Miscellaneous equipment is given an assumed size and schedule based on previous experience of similar sites, conversations with site personnel and site survey data.

Domestic hot water use is estimated based on normalized data from facilities with similar usage patterns, and type or quantity of hot-water-using fixtures.

Gas Baseline Calculation Methods

Gas consumption at these sites is primarily for space heating, pool heating, and for domestic hot water heating. The use due to space heating is calculated the same way as is the electricity consumption, using models or spreadsheet simulations. The gas use due to domestic hot water is the same as described previously in the "Electric Baseline Calculation Methods" subsection.

Water Baseline Calculation Methods

Total monthly water usage is shown in HCF. Water is provided to each site by the public local water utility. Where a full year of utility information was not available, the provided information was amortized over a full year, based on typical water usage patterns. Sewer costs are included in the water costs because sewer usage is reduced simultaneously as water usage is reduced with implementation of the measures.

Savings Calculation Methods

Once the baseline energy use is established, calculating the savings available by implementing various projects is done by using similar methods described previously. The baseline case is compared to the proposed case to calculate the annual savings potential.

ECO Energy Savings for Lighting Retrofit

All of the lighting systems at the facilities included in this report were considered for retrofit with the exception of exterior fixtures.

A detailed lighting audit was conducted at each campus. The audit includes individual fixture details, fixture counts and average annual run time, grouped by room usage, for the existing fixtures. Each fixture type was considered for replacement or retrofit. Where new systems provide equivalent or better light for less energy, the fixtures are scheduled for the upgrade. In some cases where the existing systems already represent the most effective solution, the systems will not be modified.

Reduction in kilowatts is typically accomplished by using higher-efficiency equipment. Reduction in hours typically relates to lighting control modifications, such as occupancy sensors.

The kilowatt savings were determined as a peak-demand savings, not annual-demand savings. The equation used to determine the kilowatt savings is:

$$\sum kW_{savings} = \sum \left[\left(kW_{fixture} \right)_{baseline} - \left(kW_{fixture} \right)_{retrofit} \right]$$

The equation used to determine the kilowatt savings is:

$$\sum kWh_{savings} = \sum \left[\left(kW_{fixture} \times Hours \right)_{baseline} - \left(kW_{fixture} \times Hours \right)_{retrofit} \right]$$

The kilowatt savings is applied to the effective blended dollar-per-kilowatt-hour rate for each site to determine cost savings for this measure. The detailed calculations are included in the appendix.

Lighting maintenance savings is also calculated for each facility. The existing lighting systems are assumed to have reached a steady state of failure rates where lamps and ballasts are failing in accordance with manufacturer's equipment life expectancies. It is also assumed that the equipment is repaired or replaced on an as-needed basis (unscheduled). This means if a lamp is rated at 20,000 hours and it burns 5,000 hours per year, it will require replacement once every 4 years. A failure rate of once every 4 years is equivalent to a 0.25 failure rate per year.

While scheduled service is recommended for the new equipment, Chevron ES used steady-state failure rates to calculate the maintenance costs for both the old and new equipment. For new lamps and ballasts, however, they have a delay in their maintenance schedule because the equipment is new.

The failure rates and service costs are calculated for both the existing equipment and the proposed equipment, yielding the maintenance savings, which is the difference between these two figures. The following assumptions for equipment cost and life are used for these calculations:

Table 2-16: Assumptions for Equipment Cost and Life

Equipment	Material Cost	Labor	Life, Hours
Basic T8 Lamp	$2.00	$5.00	20,000
Premium Efficiency T8 Lamp	$2.50	$5.00	24,000
250 HPS Lamp	$24.00	$50.00	24,000
400MH Lamp	$30.00	$50.00	20,000
T8 ballast	$15.00	$25.00	60,000
HID ballast	$60.00	$75.00	60,000
Incandescent lamp	$2.00	$10.00	2,000
CFL lamp	$3.00	$10.00	10,000
8' T12	$4.00	$15.00	12,000
4' T12	$1.50	$5.00	20,000
T12 Ballast	$18.00	$30.00	60,000

$$\sum_{\substack{\text{maint.}\\\text{savings}}} = \left\{ \begin{array}{l} \sum_{baseline}\left[\dfrac{(\text{lamp cost}+\text{labor})}{\text{old lamp life}} + \dfrac{(\text{ballast cost}+\text{labor})}{\text{old ballast life}}\right] X\,(\text{Existing Hours}) - \\ \sum_{retrofit}\left[\dfrac{(\text{lamp cost}+\text{labor})}{\text{new lamp life}} + \dfrac{(\text{ballast cost}+\text{labor})}{\text{new ballast life}}\right] X\,(\text{Retrofit Hours}) \end{array} \right\} X\,10_{years}$$

ECO Energy Savings for HVAC Retrofits

Energy savings can be achieved by adding, modifying, repairing or replacing equipment, as described in the following subsections.

Convert Constant Volume to Variable Air Volume

This ECO involves the installation of variable frequency drives (VFD), variable air volume (VAV) boxes, and all necessary controls to achieve a variable air volume system.

Airflow distribution at a constant flow throughout the year is a waste of energy when the greatest airflow demand is only needed at the design condition. Most of the time, a lower fan speed is adequate to meet the conditioning requirements for the space. The installation of VFDs greatly reduces the amount of power required to operate the fans at part-load conditions. Electricity is saved because rotating equipment such as fans and pumps operate according to a set of engineering principles called *affinity laws*, a set of equations used to calculate differences in the head, flow or horsepower of rotating equipment. With a VFD, the horsepower (HP) drawn by the fan varies according to the following equation:

$$HP_{\text{with VFD}} = (HP_{\text{without VFD}}) \times \left[\frac{(Flow_{\text{with VFD}})}{(Flow_{\text{without VFD}})} \right]^3$$

For example, when equipped with a VFD, a 20-HP fan motor will use:

- 10 HP at an 80 percent design flow
- 4.3 HP at a 60 percent design flow
- 1.3 HP at a 40 percent design flow

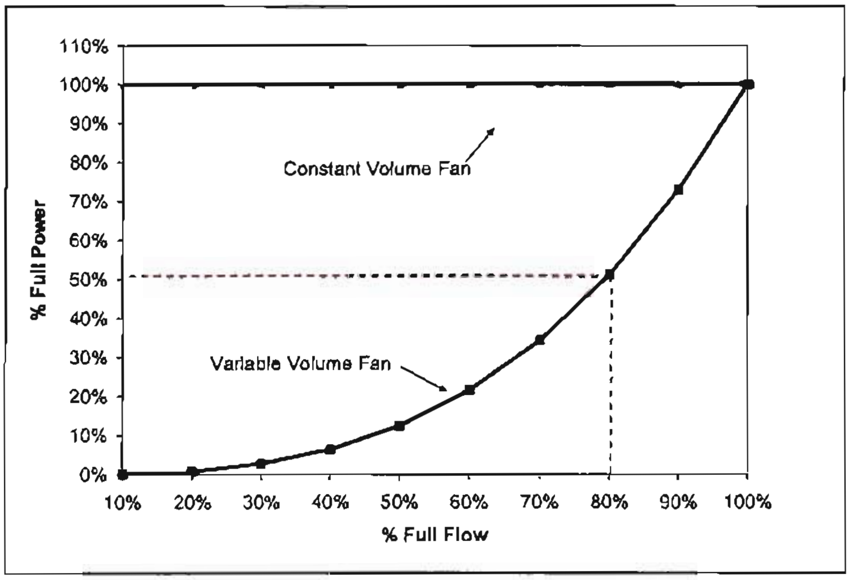


Figure 2-17: Graph of motor hp as flow decreases for constant and variable volume fans

Calculation results can be seen in the appendix.

Repair or Install Economizers

This ECO involves altering or adding air-handler dampers and controls to regulate the amount of outside air drawn in, regulated by a sequence of operation pertaining to:

- Outside air temperature
- Return air temperature
- Temperature set point

Controlling the amount of outside air to provide "free" cooling during moderate weather can also improve indoor air quality.

The savings for this ECO are calculated by simulating an increase in the amount of ventilation air when the outside air temperature is in the range of 55° F to 72° F or less than the return air temperature, thereby saving compressor energy.

Replace Package HVAC Units

Most of the package units that Chevron ES recommend replacing are nearing the end of their useful life, and some have already begun to fail. In addition to energy savings, replacing these units before they completely fail will result in additional savings due to deflected emergency maintenance costs.

Savings for this measure are calculated by taking the existing cooling and heating loads and applying the old and new efficiencies.

ECO Energy Savings Assumptions for Chilled Water Systems

Installing more efficient chillers reduces the electrical usage and demand, especially under part-load conditions. Additionally, at the sites where variable speed operation is recommended (not available on smaller chillers), this allows more efficient part-load operation.

The energy savings were calculated using Trane TRACE™ computer models at Diablo Valley College, and spreadsheet simulations at Los Medanos College and the District Office. These calculations utilize the chillers' *integrated part-load values* (IPLVs) to determine existing and proposed energy consumption.

The specific assumptions vary per site and include the amount of kilowatts per ton existing and proposed at various loads, chiller schedule, controls and sequencing.

At some of the sites, variable speed pumping of the chilled water is recommended as part of the chiller water system retrofit. Converting from constant-flow chilled water distribution to variable-flow by applying VFDs on the pumps and converting the existing three-way control valves to two-way control valves at the air handlers reduces water pumping, which saves pump energy. By allowing the water flow to match system demand, energy required to chill water is also reduced. The supply water, which has been cooled to the specified supply temperature, will not be mixed with warmer return water due to the installation of two-way valves on the chilled water coils located at the air-handling units throughout the system. This greatly reduces the amount of power required to operate the system.

Allowing the pump flow to modulate and therefore match only what is needed to maintain loop pressure reduces energy requirements. Additionally, the installation of the VFDs can greatly reduce the amount of power required to operate the pumps at part-load conditions. Electricity is saved because pumps operate according to the previously described affinity laws. As with fans, the horsepower drawn by the pump at reduced speeds vary according to the flow delivered in accordance with the following equation:

$$HP_{\text{with VFD}} = \left(HP_{\text{without VFD}}\right) \times \left[\frac{\left(Flow_{\text{with VFD}}\right)}{\left(Flow_{\text{without VFD}}\right)}\right]^3$$

The energy savings were calculated using TRACE™ computer models and spreadsheet calculations to simulate constant-speed pump motors and variable-speed pump motors while keeping the scheduled pump operation the same.

Calculation results can be seen in the appendix.

ECO Energy Savings for EMS Upgrade

TRACE™ computer models and spreadsheet calculations were used to forecast the change in energy consumption from upgrading the existing EMS.

Calculated savings due to adding VFDs and controlling fan or pump speed are highly dependent upon controls upgrades. TRACE™ computer models were used to calculate the savings from these VFD projects. Spreadsheet calculations were used for measures that do not follow a common HVAC and EMS upgrade combination.

Calculation results can be seen in the appendix.

ECO Savings Methods for Water Savings

The net energy savings for the water ECO were calculated by determining the water usage for the existing fixtures and comparing it to the proposed usage of the new fixtures. Toilets, urinals and sinks were considered for this measure. The existing units will be retrofitted or replaced with current technology low-flow devices.

Section 3

Current Equipment Status

This section of the report describes the current status of the buildings and energy-consuming equipment within.

The facilities assessed for this report for Contra Costa Community College District include:

- Contra Costa College (CCC)
- Diablo Valley College (DVC)
- Los Medanos College (LMC)
- The District Office (DO)

The lighting; the *heating, ventilation and air conditioning* (HVAC); and the plumbing systems at each building were reviewed for operational ability and efficiency and were then inventoried in detail. Light levels, temperatures, energy use and water flows were sampled and recorded for these systems. The recorded data and the energy usage baseline from the previous section are used to identify the equipment candidates for retrofit or replacement.

All Buildings

The following subsections describe general conditions for all of the buildings. Specifics for chosen buildings follow these general descriptions.

Lighting

The lighting systems at the four sites were updated or renovated since original construction. The most common lighting system is the basic grade T8, but the gyms use high-intensity discharge lighting systems. The technology of these systems is over 10 years old and they should be retrofitted or replaced with newer technology systems.

Heating, Ventilation and Air Conditioning

There is a large variation in the HVAC systems used to condition the space within these buildings:

- LMC has centralized heating and cooling equipment.
- CCC has mostly localized equipment, with some centralized heating.
- DVC uses localized equipment for most buildings.

Many of these systems are described in detail on the following pages in this section of the report.

Water-Consuming Equipment

The water-consuming equipment at CCC is by majority low-flow equipment. The equipment at LMC and DVC offers significant opportunity for improvement. The plumbing devices at these colleges are recommended for retrofit or replacement as described in Section 4 of this report. Equipment details are included in the appendix.

CCC Physical Science Building

Figure 3-1: CCC Physical Science Building

General Description

Gross Floor Area	21, 430 square feet
Year of Original Construction	1957/1973
Usage	Year-round

The Physical Science building consists of two portions: new and old. The older portion is a single-story building consisting mostly of laboratories. The newer portion is a single-story building constructed in 1973 and consists of classrooms and faculty offices.

Lighting

Total Installed Lighting	25.2 kilowatts (kW)
Watts per Square Foot	1.2

Predominant Fixture Types

The majority of the classroom, office and hallway areas are illuminated by T12 linear and compact fluorescent lamps and magnetic ballasts. There are also some T8 linear and compact fluorescent lamps and electronic ballasts, mercury vapor lamps and incandescent lamps.

Lighting System Issues

The T12 lighting systems will be retrofitted with higher-efficiency, lower-maintenance T8 components.

Existing and Proposed Fixtures

A detailed list of existing fixture types and proposed retrofits is provided in the appendix.

Heating, Ventilation and Air Conditioning

Heating Source

A hot water loop feeding five buildings on campus served by two high-efficiency Aerco condensing boilers provides heating for the building.

Table 3-1: CCC Physical Science Building Boiler Summary

Tag	Make/Model	QTY	Steam or Water	Fuel	Rated Input (MBH*)	Control Type
B-1 and B-2	Aerco Benchmark 2.0	2	Water	Natural Gas	2,000	EMS

* Thousand BTUs per hour

Figure 3-2: CCC Physical Science Building Hot Water Boilers Serving the Hot Water Loop

Cooling Source

Chilled water is provided by two air-cooled reciprocating chillers located on an equipment pad outside the building.

Table 3-2: CCC Physical Science Building Chiller Summary

Tag	Make/Model	QTY	Water- or Air-Cooled	Compressor	Size (Tons)	Control Type
CH-1 and CH-2	Chrysler HAW60-1	2	Air-cooled	Reciprocating	60	EMS

Figure 3-3: CCC Physical Science Building Chiller

Pumps

Two heating water pumps and one chilled water pump deliver heating and chilled water to the building.

Table 3-3: CCC Physical Science Building Pump Summary

Tag	Make/Model	HP*	Service	Control Type
CHWP-1	B&G	7.5	Chilled Water	With chillers
HWP-1	B&G	10	Hot Water Loop	EMS
HWP-2	B&G	10	Hot Water Loop	EMS
HWP-3	B&G		New P.S. HW	EMS
HWP-4	B&G		Old P.S. HW	EMS

* Horsepower

Figure 3-4: Heating Water Pumps Serving the Hot Water Loop

Figure 3-5: CCC Physical Science Building Chilled Water Pump

Air-Handling Systems

The old portion of the Physical Science building is conditioned by a total of six fan coils with chilled and hot water, running at a constant volume and circulating 100 percent outside air. Fan coils that used to serve the hallways and smaller rooms have since been decommissioned and no longer operate.

The newer portion of the Physical Science building is conditioned by attic fan coils with chilled water coils and hot water reheat boxes in the spaces. These systems run at a constant volume and have no economizer capability.

Table 3-4: CCC Physical Science Building Packaged Unit Summary

Unit Tag	Service Area	Heating Capacity (MBH)	Cooling Capacity (MBH)	Control Type
AC-1	New P.S.	Reheat	155	EMS
AC-2	New P.S.	Reheat	100	EMS
AC-3a	New P.S.	Reheat	87.1	EMS
AC-3b	New P.S.	Reheat	71.5	EMS
AC-4	New P.S.	Reheat	125	EMS
AC-5	New P.S.	Reheat	165	EMS
AC-7	Old P.S.	200	176	Manual
AC-8	Old P.S.	200	176	Manual
AC-9	Old P.S.	27.7	33	Manual
AC-14	Old P.S.	27.7	36	Manual
AC-15	Old P.S.	60	100	Manual
AC-16	Old P.S.	60	100	Manual

Controls

The fan coils in the newer building are controlled by the Andover *energy management system* (EMS). The fan coils in the older portion of the building are turned on and off at the breaker by the occupants. All controls are pneumatic.

The chiller and boiler are both controlled by the EMS.

Figures 3-6: CCC Physical Science Building Attic Fan Coil Serving Newer Portion

Problem Areas

- The fan coils in the newer building likely do not deliver adequate ventilation to the spaces and do not have economizer capability.
- The fan coils in the older building are turned off by the occupants while class is in session because the noise is disturbing, thereby eliminating heating, cooling and ventilation during that time.
- The fan coils in the older building are turned on and off at the breaker, instead of by the EMS.
- The equipment in the newer building does not have any status points viewable from the EMS, and therefore maintenance staff must visit the building to determine its operational status.
- Temperature data loggers installed during the survey indicate that some spaces tend to overheat.

CCC Applied Arts and Administration Building

Figure 3-7: CCC Applied Arts and Administration Building

General Description

Gross Floor Area	34,345 square feet
Year of Original Construction	1978
Usage	Year-round

The Applied Arts and Administration building (AA) is a two-story building that houses classrooms, computer labs, offices and conference rooms. This building is used for both academic and administrative purposes.

Lighting

Total Installed Lighting	57.6 kW
Watts per Square Foot	1.7

Predominant Fixture Types

The majority of the classroom, office and hallway areas are illuminated by T12 linear and compact fluorescent lamps and magnetic ballasts, with some T8 linear and compact fluorescent lamps and electronic ballasts, mercury vapor lamps and incandescent lamps.

Figure 3-8: CCC AA Building T12 Hallway Lamps

Lighting System Issues

The T12 lighting systems will be retrofitted with higher-efficiency, lower-maintenance T8 components.

Existing and Proposed Fixtures

A detailed list of existing fixture types and proposed retrofits is provided in the appendix.

Heating, Ventilation and Air Conditioning

Heating Source

Heating water is provided by one Aerco boiler, located in a mechanical room. Domestic hot water is provided by two gas-fired domestic hot water heaters located in the same mechanical room.

Table 3-5: CCC AA Building Boiler Summary

Tag	Make/Model	QTY	Steam or Water	Fuel	Rated Input (MBH)	Control Type
B-1	Aerco Benchmark 2.0	1	Water	Natural Gas	2,000	EMS

Figure 3-9: CCC AA Building Hot Water Boiler and Domestic Hot Water Heaters

Cooling Source

Chilled water is provided by one water-cooled screw chiller and a cooling tower located in a mechanical room.

Table 3-6: CCC AA Building Chiller Summary

Tag	Make/Model	QTY	Water- or Air-Cooled	Compressor	Size (Tons)	Control Type
CH-1	Carrier 330H120C	1	Water-cooled	Reciprocating	120	EMS

Table 3-7: CCC AA Building Cooling Tower Summary

Tag	Make/Model	QTY	Service
CT-1	BAC-VXT135C	1	CH-1

Figure 3-10: CCC AA Building Chiller

Pumps

Two heating water pumps, two chilled water pumps and one condenser water pump serve the AA building.

Table 3-8: CCC AA Building Pump Summary

Tag	Service	Control Type
HWP-1	Main heating	EMS
HWP-2	Boxes	EMS
CHWP-1	Main Cooling	EMS
CHWP-2	Boxes	EMS
CWP-1	Condenser water	With Chiller

Figure 3-11: CCC AA Building Chilled Water Pumps

Figure 3-12: CCC AA Building Heating Water Pumps

Air-Handling Systems

Three air-handling units with chilled and hot water coils deliver air to the first floor induction boxes. Four air-handling units with chilled and hot water deliver air to the second floor *variable air volume* (VAV) boxes. These units were originally equipped with inlet guide vanes that have since been removed, and therefore all seven air-handlers run at a constant volume.

One packaged unit with *direct expansion* (DX) cooling conditions the TV studio. Another packaged unit with DX cooling and gas-fired heating conditions a computer lab.

A total of six split systems with DX cooling serve various computer labs. A total of four air-cooled condensing units serve the kitchen refrigerators and walk-in refrigerators.

Table 3-9: CCC AA Building Packaged Unit Summary

Unit Tag	Service Area	Make/Model	Heating Capacity (MBH)	Cooling Capacity (MBH)	Control Type
AHU1-1	First floor	Temtrol DH21MR	230	273	EMS
AHU1-2	First floor	Temtrol DH17MR	250	292	EMS
AHU1-3	First floor	Temtrol DH17MR	280	340	EMS
AHU2-1	Second floor	Temtrol DH21MR	230	273	EMS
AHU2-2	Second floor	Temtrol DH12MR	250	292	EMS
AHU2-3	Second floor	Temtrol DH21MR	280	340	EMS
AHU2-4	Second floor	Temtrol DH12MR	250	292	EMS
AC-1	TV Studio	Carrier	Gas	DX	EMS
AC-2		Carrier	Gas	DX	EMS

Figure 3-13: Two of Seven Air Handlers in the CCC AA Building

Figure 3-14: CCC AA Building Split-System Condensing Units Serving the Computer Labs

Table 3-10: CCC AA Building Condensing Unit Summary

Unit Tag	Make/Model	Area Served
CU-1	Carrier 38CKC03631	Computer lab
CU-2	Carrier 38CKC048300	Computer lab
CU-3	Carrier 38CKC048620	Computer lab
CU-4	Carrier 38CKC060540	Computer lab
CU-5	Carrier 38CKC030500	Computer office
CU-6	Carrier 38CK024340	Computer lab
CU-7		Kitchen
CU-8		Kitchen
CU-9		Kitchen
CU-10		Kitchen

Controls

The air handlers are controlled by the Andover EMS. Several of the packaged and split systems are controlled manually by occupants.

Damper actuators and valves are all pneumatic.

Problem Areas

- The air handlers are all constant volume, even though the second floor contains VAV boxes.
- Maintenance staff has a difficult time finding replacement parts for the VAV and induction boxes.
- Temperature data loggers installed during the survey showed 85° F classroom temperatures during occupied class times, when the outside air temperature was less than that.
- The outside air control modulates the dampers to either full open or full closed. It is likely that many spaces are not getting adequate ventilation.
- The addition of computer labs and their own split cooling systems has made it so that the air handler that formerly served those spaces is now oversized.
- Insulation on the chilled and hot water pipes on the roof is degraded at the elbows.
- Many of the fan motors are not high-efficiency.

CCC Performing Arts Center

Figure 3-15: CCC Performing Arts Center

General Description

Gross Floor Area	21,000 square feet
Year of Original Construction	1978
Usage	Year-round

The Performing Arts Center is a single-story building that houses a theater, lobby, control booths, various preparation areas, classrooms and a construction area.

Lighting

Total Installed Lighting	41.9 kW
Watts per Square Foot	2.0

Predominant Fixture Types

The building is illuminated by a mixture of T12, T8, incandescent and compact fluorescent lamps.

Lighting System Issues

The T12 and T8 lighting systems will be retrofitted with higher-efficiency, lower-maintenance T8 components.

Existing and Proposed Fixtures

A detailed list of existing fixture types and proposed retrofits is provided in the appendix.

Heating, Ventilation and Air Conditioning

Heating Source

Heating is provided by one gas-fired hot water boiler located in a mechanical room.

Table 3-11: CCC Performing Arts Center Boiler Summary

Tag	Make/Model	QTY	Steam or Water	Fuel	Rated Input (MBH)	Control Type
B-1	Peerless	1	Water	Natural Gas	1,260	EMS

Figure 3-16: CCC Performing Arts Center Gas-Fired Hot Water Boiler

Cooling Source

Chilled water is provided by one water-cooled screw chiller located in a mechanical room.

Table 3-12: CCC Performing Arts Center Chiller Summary

Tag	Make/Model	QTY	Water- or Air-Cooled	Compressor	Size (Tons)	Control Type
CH-1	McQuay	1	Water-cooled	Screw	70	EMS

Figure 3-17: CCC Performing Arts Center Water-Cooled Screw Chiller

Table 3-13: CCC Performing Arts Center Cooling Tower Summary

Tag	Make/Model	QTY	Service
CT-1	BAC-J0405B44	1	CH-1

Pumps

One heating water pump and two chilled water pumps deliver hot and chilled water to the building. Two condenser pumps circulate condenser water between the chiller and cooling tower on the roof.

Table 3-14: CCC Performing Arts Center Pump Summary

Tag	HP	Service	Control Type
CHWP-1, 2	15, 5	Chilled Water	EMS/Dual-speed Pumping
CWP-1, 2	10, 3	Condenser Water	EMS/Dual-speed Pumping
HWP-1		Hot Water	EMS

Figure 3-18: CCC Performing Arts Center Chilled Water Pump

Figure 3-19: CCC Performing Arts Center Condenser Water Pump

Air-Handling Systems

The theater, lobby and preparation areas are conditioned by a total of five constant-volume air handlers with chilled and hot water coils. The construction area is condition by one heating and ventilating unit with a hot water coil.

Two packaged gas-fired, DX units located on the roof serve the control and lighting booths.

Figure 3-20: CCC Performing Arts Center Hot Water Pump

Table 3-15: CCC Performing Arts Center Air Handler Summary

Unit Tag	Service Area	Heating Capacity (MBH)	Cooling Capacity (MBH)	Control Type
FC-1	Theater/Stage	335	524	EMS/Motion Sensors
FC-2	Lobby	79	73	EMS/Motion Sensors
FC-4	Construction	49	none	EMS/Motion Sensors
FC-5	Prep area	79	73	EMS/Motion Sensors
FC-6	Prep area	58	57	EMS/Motion Sensors
FC-7	Prep area	42	47	EMS/Motion Sensors
AC-1	Control room	gas	DX	Manual
AC-2	Control room	gas	DX	Manual

Figure 3-21: CCC Performing Arts Center Rooftop Air Handlers Serving the Preparation Areas

Figure 3-22: CCC Performing Arts Center Rooftop Air Handlers Serving the Preparation Areas

Figure 3-23: CCC Performing Arts Center Air Handler Serving the Theater

Controls

The air handlers are enabled by the EMS and are turned on and off by way of motion sensors in the spaces. The chilled water and condenser water pumps are installed in a two-speed pumping configuration to a lower pump speed when the load is low.

The chiller and boiler are enabled by the EMS.

Problem Areas

- The hot water loop temperature is high and does not have resets, so the space tends to overheat.
- Several units appear to operate 24 hours a day, seven days a week.

CCC Controls

Existing Conditions

Contra Costa College uses an existing EMS manufactured by Andover. The system covers most of the HVAC equipment on the campus, with a few pieces of equipment controlled manually by occupants in the building.

Work performed on these controls for this phase will be limited to those buildings undergoing HVAC retrofits:

- Performing Arts Center
- Physical Science
- Applied Arts and Administration

Therefore, this section addresses only those buildings.

The Performing Arts Center uses electronic controls on the air handlers. The air handlers on the roof are enabled by the EMS and are turned on and off by way of occupancy sensors in the space. Outside air lockouts are input into the EMS – 100° F for the chiller and 65° F for the boiler at the time of the survey.

The newer portion of the Physical Science building uses pneumatic controls on the fan coils. All units are enabled by one EMS schedule point and there is no status feedback from the units. The chillers serving the building are governed by the EMS. Two Aerco boilers, governed by the EMS, serve a hot water loop that feeds into the building.

The older portion of the Physical Science building has constant-volume, 100 percent outside air units with chilled and hot water from the same sources as the newer building portion. The air handlers are not scheduled or governed by the EMS and are turned on and off at the breaker by the occupants.

The Applied Arts and Administration building uses pneumatic controls on the air handlers, induction boxes and VAV boxes. All large air handlers are enabled by the EMS; however there are no status feedbacks from the units. Some small split-cooling systems are operated manually by the occupants. The boiler, chiller, cooling tower and pumps are enabled by the EMS, again with no status feedback from the units. The outside air lockouts for the chiller and boiler were 60° F and 60° F, respectively.

Table 3-16: CCC Existing Schedules in the EMS

Building	Area	Schedule
Old Physical Science	Classrooms	None
New Physical Science	Classrooms	M-TH 6am-10pm, F 6am-6pm, Sat 7am-5pm, Sun Off
AA	1st floor	M-TH 6am-10pm, F 6am-6pm, Sat 7am-5pm, Sun Off
AA	2nd floor	M-TH 6am-10PM, F 6am-6pm, Sat/Sun Off
PAC	Prep areas	M-Sun 7am-11pm
PAC	Theater/lobby	M 9am-10pm, Tues 8am-10pm, W 10am-10pm, TH 8am-10pm, F 10am-10pm, Sat 10am-4pm, Sun off

DVC Life Health Science Building

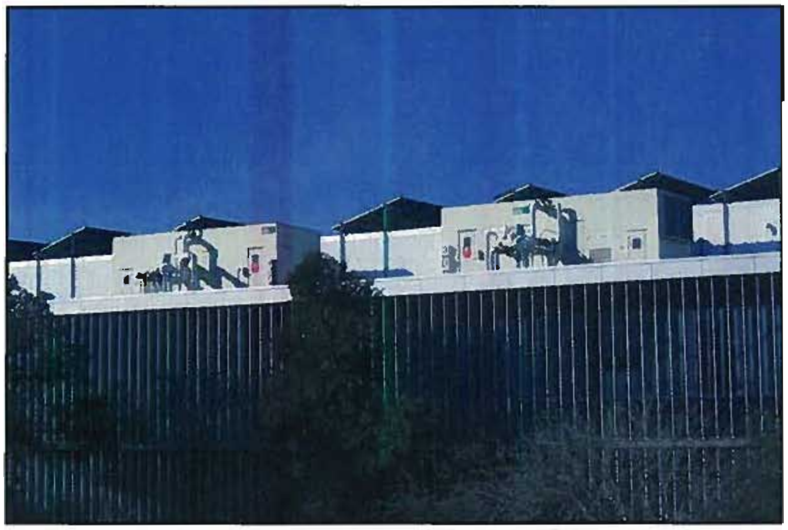


Figure 3-24: DVC Life Health Science Building

General Description

Gross Floor Area	33,844 square feet
Year of Original Construction	1998
Usage	Year-round

The original building, built in 1960 and demolished in 1998, was replaced with the newly-constructed Life Health Science (LHS) building. The three-story building is a steel-frame structure with brick veneer under a built-up roof. BP-manufactured photovoltaic cells on the roof generate 30 kilowatts of electricity to help meet the campus consumption. The facility consists of dental labs, classrooms and science labs.

The building is occupied from 8 a.m. to 10:45 p.m., Monday through Friday and from 8:30 a.m. to 11:50 a.m. on Saturday.

Lighting

Total Installed Lighting	41.2 kW
Watts per Square Foot	1.22

Predominant Fixture Types

Most of the square footage of the building receives light from T8 fluorescent fixtures, compact fluorescent fixtures and a few remaining incandescent fixtures.

Lighting System Issues

The existing fluorescent lighting systems use early-generation T8 components. Later-generation T8 systems allow for additional energy savings with similar light output and longer-life lamps.

The incandescent lighting systems should be replaced with compact fluorescent lamps to improve efficiency and extend lamp life.

Existing and Proposed Fixtures

A detailed list of existing fixture types and proposed retrofits is provided in the appendix.

Heating, Ventilation and Air Conditioning

Cooling Source

One 109-ton, water-cooled, R-22 Bohn rotary screw chiller in the Science Utility building provides chilled water to two air handlers on the roof. The cooling tower that serves condenser water to the chiller is located outside of the chiller room. The chiller, installed in 1987, was used to serve two buildings: the original LHS building and Advanced Technology Center before they were demolished.

Table 3-17: DVC Life Health Science Building Chiller Summary

Tag	Make/Model	Serial Number	Rated Capacity (Ton)	Refrigerant Type	Control Type
CH-1	Bohn/HWSC120B	BNK5007	109	R-22	EMS

Figure 3-25: DVC Life Health Science Building Water-Cooled Chiller

Table 3-18: DVC Life Health Science Building Cooling Tower Summary

Tag	Make/Model	Serial Number	Rated Capacity (Ton)	Control Type
CT-1	BAC/VT1N22-LMC	9420074	N/A	EMS

Heating Source

Two Bryan boilers, located in the basement mechanical room, provide heating hot water to the air handlers on the roof and the reheat coils throughout the building. The boilers are set up in lead and lag sequence.

Table 3-19: DVC Life Health Science Building Boiler Summary

Tag	Make/Model	Steam or Water	Fuel	GPM	Rated Output (MBH)	Control Type
B-1	Bryant/AB200W	Water	Natural Gas	115	2000	EMS
B-2	Bryant/AB200W	Water	Natural Gas	115	2000	EMS

Figure 3-26: DVC Life Health Science Building Heating Hot Water Boiler

Domestic hot water is provided by two domestic hot water boilers located in mechanical room 121.

Table 3-20: DVC Life Health Science Building Domestic Water Boiler Summary

Tag	Location	Make/Model	Fuel	Rated Input (MBH)	Control Type
WH-1	Mechanical Room 121	PVI/14P125AMX	Natural Gas	N/A	On Demand
WH-2	Mechanical Room 121	N/A	Electricity	N/A	On Demand

Pumps

Two chilled water pumps, located in the Science Utility building are set up in a primary constant-flow pumping system to circulate the chilled water. One of the chilled water pumps is a standby. A condenser water pump circulates the water from the cooling tower to the chiller.

Two heating hot water pumps, located in the basement mechanical room, are set up in a primary variable pumping system. One heating hot water pump is a standby. The pumps circulate the heating hot water from the boiler to the heating hot water coils in the air handlers and the reheat coils.

Table 3-21: DVC Life Health Science Building Pump Summary

Tag	Make/Model	HP	Control Type
CHWP-1	N/A	15	EMS
CHWP-2	N/A	15	EMS
CWP-1	N/A	20	EMS
HWP-1,2	Armstrong/ Series 4302	7.5	EMS

Figures 3-27 DVC Life Health Science Building
Chilled Water Pumps

Figure 3-28: DVC Life Health Science Building
Condenser Water Pump

Figure 3-29: DVC Life Health Science Building Heating
Hot Water Pumps

Air-Handling Systems

Two air handlers on the roof condition the building. Each air handler is a variable airflow system with VAV boxes in the service area and *variable frequency drives* (VFDs) on the supply and return fan. The units are each equipped with a chilled water coil, heating hot water coil and economizer dampers. AC-1 and AC-2 condition the southern and northern halves of the building, respectively.

Table 3-22: DVC Life Health Science Building Air Handler Summary

Unit Tag	Service Area	Make/Model	CFM*	Supply Fan (HP)	Return Fan (HP)	Control Type
AC-1	South 1st and 2nd floor	Temtrol	30,000	40	5	EMS
AC-2	North 1st and 2nd floor	Temtrol	30,000	40	5	EMS

* Cubic feet per minute

Figure 3-30: DVC Life Health Science Building, Typical Air Handler

Figure 3-31: DVC Life Health Science Building, Typical Condenser Unit for Split Systems

Four DX split systems with remote condenser units serve the aquaria, live animal room, prep room and cadaver room. The evaporators of the units are located in the service area, and the condenser units are located on the roof.

Table 3-23: DVC Life Health Science Building, Split System Summary

Unit Tag	Service Area	Make/Model	CFM	Cooling Capacity (MBH)	Heating Capacity (kW)	Control Type
FCU-1	Aquaria	/OHS012AR	250	3	5	EMS
FCU-2	Prep Room	/OHS3685DAR0R	3,685	207	26.7	EMS
FCU-3	Live Animal Room	/OHS018AR	750	20	5	EMS
FCU-4	Cadaver Room	/OHS2245DARAR	2,400	138	26.7	EMS

Controls

All HVAC equipment is controlled by the EMS. The heating coil valves are two-way valves and have *direct digital control* (DDC) valve actuators. The cooling coil valves are 3-way valves and have DDC valve actuators.

The main chiller is controlled by the EMS and is turned on based on the outside air lockout temperature. The boiler is also controlled by the EMS and is turned on by the outside air lockout temperature.

The domestic hot water boilers are available all the time, and the pumps operate with the equipment.

Problem Areas

According to the maintenance personnel, the HVAC control malfunctions, causing discomfort in the building. Control recommissioning is recommended.

DVC Music Building

Figure 3-32: DVC Music Building

General Description

Gross Floor Area	14,522 square feet
Year of Original Construction	1963
Usage	Year-round
Year of Remodeling	1985 and 1998

The Music building is a two-story building with a mechanical room in the basement. The facility consists of classrooms, practice rooms and instrument rooms. In 1985 a major HVAC remodeling was done. The original air-handling units, installed in 1963, were demolished, and new units were installed. In 1998 new small air-conditioning units were installed as the heating and cooling load of the space increased due to a change in the space usage.

The building is occupied from 8 a.m. to 10 p.m., Monday through Friday.

Lighting

Total Installed Lighting	15.2 kW
Watts per Square Foot	1.05

Predominant Fixture Types

The majority of the building receives light from T8 fluorescent fixtures, compact fluorescent fixtures and a few remaining incandescent fixtures.

Lighting System Issues

The existing fluorescent lighting systems use early-generation T8 components. Later-generation T8 systems allow for additional energy savings with similar light output and longer-life lamps

The incandescent lighting systems should be replaced with compact fluorescent lamps to improve efficiency and extend lamp life.

Existing and Proposed Fixtures

A detailed list of existing fixture types and proposed retrofits is provided in the appendix.

Heating, Ventilation and Air Conditioning

Cooling Source

One 28.5-ton, air-cooled, R-22 Carrier reciprocating chiller is located outside of the Music building and provides chilled water to the main air handler in the basement mechanical room. The chiller was installed in 1985.

Table 3-24: DVC Music Building Chiller Summary

Tag	Make/Model	Serial Number	Rated Capacity (Ton)	Refrigerant Type	Control Type
CH-1	Carrier/ 30GA030530	W596439	28.5	22	EMS

Figure 3-33: DVC Music Building Air-Cooled Chiller

Heating Source

A Rite boiler, located in the basement mechanical room, provides heating water to the main air handler. The boiler was installed in 1985.

Table 3-25: DVC Music Building Boiler Summary

Tag	Make/Model	Steam or Water	Fuel	Rated Input (MBH)	Control Type
B-1	Rite/36	Water	Natural Gas	36	EMS

Figure 3-34: DVC Music Building Heating Hot Water Boiler

Pumps

Two inline heating hot water pumps and one chilled water pump deliver heating hot water and chilled water to the air handler.

Table 3-26: DVC Music Building Pump Summary

Tag	Make/Model	HP	Service	Control Type
CHWP-1	N/A	1	Chilled Water	EMS
CHWP-2	N/A	1	Chilled Water	EMS
CHWP-1	B&G	1/2	Heating Hot Water	EMS
CHWP-2	B&G	1/2	Heating Hot Water	EMS

Figure 3-35: DVC Music Building Chilled Water Pumps

Figures 3-36: DVC Music Building Heating Hot Water Pumps

Air-Handling Systems

One multi-zone constant-volume air handler (AC-3) located in the basement serves conditioned air to half of the building. AC-3 has a chilled water coil and a heating hot water coil. AC-3 supplies air through an underground duct.

Two old rooftop units serve two large classrooms. Two brand new Carrier rooftop units serve the practice rooms and the main music lab. Four small heat pumps serve the four music labs.

Table 3-27: DVC Music Building Packaged Unit Summary

Unit Tag	Service Area	Make/Model	CFM	Heating Capacity (MBH)	Cooling Capacity (MBH)	Control Type
Multi-zone MZ-3	Room 125,126, 127 and offices	Carrier	12,000	7.5 HP (Supply Fan)	N/A	EMS
Multi-zone AC-4	Room 104	Carrier/ 48L2008510	2,400	114	91	EMS
Multi-zone AC-5	Room 101	Carrier/ 48L2008510	2,400	114	91	EMS
HP-1 and 2	Small Music Labs	N/A	252	9	8.7	EMS
HP-3 and 4	Small Music Labs	N/A	455	16.9	17.3	EMS
AC-1	Main Music Labs	Carrier/ 48HJD0065	2,000	72	61	EMS
AC-2	Practice Rooms	Carrier/ 48GX024048	800	33	23	EMS

Figure 3-37: DVC Music Building Multi-zone MZ-3

Figures 3-38: DVC Music Building, Old Packaged Rooftop Units AC-4 and AC-5

Figure 3-39: DVC Music Building, New AC-2

Figures 3-40: DVC Music Building, AC-1 and Heat Pump 1 through Heat Pump 4

Controls

The campus EMS controls MZ-3, AC-4 and AC-5. The boiler, chiller and the pumps are also controlled by the EMS. The newly added air-conditioning units are controlled by thermostats located in the service area.

Problem Areas

- The VFD on the supply fan motor of AC-3 is not properly controlled and is an incorrect VFD application with the absence of VAV boxes.
- AC-4 and AC-5 are about 21 years old and beyond their service life. The efficiency of the units has been depreciated due to the aging of the components.

DVC Engineering Technology Building

Figure 3-41: DVC Engineering Technology Building

General Description

Gross Floor Area	36,551 square feet
Year of Original Construction	1971
Usage	Year-round
Year of Remodeling	Couple years after 1989

The Engineering Technology buildings are two one-story buildings connected by the roof. Each building is a metal frame structure with brick veneer under a built-up roof. The buildings consist of classrooms, electric equipment labs, draft labs and offices. In 1989, the original rooftop units were replaced with Carrier units due to equipment age. VAV boxes were installed several years later according to the maintenance personnel.

The buildings are occupied from 8 a.m. to 10 p.m., Monday through Friday, and from 8:30 a.m. to 3:15 p.m. on Saturday.

Lighting

Total Installed Lighting	44.30 kW
Watts per Square Foot	1.21

Predominant Fixture Types

Most of the square footage receives light from T8 fluorescent fixtures and compact fluorescent fixtures.

Lighting System Issues

The existing fluorescent lighting systems use early-generation T8 components. Later-generation T8 systems allow for additional energy savings with similar light output and longer-life lamps.

Existing and Proposed Fixtures

A detailed list of existing fixture types and proposed retrofits is provided in the appendix.

Heating, Ventilation and Air Conditioning

Heating Source

Domestic hot water is provided by one domestic hot water boiler located in the mechanical room.

Table 3-28: DVC Engineering Technology Building Boiler Summary

Tag	Make/Model	Steam or Water	Fuel	Rated Input (MBH)	Control Type
DHWH	Rheem/41VR40IN	Water	Natural Gas	40	On Demand

Air-Handling Systems

A total of seven air-conditioning units, one constant-volume single-zone and six multi-zone rooftop units serve the Engineering Technology buildings. MZ 1 through MZ 5 are equipped with economizer dampers and VFDs on fan motors. MZ 6 is a constant air volume multi-zone system. AC-7, the constant-volume single-zone rooftop unit, serves the TV room.

Table 3-29: DVC Engineering Technology Building Packaged Unit Summary

Unit Tag	Service Area	Make/Model	Fan HP	Heating Capacity (MBH)	Cooling Capacity (MBH)	Control Type
MZ-1	Room 116, 116A-F, 117A, 118, 119A-E	Carrier/48MA028	10	540	25	EMS
MZ-2	Room 119, 119F-H, 120, 120A, 120B, 121, 121A	Carrier/48MA028	10	540	25	EMS
MZ-3	Room 122, 122A, 122B, 123	Carrier/48MA034	20	648	30	EMS
MZ-4	Room 126	Carrier/48MA034	20	648	30	EMS
MZ-5	Room 105, 107, Hallway	Carrier/48MA028	10	540	25	EMS
MZ-6	Room 104, 108, 112	Carrier/48MA016	5	432	15	EMS
AC-7	TV/Drama	Lennox/LGA060SH1G	N/A	74	N/A	EMS

Figure 3-42: DVC Engineering Technology Building, Typical Multi-zone Rooftop Unit with VFD

Figures 3-43: DVC Engineering Technology Building AC-7

Controls

All HVAC equipment is controlled by the EMS.

Problem Areas

- During the survey it was noted that the VFDs were switched to bypass mode. The VFD controls need to be recommissioned to check the functionality.
- The existing multi-zone units were installed in 1989 and are beyond the service life. The efficiency of units has been depreciated due to the aging of the components.

- According to the maintenance personnel, the existing VAV boxes are malfunctioning, causing discomfort in the space.

Figure 3-44: DVC Engineering Technology Building VFD Switched to Bypass Mode

DVC Physical Science Building

Figure 3-45: DVC Physical Science Building

General Description

Gross Floor Area	24,274 square feet
Year of Original Construction	1967
Usage	Year-round

The original building, built in 1967, was demolished in 2000, and the current Physical Science North and South buildings were constructed. The Physical Science building is a steel-frame structure with wood siding under a built-up roof. The facilities consist of offices, classrooms and science labs.

The building is occupied from 8 a.m. to 10:30 p.m., Monday through Friday, and is not used over the weekend.

Lighting

Total Installed Lighting	49.56 kW
Watts per Square Foot	2.04

Predominant Fixture Types

Most of the square footage receives light from T8 fluorescent fixtures and compact fluorescent fixtures.

Lighting System Issues

The existing fluorescent lighting systems use early-generation T8 components. Later-generation T8 systems allow for additional energy savings with similar light output and longer-life lamps

Existing and Proposed Fixtures

A detailed list of existing fixture types and proposed retrofits is provided in the appendix.

Heating, Ventilation and Air Conditioning

Heating Source

One Bryan boiler, located in the basement mechanical room, provides heating hot water to the air handlers on the roof and the reheat coils throughout the building.

Table 3-30: DVC Physical Science Building Boiler Summary

Tag	Make/Model	Steam or Water	Fuel	GPM	Rated Input (MBH)	Control Type
B-1	Bryan/RV300-W-FDG	Water	Natural Gas	125	3,000	EMS

Pumps

Two heating hot water pumps, located in the basement mechanical room, are set up in a primary variable pumping system. One heating hot water pump is a standby. The pumps circulate the heating hot water from the boiler to the heating hot water coils in the air handlers and the reheat coils.

Table 3-31: DVC Physical Science Building Pump Summary

Tag	Make/Model	HP	Control Type
P-1,2	B&G/Series1510	7.5	EMS

Figure 3-46: DVC Physical Science Building Heating Hot Water Pumps (P-1 and P-2)

Air-Handling Systems

Three air handlers on the roof condition the building. They are variable airflow systems with VFDs on the supply and return fans, and are equipped with a DX coil for cooling and have main and reheat hot water coils for heating. AHU-1 circulates 100 percent outside air and conditions the science labs, whereas AHU-2 and AHU-3 have economizer dampers to modulate the percentage of outside air.

Table 3-32: DVC Physical Science Building Air Handler Summary

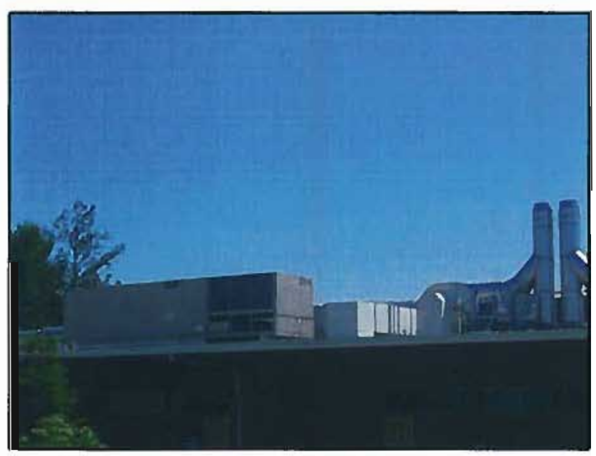
Unit Tag	Service Area	Make/Model	CFM	Supply Fan (HP)	Return Fan (HP)	Control Type
AHU-1	Second floor chemistry lab	McQuay/RDT115C	28,000	50	N/A	EMS
AHU-2	First floor physics lab	McQuay/RDT50C	15,000	20	7.5	EMS
AHU-3	First and second floor physics lab	McQuay/RDT70C	18,000	20	10	EMS

Controls

All HVAC equipment is controlled by the EMS. The heating coil valves are two-way valves and have DDC valve actuators.

Problem Areas

The DX cooling coils in the air handlers are inefficient in comparison with chilled water coils.



Figures 3-47: DVC Physical Science Building, Typical DX Air Handler

DVC Men's Locker Building

Figure 3-48: DVC Men's Locker Building

General Description

Gross Floor Area	14,889 square feet
Year of Original Construction	1961
Usage	Year-round
Year of Remodeling	1970 and 1986

The Men's Locker building is a one-story building. The building houses showers, lockers and a team room. In 1970, a locker room, restroom and sauna were added to the original building (additional 6,000 square feet). In 1986, the old unit heaters were dismantled and replaced with heating ventilation units.

Lighting

Total Installed Lighting	13.88 kW
Watts per Square Foot	0.93

Predominant Fixture Types

Most of the square footage receives light from T8 fluorescent fixtures, compact fluorescent fixtures and a few remaining incandescent fixtures.

Lighting System Issues

The existing fluorescent lighting systems use early-generation T8 components. Later-generation T8 systems allow for additional energy savings with similar light output and longer-life lamps

The incandescent lighting systems should be replaced with compact fluorescent lamps to improve efficiency and extend lamp life.

Existing and Proposed Fixtures

A detailed list of existing fixture types and proposed retrofits is provided in the appendix.

Heating, Ventilation and Air Conditioning

Heating Source

A Bryan boiler, located in a mechanical room, provides heating water to the heating ventilators on the roof and the unit heaters in the building. The boiler was installed in 1986.

Table 3-33: DVC Men's Locker Building Boiler Summary

Tag	Make/Model	Steam or Water	Fuel	Rated Output (MBH)	Control Type
B-1	Bryan/CL120WGI	Water	Natural Gas	960	EMS

Figure 3-49: DVC Men's Locker Building Heating Hot Water Boiler

Domestic hot water is provided by one domestic hot water boiler located in the mechanical room.

Table 3-34: DVC Men's Locker Building Domestic Water Heater Summary

Tag	Make/Model	Steam or Water	Fuel	Rated Input (MBH)	Control Type
DHWH	Teledyne Laars	Water	Natural Gas	266	On Demand

Figure 3-50: DVC Men's Locker Building Domestic Hot Water Boiler and Hot Water Storage Tank

Pumps

Two heating hot water pumps circulate heating hot water to the heating ventilation units on the roof. One domestic hot water heater delivers hot water to showers and sinks.

Table 3-35: DVC Men's Locker Building Pump Summary

Tag	Make/Model	HP	Service	Control Type
HWP-1	B&G	1/4	Heating Hot Water	With Equipment
HWP-2	B&G	1/2	Heating Hot Water	With Equipment
DHWP-1	N/A	N/A	Domestic Hot Water	On Demand

Figure 3-51: DVC Men's Locker Building Heating Hot Water Pumps

Figure 3-52: DVC Men's Locker Building, Domestic Hot Water Pump

Air-Handling Systems

Three heating only air handlers, located on the roof, condition the building.

Table 3-36: DVC Men's Locker Building Heating Ventilation Units Summary

Unit Tag	Service Area	Make/Model	CFM	Heating Capacity (MBH)	Control Type
MU-1	Locker Area	Carrier/ER08	2,000	118.8	EMS
MU-2	Locker Area	Carrier/ER08	3,400	242.3	EMS
MU-3	Locker Area	Carrier/ER08	2,600	199.4	EMS

Controls

All HVAC equipment is controlled by the EMS. The boiler is turned on and off based on the outside lockout temperature.

The domestic hot water boilers are available all the time, and the pumps operate with the equipment.

Problem Areas

The existing heating ventilators, installed in 1986, are beyond the equipment service life.

Figures 3-53: DVC Men's Locker Building Fenced Area for Multi-zone Units on Roof

DVC Library Building

Figure 3-54: DVC Library Building

General Description

Gross Floor Area	63,201 square feet
Year of Original Construction	1970
Usage	Year-round
Year of Remodeling	1986 and 1999

The Library building is a two-story building with a mezzanine. The facility consists of classrooms, computer labs, a tutoring area and a library. There were two additions to the original Library building. In 1986, the main computer lab on the first floor was constructed, and in 1999, approximately 6,900 square feet of space was added.

The business hours of the library are from 8 a.m. to 9 p.m., Monday through Friday, and from noon to 4 p.m. on Saturday.

Lighting

Total Installed Lighting	97.92 kW
Watts per Square Foot	1.55

Predominant Fixture Types

Most of the square footage receives light from T8 fluorescent fixtures, compact fluorescent fixtures and a few remaining incandescent fixtures.

Lighting System Issues

The existing fluorescent lighting systems uses early-generation T8 components. Later-generation T8 systems allow for additional energy savings with similar light output and longer-life lamps.

The incandescent lighting systems should be replaced with compact fluorescent lamps to improve efficiency and extend lamp life.

Existing and Proposed Fixtures

A detailed list of existing fixture types and proposed retrofits is provided in the appendix.

Heating, Ventilation and Air Conditioning

Cooling Source

One 30-ton, water-cooled, R-22 Bohn screw chiller in the mechanical room provides chilled water to the fan coils and air handlers in the building. The cooling tower that serves condenser water to the chiller is located outside of the mechanical room. The chiller was installed in 1989.

One 60-ton, air-cooled, R-22 Carrier scroll chiller is dedicated to serve the computer lab on the first floor.

Table 3-37: DVC Library Building Chiller Summary

Tag	Make/Model	Serial Number	Rated Capacity (Ton)	Refrigerant Type	Control Type
CH-1	Bohn/HWSC150C	A89070684	130	R-22	EMS
CH-2	Carrier	N/A	60	R-22	EMS

Figures 3-55: DVC Library Building Water-Cooled Chiller

Figures 3-56: DVC Library Building Cooling Tower

Figure 3-57: DVC Library Building Air-Cooled Chiller for Computer Lab

Table 3-38: DVC Library Building Cooling Tower Summary

Tag	Make/Model	Serial Number	Rated Capacity (Ton)	Control Type
CT-1	BAC/VXTN240RC	88200341	N/A	EMS

Heating Source

A Bryan boiler, located in the mechanical room, provides heating water to the fan coils and air handlers in the building.

Table 3-39: DVC Library Building Boiler Summary

Tag	Make/Model	Steam or Water	Fuel	Rated Output (MBH)	Control Type
B-1	Bryan/K450WGI	Water	Natural Gas	3600	EMS

Figure 3-58: DVC Library Building Heating Hot Water Boiler

Domestic hot water heaters, located throughout the building, provide domestic hot water to the building.

Table 3-40: DVC Library Building Domestic Water Boiler Summary

Tag	Location	Make/Model	Steam or Water	Fuel	Rated Input (MBH)	Control Type
DHWH	Janitorial closet on second floor	State/ Censible510E	Water	Natural Gas	30 gal	On Demand
DHWH	Boiler and chiller room	A.O. Smith/ DVE52916	Water	Electricity	18 kW	On Demand

Pumps

There are two pumps in the mechanical room:

- A main chilled water pump (CHWP-1)
- A heating hot water pump (HWP-1)

The condenser water pump (CWP-1) is located in the fenced area where the cooling tower is located.

One chilled water pump (CHWP-2), located outside with the air-cooled chiller, is dedicated to circulate the chilled water from the air-cooled chiller to the main air handler for the computer lab.

Table 3-41: DVC Library Building Pump Summary

Tag	HP	Control Type
CHWP-1	10	EMS
CHWP-2	5	EMS
CWP-1	10	EMS
HWP-1	7.5	EMS

Figure 3-59: DVC Library Building Chilled Water Pump and Heating Hot Water Pumps

Figure 3-60: DVC Library Building Condenser Water Pump

Air-Handling Systems

Fan coil units, AC-1 through AC-10, are located in the West mechanical room on the roof and condition the second floor of the Library. Three supply fans, SF-1 through SF-3, are equipped with economizer dampers and supply fresh outside air or mixed air to the West mechanical room. SF-4, located outside of the East mechanical room, brings fresh outside air or mixed air to the fan coils in the mechanical room. The computer lab (approximately 8,690 square feet) was added in 1986. AH-1, a cooling-only unit and a variable airflow air handler with VAV box and VFD on the supply fan motor, serves the lab. Two Liebert split systems keep the server room in the computer lab cool year-round.

Figure 3-61: DVC Library Building Chilled Water Pump for Air-Cooled Chiller

In 1999, approximately 6,900 square feet of space was added to the original Library, and a total of five fan coils were installed to condition the space. In the same year, two split systems, AC-1 and AC-2, were added to condition a mechanical room and a new server room in the mezzanine, respectively.

There are a total of three electric window units in the perimeter offices of the building.

Table 3-42: DVC Library Building Fan Coils and Supply Fans Summary

Unit Tag	Service Area	Make/ Model	CFM	Fan (HP)	Heating Capacity (MBH)	Cooling Capacity (MBH)	Control Type
AC-1	N/A	Carrier/ 40RS008	3,300	1.5	155	98	EMS
AC-2	N/A	Carrier/ 40RS012	3,735	1.5	175.5	110	EMS
AC-3	N/A	Carrier/ 40RS016	5,400	1.5	253.5	172	EMS
AC-4	N/A	Carrier/ 40RS024	9,000	5	417	270	EMS
AC-5	N/A	Carrier/ 40RS016	5,265	1.5	200	165.5	EMS
AC-6	N/A	Carrier/ 40RS008	2,210	.75	75.4	60	EMS
AC-7	N/A	Carrier/ 40RS012	3,735	1.5	175.5	110	EMS
AC-8	N/A	Carrier/ 40RS008	1,620	.75	75	48	EMS
AC-9	N/A	Carrier/ 40RS008	2,760	1	100.4	84	EMS
AC-10	N/A	Carrier/ 40RS010	3,350	1.5	157.5	98	EMS
AC-11	N/A	Trane/ D36A12	1,200	.17	63.2	36	No Control
AC-12	N/A	Carrier/ 40RS016	2,320	1	108.2	76	EMS
AC-13	N/A	Carrier/ 40RS016	5,580	1.5	214	178.4	EMS
AC-14	N/A	Trane/ 026A08	800	.17	43.1	24	EMS
AC-15	N/A	Carrier/ 40RS008	2,400	1.75	121.7	72	EMS
AC-16	N/A	Carrier/ 40RS016	5,400	1.5	188	172.7	EMS
Computer Lab AC-1	Computer Lab	Trane/ Climate Changer	N/A	15	None	N/A	EMS
Reznor SF-1	Fan coils in West mechanical room	Reznor/ RBLCAB	10,000	10	None	None	EMS
Reznor SF-2	Fan coils in West mechanical room	Reznor/ RBLCAB	N/A	7.5	None	None	EMS
Reznor SF-3	Fan coils in West mechanical room	Reznor/ RBLCAB	7,000		None	None	EMS
Reznor SF-4	Fan coils in West mechanical room	Reznor/ RBLCAB	10,000	7.5	None	None	EMS
FC 1-1	N/A	Trane/ BCHB-36	1,200	.5	33.2	54.3	EMS

Unit Tag	Service Area	Make/ Model	CFM	Fan (HP)	Heating Capacity (MBH)	Cooling Capacity (MBH)	Control Type
FC 2-1	N/A	Trane/ BCHB-54	1,500	.5	52.5	73.5	EMS
FC 2-2	N/A	Trane/ BCHB-72	2,200	1	73.5	94.5	EMS
FC 2-3	N/A	Trane/ BCHB-120	3,240	1	113	140.5	EMS
FC 2-4	N/A	Trane/ BCHB-72	2,400	1	66.5	97.5	EMS

Figure 3-62: DVC Library Building, Typical Fan Coil Unit

Figure 3-63: DVC Library Building, Typical Fan Coil Unit

Figures 3-64: DVC Library Building, Typical Reznor Outside Air Supply Fan for Fan Coils

Figure 3-65: DVC Library Building Fan Coil Unit on First Floor (AC-13)

Figure 3-66: DVC Library Building, New Fan Coil Unit FC 1-1 Serving the New Addition on the First Floor

Figure 3-67: DVC Library Building, Typical Window Unit in Office

Figure 3-68: DVC Library Building AC Unit for Room L103

Figure 3-69: DVC Library Building Condenser Units that Serve the Computer Server Room

Table 3-43: DVC Library Building Split System Summary

Unit Tag	Service Area	Make/Model	Fan (HP)	Cooling Capacity (MBH)	Control Type
AC-1	Server room in Mezzanine	Carrier/ FB4A-018	1/5	18	EMS
AC-2	Mechanical room on second floor	Carrier/ FB4A-018	1/5	15	EMS

Controls

All HVAC equipment except AC-11 is controlled by the EMS. The heating and cooling valves are three-way valves and have Honeywell DDC valve actuators. The window units in the offices are individually controlled by the switch embedded in the unit.

Chillers and boilers are as follows:

- The air-cooled chiller is controlled by the space temperature of the computer lab and the chilled water pump runs with the chiller.
- The main chiller is scheduled to be off during the winter months, and the boiler is scheduled to be off during the summer months.
- The domestic hot water boilers are available all the time and the pumps operate with the equipment.

There is an air compressor in the mechanical room that provides compressed air to pneumatic control valves in the fan coil units that condition the first floor. The compressor also provides compressed air to the old Andover pneumatic control devices.

Problem Areas

- The air-cooled chiller was cycling frequently during the March 2006 survey when outside air could be utilized to cool the space. This indicates that the chiller is oversized to handle the low cooling load during the month and the economizer in the air handler is not functioning properly.
- During the survey, it was noted that the computer lab was very humid and warm. Air balancing is recommended to see if the existing air handler is providing the specified cubic feet of air flow per minute. The space cooling load calculation is also necessary to check if the existing system is sized properly.
- The occupants in the Listening and Viewing area expressed their discomfort, citing warm space temperatures during summer months and cool temperatures during winter months.

Diablo Valley College Controls

Existing Conditions

Diablo Valley College uses an EMS manufactured by Andover. The system covers most of the HVAC equipment on the campus, with a few pieces of equipment controlled manually by occupants in the building. The existing Andover EMS enables a user to monitor the status of a piece of equipment and control and schedule the equipment.

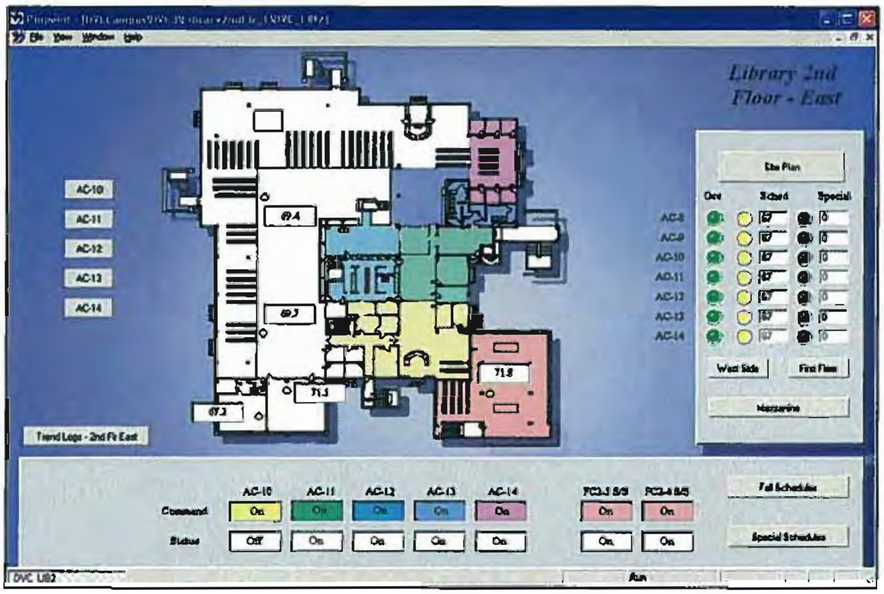


Figure 3-70: Typical Andover EMS Front End

Figure 3-71: Typical Andover EMS Schedule Screen

Work performed on these controls for this phase will be limited to those buildings undergoing HVAC retrofits:

- Engineering Technology
- Life Health Science
- Physical Science
- Library
- Men's Locker
- Music

Therefore, this section will address only those buildings.

The Engineering Technology building uses electronic controls on the multi-zone rooftop units. The units are monitored by the EMS and operate on a schedule set up by the maintenance personnel.

The Life Health Science building uses electronic controls on the air handlers. The air handlers on the roof are governed by the EMS and are turned on and off according to the schedule. The chiller and boiler that serves the facility is controlled by the EMS and is turned on and off by the outside air lockout temperature.

The Physical Science building uses electronic controls on the air handlers on the roof. The air handlers are controlled by the EMS and operate on schedule. The boiler is governed by the EMS and is turned on and off by the outside air lockout temperature.

The Library building uses electronic and pneumatic controls on the fan coils and operate according to the set schedule. The fan coils that serve the second floor are controlled by electronic control devices, and the fan coils that serve the first floor use pneumatic control devices. The air compressor in the chiller room provides compressed air to the pneumatic controls. The main chiller and boiler that serve the facility with chilled water and heating hot water is controlled by the EMS and is turned on and off by the outside air lockout temperature. The air-cooled chiller that serves the computer lab is controlled by the EMS.

The Men's Locker building uses electronic controls. The unit ventilators on the roof are governed by the EMS and operate according to the set schedule. The boiler that serves heating hot water to the facility is controlled by the EMS and is turned on and off by the outside air lockout temperature.

The Music building uses electronic controls. The air handlers in the basement (AC-3) and rooftop units (AC-4 and AC-5) are controlled by the EMS. Newly added heat pumps and rooftop units are controlled by thermostats in the service area.

Table 3-44: Diablo Valley College Existing EMS Schedule

Building	Units	Schedule
Engineering Technology	RTUs	M-Sat 6am – 10pm, Sun Off
Life Health Science	Air Handlers	M-F 6am – 10pm, Sat/Sun Off
Physical Science	Air Handlers	M-F 6am – 10pm, Sat/Sun Off
Library	Air Handlers	M-Sat 6am – 10pm, Sun Off
Men's Locker	Unit Ventilators	M-F 6am – 10pm, Sat/Sun Off
Music	Air Handler/RTUs	M-F 8am – 6pm, Sat/Sun Off

Los Medanos College

Figure 3-72: Los Medanos College

General Description

Gross Floor Area	267,060 square feet
Year of Original Construction	1971
Usage	Year-round

Los Medanos College is a four-level complex that comprises multiple buildings under a common roof and walkway system. The facility consists of classrooms, a library, computer labs, administrative offices, a cafeteria, a theater, a recital hall, and offices used by Police Services. A childcare center is separate from the main complex. The Music building addition was constructed in the early 1990s.

Apart from the main complex is the gymnasium, men's and women's locker rooms, portable activity rooms and the swimming pool. Currently under construction are the new Library, Science and Math buildings.

The hours of the facility are Monday through Saturday, from 6 a.m. to 10 p.m., and Saturday 8 a.m. to 5 p.m. The Theater and Music Recital Hall have occasional Sunday occupancies.

Lighting

Total Installed Lighting	261.2 kW
Watts per Square Foot	0.98

Predominant Fixture Types

Most of the square footage in the buildings receives light from T8 fluorescent fixtures and compact fluorescent fixtures.

Lighting System Issues

The existing fluorescent lighting systems use early-generation T8 components. Later-generation T8 systems allow for additional energy savings with similar light output and longer-life lamps

Existing and Proposed Fixtures

A detailed list of the existing fixture types and proposed retrofits is provided in the appendix.

Heating, Ventilation and Air Conditioning

Cooling Source

Two 350-ton, water-cooled, R-123 York Centrifugal Variable-Speed Chillers located at the central plant provide chilled water to the air handlers serving the main building complex. Three Marley cooling towers serve the condenser water to the chiller. The chillers and cooling towers were installed in 2001.

Table 3-45: LMC Chiller Summary

Tag	Make/Model	QTY	Water- or Air-Cooled	Compressor	Size (tons)	Control Type
CH-1	York	1	Water	Centrifugal	350	EMS
CH-1	York	1	Water	Centrifugal	350	EMS

Figure 3-73: LMC Water-Cooled Chiller

Figure 3-74: LMC Cooling Tower

Table 3-46: LMC Cooling Tower Summary

Tag	Make/Model	QTY	Service
CT-1	Marley	1	Condenser Water
CT-2	Marley	1	Condenser Water
CT-3	Marley	1	Condenser Water

Heating Source

Six Aerco high-efficiency condensing hot water boilers provide heating water to the air handlers and reheat coils throughout the main building complex. These boilers also serve a heat exchanger to provide domestic hot water.

Two Aerco high-efficiency condensing hot water boilers located adjacent to the Pool building provide heating water for the gymnasium air handlers. These boilers also serve a heat exchanger for pool heating.

One small steam boiler located on the roof provides process steam for the science labs.

Table 3-47: LMC Boiler Summary

Tag	Make/Model	QTY	Steam or Water	Service	Fuel	Rated Input (MBH)	Control Type
B-1	Aerco Benchmark 2.0	1	Water	Building heating	NG	2000	EMS
B-2	Aerco Benchmark 2.0	1	Water	Building heating	NG	2000	EMS
B-3	Aerco Benchmark 2.0	1	Water	Building heating	NG	2000	EMS
B-4	Aerco Benchmark 2.0	1	Water	Building heating	NG	2000	EMS
B-5	Aerco Benchmark 2.0	1	Water	Building heating	NG	2000	EMS
B-6	Aerco Benchmark 2.0	1	Water	Building heating	NG	2000	EMS
B-7	Aerco Benchmark 2.0	1	Water	Pool and Gym	NG	2000	On Demand
B-8	Aerco Benchmark 2.0	1	Water	Pool and Gym	NG	2000	On Demand
B-9		1	Steam	Biology process	NG		On Demand

Figure 3-75: LMC Heating Hot Water Boilers

Figure 3-76: LMC Heating Water to Domestic Hot Water Heat Exchanger

Figure 3-77: LMC Steam Boiler Serving the Science Labs

Figure 3-78: LMC Heating Water to Pool Water Heat Exchanger

Pumps

Two primary chilled water pumps and two primary heating water pumps, located at the central plant, circulate chilled and hot water to the building, respectively. Two condenser water pumps circulate condenser water between the chillers and cooling towers, located at the central plant. All three sets of pumps are piped in parallel. The heating water pumps have VFDs installed.

Each air-handler that has a cooling coil is equipped with a small chilled water circulation pump installed at the coil. This pump acts as a booster pump.

One constant-volume pump serves the swimming pool, circulating water through the filters and the heat exchanger's cold side. One constant-volume heating water pump serves the gymnasium, the heat exchanger's hot side, and the boilers located next to the Pool building. Two parallel pumps provide irrigation water to the campus.

Table 3-48: LMC Pump Summary

Tag	Make/Model	HP	Service	Control Type
CHWP-1	B&G CJS886	25	Primary CHW	EMS
CHWP-2	B&G CJS886	25	Primary CHW	EMS
CWP-1	B&G	15	Condenser Water	With Chiller
CWP-2	B&G	15	Condenser Water	With Chiller
HWP-1	B&G 5BC	20	Primary HW	VFD/EMS
HWP-2	B&G 5BC	20	Primary HW	VFD/EMS
Pool-1		25	Swimming Pool	On demand
HWP-3			Gym/Pool HX	On demand
CHWBP-1	B&G	1.5	S-1	On demand
CHWBP-2	B&G	0.25	S-2	On demand
CHWBP-3	B&G	1	S-3	On demand
CHWBP-4	B&G	0.5	S-4	On demand
CHWBP-5	B&G	1	S-5	On demand
CHWBP-6	B&G	1	S-6	On demand
CHWBP-7	B&G	1	S-7	On demand
CHWBP-8	B&G	0.75	S-8	On demand
CHWBP-9	B&G	1	S-9	On demand
CHWBP-13	B&G	0.25	S-13	On demand
CHWBP-N1	B&G	0.75	N-1	On demand
CHWP-N2	B&G	0.75	N-2	On demand
IP-1	Paco 29-30145-140001	40	Irrigation	On demand
IP-2	Sulzer	40	Irrigation	On demand

Figure 3-79: LMC Central Plant Condenser Water Pumps

Figure 3-80: LMC Central Plant Heating Water Pumps

Figure 3-81: LMC Central Plant Chilled Water Pumps

Figure 3-82: LMC Pool Pump

Figure 3-83: LMC Chilled Water Coil Pump

Air-Handling Systems

Twelve air handlers with chilled water and hot water condition the majority of the main building complex. One air handler with hot water conditions the maintenance area on the ground floor.

Of the twelve air handlers, eight have VFDs installed on the supply and return fans as part of a retrofit done in the 1990s. The static pressure sensor that controls the drives is located just downstream of the supply fan. These units serve VAV boxes that were installed upstream of the existing hot water reheat coils.

Eight packaged rooftop units with gas heating and DX cooling condition the Music building addition. Four other packaged gas/DX units serve spaces in the Nursing building, the Vocational Technology building and the computer labs.

Several small split-system DX units serve the Biology building's cadaver and animal rooms and other classrooms and offices.

The gymnasium is conditioned by two hot water heating and ventilating units that receive hot water from the boilers adjacent to the Pool building. The portable classrooms and locker rooms are conditioned by wall-mounted heat pumps.

Table 3-49: LMC Air-Handling Unit Summary

Unit Tag	Service Area	Make/Model	Heating Capacity (MBH)	Cooling Capacity (MBH)	Control Type
S-1	Biology, Classrooms	Alladin	696	1,285	EMS
S-2	Planetarium	Alladin	223	125.8	EMS
S-3	Art, Classrooms, Maintenance	Alladin	725	1,220	EMS
S-4	Drama	Alladin	142	239	EMS
S-5	Nursing, Admin	Alladin	525	854	EMS
S-6	Voc Tech	Alladin	390	804	EMS
S-7	LHS	Alladin	539	810	EMS
S-8	Music, Admin	Alladin	379	585	EMS
S-9	Cafeteria	Alladin	542	836	EMS
S-12	Maintenance		235	None	EMS
S-13	Old Childcare	Alladin	125	171.5	EMS
N-1	Nursing	Carrier	156.6	218.2	EMS
N-2	Nursing	Carrier	182	181.2	EMS
AC-1	Admin/Nursing	Carrier 48HJE004-631-	Gas	DX	Thermostat
AC-2	Admin/Nursing	Carrier	Gas	DX	Thermostat
AC-3	Voc Tech	Carrier 48HJD007-M-531CA	Gas	DX	Thermostat
AC-4	Computer lab	Carrier 48HJD012-661-	Gas	DX	Thermostat
HVAC-1	Music Recital Hall	Lennox GCS16-3003-450	Gas	DX	EMS

Unit Tag	Service Area	Make/Model	Heating Capacity (MBH)	Cooling Capacity (MBH)	Control Type
HVAC-2	Music Recital Hall	Lennox GCS16-3003-450	Gas	DX	EMS
HVAC-3	Music classrooms	Lennox GCS16-953-200	Gas	DX	EMS
HVAC-4	Music classrooms	Lennox GCS16-653-75	Gas	DX	EMS
HVAC-5	Music classrooms	Lennox GCS16-653-75	Gas	DX	EMS
HVAC-6	Music classrooms	Lennox GCS16-653-75	Gas	DX	EMS
HVAC-7	Music classrooms	Lennox GCS16-953-200	Gas	DX	EMS
HVAC-8	Music classrooms	Lennox GCS16-953-200	Gas	DX	EMS
PU-1	New Childcare	Carrier 48HJE006---641	Gas	DX	EMS
PU-2	New Childcare	Carrier 48HJE004---641	Gas	DX	EMS
PU-3	New Childcare	Carrier 48HJD005---641	Gas	DX	EMS
PU-4	New Childcare	Carrier 48HJE007---641	Gas	DX	EMS
PU-5	New Childcare	Carrier 48HJE007---641	Gas	DX	EMS
PU-6	New Childcare	Carrier 48HJD006---631	Gas	DX	EMS
PU-7	New Childcare	Carrier 48HJE004---641	Gas	DX	EMS
PU-8	New Childcare	Carrier 48HJE004---641	Gas	DX	EMS
HV-1	Gym		HW	None	Manual
HV-2	Gym		HW	None	Manual
PAC-1	WLR	BARD	DX	DX	Manual
PAC-2	WLR	BARD	DX	DX	Manual
PAC-3	MLR	BARD	DX	DX	Manual
PAC-4	MLR	BARD	DX	DX	Manual
PAC-5	Portable Classroom	BARD	DX	DX	Manual
PAC-6	Portable Classroom	BARD	DX	DX	Manual
PAC-7	Portable Classroom	BARD	DX	DX	Manual

Figure 3-84: LMC Packaged Units on the Roof of the Childcare Center

Figure 3-85: LMC Packaged Unit on the Roof of the Music Building

Figures 3-86: LMC Air Handlers

Figures 3-87: LMC Chilled Hot Water Coils

Figure 3-88: LMC VAV Box and Reheat Coil

Figure 3-89: LMC Split System Condensing Units

Table 3-50: LMC Split System Summary

Unit Tag	Make/Model	Area Served
S-10	Heatcraft HDH0500D74	Cadaver Room
S-11		Animal Room
CU-1	Carrier 38TH018300	Nursing
CU-3		Cafeteria
CU-4		Cafeteria
CU-5		Cafeteria
CU-6	Sanyo CH1812	
CU-7	Sanyo heat pump	
CU-8	Carrier 38CKC060670	Classrooms
CU-9	Carrier 384CC036650	Classrooms
CU-10	Carrier 38YCC036650	Classrooms

Controls

Most of the HVAC equipment is controlled by the Andover EMS. Maintenance staff has done a good job with scheduling equipment as tightly as possible.

There are some electronic controls; however the majority are pneumatic. The chilled and hot water coils on the air handlers have three-way electronic valves controlling the flow. The majority of the reheat boxes have two-way pneumatic valves, and the VAV boxes have pneumatic damper actuators.

Several packaged units and split systems are manually controlled by occupants in the building. The heating and ventilating units at the gymnasium are controlled manually.

The Music Recital Hall has a push button that drops fan speed to half for the purpose of minimizing noise during performances. Selected spaces on campus have been equipped with push-button overrides in case occupants are there after scheduled hours.

Problem Areas

- The static pressure sensors that control the VFDs on the fans of the air handlers were installed in the wrong location. As a result, the fan speed is not controlled properly and likely doesn't drop below 75 percent of maximum. Several VAV boxes have been forced open because of noise and/or comfort issues. As a result, many of these units operate close to constant volume.
- In several locations, one air handler conditions several floors of differing usage, and systems are not currently capable of isolating areas that are unoccupied.
- The VFDs that are installed on the heating water pumps must not drop below 77 percent or the pump will shut off.
- And economizer retrofit performed on the air handler serving the Music building was done incorrectly. The outside air dampers were permanently shut to prevent the building from becoming over-pressurized.

- The motors on the air handlers were installed in a different location than where they were designed. The resulting vibration has contributed to severe metal fatigue on many of the units and ductwork.

Los Medanos College Controls

Existing Conditions

Los Medanos College uses an existing EMS manufactured by Andover. The system covers most of the HVAC equipment on the campus, with a few pieces of equipment controlled manually by the occupants in the building.

Condenser water pumps, chilled water pumps and hot water pumps – as well as the cooling towers, chillers and boilers – are all viewable from the EMS.

The college has purchased and arranged for the installation of a boiler management system that will sequence the six Aerco boilers so they operate at the highest efficiency possible for a given heating load. The college has arranged for the installation of BACnet (building automation and control networking) so that more chiller information and settings can be controlled through the EMS.

The air handlers located on the roof of the main building use electronic controls; however the VAV boxes, reheat boxes and some indoor units still use pneumatic controls. The air handlers all have command and status points, in addition to VFD percent speed controls on the variable volume units, supply air temperature readings, and two to four space temperature readings per unit.

The heating and ventilating units located on the roof of the gymnasium are manually controlled by the occupants.

Table 3-51: LMS Existing Schedules in the EMS

Unit	Schedule
S-1	M 6a-10p, T-TH 7a-10p, F 7a-5p, Sat 8a-5p, Sun off
S-2	M 6a-10p, T-TH 7a-10p, F 7a-5p, Sat 8a-5p, Sun off
S-3	M 6a-10p, T-TH 7a-10p, F 7a-5p, Sat 8a-5p, Sun off
S-4	M 6a-10p, T-TH 7a-10p, F 8a-11p, Sat 8a-9p, Sun 8a-11p
S-5	M 6a-10p, T-TH 7a-10p, F 7a-5p, Sat 8a-5p, Sun off
S-6	M 6a-10, T-TH 7a-10p, F 7a-8p, Sat/Sun off
S-7	M 6a-10p, T-TH 7a-10p, F 7a-5p, Sat 8a-5p, Sun off
S-8	M 6a-10p, T-TH 7a-10p, F 7a-5p, Sat 8a-5p, Sun off
S-9	M 6a-10p, T-TH 7a-10p, F 7a-5p, Sat 8a-5p, Sun off
S-12	Manual
S-13	M-F 6a-10p, Sat 7a-5p, Sun off
HVAC-1,2	M 7a-10p, T-Sat 8a-10p, Sun off
HVAC-3,4	24/7
HVAC-4,5,6,7	M 7a-10p, TH-F 8a-10p, Sat 10a-2p, Sun off
N1	M 6a-10p, T-TH 7a-10p, F 7a-5p, Sat 8a-5p, Sun off
N2	M 6a-10p, T-TH 7a-10p, F 7a-5p, Sat 8a-5p, Sun off
CDC packaged	M-F 8a-10p, Sat 8a-5p, Sun off

District Office Building

Figure 3-90: District Office Building

General Description

Gross Floor Area	34,363 square feet
Year of Original Construction	1971
Usage	Year-round

The District Office is a six-story building that consists of offices, conference rooms and server rooms. The Sheriff's office occupies the second floor, 24 hours a day, seven days a week.

Lighting

Total Installed Lighting	50.7 kW
Watts per Square Foot	1.5

Predominant Fixture Types

Most of the building is illuminated by T12 and T8 linear, U-tube and compact fluorescent lamps and some incandescent lamps.

Figure 3-91: District Office Building Interior Lighting

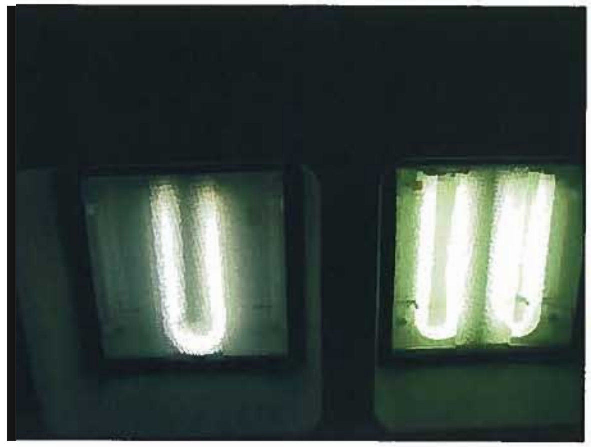


Figure 3-92: District Office Building Interior Lighting

Lighting System Issues

The T12, T8 and incandescent lighting systems will be retrofitted with higher-efficiency, lower-maintenance T8 components.

Existing and Proposed Fixtures

A detailed list of existing fixture types and proposed retrofits is provided in the appendix.

Heating, Ventilation and Air Conditioning

Heating Source

Heating is provided by one Parker hot water boiler located on the roof.

Table 3-52: District Office Building Boiler Summary

Tag	Make/Model	QTY	Steam or Water	Service	Fuel	Rated Input (MBH)	Control Type
B-1	Parker T-1460-T	1	Water	Building	Natural Gas	1,460	EMS

Figure 3-93: District Office Building Hot Water Boiler and Pump

Cooling Source

Chilled water is provided by one water-cooled reciprocating chiller and cooling tower located in the basement of the building.

Table 3-53: District Office Building Chiller Summary

Tag	Make/Model	QTY	Water- or Air-Cooled	Compressor	Size (tons)	Control Type
CH-1	Acme HMCW-120	1	Water-cooled	Reciprocating	120	EMS

Table 3-54: District Office Building Cooling Tower Summary

Tag	Make/Model	QTY	Service
CT-1	BAC VXT-95RC	1	CH-1

Figure 3-94: District Office Building Chiller

Figure 3-95: District Office Building Cooling Tower and Condenser Water Pump

Pumps

One heating water pump and one chilled water pump deliver hot and chilled water to the building. One condenser water pump circulates condenser water between the chiller and cooling tower.

Table 3-55: District Office Building Pump Summary

Tag	HP	Service	Control Type
CHP-1	5	Chilled Water	With Chiller
CWP-1		Condenser Water	With Chillers
HWP-1	2	Hot Water	On Demand

Figure 3-96: District Office Building Chilled Water Pump

Air-Handling Systems

One air handler on the roof delivers air to the VAV reheat boxes throughout the building. This unit is equipped with a VFD that controls both the supply and return fans.

Table 3-56: District Office Building Air Handler Summary

Unit Tag	Service Area	Make/Model	Heating Capacity (MBH)	Cooling Capacity (MBH)	Control Type
AH-1	Building	McQuay MM-164	1,163	1,355	EMS

Controls

The air handler, boiler, chiller and cooling tower are controlled by the Andover EMS.

Damper actuators and valves are all pneumatic.

Problem Areas

- Although only the second floor remains occupied overnight, supply fan speed never drops below 57 percent of full.
- Interior walls have been erected and various modifications have been made to ductwork and internal loads, leading to uneven temperature distribution throughout the building.
- The airside and waterside systems require balancing and recommissioning to help solve uneven temperature distributions within the building.

Figure 3-97: District Office Building Rooftop Air Handlers Serving Entire Building

District Office Controls

Existing Conditions

The District Office uses an existing EMS manufactured by Andover. The system covers the HVAC equipment at the building.

The air handler on the roof has command and status points, as well as readings for the VFD percent speed controls and the supply and return air temperatures. The boiler and chiller are both viewable from the EMS. The VAV boxes are viewable and the set points can be changed for different spaces.

Space temperature loggers have indicated there is some uneven temperature distribution. The data also showed that one room was being conditioned only during unoccupied times and remained unconditioned during occupied times. The graphics, though somewhat accurate, were not completely representative of room locations and wall layout. Overrides have been placed on the EMS so that occupants can change equipment operation to solve space temperature issues.

The second floor is occupied 24 hours a day, seven days a week. Space temperature and power logger data indicate that the mechanical systems are not being ramped down at night as much as possible.

Section 4

Energy Conservation Measures

This section of the report describes the details of the *energy conservation measures* (ECMs) recommended for implementation. Several *energy conservation opportunities* (ECOs) have been identified in addition to the ECMs, and some of these ECOs are included toward the end of the report sections at each campus or site.

Contra Costa College – Photovoltaic Systems

This *energy conservation measure* (ECM) recommends photovoltaic (PV) systems installed at each campus.

Proposed Solution

Chevron ES proposes installing PV systems to offset a percentage of CCCCD's power demand with PV power generation. A PV cell is a semiconductor device that converts photons of light energy from the sun into direct current electricity. PV systems produce the most amount of electricity during peak hours of the day when electric utility rates are the highest. By installing PV at Contra Costa College (CCC), the PV power generation will displace power purchased at peak rates. Additionally through net metering, when the district generates more electricity than it consumes, the district can effectively sell the energy back to the grid at fair market value. Net metering is facilitated by installing a single meter capable of registering the flow of electricity in both directions. The estimated annual cost savings does not capture the financial benefits of net metering.

CCCCD has applied for incentive money from the Self-Generation Incentive Program (SGIP) authorized by the California Public Utility Commission and administered by PG&E. The SGIP offers capacity-based incentives of $3 per watt.

Additional benefits of photovoltaic systems include:

- Environmental stewardship
- Public recognition
- A diversified energy portfolio
- Power reliability
- A secure positive return on investment through competitive fixed energy costs

Scope of Work

Chevron ES proposes 1,024 kilowatts of PV at the CCC campus. The individual system sizes range from 54 watts to 595 kilowatts. Chevron ES recommends a variety of applications, including roof-mounted systems, ground-mounted systems and parking shade structures.

Roof-mounted systems can be installed on either flat or sloped roofs, and there are a variety of mounting options. Roof-mounted systems provide the additional benefit of shielding the roof membrane from harmful UV radiation, thereby extending the roof life. Additionally, roof-mounted systems provide added roof insulation that can reduce a building's heating and cooling demand.

Figure 4-1: Roof-Mounted System

Figure 4-2: Parking Shade Structure

Ground-mounted systems can be installed on flat or sloped ground. Frequently, ground-mounted systems are installed on hillsides to take advantage of the natural slope.

Parking shade structures are solar-covered parking structures. The parking structure offers a dual benefit of electricity production and shade for parked cars.

Table 4-1 outlines the proposed locations, system applications and PV system sizes.

Table 4-1: Contra Costa College System Application and System Size

Campus	System Application and System Size						Total
	Roof-Mounted	System Size, DC	Ground-Mounted	System Size, DC	Parking Structure	System Size, DC	
Contra Costa College	Gym Annex	95 kW	Upper Hillside	595 kW	Lot 10	120 kW	1,024 kW
	Gym	54 kW					
	Library	89 kW					
	Liberal Arts	71 kW					

Operation and Maintenance

Chevron ES shall provide site-specific operation, maintenance and parts manuals for the PV system and modifications to any existing facility or feature therein. The manuals shall cover components, options and accessories supplied. They shall include maintenance, troubleshooting, and safety precautions specific to the supplied equipment. Maintenance schedules shall be provided. Actual operation and maintenance of the PV panels and system will be performed by a third party.

Contra Costa College – Lighting

T12/T8 Retrofit

This ECM recommends retrofitting first-generation T8 and T12 lighting with third-generation T8 components.

Existing Conditions

The existing linear fluorescent fixtures used throughout the facility have either T12 lamps and magnetic ballasts or first-generation T8 lamps and electronic ballasts. Some of the buildings were retrofitted from T12 components to T8 components about 10 years ago during a previous energy conservation project. The T8 lamps in use are 700-series lamps, and the ballasts are standard electronic ballasts. The 700-series lamps have a color rendering index that is below 80 percent and their lumen output is less than 2,900 lumens. The existing ballasts catalog rating is 58 watts (two-lamp fixture). This system produces only 78 maintained lumens per watt. There are also several incandescent lamps in operation. The existing fixtures are in good condition and are good candidates for the recommended retrofits.

Figure 4-3: Contra Costa College T12 Fixture

Proposed Solution

This *energy conservation measure* (ECM) proposes replacing T12 and standard grade T8 lamps with long-life, high-color-rendering and high-efficiency lamps. This ECM also proposes replacing magnetic and standard electronic ballasts with premium efficiency third-generation ballasts. These new components will provide similar light levels with improved color qualities. The new lamp color-rendering index is greater than 85 percent with similar lumen output while using less energy. The new third-generation low-ballast factor ballasts use as low as 45 watts (two-lamp fixture). The new system produces as high as 99 maintained lumens per watt. Two-lamp fixtures will be retrofitted with two lamps, and three- and four-lamp fixtures may be de-lamped with higher power ballasts. Retrofit details are shown in the appendix.

Scope of Work

Chevron ES recommends that Contra Costa College remove existing light fixtures and replace with new fixtures as specified below:

- Fixture retrofits shall use high-efficiency lamps and ballasts with the ballast factor rating as specified on the lighting spreadsheet in the appendix.
- Ballasts shall be GE, Sylvania, Advance, Universal, Howard or an approved equal.
- New lamps shall be third-generation premium efficiency T8 lamps.

- Lamps shall have a color-rendering index greater than 80 percent.
- Lamp life ratings shall be equal to or greater than 24,000 hours at 12 hours per start.
- Lamps shall be as manufactured by GE, Sylvania or Philips.

Operation and Maintenance

To maintain proper lighting levels within the facility, it is recommended that the lamps, lenses, reflectors and fixture housings be cleaned annually and at the time of any required service. At the conclusion of the implementation of this project, lamps and ballasts will be new. It is recommended that lamps be replaced in a group on a schedule at 75 percent of their rated lamp life. It is recommended that ballasts and sensors be replaced only upon failure. This measure will reduce the required stock on hand for lighting equipment. Actual maintenance requirements include the following:

- Clean reflector surfaces.
- Replace lamps prior to burning out.

Contra Costa College – Personal Computer Controls

Recommended Application of Computer Energy Management Software

The calculated energy savings from installing computer energy management software on the personal computers at Contra Costa College is shown in Figure 4-4. The existing energy consumption is compared to the energy consumption after the proposed changes.

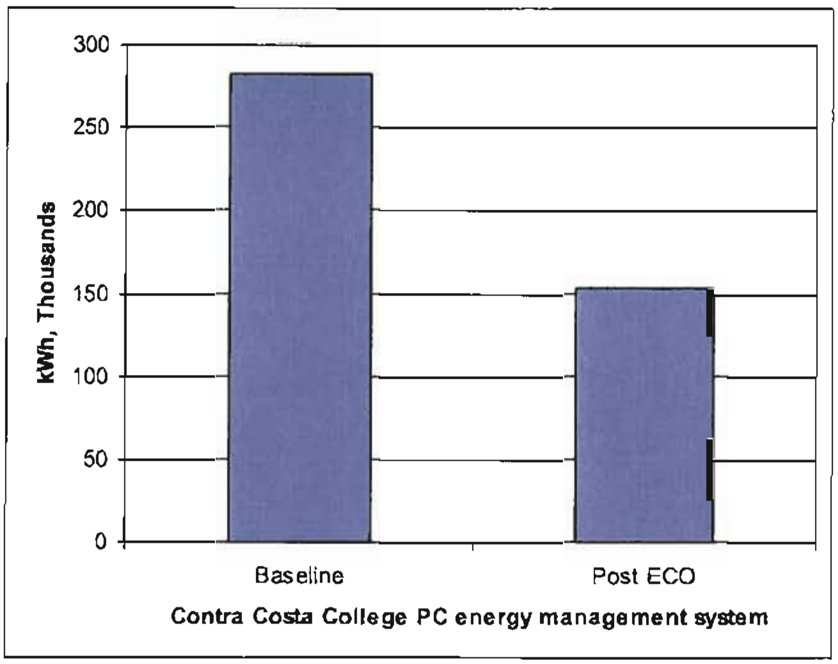


Figure 4-4: CCC Baseline and Post-ECM Personal Computer Energy Management Software

Existing Conditions

Contra Costa College has approximately 850 personal computers in use at the campus. These computers are deployed with standard settings for Suspend, Standby and Shutdown modes on each computer within the operating system. Computer keystroke activity and energy-saving modes utilization logging was performed for two weeks on a representative sample of the computers at this facility. A significant portion of the computers have had the standard settings modified with non-energy-saving screen savers or have had the energy-conserving modes disabled in the operating systems.

Proposed Solution

The personal computer energy management software is a supervisory system installed on the network. Once installed, the system listens for network connectivity between the computer and the network. Power management profiles are developed for groups of users on the server; these profiles are used to adjust the Standby, Hibernate, Sleep and Shutdown modes on each computer and its monitor as needed by each usage group. The user still has the ability to change the settings temporarily, if needed for a specific task, or permanently, if required. The system also records computer usage patterns, tracks energy conservation realized, and creates reports, if required. The system can be tailored to meet the needs of the site or user as required.

Scope of Work

Information about the installation of network-based personal computer energy management control systems, including annual site licenses, are displayed in Table 4-2.

Table 4-2: CCC Units for Computer Controller Installations

Building/Area	Quantity of Personal Computers	Quantity of Software Site Licenses
All - CCC	850	850

Operation and Maintenance

Installation and support of the system is included.

Contra Costa College – Controllers

Recommended Application of Compressor Controllers

The calculated energy savings from installing compressor controllers on small-packaged and refrigeration units at Contra Costa College is shown in Figure 4-5. The existing energy consumption is compared to the energy consumption after the proposed changes.

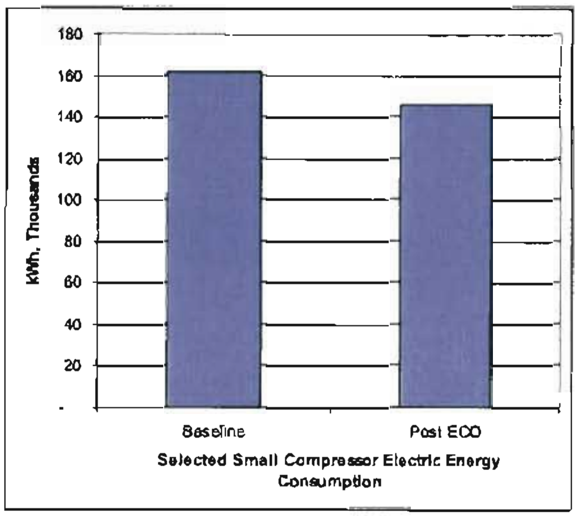


Figure 4-5: CCC Baseline and Post-ECM Compressor Electric Energy Consumption Comparison

Existing Conditions

CCC has many, relatively small-packaged cooling units and split systems that provide cooling and refrigeration for various purposes. The sizing of refrigeration systems is based upon a number of factors. When any of the design considerations are not met, the refrigeration system is oversized for the load and thus, less efficient.

Figure 4-6: CCC Applied Arts and Administration Building Packaged Unit on Roof

Proposed Solution

Compressor controllers continually monitor the system to detect load changes. In cases where the load is less than the system maximum output, the control delays the start of the system to lower the energy output to match the reduced load. This process is varied dynamically from cycle to cycle.

Scope of Work

The compressor controllers will be installed and commissioned on the following packaged units and refrigeration units:

Table 4-3: CCC Units for Controller Installations

Building/ Area	Qty Refrigeration Units	Qty Cooling Units
AA	4	8
CDC	0	8
PAC	0	2

Operation and Maintenance

The installation of this ECM is expected to lengthen the life of existing units due to reduction in compressor short-cycling and wear on components.

Phase 2: Contra Costa College – HVAC

Note: This subsection falls within phase 2 of the project. It is not part of the current scope.

Recommended Airflow Conversion

For the heating, ventilation and air conditioning (HVAC) systems, a constant airflow system changes the supply air temperature and provides a constant volume of air continuously to the zone regardless of the variation of load. Consequently, the fan motor operates continuously.

In contrast, a *variable air volume* (VAV) system controls temperature in a space by varying the quantity of supply air rather than varying the supply air temperature. A VAV terminal box at the zone varies the quantity of supply air to the space by varying the position of a damper in the box. The energy savings associated with VAV occurs as the heating and cooling load of the zone changes. The variations of the zone load allow the supply air quantity to be reduced and consequently reduce the fan motor power consumption when equipped with variable speed motors. In addition to varying airflows and saving fan motor energy, VAV systems prevent simultaneous overcooling and overheating by adjusting airflows.

For this campus, Chevron ES recommends VAV conversion in three buildings:

- Applied Arts and Administration
- Physical Science
- Performing Arts Center

The baseline and post-ECO VAV conversion electric and natural gas energy savings are shown in Figure 4-7 and Figure 4-8. The building-by-building electric energy savings contribution is shown in Figure 4-9.

Phase 2 Project

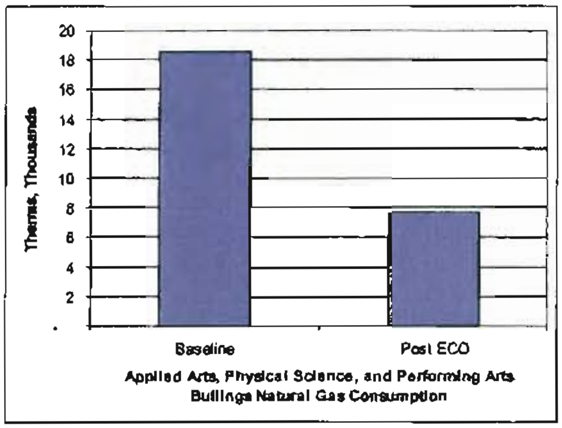


Figure 4-7: CCC Baseline and Post-ECO VAV Conversion ECO Electric Energy Consumption Comparison

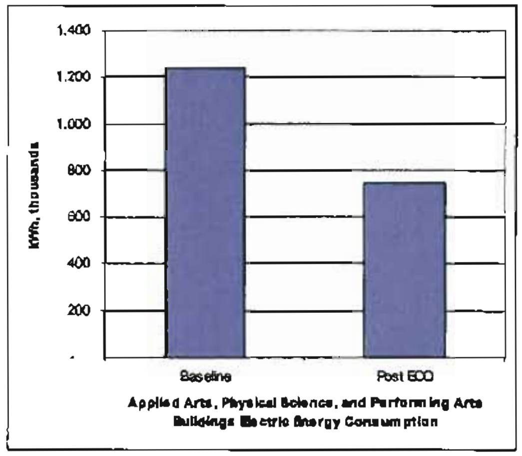


Figure 4-8: CCC Baseline and Post-ECO VAV Conversion ECO Natural Gas Energy Consumption Comparison

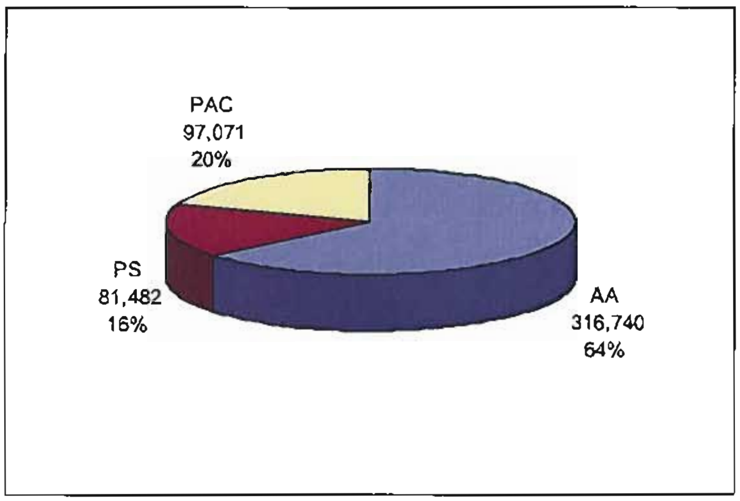
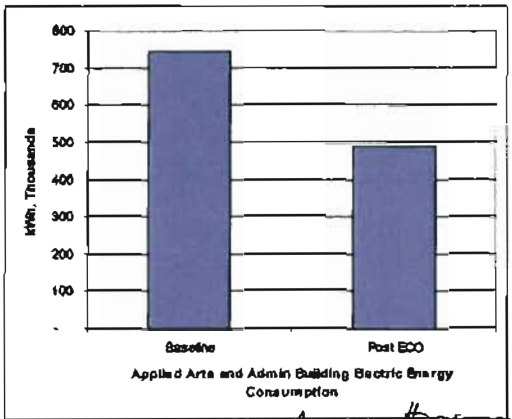


Figure 4-9: CCC Building-by-Building Electric Energy Savings Contribution (kWh)

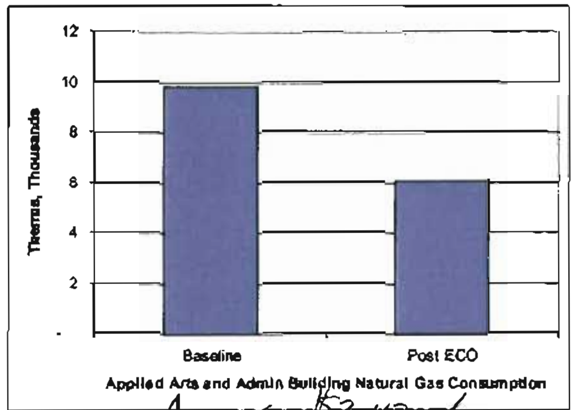
Applied Arts and Administration Building

This ECO recommends replacing the existing constant-volume system for the Applied Arts and Administration building with a variable airflow system.



Δ ≈ $35,000/YR

Figure 4-10: CCC Applied Arts and Administration Building Baseline and Post-ECO Electric Energy Consumption Comparison



Δ ≈ $3,420/YR

Figure 4-11: CCC Applied Arts and Administration Building Baseline and Post-ECO Natural Gas Energy Consumption Comparison

Existing Conditions

Three *air-handling units* (AHUs) with chilled and hot water coils deliver air to the first-floor induction boxes. Four air-handling units with chilled and hot water deliver air to the second-floor VAV boxes. These units were originally equipped with inlet guide vanes that have since been removed, and therefore these seven air-handlers function at a constant volume.

Temperature data loggers installed in the classrooms and hallways showed that some spaces reached 85° F during occupied hours, even when the outside air temperature was less than that. This is due to inadequate controls and lack of temperature resets that would allow the space to maintain a more consistent temperature. Instead, the rooms overheat, cool down and overheat again. Additionally, the air handlers are not equipped with integrated economizers. The outside air dampers are either fully open or fully closed and are not utilizing the outside air for cooling nor using added ventilation to the fullest extent.

Figure 4-12: CCC Applied Arts and Administration Building Rooftop Air-Handling Units

The maintenance staff has had a difficult time finding replacement parts for the VAV and induction boxes. These boxes are original to the building, which was built in 1978.

Furthermore, the addition of computer labs and their own split cooling systems have made it so that the air handler that serves those spaces is now oversized. Many of the supply and return fan motors on the air handlers are not high-efficiency.

Phase 2 Project

Proposed Solution

This ECO would remove the existing seven air handlers and install six new air handlers with hot water, chilled water, economizer capability, full *energy management system* (EMS) control and *variable frequency drives* (VFDs) on the supply and return fans. The existing induction boxes and VAV boxes will be removed and replaced with new VAV reheat boxes.

Scope of Work

- The existing units, AHU 1-1, AHU 1-2, AHU 1-3, AHU 2-1, AHU 2-2, AHU 2-3 and AHU 2-4, will be demolished and replaced with AHU 1-1, AHU 1-2, AHU 2-1, AHU 2-2, AHU 2-3 and AHU 2-4, with VFDs on the supply and return fans.
- The existing AHU 2-2 and AHU 1-3 supply and return ductwork will be combined and connected to the new AHU 1-2.
- The new units will be connected to the existing chilled and hot water piping.
- The existing VAV and induction boxes will be removed and replaced with new VAV reheat boxes in the same location (except for the rooms served by separate *direct expansion* [DX] units).
- A new differential pressure sensor in the supply duct at two-thirds of the distance from the AHU's supply fans will be installed to modulate fan airflow.
- An outdoor-type rooftop unit with a corrosion-resistant coating on the coils, pitched roof housing and stainless steel drain pan will be provided. Motors will be high-efficiency and inverter duty construction.

Table 4-4: New CCC Applied Arts and Administration Building Air Handlers

Tag	CFM*	ESP**	Comment
AHU 1-1	6,082	2.2	Rooftop/VFD/Econ
AHU 1-1 return fan	6,797	0.8	
AHU 1-2			Remove
AHU 1-2 return fan			Remove
AHU 1-3	7,870	2.2	Rooftop/VFD/Econ
AHU 1-3 return fan	6,439	0.8	
AHU 2-1	7,012	2.2	Rooftop/VFD/Econ
AHU 2-1 return fan	6,439	0.8	
AH 2-2	8,586	2.2	Rooftop/VFD/Econ
AHU 2-2 return fan	7,513	0.8	
AH 2-3	5,366	2.3	Rooftop/VFD/Econ
AHU 2-3 return fan	7,906	0.8	
AH 2-4	10,983	2.2	Rooftop/VFD/Econ
AHU 2-4 return fan	5,259	0.9	

* cubic feet per minute
** external static pressure

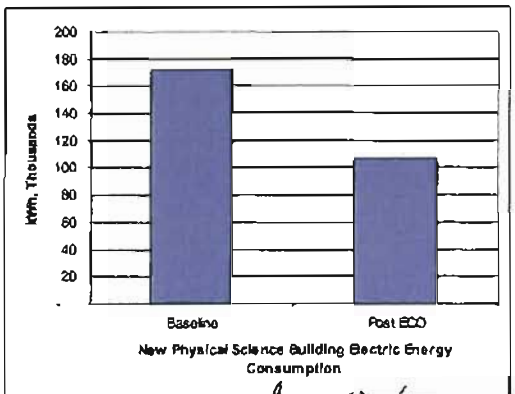
Phase 2 Project

Operation and Maintenance

The installation of this ECO will reduce both short-term and long-term maintenance costs due to the reduction in the number of units and the longer life of new equipment.

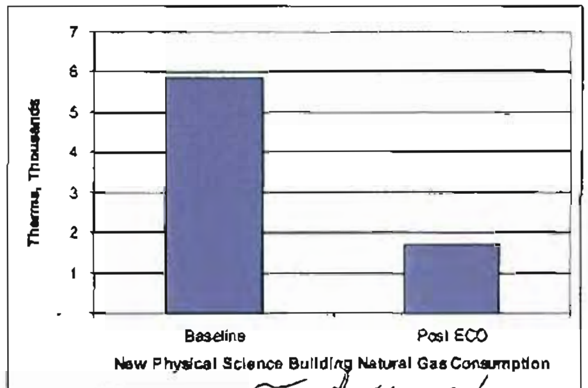
Physical Science Building

This ECO recommends upgrading the HVAC systems.



≈ $9,100/YR

Figure 4-13: CCC Physical Science Building Baseline and Post-ECO Electric Energy Consumption Comparison



≈ $4,590/YR

Figure 4-14: CCC Physical Science Building Baseline and Post-ECO Natural Gas Energy Consumption Comparison

Existing Conditions

The Physical Science building consists of two portions: new and old. The older portion, constructed in 1957, is a single-story building consisting mostly of laboratories. The newer portion is a single-story building constructed in 1973 and consists of classrooms and faculty offices.

The old portion of the Physical Science building is conditioned by a total of six fan coils (FCs) using chilled and hot water for cooling and heating. These units operate at a constant volume and blow 100 percent outside air. Fan coils that formerly served the hallways and smaller rooms have since been decommissioned and no longer operate. The fan coils currently serving the labs are turned off by the occupants while class is in session because the noise is disturbing, thereby eliminating heating, cooling and ventilation during that time.

Figure 4-15: CCC Physical Science Building: One of Six Attic Fan Coils Serving the Newer Portion of the Building

The newer portion of the Physical Science building is conditioned by chilled water attic fan coils serving hot water reheat boxes in the spaces. These systems run at a constant volume with no economizer

Phase 2 Project

capability. Temperature data loggers installed in the classrooms indicate that the rooms tend to overheat.

The fan coils in the older building are turned on and off at the breaker instead of by the EMS.

The equipment in the newer building does not have any status points viewable from the EMS, and therefore maintenance staff must visit the building to determine its temperature status.

Proposed Solution

This ECO would remove the existing six fan coils in the attic of the newer portion of the building. They would be replaced with two new air handlers with chilled water, economizers and VFDs on the supply and return fans. These units will be located in a mechanical room on the ground floor and connected into the existing ductwork. The existing reheat boxes will be replaced with VAV reheat boxes.

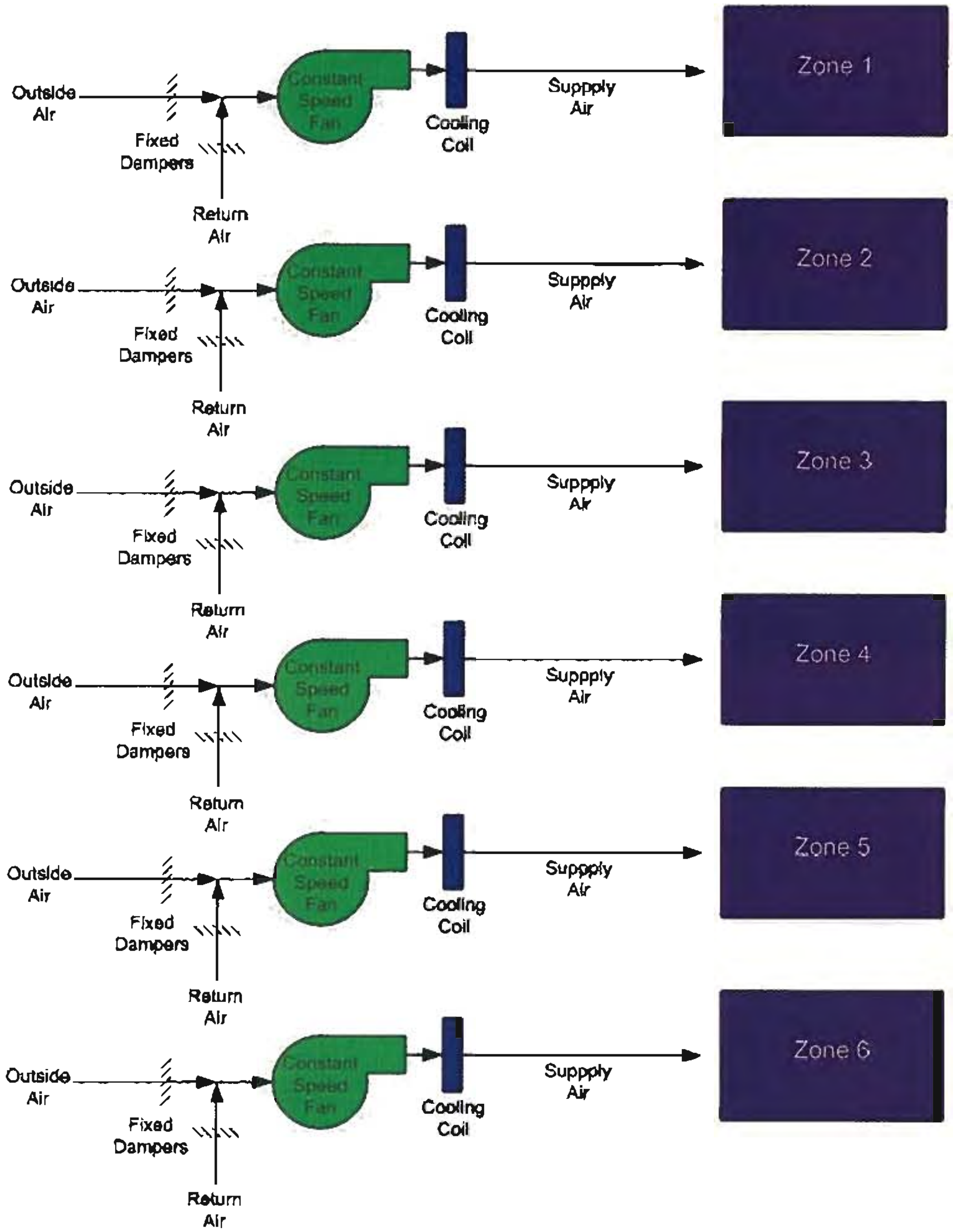


Figure 4-16: CCC Physical Science Building, Schematic of Existing Fan Coils

Note: Hot water reheat boxes are not shown because locations and quantity will not change.

Phase 2 Project

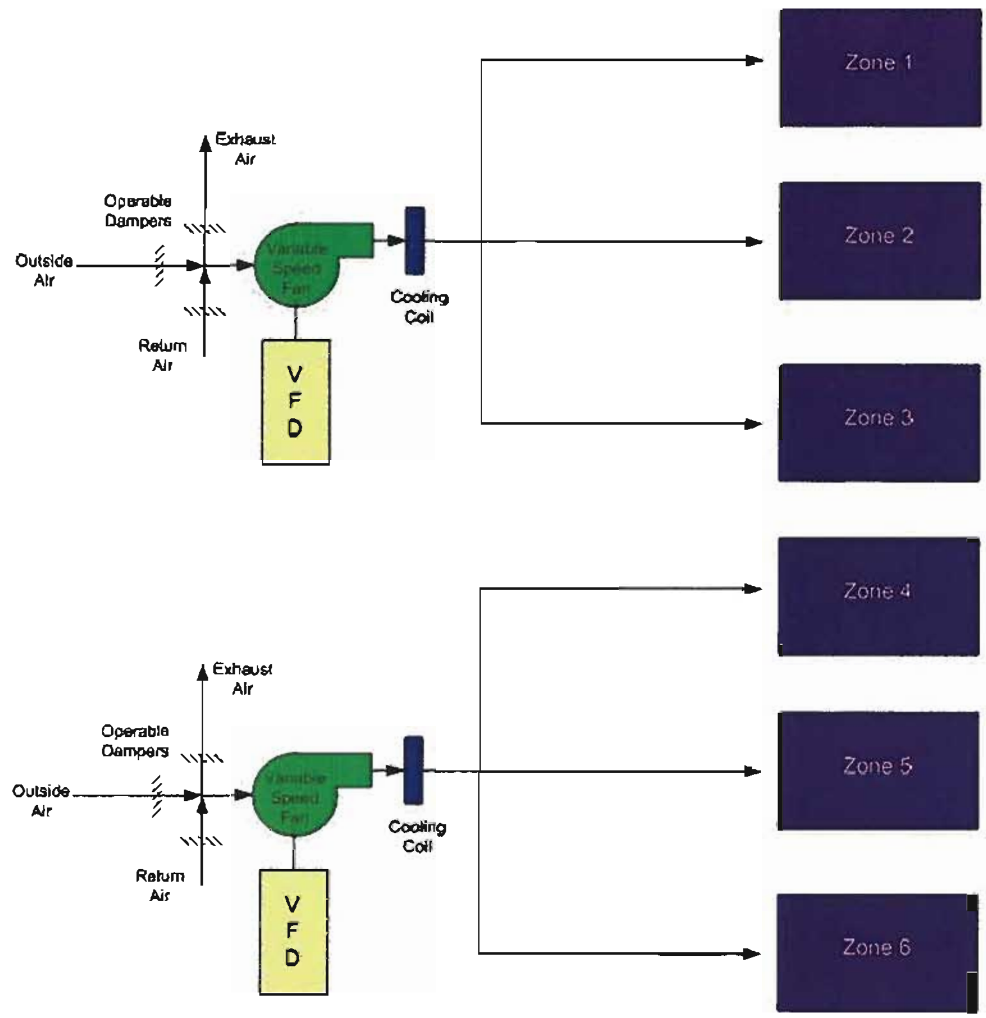


Figure 4-17: CCC Physical Science Building, Schematic of Proposed Air Handlers Serving Same Six Zones

The work in the older building portion is part of a recommended maintenance measure, not an energy conservation opportunity, because the proposed energy consumption would exceed current conditions. This is due to an increase in operating hours while the new units are brought under EMS control. The noise reduction will allow the units to run while class is in session without disturbance. The room ventilation will be brought to current requirements for laboratories and classrooms, and space comfort will be improved.

Scope of Work

Physical Science (New)

- The existing AC-2, AC-3A and AC-3B will be removed and one new air handler will be installed, which will be located in a mechanical room on the ground floor below the existing AC-3B and AC-4. The new supply and return ducts will be run to the locations of the existing AC units and connected to the existing ductwork.

Phase 2 Project

- The existing AC-1, AC-4 and AC-5 will be removed, and one new air handler will be installed in a mechanical room on the ground floor below the existing AC-3B and AC-4. The new supply and return ducts will be run to the locations of the existing AC units and connected to the existing ductwork.
- New reheat VAV boxes will be installed.
- A new *differential pressure* (DP) sensor in the supply air duct will be installed at two-thirds of the distance from the AHU-1 supply fan, and another sensor will be installed from the supply air duct at two-thirds of the distance from the AHU-2 supply fan.
- The new units will be connected into the existing chilled water and hot water piping.
- Motors will be premium efficiency and the units will have corrosion-resistant coatings on the coils.

Physical Science (Old)

- The existing AC-7, AC-8, AC-15 and AC-16 will be demolished and replaced with the new AHU-3, AHU-4, AHU-5 and AHU-6. The new units will be located on the roof. A new supply duct to the existing units duct connections will be added. The new units will circulate 100 percent outside air with chilled and hot water coils.
- The existing AC-9 and AC-14 will be demolished and replaced with AHU-7 and AHU-8 in the same location serving the same area.
- The new air handlers will be connected to the existing chilled and hot water piping.
- Motors will be premium efficiency and the units will have corrosion-resistant coatings on the coils.

Phase 2 Project

Table 4-5: CCC Physical Science Building New Air Handlers for the Newer Portion

Tag	Model	CFM	MIN OSA*	Notes
AHU-1	Trane-T	7,824	2,347	Indoor/Econ/Variable Flow
AHU-2	Trane-T	10,657	3,197	Indoor/Econ/Variable Flow

* minimum outside air

Table 4-6: CCC Physical Science Building New Air Handlers for the Older Portion

Tag	Serving	CFM	Notes
AHU-3	Lab	5,000	Rooftop/Constant Flow
AHU-4	Lab	5,000	Rooftop/Constant Flow
AHU-5	Lab	5,000	Rooftop/Constant Flow
AHU-6	Lab	5,000	Rooftop/Constant Flow
AHU-7	Office	500	Indoor/Econ/Constant Flow
AHU-8	Office	500	Indoor/Econ/Constant Flow

Operation and Maintenance

The installation of this ECO will reduce both short-term and long-term maintenance costs.

Some of the existing attic fan coils in the newer building portion are difficult to access; therefore the new units will be installed on the ground level in a mechanical room. Additionally, the quantity of the units that must be maintained will be reduced. This opportunity will also wrap the new units into the existing EMS, including status points which would allow staff greater remote-viewing capabilities than what is currently installed.

In the older portion of the building, the existing units frequently go down and require staff to take time to repair the problem.

Performing Arts Center

This ECO recommends replacing the existing constant-volume units for the Performing Arts Center with new VAV air handlers.

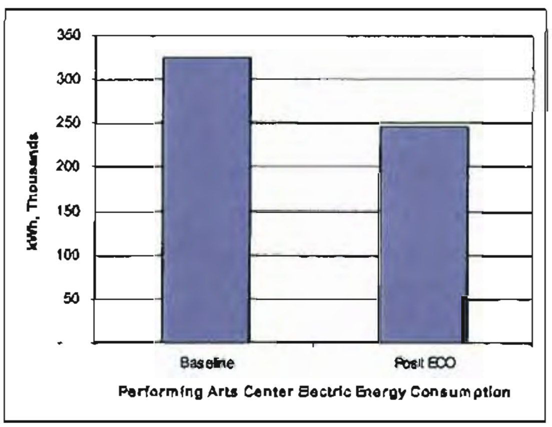


Figure 4-18: CCC Performing Arts Center Baseline and Post-ECO Electric Energy Consumption Comparison

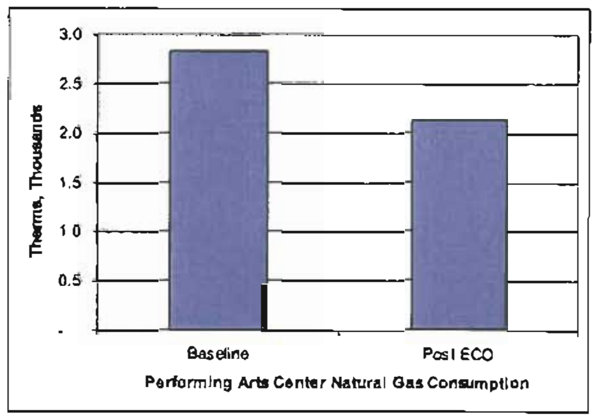


Figure 4-19: CCC Performing Arts Center Baseline and Post-ECO Natural Gas Energy Consumption Comparison

Existing Conditions

The theater, lobby and preparation areas are conditioned by a total of five constant-volume air handlers with chilled and hot water coils. The construction area is conditioned by one heating and ventilating unit with a hot water coil.

Figure 4-20: CCC Performing Arts Center Rooftop Air Handlers Serving the Preparation Areas

Figure 4-21: CCC Performing Arts Center Rooftop Air Handlers Serving the Preparation Areas

Figure 4-22: CCC Performing Arts Center Air Handler Serving the Theater

Proposed Solution

This ECO recommends removing the existing five fan coils serving the theater, lobby and preparation areas and replacing them with two new variable volume air handlers with chilled water, hot water, economizers and full EMS controls. The heating-only unit serving the construction area will be left as is.

Table 4-7: CCC Performing Arts Center Air Handlers To Be Installed

Tag	Model	Serving	CFM	Notes
AHU-1	Trane-T	Theater/Lobby	13,564	Rooftop/VAV/Econ
AHU-2	Trane-T	Prep Areas	6,021	Rooftop/VAV/Econ

Scope of Work

Theater Area

- The existing FC-1 and FC-2 rooftop units will be demolished and a new AHU-1 will be installed. The new unit will be equipped with a return fan, economizer, VFD, dampers and chilled and hot water coils.
- The existing supply and return ducts will be combined and connected to the new AHU-1.
- A new VAV box with reheat coil will be added in place of FC-2.
- Two new VAV boxes will be added inside the theater in the supply air duct.
- A new DP sensor will be installed in the supply duct at two-thirds of the distance from the AHU-1 supply fan.
- The new unit will be connected to the existing chilled and hot water piping.
- The new rooftop unit will be an outdoor type with a corrosion-resistant coating on the coils, pitched roof housing and stainless steel drain pans construction.

Preparation/Production Areas

- The existing FC-5, FC-6 and FC-7 rooftop units will be demolished and a new AHU-2 will be installed. The new unit will be equipped with a return fan, dampers, economizers, VFD and chilled and hot water coils.
- New VAV boxes will be added in the supply air of FC-5, FC-6 and FC-7. The VAV boxes will be located inside the building and not on the roof.
- Supply and return ducts from the demolished FC units will be combined and connected to the new AHU-2.
- A new DP sensor will be installed in the supply air duct at two-thirds of the distance from the AHU-2 supply fan.
- The new unit will be connected to the existing chilled water and hot water piping.
- The new rooftop unit will be an outdoor type with a corrosion-resistant coating on the coils, pitched roof housing and stainless steel drain pan.

Operation and Maintenance

The installation of this ECO will reduce both short-term and long-term maintenance costs due to reduction in the number of units and the longer life of new equipment.

Phase 2: Contra Costa College – Controls

Note: This subsection is also part of phase 2. It does not fall within the current scope.

Existing Conditions

Contra Costa College uses an existing EMS manufactured by Andover Controls and installed by various contractors through the years. The system covers most of the HVAC equipment on the campus, but it is limited, in most cases, to an enable/disable capability (start/stop, no status). Many buildings are limited to a single schedule for the entire building. There are limited monitoring points, and most of the actual controls are being performed pneumatically (no feedback or interface to the EMS). Many existing points were observed, from the front end, to be nonfunctional at the time of the survey.

Due to the lack of information available to the EMS user from the existing pneumatic systems, and due to limited monitoring capability, it is difficult for the building operators to understand and coordinate the building systems efficiently. This has resulted in many of the controls being manually overridden, causing increased energy expenses.

The system, while not state of the art, is contemporary and upgradeable. Any additional points needed to expand existing controls and/or support the measures developed in this project can be added to this existing system.

Phase 2 Project

Proposed Solution

Recommissioning

This ECO proposes to recommission the existing Andover EMS at Contra Costa College for the three buildings undergoing the proposed HVAC retrofit. Each individual I/O (input and output) control point and existing sensors, relays, transducers, damper and valve actuators, etc., will be tested for function and accuracy. The scope of the recommission includes testing and refurbishment as necessary of the following:

- Off/on control of:
  - Air handlers
  - Chillers
  - Boilers
  - Pumps
- Space temperature control
  - Cooling coil valves

- Heating coil valves
- VAVs and mixing boxes

- Economizer damper controls
- Variable-speed drive controls

In addition to checking each I/O point, the control strategies will be reviewed and modified if necessary. Each HVAC system will be scheduled to operate when the building or occupied spaces are used. The proper scheduling and set points will be verified during recommissioning by Chevron ES and the Andover controls contractor.

New Controls

New upgraded controllers, sensors and programming will be added to accommodate the new equipment and any additional points proposed by this project. A "standard" will be established for every type of air and water system, and the existing systems will be retrofitted with additional points to meet the standard. In addition to start/stop, the standard will include:

- Discharge air and water temperature sensors for the monitoring and control of the equipment
- Mixed air temperature sensors for the monitoring and control of refurbished economizer systems
- Equipment status through a current switch for positive feedback of equipment operation

These additional points will provide facilities staff with valuable information that can be alarmed and trended to identify problems in a user-friendly format and support the overall effort of energy efficiency.

Commissioning

New controls will be formally commissioned in a manner similar to the recommissioning described previously.

Training

Chevron ES will provide onsite training on the operation of the EMS. It is recommended that members of facility maintenance staff participate in both the recommissioning and commissioning processes. Their participation will provide them with hands-on involvement in the entire system, from mechanical equipment to software control strategies. Onsite training under real-time conditions will allow the Contra Costa College staff to more effectively operate and maintain the system.

In addition, eight hours of classroom training will be provided for the appropriate Contra Costa College personnel by the EMS manufacturer or contractor. Basic troubleshooting and component replacement will be discussed during this training.

Contra Costa College Responsibilities

For the proposed solution to be a success, Chevron ES asks that CCC:

- Provide members of the maintenance staff to participate in the commissioning processes.

- Maintain temperatures and operating schedules that support the savings plan.

Scope of Work

The scope of work includes the following general tasks:

- Install new EMS controllers, points and software to provide expanded control capability and graphic user interface for the new HVAC equipment.
- Recommission existing controls, checking for operation and accuracy of devices and sequences (under direction of and participation with Chevron ES representative).
- Engage facility's staff in the recommissioning effort (as training for staff).
- Perform full formal commissioning of the new work (under direction of and participation with the Chevron ES representative).
- Perform eight hours of formal training for Contra Costa College staff on system operation and maintenance.
- Remove existing controls where being replaced, move pneumatic tubing back to the panel of origin, and properly cap the main air lines.
- Install wiring in compliance with applicable codes.

The scope of work also includes the installation of devices in the following locations:

- **Performing Arts Center**

  AHU-1 and AHU-2: Install controls and controls peripherals for two new air handlers. Install VFDs on the supply and return fans. Install two-way valves on the chilled water and hot water coils.

  VAV-1 through VAV-5: Install automated *direct digital controls* (DDCs) for five VAV/reheat boxes. Install one two-way reheat valve for each box.

- **Applied Arts and Administration Building**

  AHU1-1, AHU1-2, AHU2-1, AHU2-2, AHU2-3 and AHU2-4: Install controls and controls peripherals for six new air handlers. Install VFDs on the supply and return fans. Install two-way valves on the chilled water and hot water coils.

  VAV1-1-1 through VAV1-1-7, VAV1-3-1 through VAV1-3-13, VAV2-1-1 through VAV2-1-6, VAV2-2-1 through VAV2-2-10, VAV2-3-1 through VAV2-3-11: Install automated DDCs for 46 VAV/reheat boxes. Install one two-way reheat valve for each box.

- **Physical Science Building (New)**

  AHU-1 and AHU-2: Install controls and controls peripherals for two new air handlers. Install VFDs on the supply and return fans. Install two-way valves on the chilled water and hot water coils.

  VAV-1 through VAV-10: Install automated DDCs for 10 VAV/reheat boxes. Install one two-way reheat valve for each box.

- **Physical Science Building (Old)**

  AHU-3 and AHU-4: Install controls and controls peripherals for four new air handlers.

Operation and Maintenance

With an efficiently running EMS system, maintenance costs are more likely to decrease than increase. Control of equipment from a central EMS maintenance location allows maintenance personnel to make more effective use of their time. Troubleshooting of HVAC systems can be done prior to sending any personnel into the field, allowing them to take the necessary tools to make any repairs that are needed.

Typical maintenance activities associated with control systems include the following:

- Periodic inspections of entire working systems
- Review of daily alarms and trend logs
- Review and performance of manufacturer's recommended maintenance procedures

A recommended recommissioning check of the EMS system should occur before the 10-year anniversary. Though these checks require an expenditure of time, the organization recoups the time through saved annual labor costs.

Phase 2 Project

Diablo Valley College – Photovoltaic Systems

This ECM recommends photovoltaic (PV) systems installed at each campus.

Proposed Solution

This ECM proposes installing PV systems to offset a percentage of CCCCD's power demand with PV power generation. A PV cell is a semiconductor device that converts photons of light energy from the sun into direct current electricity. PV systems produce the most amount of electricity during peak hours of the day when electric utility rates are the highest. By installing PV at DVC, the PV power generation will displace power purchased at peak rates. Additionally through net metering, when the district generates more electricity than it consumes, the district can effectively sell the energy back to the grid at fair market value. Net metering is facilitated by installing a single meter capable of registering the flow of electricity in both directions. The estimated annual costs savings does not capture the financial benefits of net metering.

CCCD has applied for incentive money from the Self-Generation Incentive Program authorized by the California Public Utility Commission and administered by PG&E. The SGIP program offers capacity-based incentives of $3 per watt of system output.

Additional benefits of photovoltaic systems include:

- Environmental stewardship
- Public recognition
- A diversified energy portfolio
- Power reliability
- A secure positive return on investment through competitive fixed energy costs

Scope of Work

Chevron ES proposes 1,071 kilowatts of PV at the DVC campus. The individual system sizes range from 130 to 595 kilowatts. Chevron ES recommends a variety of applications, including roof-mounted systems, ground-mounted systems and parking shade structures.

Roof- mounted systems can be installed on either flat or sloped roofs; there are a variety of mounting options. Roof-mounted systems provide the additional benefit of shielding the roof membrane from harmful UV radiation and thereby extending the roof life. Additionally, the roof-mounted systems provide added roof insulation that can reduce a building's heating and cooling demand.

Figure 4-23: Roof-Mounted System

Figure 4-24: Parking Shade Structure

Ground-mounted systems can be installed on flat or sloped ground. Frequently ground-mounted systems are installed on hillsides to take advantage of the natural slope.

Parking shade structures are solar covered parking structures. The parking structured offers a dual benefit of electricity production and shade for parked cars.

Table 4-8 outlines the proposed locations, system applications and system sizes.

Table 4-8: DVC, System Application and System Size

Campus	System Application and System Size				Total
	Roof-Mounted	System Size, DC	Parking Structure	System Size, DC	
Diablo Valley College	Library	137 kW	Lot 1	179 kW	1,071 kW
	ATC	161 kW	Lot 3 & 4	595 kW	

Operation and Maintenance

Chevron ES shall provide six sets of site-specific operation, maintenance and parts manuals for the PV system and modifications to any existing facility or feature therein. The manuals shall cover components, options and accessories supplied. They shall include maintenance, troubleshooting, and safety precautions specific to the supplied equipment. Maintenance schedules shall be provided. Actual operation and maintenance the PV panels and system will be performed by a third party.

Diablo Valley College – Lighting

T12/T8 Retrofit

This ECO recommends retrofitting the first-generation T8 and T12 lighting with third-generation T8 components.

Existing Conditions

The existing linear fluorescent fixtures used throughout the facility have either T12 lamps and magnetic ballasts or first-generation T8 lamps and electronic ballasts. Some of the buildings were retrofitted from T12 components to T8 components about 10 years ago during a previous energy conservation project. The T8 lamps in use are 700-series lamps, and the ballasts are standard electronic ballasts. The 700-series lamps have a color-rendering index that is below 80 percent and their lumen output is less than 2,900 lumens. The existing ballasts catalog rating is 58 watts (two-lamp fixture). This system produces only 78 maintained lumens per watt. There are also several incandescent lamps in operation. The existing fixtures are in good condition and are good candidates for the recommended retrofits. Gymnasium fixtures are high-intensity discharge lighting systems requiring long start times.

Figure 4-25: DVC Gym Fixture

Proposed Solution

This ECO recommends replacing the T12 and standard grade T8 lamps with long-life, high-color rendering and high-efficiency lamps. This ECO also recommends replacing magnetic and standard electronic ballasts with premium-efficiency third-generation ballasts. These new components will provide similar light levels with improved color qualities. The new lamp color-rendering index is greater than 85 percent with similar lumen output while using less energy. The new third-generation low ballast factor ballasts use as low as 45 watts (two-lamp fixture). The new system produces as high as 99 maintained lumens per watt. Two-lamp fixtures will be retrofitted with two lamps, and three- and four-lamp fixtures may be de-lamped with higher power ballasts. Gymnasium fixtures will be replaced with instant start linear fluorescent fixtures. Retrofit details are shown in the Appendix.

Scope of Work

Chevron ES recommends that DVC remove existing light fixtures and replace with new fixtures as follows:

- Fixture retrofits shall use high-efficiency lamps and ballasts with the ballast factor rating as specified on the lighting spreadsheet in the Appendix.

- Ballasts shall be GE, Sylvania, Advance, Universal, Howard or an approved equal.
- New lamps shall be third-generation premium efficiency T8 lamps.
- Lamps shall have a color-rendering index greater than 80 percent.
- Lamp life ratings shall be equal to or greater than 24,000 hours at 12 hours per start.
- Lamps shall be as manufactured by GE, Sylvania or Philips.

Operation and Maintenance

To maintain proper lighting levels within the facility, it is recommended that the lamps, lenses, reflectors and fixture housings be cleaned annually and at the time of any required service. At the conclusion of the implementation of this project, lamps and ballasts will be new. It is recommended that the lamps be replaced in a group on a schedule at 75 percent of their rated lamp life. It is recommended that ballasts and sensors be replaced only upon failure. This measure will reduce the required stock on hand for lighting equipment. Actual maintenance requirements include the following:

- Clean reflector surfaces.
- Replace lamps prior to burning out.

Diablo Valley College – Personal Computer Controls

Recommended Application of Computer Energy Management Software

The calculated energy savings from installing computer energy management software on the personal computers at DVC is shown in Figure 4-26. The existing energy consumption is compared to the energy consumption after the proposed changes.

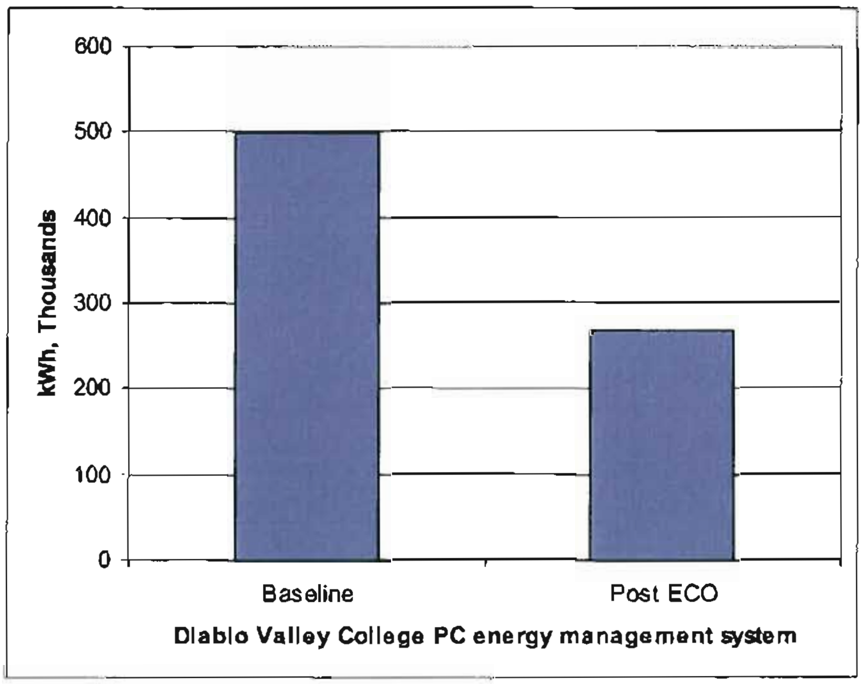


Figure 4-26: DVC Baseline and Post-ECO Personal Computer Energy Management Software

Existing Conditions

Diablo Valley College has approximately 1,500 personal computers in use at the campus. These computers are deployed with standard settings for Suspend, Standby and Shutdown modes on each computer within the operating system. Computer keystroke activity and energy-saving modes utilization logging was performed for two weeks on a representative sample of the computers at this facility. A significant portion of the computers have had the standard settings modified with non-energy-saving screen savers or have had the energy-conserving modes disabled in the operating systems.

Proposed Solution

The personal computer energy management software is a supervisory system installed on the network. Once installed, the system listens for network connectivity between the computer and the network. Power management profiles are developed for groups of users on the server; these profiles are used to adjust the Standby, Hibernate, Sleep and Shutdown modes on each computer and its monitor as needed by each usage group. The user still has the ability to change the settings temporarily, if needed for a specific task, or permanently, if required. The system also records computer usage patterns, tracks energy conservation realized, and creates reports, if required. The system can be tailored to meet the needs of the site or user as required.

Scope of Work

Information about the installation of network-based personal computer energy management control systems, including annual site licenses, are displayed in Table 4-9:

Table 4-9: DVC Units for Computer Controller Installations

Building/Area	Quantity of personal computers	Quantity of software site licenses
All - DVC	1500	1500

Operation and Maintenance

Installation and support of the system is included.

Diablo Valley College - Controllers

Recommended Application of Compressor Controllers

The calculated energy savings from installing compressor controllers on small-packaged and refrigeration units at DVC is shown in Figure 4-27. The existing energy consumption is compared to the energy consumption after the proposed changes.

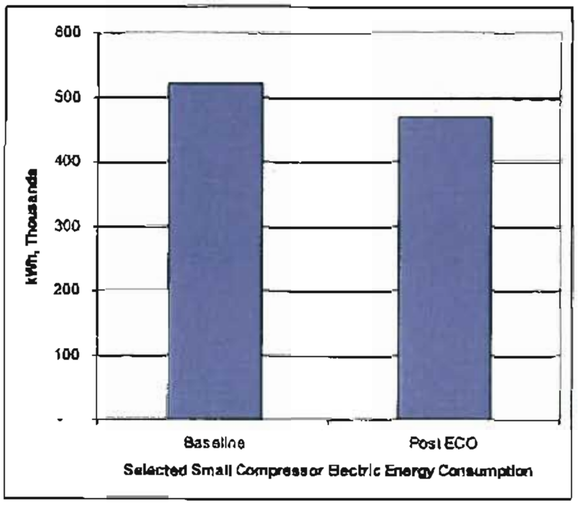


Figure 4-27: DVC Baseline and Post-ECO Electric Energy Consumption Comparison

Existing Conditions

DVC has many, relatively small-packaged cooling units and split systems that provide cooling and refrigeration for various purposes. The sizing of refrigeration systems is based upon a number of factors. When any of the design considerations are not met, the refrigeration system is oversized for the load and thus, less efficient.

Figure 4-28: DVC Counseling Building Condensing Units on Roof

Figure 4-29: DVC Learning Center Condensing Units on Roof

Proposed Solution

Compressor controllers continually monitor the system to detect load changes. In cases where the load is less than the system maximum output, the control delays the start of the system to lower the energy output to match the reduced load. This process is varied dynamically from cycle to cycle.

Scope of Work

The compressor controllers will be installed and commissioned on the packaged units and refrigeration units listed in Table 4-10.

Operations and Maintenance

The installation of this ECM is expected to lengthen the life of existing units due to a reduction in compressor short-cycling and wear on components.

Table 4-10: DVC Units for Controller Installation

Building/ Area	Qty Refrigeration Units	Qty Cooling Units
Gym	0	1
MA	0	4
L	0	2
LC	0	6
FL/FLA	0	3
AB	0	8
C	0	8
A	0	6
CC	3	2
SC	0	3
SU	0	7

Diablo Valley College – Primary Voltage Upgrade

Primary Power Transformer Replacement/Ownership

This measure recommends replacing the PG&E-owned main transformer with a transformer owned by the college district. There is no energy savings associated with this measure – only cost savings.

Existing Conditions

The DVC campus is currently served by PG&E secondary rates. Standard utility rates are usually dependant on the size of customer loads as well as the scope of utility equipment required to distribute and deliver the power. The larger loads usually pay less dollars per kilowatt. Similarly, accounts that receive service at higher voltages, thus requiring less PG&E-owned equipment, also pay lower rates. The project to convert to the higher voltage service is called a primary voltage upgrade (PVU) and results in a significant savings in electric rates.

A PVU is performed for facilities currently receiving secondary service(s) at 4 kilovolts, which can be converted to receive primary (21 kilovolts, also referred to as medium voltage) metered service from the local utility company. The project involves purchasing primary switchgear to meter and distribute power to the transformer that delivers power to the campus. This equipment will replace the existing PG&E system from the property line to each building service. The resulting rate is listed under E20P in the Appendix. The actual electrical charges for DVC will be slightly different because the campus buys power directly from a commodity provider.

Proposed Solution

Chevron ES suggests that DVC remove the existing PG&E transformer and replace it with a transformer owned by the school.

Scope of Work

Chevron ES recommends the following:

- Install a new medium-voltage transformer, switchgear and metering equipment.
- Repair trenches, landscaping and paving, which will restore the campus to pre-existing conditions.
- Increase the electrical service to allow for marginal increases in load.

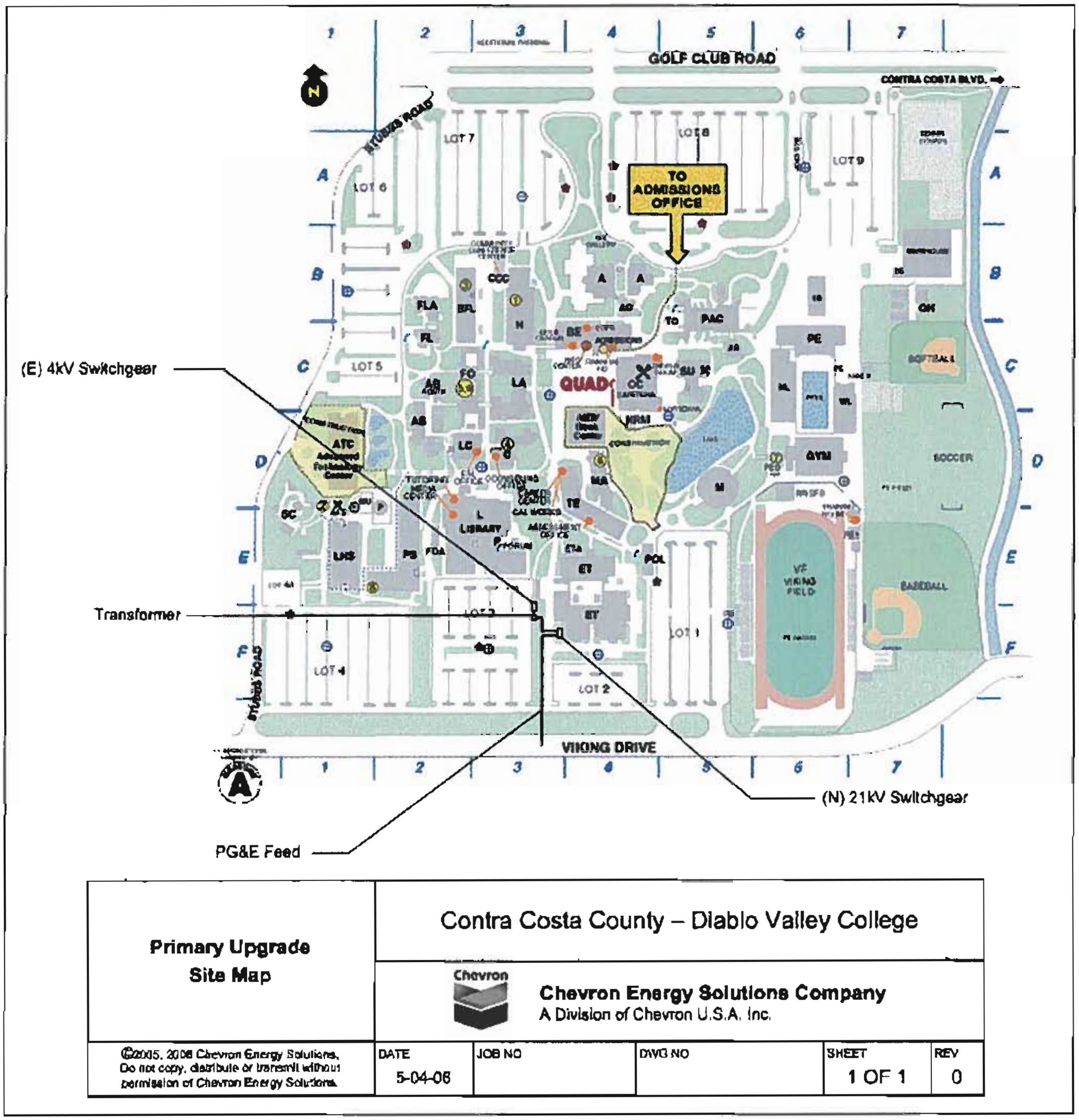


Figure 4-30: DVC Primary Upgrade Site Map

Diablo Valley College – Water Conservation

Replace Existing Standard-Flow Fixtures with Low-Flow Fixtures

This measure recommends replacing the standard-flow plumbing fixtures with low-flow fixtures.

Existing Conditions

Many of the existing plumbing fixtures at this facility are standard-flow devices. The existing water closets flow 3.5 gallons per flush and the urinals flow 2 gallons per flush. The majority of the existing standard-flow sinks were measured to flow 2 gallons per minute, although the range varied from 1 to 3.5 gallons per minute. These systems should be replaced with new low-flow moderators.

Water use is often overlooked as a significant source of electrical energy use. While water costs are charged in units of gallons or cubic feet, the electrical cost to pump water is a significant portion of the overall water cost. Throughout the state, the energy consumed in water pumping systems accounts for approximately 15 percent of California's electrical energy consumption (according to the California Energy Commission Census 2002). The trend to higher electricity costs is expected to be seen in higher water costs in the near future. The United States Environmental Protection Agency studies have shown that water conservation improves water quality and reduces pollution.

Proposed Solution

The following solutions will help advance DVC's water-conservation efforts:

- Install new low-flow plumbing fixtures in place of existing standard-flow fixtures, saving water as follows:
  - Low-flow lavatory faucets will reduce flow to 1 gallon per minute.
  - New flushometer toilets will lower water use to 1.6 gallons per flush.
  - Low-flow urinals will reduce flow to 1.0 gallon per flush.
- Modify the bathroom sinks with 0.5 gallon per minute spray moderators.
- Modify the kitchen sinks with 1.5 laminar flow moderators.

Scope of Work

For optimum water conservation, Chevron ES recommends that DVC:

- Retrofit or replace existing plumbing equipment.
- Replace the moderators on existing faucets with new laminar low-flow units; existing lavatories and faucets are to remain.

- Retrofit or replace the flushometers on the existing urinals with new Sloan (or Zurn) devices.
- Replace water closet bowls with new china and new valves.

A detailed list of equipment and location is included in the Appendix.

Diablo Valley College – Utility Master Plan

The purpose of a utility master plan is to evaluate the capability of the existing utility infrastructure to support current and future campus buildings and to identify how the campus can best meet its utility needs in the future.

Existing Conditions

The buildings and infrastructure systems at DVC vary considerably as a result of being built and rebuilt under various scenarios. The underground support systems were not designed to support the buildings that now stand at this campus. The facility maintenance staff has also indicated that some of these systems have high failure rates and they may be beyond their useful life.

Proposed Solution

Chevron ES will develop a utility master plan to allow the school district to plan for its current and future needs at this campus.

The master plan will provide guidelines for the campus to follow as it progresses with plans to add new buildings and replace some of the existing buildings. The master plan will address the following utility systems:

- Chilled water
- Heating hot water
- Domestic water
- Fire protection water
- Sanitary sewer
- Storm drains
- Irrigation water
- Natural gas
- Electrical distribution

The campus currently has central utility distribution systems for most of the systems listed above, except for chilled water and heating hot water. This master planning effort will investigate the viability of installing chilled and heating hot water systems to initially serve groups of buildings and ultimately most of the campus buildings.

The master plan will evaluate current and future campus building demands on each of the listed utility systems. Future loads will be estimated based on the long-term building plan for the campus, current building demands, and projected future building performance standards and codes. The final master plan document will include a series of campus utility maps showing how each of the utility systems will need to evolve over time to meet the campus needs.

Phase 2: Diablo Valley College – Central Plant

Note: This subsection falls within phase 2 of the project. It is not part of the current scope.

Currently the campus has five air-cooled chillers, three cooling towers and three water-cooled chillers along with several rooftop direct expansion (DX) and heat pump systems. The heating is primarily provided by 16 stand-alone boilers throughout the campus. This ECM would offer a provision to consolidate the eight chillers, three cooling towers and sixteen boilers and would wrap several DX cooling and gas-heating systems into hot water and chilled water systems. In this phase, this ECM would consolidate five chillers, two cooling towers, six boilers and several DX system conversions in the central plant. This ECM would also allow for the future consolidation of the remaining chillers, cooling towers and boilers, and allow for the conversion of the remaining DX cooling, gas heating and heat pumps to chilled water and heating hot water systems.

The existing buildings with the stand-alone chillers have no backup chillers. These chillers have passed their useful life expectancies, are unreliable and inefficient. These chillers also use CFC refrigerant R-22, a hydrochlorofluorocarbon (HCFC) refrigerant that does contribute to ozone depletion if leaked to the atmosphere. The number and the ages of the stand-alone chillers require more maintenance than a new centralized chilled water system with less equipment to maintain. Figure 4-31 is the schematic diagram for the proposed central plant chilled water system. This system is expandable for the future building connections. The proposed central chilled water plant reduces the campus energy consumption due to the higher efficiency of the proposed centralized equipment that uses more advanced technologies in comparison with the efficiency of the existing stand-alone equipment.

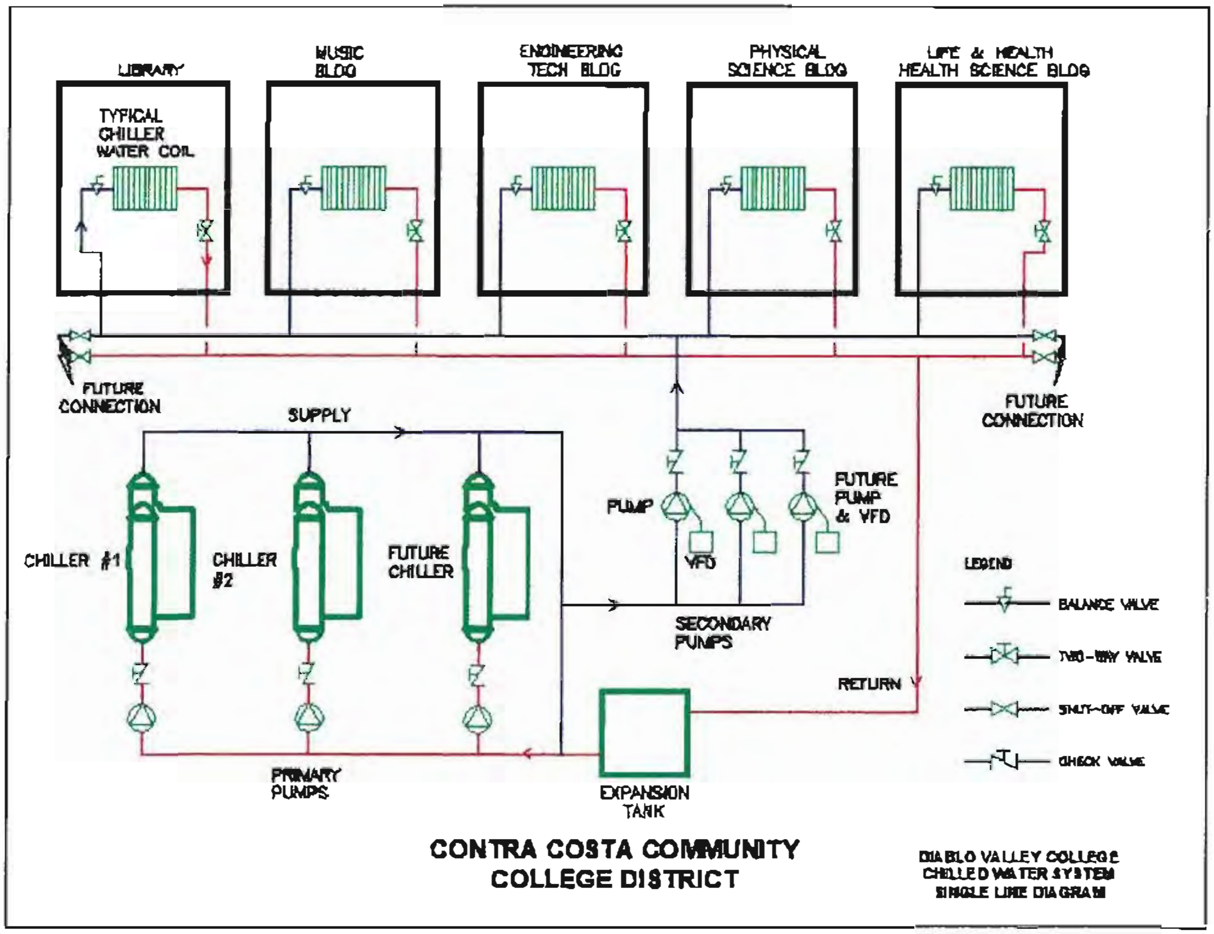


Figure 4-31: DVC Proposed Campus Central Chilled Water System

The buildings' boilers are operational; however, they are in most cases oversized, inefficient to operate and are not equipped with the available low NOx burners. The Bay Area Air Quality Management District (BAAQMD) does not currently regulate these smaller size boilers, but more restrictive rules are anticipated to lower boiler NOx levels in the future. Boilers, when used in stand-alone configurations, operate the majority of the time in part-load condition. American Society of Heating, Refrigerating and Air-conditioning Engineers (ASHRAE) has developed standard 155 P to measure and calculate boilers' part-load efficiencies. Figure 4-32 shows a rapid decline in boiler efficiencies as loads decrease below 50 percent of full-load capacity. Added to the part-load inefficiency effect, is the oversizing impact of the equipment.

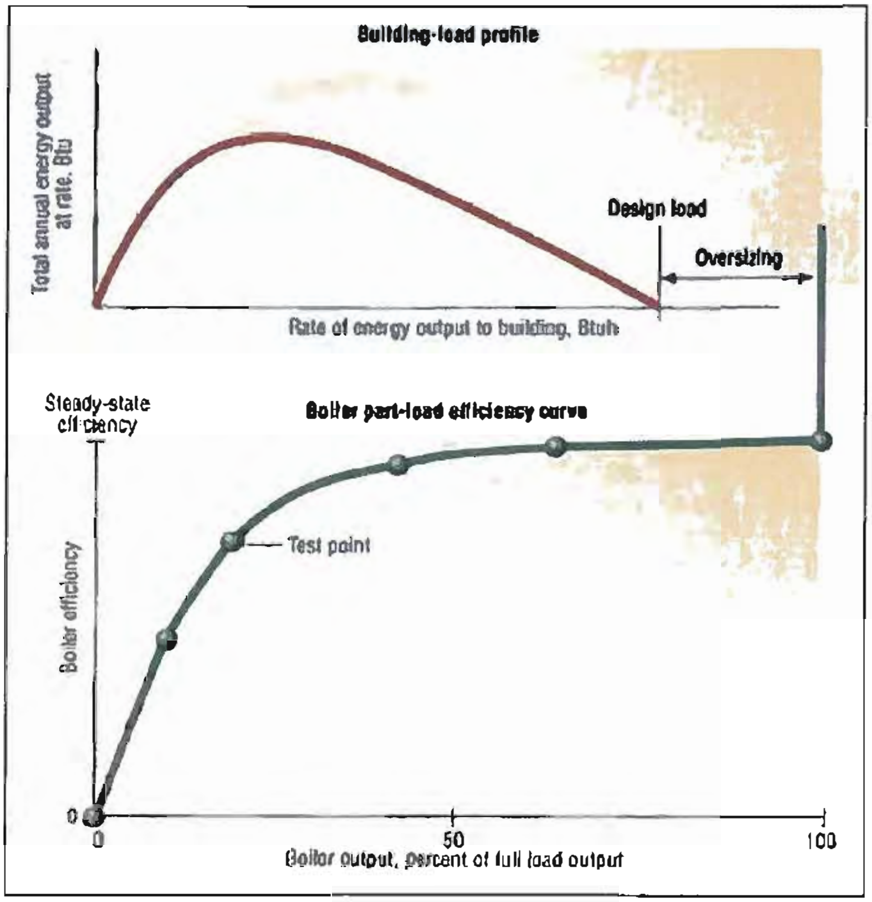


Figure 4-32: Interaction of Building Load Profile, Boiler Efficiency Curve and Oversizing in Determining Seasonal Efficiency of Single Boiler System. Source: ASHREA Standard 155P.

A centralized boiler plant overcomes the part-load deficiencies by sequencing several boilers to meet the heat load demand and reduces standby losses. A more sophisticated technology available with larger central plant boilers allows for higher turn-down ratios. Additionally, a centralized boiler location has maintenance advantages. The number and the ages of the existing boilers would require more maintenance than fewer more technologically advanced centralized boiler systems. Figure 4-33 is the schematic diagram for the proposed central hot water boiler system.

Phase 2 Project

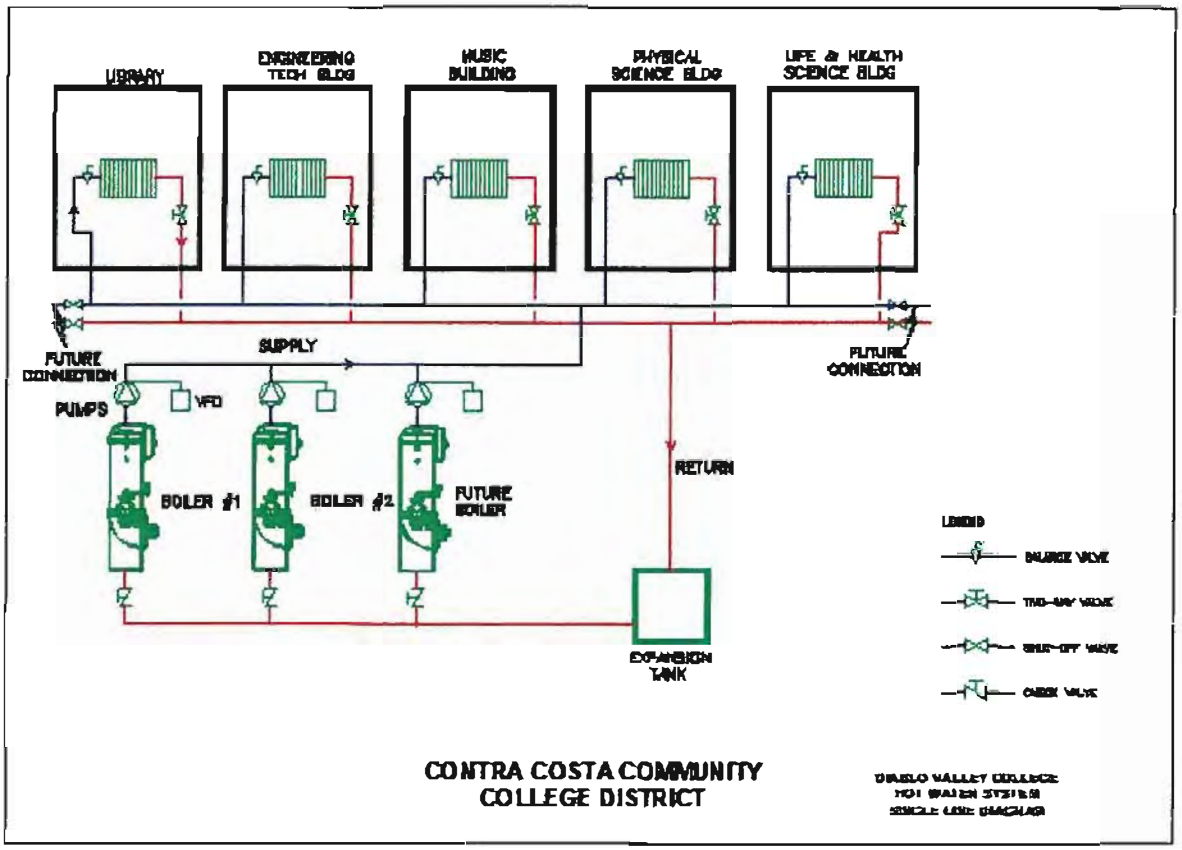


Figure 4-33: DVC Proposed Campus Central Hot Water System

The calculated energy savings that result from converting the existing stand-alone chilled and hot water systems are shown in Figure 4-34 and Figure 4-35. The energy consumption of the proposed central plant is compared with existing energy consumption.

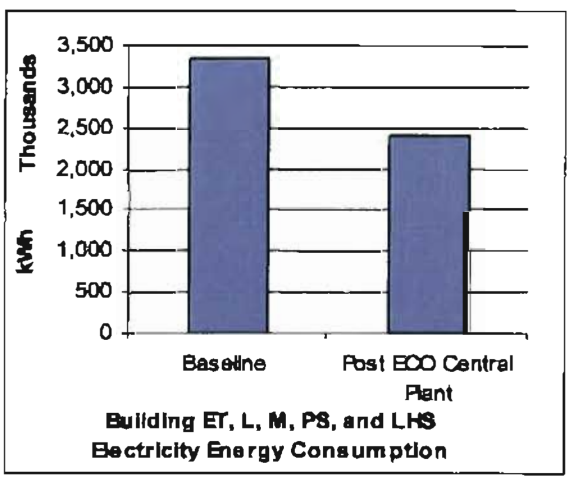


Figure 4-34: DVC Baseline and Post-ECO Central Plant ECM Electricity Energy Consumption Comparison

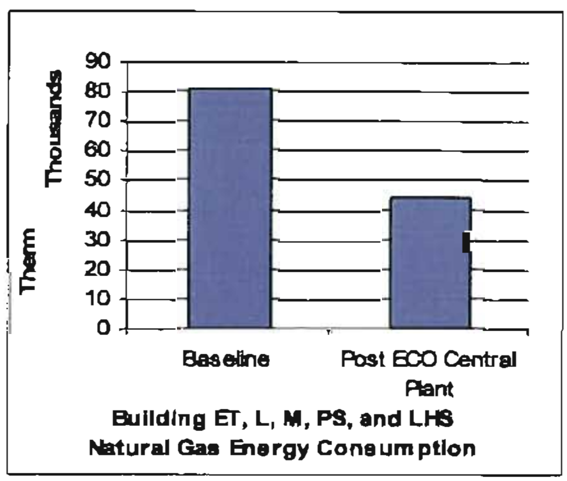


Figure 4-35: DVC Baseline and Post-ECO Central Plant ECM Natural Gas Energy Consumption Comparison

Phase 2 Project

The proposed central chilled and hot water plant would serve the following buildings:

- Library
- Life Health Science
- Physical Science
- Engineering Technology

Existing Conditions

Library Building

The Library building has a 130-ton water-cooled Bohn screw chiller with an associated Baltimore Air Coil (BAC) cooling tower, which were installed in 1989. Additionally, the building's computer facility is served with a 60-ton air-cooled Carrier scroll chiller, which was installed in 1996. The combined chiller capacities exceed the building cooling load demand of 120 tons. Both chillers run at a constant speed and use refrigerant R-22. The chilled water is pumped at a constant speed to the air handlers and fan coils in the building. The chilled water coils are controlled with three-way valves, which makes the flow modulation impossible. The cooling tower is designed for a 85° F condenser water supply, which is high. The desirable condenser water temperature of 74° F can be achieved with today's high-performance cooling towers.

Figure 4-36: DVC Library Building Existing Water-Cooled Chiller

Figure 4-37: DVC Library Building Existing Cooling Tower

Phase 2 Project

Figure 4-38: DVC Library Building Chilled Water Pump

Figure 4-39: DVC Library Building Air-Cooled Chiller

The Library building is equipped with a 28.5-ton reciprocating air-cooled Carrier chiller, installed in 1985. The chilled water that flows through the cooling coils is constant, and the control valves are three-way.

Figure 4-40: DVC Library Building Air-Cooled Chiller

The heating is provided by a Rite boiler with a constant-flow hot water pump.

Life Health Science Building

A 109-ton Bohn water-cooled screw chiller, installed in 1986, provides for the Life Health Science building cooling demand. The cooling tower associated with this chiller is a BAC product with a constant speed fan. The cooling tower is designed for an 85° F *leaving cooling tower* temperature, which is high compared to today's available cooling towers. The chilled water flow is constant and is provided by two 15-horsepower (HP) chilled water pumps sequenced in lead and lag mode. The control valves at the coils are three-way valves.

Figure 4-41: DVC Life Health Science Building Water-Cooled Chiller

Figure 4-42: DVC Life Health Science Building Chilled Water Pumps

The heating is provided with two 2,000-MBH Bryan boilers set up in lead and lag sequences. The hot water supply pumping system is primary variable pumping and provided by two 7.5-HP pumps sequenced in lead and lag positions.

Physical Science Building

This Physical Science building is cooled by three rooftop McQuay DX units that were installed in 2000. The DX systems have lower energy efficiency than a comparable chilled water system and cannot control the space temperature as well as the chilled water coils

The heating is provided by one 3000-MBH Bryan boiler with two 7.5-HP pumps sequenced in lead and lag mode. The hot water supply system is a primary variable pumping system and the heating coil control valves are both two- and three-way.

Engineering Technology Building

Six multi-zone gas-heating and DX cooling rooftop units and three rooftop DX cooling units serve the Engineering Technology building. The multi-zone units were installed in 1986 and are equipped with VFDs. The installation of VFDs is incorrect for these multi-zone units. These units are showing signs of body deteriorations.

Figure 4-43: Typical Multi-zone Rooftop Unit with VFD

Figure 4-44: Typical Constant Volume Single Zone Unit

Proposed Solution

Chevron ES recommends building a consolidated central chilled and hot water plant to serve the cooling and heating requirements of the Library, Engineering Technology, Life Health Science, and Physical Science buildings with a provision for expansion to accommodate the entire campus.

The proposed location of this central plant is at the current location of the Technical Education building. This building is scheduled for demolition and provides an ideal centralized location for a consolidated central plant. This site provides easy access to the central plant equipment and is remote from the campus foot traffic and the other buildings. The chillers and the pumps that generate most of the sounds would be located in the plant, and only the cooling towers equipped with fans would be located outside. The sound levels generated from the proposed cooling towers would not be more than the existing air-cooled chiller at this building. From this location, new underground piping would carry the chilled and hot water to the buildings listed above. Shut-off valves would be installed in the underground piping to allow for the future extension of the piping to the other buildings.

The cooling demand for this phase provided by the consolidated central plant is 544 tons. Two 400-ton chillers, planned for this phase, would provide the current capacity needed as well as providing adequate backup capacity. The chillers would be selected with variable speed compressors for higher efficiency and would have refrigerant R-134a for compliance with the environmental requirements. Additionally, space is planned in the central plant for the future chiller and pumps. When eventually most of the remaining buildings are connected to this plant, an additional 400-ton chilled water capacity would be required; however, the planned space for the future chiller can accommodate any size chiller up to a 1000-ton chiller. The chilled water pumping would be a primary/secondary variable flow system providing higher pumping efficiency. Two cooling towers are planned for this phase and space is provided for the future tower.

The buildings' heating demand for this phase, provided by the central plant, is 4,333 thousand BTUs per hour (MBH). Two 4,788-MBH output boilers are planned for this phase with a space provision for a third boiler. One boiler will meet this phase's heating load demand, and the other boiler is the backup. The remaining building heating demand, including the heated swimming pool, is 6,312 MBH.

The heating hot water would be a primary variable-flow system providing higher pumping energy efficiency.

Scope of Work

Chevron ES recommends that the following:

Demolition

- Remove three air-cooled chillers at the Music, Technical Education and Library buildings. Dispose the refrigerant in accordance with applicable codes. The demolition work and the new installation of the central plant would be staged so that the facility stays operational.
- Demolish the existing cooling tower and the cooling tower pumps serving the Library building chiller.
- Demolish the Library building water-cooled chiller and chilled water pumps.
- Demolish the boilers and the hot water pumps from the Library, Music, Physical Science and Life Health Science buildings.
- Remove the compressors, DX coils and related devices from the three existing McQuay rooftop units in the Physical Science building.
- Remove the Life Health Science building's chiller, cooling tower, chilled and condenser water pumps, boilers and hot water pumps.
- Dispose of the refrigerant in the DX units in accordance with building codes.

New Chilled Water Central Plant Work

- Install two new water-cooled centrifugal chillers. Each new chiller is a 400-ton, York R-134a centrifugal at 44° F Leaving Water Temperature (LWT), 60° F Entering Water Temperature (EWT), 74° F Entering Condenser Water Temperature (ECWT), 85° F Leaving Condenser Water Temperature (LCWT).
- Install two new primary chilled water pumps and the associated devices. Each pump is a B&G End Suction Pump, 900 gallons per minute (gpm), 20-ft head and 25-HP motor. Provide the pumps with VFDs with bypass. Install new disconnects and wiring (pump will vary speed based on the number of chillers in operation).
- Install two new secondary chilled water pumps and the associated devices. Each pump is a B&G End Suction Pump, 900 gpm, 140-ft head, and 60-HP motor. Provide the pumps with VFDs with bypass. Install new electrical disconnects and wiring (pump will vary speed based on the number of chillers in operation).
- Install an MSA Chillguard Refrigerant Leak Detection system.
- Install two new condenser water pumps and the associated devices. Each pump is sized for 1,080 gpm, 45-ft head and 20 HP.

- Install new existing expansion tanks and miscellaneous devices applicable to the new chilled water system.
- Install two new BAC-3412/A cooling towers each for 1,080 gpm and equipped with 25-HP fan operating with VFDs.
- Install a new water Lacos dirt separator for the cooling tower system.
- Install isolation valves, flow switches and strainers as indicated in the chilled water piping and condenser water piping schematic.
- Include piping, insulation and line-voltage and low-voltage electrical modifications for a fully functioning system.
- Provide controls and interlocks between the chiller and the chilled water and condenser water pumps.
- Install three new chilled water coils in the existing McQuay rooftop units in the Physical Science building.
- Pressure test the new chilled water coils for leaks before installation in the Physical Science building.
- Include two-way chilled water control valves for the Physical Science and the Life Health Science buildings.

New Hot Water Central Plant Work

- Install two new hot water boilers. Each new boiler has a 4,788-MBH output capacity, is manufactured by Parker and operates from 150° F to 190° F.
- Install two new primary hot water variable flow pumps and the associated devices. Each pump is a B&G End Suction Pump, 230 gpm, 140-ft head and 25-HP motor. Provide the pumps with VFDs with bypass. Install new electrical disconnects and wiring (pump will vary speed based on the number of boilers in operation).
- Install new expansion tanks and miscellaneous devices applicable to the new hot water system.
- Install isolation valves, flow switches, strainers and the new chilled, hot water and condenser water piping.

Phase 2 Project

Operation and Maintenance

Operation and maintenance requirements of the new chillers will be reduced compared to the maintenance and operation required by the multiple and aged existing systems. The installation of this ECM will reduce short-term maintenance costs. As the system ages, long-term maintenance costs should not increase above the current levels. The required preventive maintenance program for the new equipment will ensure longer equipment life and fewer unscheduled breakdowns.

This ECM may be scheduled to be installed during the cooler months when the facility will have no requirements for air conditioning. Additionally, after the installation of the associated work, there will be a water balance of each system to ensure proper operation.

A preventive maintenance program after installation may include the following:

Chillers

- Check evaporator and condenser pressures, verify with manufacturer's documentation.
- Measure oil filter pressure drop, replace oil filter if required.
- If operating conditions indicate a refrigerant shortage, check the unit for leaks and repair as needed.
- Test vent piping of relief valves for presence of refrigerant; replace any leaking relief valves.
- Inspect condenser tubes for fouling; clean if necessary.

Chilled Water System

- Clean strainers.
- Inspect piping components for leakage, damage and signs of corrosion. Clean, repair or repaint as necessary.
- Review and perform manufacturer's recommended maintenance procedures.

Pumps

- Lubricate bearings.
- Review and perform manufacturer's recommended maintenance procedures.
- Check and tighten seals if required.

Cooling Tower

- Lubricate bearings on the fans.
- Review and perform manufacturer's recommended maintenance procedures.
- Clean the cooling tower.
- Monitor water treatment.

VFDs

- Clean dust and debris from VFD cabinets.

Phase 2: Diablo Valley College – HVAC Conversion

Note: This subsection is also part of phase 2. It does not fall within the current scope.

A constant airflow system changes the supply air temperature and provides constant volume of air continuously to the zone regardless of the variation of load. Consequently, the fan motor operates continuously.

In contrast, a VAV system controls temperature in a space by varying the quantity of supply air rather than varying the supply air temperature. A VAV terminal box at the zone varies the quantity of supply air to the space through varying the position of a damper in the box. The energy savings associated with VAV occur as the heating and cooling load of the zone changes. The variations of the zone load allow the supply air quantity to be reduced and consequently reduce the fan motor power consumption when equipped with variable speed motors. In addition to varying airflows and saving fan motor energy, VAV systems prevent simultaneous overcooling and overheating by adjusting airflows.

For this campus, Chevron ES recommends VAV conversion in four buildings:

- Music
- Engineering Technology
- Men's Locker
- Library

The baseline and post-ECO VAV conversion electricity and natural gas energy savings are shown in Figure 4-45 and Figure 4-46. The building-by-building electricity energy savings contribution is shown in Figure 4-47.

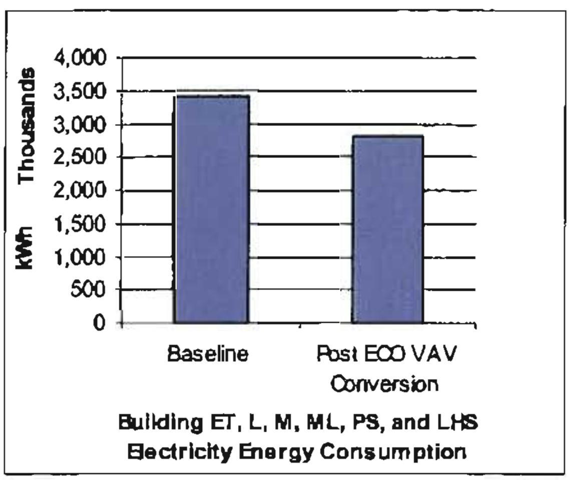


Figure 4-45: DVC Baseline and Post-ECO VAV Conversion ECM Electricity Energy Consumption

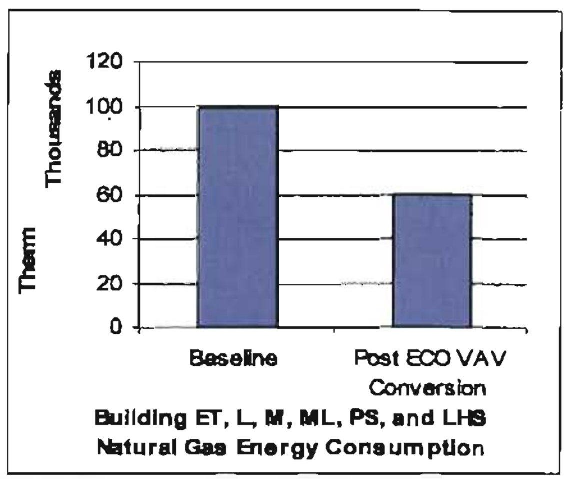


Figure 4-46: DVC Baseline and Post-ECO VAV Conversion ECM Natural Gas Energy Consumption

Comparison Comparison

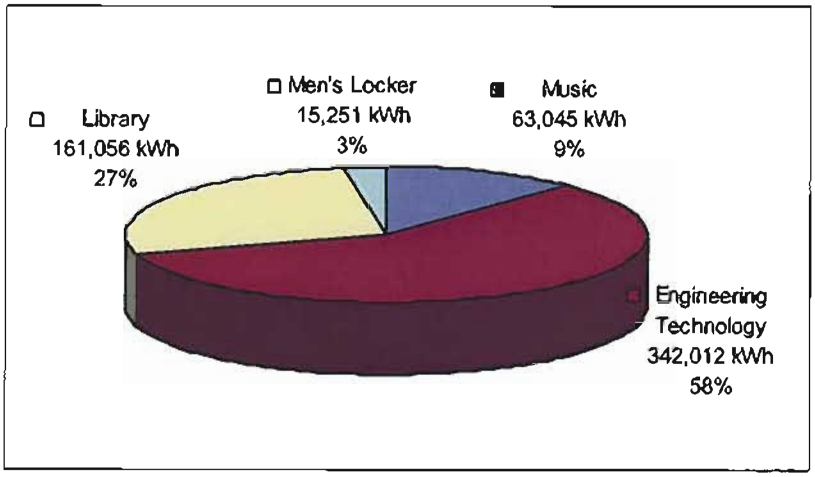


Figure 4-47: DVC Building-by-Building Electricity Energy Savings Contribution

Music Building

This ECM recommends replacing the existing multi-zone constant airflow unit for the Music building with a variable airflow unit.

Existing Conditions

The existing multi-zone AC-3 is a constant air volume unit, located in the basement, which serves the main section of the building. A VFD is installed on the supply fan, but it is set in the bypass mode. The unit receives chilled and hot water from the existing Music building air-cooled chiller and the hot water boiler. The unit was installed 1986; however, it does not present any serious operational issues with the exception of low efficiency.

Other units in this building are AC-4 and AC-5, serving two lecture rooms. They are each 6-ton DX, cooling and gas-heating rooftop units that were installed in 1986. These units are inefficient and have passed their intended useful lives. Serving the music lab is AC-1, which is a 5-ton DX rooftop unit, installed in 2001 as part of the building modification. This unit has another 15 years of useful life but is not as efficient as a variable chilled water air-handler system. The units that remain are five other small heat pumps and one 2-ton DX rooftop unit that were installed in 2000. These units, serving the recording and practice rooms, run on a different operating schedule than the rest of the building.

Figure 4-48: DVC Music Building AC-4 and AC-5 Rooftop Units

Proposed Solution

This ECM would remove the existing units (AC-1, AC-3, AC-4 and AC-5) and install new VAV air-handler units with new VAV boxes. The air handlers would be equipped with VFDs to modulate the supply and the return fans. These units would be specified as Trane air handlers with supply and return fans and economizers.

Scope of Work

Chevron ES recommends the following:

Demolition

- Remove the existing constant-volume, multi-zone AC-3 unit located in the basement.
- Remove the existing AC-1, AC-4 and AC-5 DX rooftop units.
- Dispose of the refrigerant, per building codes.

New Work

- Install a new VAV air handler, AHU-1, in place of AC-3. Connect to chilled and hot water piping.
- Install four VAV boxes in the AC-3 supply air ducts in place of the existing zones.
- Install one new rooftop VAV air-handler unit, AHU-2, to replace AC-1, AC-4 and AC-5.
- Install three VAV boxes in the supply air duct for the AC-1, AC-4 and AC-5 zones.
- Set the VAV boxes at the required minimum and the maximum airflow.
- Include controls and the electrical work.
- Modify the existing roof curbs to accommodate the new AHU-2.

Table 4-11: DVC Music Building New Air Handler Units

Unit	Model	CFM	HP	Remarks
AHU-1	Trane-M	9000	10	W/VFD/ECO/Return Fan
AHU-2	Trane-T	4100	5	W/VFD/ECO/Return Fan

Operation and Maintenance

The installation of this ECM will reduce both short-term and long-term maintenance costs due to reduced DX system and compressor maintenance requirements.

Typical maintenance includes:

- Lubricate bearings.
- Review and perform manufacturer's recommended maintenance procedures.
- Change filters and keep the coils clean.

Phase 2 Project

Engineering Technology Building

This ECM recommends replacing the existing constant volume multi-zone rooftop and DX units for the Engineering Technology building with a VAV system.

Existing Condition

The existing six rooftop multi-zone constant volume units (MZ-1, MZ-2, MZ-3, MZ-4, MZ-5 and MZ-6) and the AC-1 DX rooftop unit were installed in the 1980s. These units are DX cooling and gas heating. The multi-zone units later were retrofitted with VAV boxes and VFDs to modulate the airflow in the spaces. These retrofits were incorrect for these units because the multi-zones are manufactured to work as constant flow. Currently, the VFDs are set for a constant flow on manual settings. These units have passed their useful life expectancies and are inefficient to operate. The existing VAV boxes have gone through a few control modifications and are not operational.

Phase 2 Project

Proposed Solution

This ECM would replace the existing six rooftop multi-zone units and the existing rooftop AC-7 unit with six VAV air handlers. AHU-6 would replace the existing MZ-6 and AC-7; AHU-1 through AHU-5 would replace the MZ-1 through MZ-5 units. VAV boxes would be replaced with new boxes. The new air handler would be connected to the proposed central plant piping for the chilled and hot water requirements. The new units will have premium efficiency motors, which have extended useful life expectancies.

Scope of Work

Chevron ES recommends the following:

Demolition

- Remove the existing six rooftop multi-zone units and AC-7 unit.
- Capture and dispose of the refrigerants in accordance with codes.
- Remove the existing VAV boxes.

New Work

- Install six new rooftop VAV air handlers.
- Modify the existing roof curbs to match the new units.
- Install new VAV boxes and controls.
- Set the VAV airflow to the minimum and the maximum requirements.
- Connect the new chilled and hot water to the new air handlers.
- Include electrical and controls.

Table 4-12: DVC Engineering Technology Building New Air-Handler Units

Unit	Model	CFM	HP	Remarks
AHU-1	Trane-T	10790	10	W/VFD/ECO/Return Fan
AHU-2	Trane-T	7900	7.5	W/VFD/ECO/Return Fan
AHU-3	Trane-T	10000	10	W/VFD/ECO/Return Fan
AHU-4	Trane-T	6000	7.5	W/VFD/ECO/Return Fan
AHU-5	Trane-T	7700	7.5	W/VFD/ECO/Return Fan
AHU-6	Trane-T	8100	10	W/VFD/ECO/Return Fan

Table 4-13: DVC Engineering Technology Building VAV Schedule

Unit	Size (inch)	MIN CFM	MAX CFM	MB H	Control Valve
AHU-1					
VAV1-1	9	300	800	TBD	Two-way
VAV1-2	7	300	400	TBD	Two-way
VAV1-3	9	300	800	TBD	Two-way
VAV1-4	10	300	1000	TBD	Two-way
VAV1-5	10	300	1000	TBD	Two-way
AHU-2					
VAV2-1	7	300	600	TBD	Two-way
VAV2-2	16	1000	3000	TBD	Two-way
VAV2-3	10	300	900	TBD	Two-way
VAV2-4	10	300	900	TBD	Two-way
VAV2-5	14	600	2500	TBD	Two-way
AHU-3					
VAV3-1	14	400	2500	TBD	Two-way
VAV3-2	14	800	2400	TBD	Two-way
VAV3-3	14	600	2400	TBD	Two-way
VAV3-4	12	400	1600	TBD	Two-way
AHU4					
VAV4-1	7	300	600	TBD	Two-way
VAV4-2	7	300	600	TBD	Two-way
VAV4-3	10	300	900	TBD	Two-way
VAV4-4	10	300	900	TBD	Two-way
AHU-5					
VAV5-1	14	400	2000	TBD	Two-way
VAV5-2	14	400	2000	TBD	Two-way
VAV5-3	10	300	1000	TBD	Two-way

Unit	Size (inch)	MIN CFM	MAX CFM	MB H	Control Valve
VAV5-4	12	400	1200	TBD	Two-way
AHU-6					
VAV6-1	12		1200	TBD	Two-way
VAV6-2	10		1000	TBD	Two-way
VAV6-3	24 x 16		4600	TBD	Two-way

Operation and Maintenance

The installation of this ECM will reduce both short-term and long-term maintenance costs due to reduced DX system and compressor maintenance requirements.

Typical maintenance includes:

- Lubricate bearings.
- Review and perform manufacturer's recommended maintenance procedures.
- Change filters and keep the coils clean.

Library Building

This ECM recommends replacing the existing constant-volume fan coil units for the Library building with new VAV air handlers.

Existing Conditions

The second floor and the mezzanine in the original section of the library, built in 1968, still have the original 14 fan-coil units, referred to as AC units. The units are installed in the building duct spaces, which also serve as mixed air plenums. Four Reznor return and makeup (MU) air units were added later to increase the outside air intake. The duct space is small and makes it hard to access the units for maintenance. The AC units receive the chilled and hot water from the existing building chiller and boiler. The AC units have passed their life expectancies and can barely handle the current heating and cooling loads.

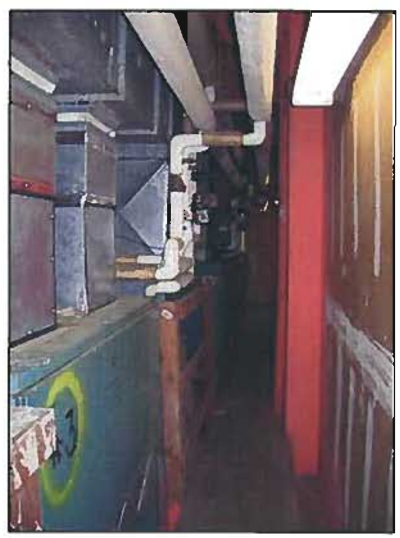


Figure 4-49: DVC Library Building AC Units in Duct Space

A computer room and other office areas occupy the first floor of the building. The computer room is served by an existing AC-1 air handler. This unit is experiencing excessive vibration and its fan needs realignment and adjustments. This unit receives chilled water from the building air-cooled chiller and is equipped with a VFD. Attached to this air handler are nine VAV boxes with adequately designed airflow, but their controls needs to be recommissioned. The outside damper to this unit is shut and no amount of outside air can enter the room; also, the economizer is not working.

Three offices on the east side of the computer room have individual window-mounted heat pumps. These offices can be conditioned with the existing AC-1, which has adequate capacity to accommodate them.

Proposed Solution

This ECM recommends replacing the existing AC units and their associated Reznor makeup air units with five new VAV air handlers. The existing AC units would be demolished and new VAV boxes with reheat coils would replace their associated zones. New supply duct from the new air handlers would provide air to the new VAV boxes. Chilled and hot water piping would be extended to the new air handlers and new controls would modulate the VAV boxes to meet the space temperature requirement. The new air handlers on the roof would have ample maintenance access available.

The first-floor AC-1 unit and the air economizes would be refurbished and the existing VAV box controls would be calibrated and adjusted.

A new VAV box would be added to AC-1 to condition three offices on the east side of the computer room.

Table 4-14: DVC Library Building New Air Handler Units

Unit	Model	CFM	HP	Remarks
AHU-1	Trane-T	7300	10	W/VFD/ECO
AHU-2	Trane-T	6340	10	W/VFD/ECO
AHU-3	Trane-T	11000	15	W/VFD/ECO
AHU-4	Trane-T	7100	10	W/VFD/ECO
AHU-5	Trane-T	3800	5	W/VFD/ECO

Scope of Work

Chevron ES recommends the following:

Demolition

- Remove the existing 14 fan-coil (AC) units in the duct spaces.
- Remove the existing four Reznor makeup air units.

New Work

- Install five new VAV air handlers with VFDs and economizers.
- Install 15 new VAV boxes with controls for the second floor and the mezzanine.
- Add a new VAV box to the existing AC-3 unit to serve the three offices.
- Refurbish the existing AC-1 unit and its economizer dampers and controls.
- Install new chilled and hot water piping to the new air-handler units.
- Install hot water piping to the new VAV boxes.

Phase 2 Project

Operation and Maintenance

The installation of this ECM will reduce both short-term and long-term maintenance costs because there are fewer pieces of equipment to maintain. The required preventive maintenance for the new equipment is the same for the existing units.

Typical maintenance includes:

- Lubricate bearings.
- Review and perform manufacturer's recommended maintenance procedures.
- Change filters and keep the coils clean.

Men's Locker Building

Phase 2 Project

This ECM recommends replacing existing constant airflow rooftop and indoor unit heaters for the Men's Locker building with a variable airflow unit.

Existing Conditions

The original Men's Locker building was built in 1968 and was expanded with a new section in the 1980s. Three constant-volume rooftop units and five ceiling-suspended hot water unit heaters provide for the building heating and ventilation demand. The heating source is hot water provided by the building hot water boiler. The hot water pumping runs at a constant flow and circulates through the existing three-way valves. The units on the roof are in working condition, although they have reached the end of their life expectancies.

Proposed Solution

Consolidating the three rooftop units and the indoor unit heaters into one VAV rooftop unit would result in energy savings and improve the ventilation. This unit would have two airflow settings. The lower airflow setting would be for heating, and the higher setting would be for the ventilation set by a VFD on the unit. The supply air duct would be expanded to distribute air in the areas. Two hot water reheat coils would be added to the supply air duct serving the zones.

Scope of Work

Chevron ES recommends the following:

Demolition

- Remove the three existing heating and ventilating units on the roof.
- Remove the existing five unit heaters.
- Remove the existing building boiler and the hot water pump.

New Work

- Install one new rooftop heating and ventilating unit with VFD and economizers.

- Install two new hot water reheat coils in the supply air duct.
- Set the minimum airflow for heating and the maximum airflow for ventilating.

Table 4-15: DVC Men's Locker Building Heating Ventilating Unit

Unit	Model	CFM	HP	Remarks
H/V-1	Reznor ADF	8000	7.5	W/VFD/ECO

Operation and Maintenance

The installation of this ECM will reduce both short-term and long-term maintenance costs because there are fewer pieces of equipment to maintain. The required preventive maintenance for the new equipment is the same as the existing units.

Typical maintenance includes:

- Lubricate bearings.
- Review and perform manufacturer's recommended maintenance procedures.
- Change filters and keep the coils clean.

Phase 2 Project

Phase 2: Diablo Valley College – Controls

Note: This subsection is also part of phase 2. It does not fall within the current scope.

Existing Conditions

Diablo Valley College uses an existing EMS manufactured by Andover Controls and installed by various contractors throughout the years. The system covers most of the HVAC equipment on the campus, but is limited, in most cases, to enable/disable capability (start/stop, no status). Many buildings are limited to a single schedule for the entire building. There are limited monitoring points and most of the actual controls are being performed pneumatically (no feedback or interface to the EMS). Many existing points were observed, from the front end, to be nonfunctional at the time of the survey.

Due to the lack of information available to the EMS user from the existing pneumatic systems and limited monitoring capability, it is difficult for the building operators to understand and coordinate the building systems efficiently. This has resulted in many of the controls being manually overridden, causing increased energy expenses.

The system, while not state of the art, is contemporary and upgradeable. Any additional points needed to expand existing controls and/or support the measures developed in this project can be added to this existing system.

Proposed Solution

Recommissioning

This ECO proposes to recommission the existing Andover EMS at DVC for the buildings undergoing HVAC retrofit. Each individual I/O (input and output) control point and existing sensors, relays, transducers, damper and valve actuators, etc., will be tested for function and accuracy. The scope of the recommission includes testing and the refurbishment, as necessary, of the following:

- Off/on control of:
    - Air handlers
    - Chillers
    - Boilers
    - Pumps
- Space temperature control
    - Cooling coil valves
    - Heating coil valves

  - VAVs and mixing boxes
- Economizer damper controls
- Variable-speed drive controls

In addition to checking each I/O point, the control strategies will be reviewed and modified if necessary. Each HVAC system will be scheduled to operate when the building or occupied spaces are used. The proper scheduling and set-points will be verified during recommissioning by Chevron ES and the Andover controls contractor.

New Controls

New upgraded controllers, sensors and programming will be added to accommodate the new central plant and any additional points proposed by this project. A "standard" will be established for every type of air and/or water system, and the existing systems will be retrofitted with additional points to meet the standard. In addition to start/stop, the standard will include:

- Discharge air and water temperature sensors for of the monitoring and control of the equipment
- Mixed air temperature sensors for of the monitoring and control of the refurbished economizer systems
- Equipment status through a current switch for positive feedback of equipment operation.

These additional points will provide facilities staff with valuable information that can be alarmed and trended to identify problems in a user-friendly format and support the overall effort of energy efficiency.

Commissioning

New controls will be formally commissioned in a manner similar to the recommissioning described above.

Training

Chevron ES will provide onsite training on the operation of the EMS. It is recommended that members of facility maintenance staff participate in both the recommissioning and commissioning processes. Their participation will provide them with hands-on involvement in the entire system, from mechanical equipment to software control strategies. Onsite training under real-time conditions will enable the DVC staff to more effectively operate and maintain the system.

In addition, eight hours of classroom training will be provided for the appropriate DVC personnel by the EMS manufacturer or contractor. Basic troubleshooting and component replacement will be discussed during this training.

Diablo Valley College Responsibilities

For the proposed solution to be a success, Chevron ES asks that DVC:

- Provide members of the maintenance staff to participate in the commissioning processes.
- Maintain temperatures and operating schedules that support the savings plan.

Scope of Work

The scope of work includes the following general tasks:

- Install new EMS controllers, points and software to provide expanded control capability and graphic user interface for the new HVAC equipment.
- Recommission the existing controls, checking for operation and accuracy of devices and sequences (under the direction of and in participation with the Chevron ES representative).
- Engage facility's staff in the recommissioning effort (as training for staff).
- Perform full formal commissioning of the new work (under the direction of and in participation with the Chevron ES representative).
- Perform eight hours of formal training for DVC staff on system operation and maintenance.
- Remove existing controls where being replaced, remove pneumatic tubing back to the panel of origin, and properly cap the main air lines.
- Install wiring in compliance with applicable codes.

The scope of work also includes the installation of devices in the following locations:

- **DVC New Central Cooling and Heating Plant**

  Provide parts and labor to control a chilled water system with variable frequency drives on the two primary chilled water pumps. Provide parts and labor to control a heating water system with variable frequency drives on the two primary hot water pumps. Provide engineering, project management, programming, validation and training required to complete a turnkey controls installation.

- **Library Building**

  HVAC Modifications, VAV-11 through VAV-25: Install automated DDC controls for 16 VAV/reheat boxes. Install one two-way reheat valve for each box.

  HVAC Modifications, AC-1: Install controls and controls peripherals for one new air handler. Install VFDs on the supply and return fans. Install two-way valves on the chilled water and hot water coils.

  HVAC Rooftop Units, AH1 through AH5: Install controls and controls peripherals for five new air handlers. Install VFDs on the supply and return fans. Install two-way valves on the chilled water and hot water coils.

- **Music Building**

Phase 2 Project

AH-1 and AH-2: Install the controls and controls peripherals for two new air handlers. Install Variable Frequency Drives on the supply and return fans. Install two-way valves on the chilled water and hot water coils.

VAV-1 through VAV-7: Install automated DDC controls for seven VAV/reheat boxes. Install one two-way reheat valve for each box.

- **DVC Men's Locker Building**

  HV-1: Install the controls and controls peripherals for one new fan-coil unit. Install two-way valves on the and hot water coils.

- **DVC Engineering Technology Building**:

  AH-1, AH-2, AH-3, AH-4, AH-5 and AH-6: Install the controls and controls peripherals for six new air handlers. Install VFDs on the supply and return fans. Install two-way valves on the chilled water and hot water coils.

  VAV1-1 through VAV1-5, VAV2-1 through VAV2-5, VAV3-1 through VAV3-4, VAV4-1 through VAV4-4, VAV5-1 through VAV5-4, VAV6-1 through VAV6-3: Install automated DDC controls for 25 VAV/reheat boxes. Install one two-way reheat valve for each box.

- **Physical Science Building**

  Install the controls and controls peripherals to retrofit three air handlers. Install two-way valves on the chilled water and hot water coils.

- **Life Health Science Building**

  Install the controls and controls peripherals to retrofit two air handlers. Install two-way valves on the chilled water and hot water coils.

Operation and Maintenance

With an efficiently running EMS, maintenance costs are more likely to decrease than increase. Control of equipment from a central EMS maintenance location allows maintenance personnel to make more effective use of their time. Troubleshooting of HVAC systems can be done prior to sending any personnel into the field, allowing them to take the necessary tools to make any repairs that are needed.

Typical maintenance activities associated with control systems include the following:

- Periodic inspections of entire working systems
- Review of daily alarms and trend logs
- Review and performance of manufacturer's recommended maintenance procedures

A recommended recommissioning check of the EMS should occur before the 10-year anniversary. Though these checks require an expenditure of time, the organization recoups the time through saved annual labor costs.

Phase 2 Project

Los Medanos College – Photovoltaic Systems

This ECM recommends photovoltaic (PV) systems installed at each campus.

Proposed Solution

This ECM proposes installing PV systems to offset a percentage of CCCCD's power demand with PV power generation. A PV cell is a semiconductor device that converts photons of light energy from the sun into direct current electricity. PV systems produce the most amount of electricity during peak hours of the day when electric utility rates are the highest. By installing PV at Los Medanos College, the PV power generation will displace power purchased at peak rates. Additionally through net metering, when the district generates more electricity then it consumes, the district can effectively sell the energy back to the grid at a fair market value. Net metering is facilitated by installing a single meter capable of registering the flow of electricity in both directions. The estimated annual cost savings does not capture the financial benefits of net metering.

CCCCD has applied for incentive money from the Self-Generation Incentive Program authorized by the California Public Utility Commission and administered by PG&E. The SGIP program offers capacity-based incentives of $3 per watt system output.

Additional benefits of photovoltaic systems include:

- Environmental stewardship
- Public recognition
- A diversified energy portfolio
- Power reliability
- A secure positive return on investment through competitive fixed energy costs

Scope of Work

Chevron ES proposes 1,155 kilowatts of PV at the Los Medanos College campus. The individual system sizes range from 77 to 714 kilowatts. Chevron ES recommends a variety of applications, including roof-mounted systems, ground-mounted systems and parking shade structures.

Roof- mounted systems can be installed on either flat or sloped roofs; there are a variety of mounting options. Roof-mounted systems provide the additional benefit of shielding the roof membrane from harmful UV radiation, thereby extending the roof life. Additionally, the roof-mounted systems provide added roof insulation, which can reduce a building's heating and cooling demand.

Figure 4-50: Roof-Mounted System

Figure 4-51: Parking Shade Structure

Ground-mounted systems can be installed on flat or sloped ground. Frequently, ground-mounted systems are installed on hillsides to take advantage of the natural slope.

Parking shade structures are solar-covered parking structures. The parking structured offers a dual benefit of electricity production and shade for parked cars.

Table 4-16 outlines the proposed locations, system applications and system sizes.

Table 4-16: LMC System Application and System Size

Campus	System Application and System Size				
	Roof-Mounted	**System Size, DC**	**Parking Structure**	**System Size, DC**	**Total**
Los Medanos College	Main Building (Southwest)	77 kW	Lot C	714 kW	1,089 kW
			Lot B	298 kW	

Operation and Maintenance

Chevron ES shall provide six sets of site-specific operation, maintenance and parts manuals for the PV system and modifications to any existing facility or feature therein. The manuals shall cover components, options and accessories supplied. They shall include maintenance, troubleshooting, and safety precautions specific to the supplied equipment. Maintenance schedules shall be provided. Actual operation and maintenance of the PV panels and system will be performed by a third party.

Los Medanos College – Lighting

T8 Retrofit

This ECO recommends retrofitting first-generation T8 lighting with third-generation T8 components.

Existing Conditions

The existing linear fluorescent fixtures throughout the facility have first-generation T8 lamps and electronic ballasts. The buildings were retrofitted from T12 components to T8 components about 10 years ago during a previous energy conservation project. The T8 lamps in use are 700-series lamps, and the ballasts are standard electronic ballasts. The 700-series lamps have a color-rendering index that is below 80 percent and their lumen output is less than 2,900 lumens. The existing ballasts catalog rating is 58 watts (two-lamp fixture). This system produces only 78 maintained lumens per watt. There are also several incandescent lamps in operation. The existing fixtures are in good condition and are good candidates for the recommended retrofits. Gymnasium fixtures are high-intensity discharge lighting systems requiring long start times.

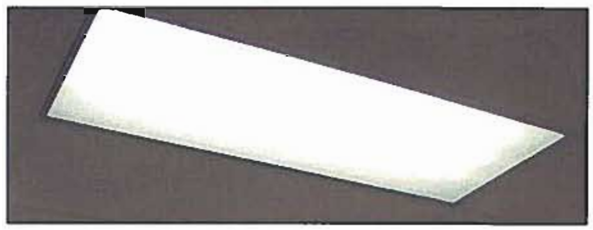


Figure 4-43: LMC Classroom Fixture

CHANGED OUT 2008/09

Figure 4-44: LMC Gym Fixture

Proposed Solutions

This ECO recommends replacing standard grade T8 lamps with long life, high-color rendering and high-efficiency lamps. This ECO also recommends replacing magnetic and standard electronic ballasts with premium-efficiency third-generation ballasts. These new components will provide similar light levels with improved color qualities. The new lamp color-rendering index is greater than 85 percent with similar lumen output while using less energy. The new third-generation low ballast factor ballasts use as low as 45 watts (two-lamp fixture). The new system produces as high as 99 maintained lumens per watt. Two-lamp fixtures will be retrofitted with two lamps, and three- and four-lamp fixtures may be de-lamped with higher power ballasts. Gymnasium fixtures will be replaced with instant start linear fluorescent fixtures. Retrofit details are shown in the appendix.

Scope of Work

Chevron ES recommends that LMC remove existing light fixtures and replace with new fixtures as specified below:

- Fixture retrofits shall use high-efficiency lamps and ballasts with the ballast factor rating as specified on the lighting spreadsheet in the appendix
- Ballasts shall be GE, Sylvania, Advance, Universal, Howard or an approved equal.
- New lamps shall be third-generation premium-efficiency T8 lamps.
- Lamps shall have a color-rendering index greater than 80 percent.
- Lamp life ratings shall be equal to or greater than 24,000 hours at 12 hours per start.
- Lamps shall be as manufactured by GE, Sylvania or Philips.

Operation and Maintenance

To maintain proper lighting levels within the facility, it is recommended that the lamps, lenses, reflectors and fixture housings be cleaned annually and at the time of any required service. At the conclusion of the implementation of this project, lamps and ballasts will be new. It is recommended that lamps be replaced in a group on a schedule at 75 percent of their rated lamp life. It is recommended that ballasts and sensors be replaced only upon failure. This measure will reduce the required stock on hand for lighting equipment. Actual maintenance requirements include the following:

- Clean reflector surfaces.
- Replace lamps prior to burning out.

Los Medanos College – Personal Computer Controls

Recommended Application of Computer Energy Management Software

The calculated energy savings from installing computer energy management software on the personal computers at Los Medanos College is shown in Figure 4-52. The existing energy consumption is compared to the energy consumption after the proposed changes.

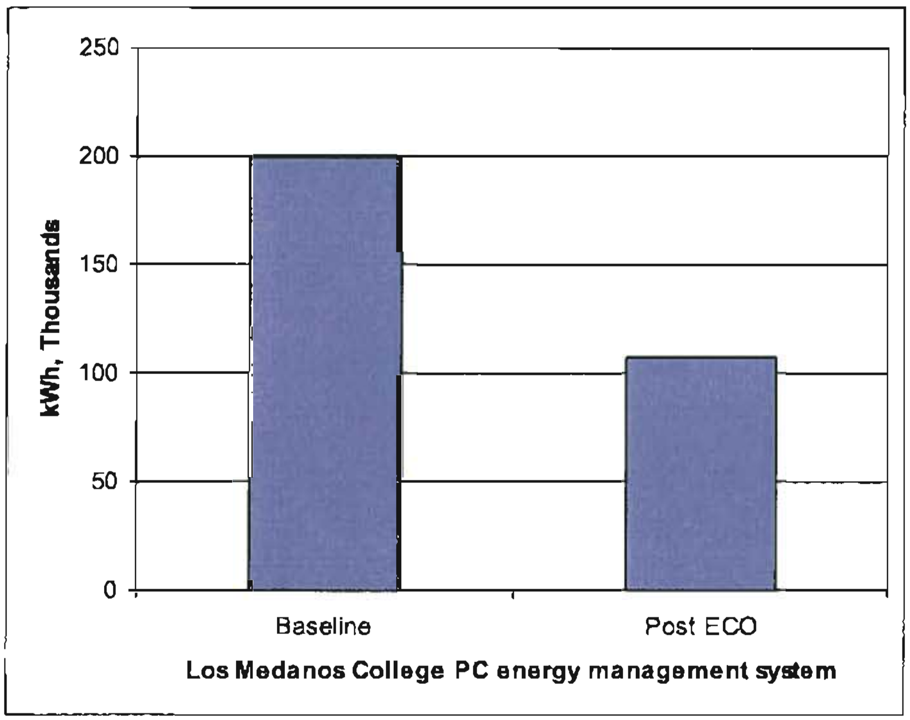


Figure 4-52: LMC Baseline and Post-ECO Personal Computer Energy Management Software

Existing Conditions

Los Medanos College has approximately 600 personal computers in use at the campus. These computers are deployed with standard settings for Suspend, Standby and Shutdown modes on each computer within the operating system. Computer keystroke activity and energy saving modes utilization logging was performed for two weeks on a representative sample of the computers at this facility. A significant portion of the computers have had the standard settings modified with non-energy-saving screen savers or have had the energy-conserving modes disabled in the operating systems.

Proposed Solution

The personal computer energy management software is a supervisory system installed on the network. Once installed, the system listens for network connectivity between the computer and the network. Power management profiles are developed for groups of users on the server; these profiles are used to adjust the Standby, Hibernate, Sleep and Shutdown modes on each computer and its monitor as needed by each usage group. The user still has the ability to change the settings temporarily, if needed for a specific task, or permanently, if required. The system also records computer usage patterns, tracks energy conservation realized, and creates reports, if required. The system can be tailored to meet the needs of the site or user as required.

Scope of Work

Information about the installation of network-based personal computer energy management control systems, including annual site licenses, are displayed in Table 4-17:

Table 4-17: LMC Units for Computer Controller Installations

Building/Area	Quantity of personal computers	Quantity of software site licenses
All - LMC	600	600

Operation and Maintenance

Installation and support of the system is included.

Los Medanos College – Controllers

Recommended Application of Compressor Controllers

The calculated energy savings from installing compressor controllers on small-packaged and refrigeration units at LMC is shown in Figure 4-53. The existing energy consumption is compared to the energy consumption after the proposed changes.

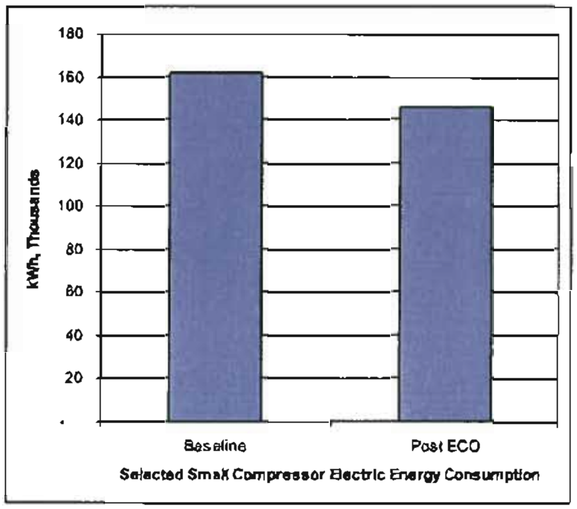


Figure 4-53: LMC Baseline and Post-ECO Electric Energy Consumption Comparison

Existing Conditions

Los Medanos College has many, relatively small packaged cooling units and split systems that provide cooling and refrigeration for various purposes. The sizing of refrigeration systems is based upon a number of factors. When any of the design considerations are not met, the refrigeration system is oversized for the load and thus, less efficient.

Figure 4-54: LMC Childcare Rooftop Packaged Units

Figure 4-55: LMC Cafeteria Rooftop Packaged Units

Proposed Solution

Compressor controllers continually monitor the system to detect load changes. In cases where the load is less than the system maximum output, the control delays the start of the system to lower the energy output to match the reduced load. This process is varied dynamically from cycle to cycle.

Scope of Work

The compressor controllers will be installed and commissioned on the following packaged units and refrigeration units:

Table 4-18: LMC Units for Controller Installation

Building/ Area	Qty Refrigeration Units	Qty Cooling Units
Nursing	0	1
Cafeteria	3	0
Music	0	2
Art	0	1
Voc Tech	0	1
Comp. lab	0	5
Childcare	0	8

Operations and Maintenance

The installation of this ECM is expected to lengthen the life of existing units due to reduction in compressor short-cycling and wear on components.

Los Medanos College – Primary Voltage Upgrade

Primary Power Transformer Replacement/Ownership

This measure recommends replacing the PG&E-owned main transformer with a transformer owned by the district. There is no energy savings associated with this measure – only cost savings.

Existing Conditions

The LMC campus is currently served by PG&E secondary rates. Standard utility rates are usually dependant on the size of customer loads as well as the scope of utility equipment required to distribute and deliver the power. The larger loads usually pay less dollars per kilowatt. Similarly, accounts that receive service at higher voltages, thus requiring less PG&E-owned equipment, also pay lower rates. The project to convert to the higher voltage service is called a primary voltage upgrade and results in a significant savings in electric rates.

A PVU is performed for facilities currently receiving secondary service(s) at 4 kilovolts, which can be converted to receive primary (21 kilovolts, also referred to as medium voltage) metered service from the local utility company. The project involves purchasing primary switchgear to meter and distribute power to the transformer that delivers power to the campus. This equipment will replace the existing PG&E system from the property line to each building service. The resulting rate is listed under E20P in the appendix. The actual electrical charges for LMC will be slightly different because the campus buys power directly from a commodity provider.

Proposed Solution

Chevron ES suggests that LMC remove the existing PG&E transformer and replace it with a transformer owned by the school.

Scope of Work

Chevron ES recommends the following:

- Install a new medium-voltage transformer, switchgear and metering equipment.
- Repair trenches, landscaping, and paving, which will restore the campus to pre-existing conditions.
- Increase the electrical service to allow for marginal increases in load.

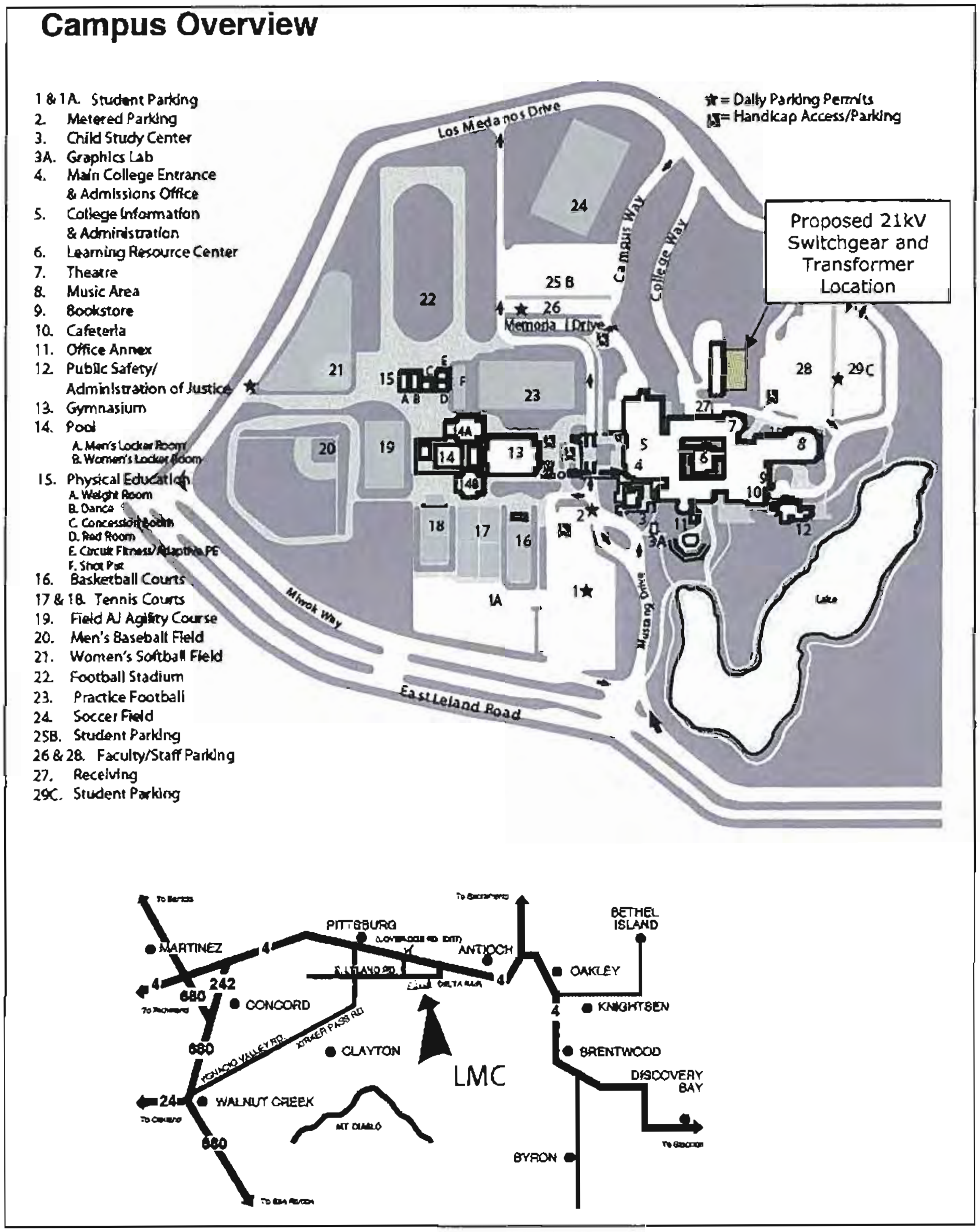


Figure 4-56: LMC Site Map

Los Medanos College – Water Conservation Measures

Replace Existing Standard-Flow Fixtures with Low-Flow Fixtures

This measure recommends replacing the standard flow plumbing fixtures with low-flow fixtures.

Existing Conditions

Many of the existing plumbing fixtures at this facility are standard-flow devices. The existing water closets flow 3.5 gallons per flush and the urinals flow 2 gallons per flush. The majority of the existing standard-flow sinks were measured to flow 2 gallons per minute, although the range varied from 1 to 3.5 gallons per minute. These systems should be replaced with new low-flow moderators.

Water use is often overlooked as a significant source of electrical energy use. While water costs are charged in units of gallons or cubic feet, the electrical cost to pump water is a significant portion of the overall water cost. Throughout the state, the energy consumed in water pumping systems accounts for approximately 15 percent of California's electrical energy consumption (according to the California Energy Commission Census 2002). The trend to higher electricity costs is expected to be seen in higher water costs in the near future. The United States Environmental Protection Agency studies have shown that water conservation improves water quality and reduces pollution.

Proposed Solution

The following solutions will help advance LMC's water-conservation efforts:

- Install new low-flow plumbing fixtures in place of existing standard-flow fixtures, saving water as follows:
  - Low-flow lavatory faucets will reduce flow to 1 gallon per minute.
  - New flushometer toilets will lower water use to 1.6 gallons per flush.
  - Low-flow urinals will reduce flow to 1 gallon per flush.
- Modify the bathroom sinks with 0.5 gallon per minute spray moderators.
- Modify the kitchen sinks with 1.5 laminar flow moderators.

Scope of Work

For optimum water conservation, Chevron ES recommends that LMC:

- Retrofit or replace existing plumbing equipment.
- Replace the moderators on existing faucets with new laminar low-flow units; existing lavatories and faucets are to remain.
- Retrofit or replace the flushometers on the existing urinals with new Sloan (or Zurn) devices.

- Replace water closet bowls with new china and new valves.

A detailed list of equipment and location is included in the appendix.

Pool Filtration

The calculated energy savings by installing a new pool pump and motor are shown in Figure 4-57. The existing energy consumption is compared to the energy consumption after the proposed changes.

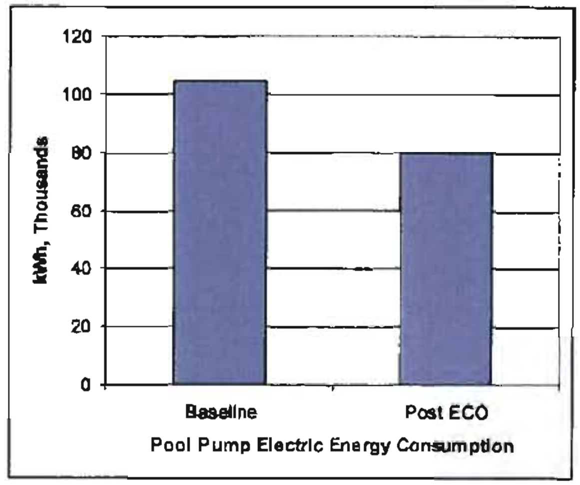


Figure 4-57: LMC Baseline and Post-ECO Pool Pump Electric Energy Consumption Comparison

Existing Conditions

The campus swimming pool currently uses a diatomaceous earth (DE) filtration system. A constant-volume pump circulates water among the swimming pool, heat exchanger and filter. Due to the nature of the filter, if the pump does not continually maintain a minimum flow rate through the filter, the media will fall off and maintenance staff must spend extra time replacing the media and getting the system back up and running. This minimum flow rate is higher than the minimum water changes per hour that the school must abide by during unoccupied hours. Additionally, the pump itself was not sized correctly for this application, and a valve constantly throttles the flow to reach the design flow rate.

Figure 4-58: LMC Existing DE Filter

Figure 4-59: LMC Existing Pool Pump

Proposed Solution

Chevron ES recommends that LMC:

- Replace the DE filters with new sand filters.
- Install a new pump sized for this application.
- Apply a VFD to the pump to drop the flow rate to the minimum during unoccupied hours.

Scope of Work

Chevron ES recommends the following:

Filters

- Remove the existing DE filters.
- Fill the existing filter pit with concrete to match the existing floor level.
- Install new high-rate sand filters and connect them to the existing piping.
- Provide the drain and miscellaneous piping and devices for a complete and workable system.
- Cut the existing wall to allow for the new equipment installation as needed. After installation, the wall will be patched and repaired to match the existing.
- Dispose of the old equipment. Disposal costs are included.

Filtration Pump

- Remove the existing filtration pump.
- Install a new pump. The gpm will correspond to six pool turnarounds. The pool has a water capacity of 500,000 gallons.
- Add a VFD to the pump to reduce the flow during unoccupied periods.
- Dispose of the old equipment. Disposal costs are included.

Operation and Maintenance

The installation of this ECM is expected to significantly impact the maintenance required on the pool filtration system. Currently, maintenance staff spent on average three hours a day, five days a week maintaining the system. If the pump shuts off, it takes an entire day for staff to get the system running again.

The new sand filters will require approximately 10 hours per month for maintenance, and the pump will be able to turn off without additional work required by the staff to get it started again.

Phase 2: Los Medanos College – HVAC

Note: This subsection falls within phase 2 of the project. It is not part of the current scope.

Central Plant Hot Water Pumping

The calculated energy savings from fixing the hot water pumping issues are shown in Figure 4-60. The existing energy consumption is compared to the energy consumption after the proposed changes.

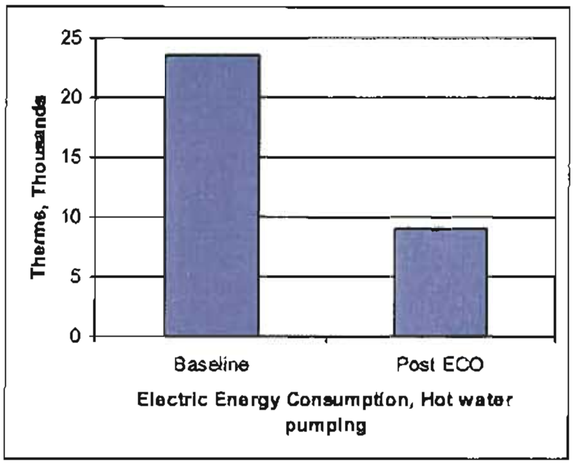


Figure 4-60: LMC Baseline and Post-ECO Hot Water Pump Electric Energy Consumption Comparison

Existing Conditions

The existing hot water system consists of six Aerco boilers, model Benchmark 2.0, and two hot water pumps located in the campus central plant. The building heat load demand can be handled by four of the six boilers, and the other two can serve as backups. The boilers and the pumps were installed in 2000 with VFDs on the hot water pumps to provide a variable flow system. The VFDs are currently set at a minimum of 77 percent of their capacity because lower settings do not provide adequate flow to one of the air handlers on the roof.

Proposed Solution

The existing pumps have adequate flow and head capacity; the problem is unrestricted flow at the existing three-way hot water control valve. The three-way valves allow hot water to pass through the valve bypass and therefore short-circuit the water needed for the demanding coils. Some of the internal zone reheat coils were closed off due to overheating the space, and they are left opened and

Phase 2 Project

controlled. This ECM would convert the three-way control valves to two-way but would maintain a number of the three-way valves at the end of the hot water loop to provide the required minimum 45 gallons per minute (gpm) of hot water though the boilers. This ECM would eliminate the flow issues and allow the hot water pumps to slow down during the low-demand requirement and therefore save energy.

Scope of Work

Chevron ES recommends converting the three-way valves listed in Table 4-19 with two-way valves, with the exception of the first seven valves.

Table 4-19: LMC Three-Way Hot Water Valves

Type	Coil	GPM	C(v) (psi)	MBH	Convert?
Reheat	RH3101	10.8	1.5	148.0	N
Reheat	RH4105	3.2	1.5	76.1	N
Reheat	RH586	1.8	1.5	32.5	N
Reheat	RH5825	38.0	1.5	2.6	N
Reheat	RH696	3.1	1.5	75.7	N
Reheat	RH698	3.2	1.5	76.1	N
Reheat	RH851	0.5	1.5	8.8	N
Reheat	RH9141	10.4	1.5	239.3	Y
Reheat	RH9144	11.0	1.5	159.5	Y
Reheat	RH1373	20.2	1.5	216.0	Y
Reheat	RHC1-6	11.0	1.5	110.0	Y
Reheat	RHC2-1	2.8	1.5	28.0	Y
Reheat	RHC2-5	8.0	1.5	80.0	Y
Preheat	PHC-2	9.0	1,5	181.2	Y
Preheat	PHC-1	11.5	1.5	218.2	Y
Preheat	PH1	34.8	1.5	696.0	Y
Preheat	PH2	11.2	1.5	223.0	Y
Preheat	PH3	36.2	1.5	725.0	Y
Preheat	PH4	7.1	1.5	142.0	Y
Preheat	PH5	26.2	1.5	525.0	Y
Preheat	PH6	19.5	1.5	390.0	Y
Preheat	PH7	26.9	1.5	539.0	Y
Preheat	PH8	19.0	1.5	379.0	Y
Preheat	PH9	27.1	1.5	542.0	Y
Main heat	H12	11.8	1.5	235.0	Y
Preheat	PH13	15.0	1.5	125.0	Y

Phase 2 Project

Operation and Maintenance

The installation of this ECM is not expected to significantly affect maintenance. It is expected that the existing hot water pump motor will have a longer life due to reduced load.

- Follow the manufacturer's recommended maintenance schedules for the existing VFD and motor.
- Regularly inspect VFD cabinet and clean out dust and debris.

Central Plant Chilled Water Pumping

The calculated energy savings that result from converting from constant-volume chilled water to variable-volume are shown in Figure 4-61. The existing energy consumption is compared to the energy consumption after the proposed changes.

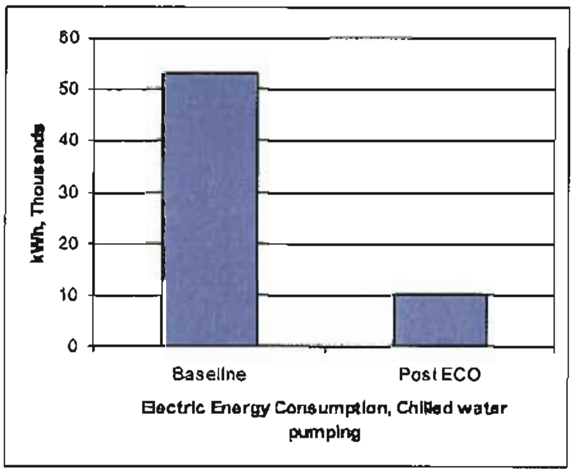


Figure 4-61: LMC Baseline and Post-ECO Chilled Water Pump Electric Energy Consumption Comparison

Existing Conditions

The existing York chillers and the chilled water pumps were installed in 2001. The original chilled water system was installed in the 1970s as a primary/tertiary pumping system; however, the latest chiller and pump replacement project did not change the pumping configuration. The current chillers are equipped with a VSD, and the pumps run at a constant flow. Cooling coil valves at the building air handlers are three-way and were installed with the original air handlers. The chiller and the pumps have ample capacity, and usually only one chiller and one pump are adequate to handle the cooling loads. Figure 4-62 depicts the existing chilled water configuration.

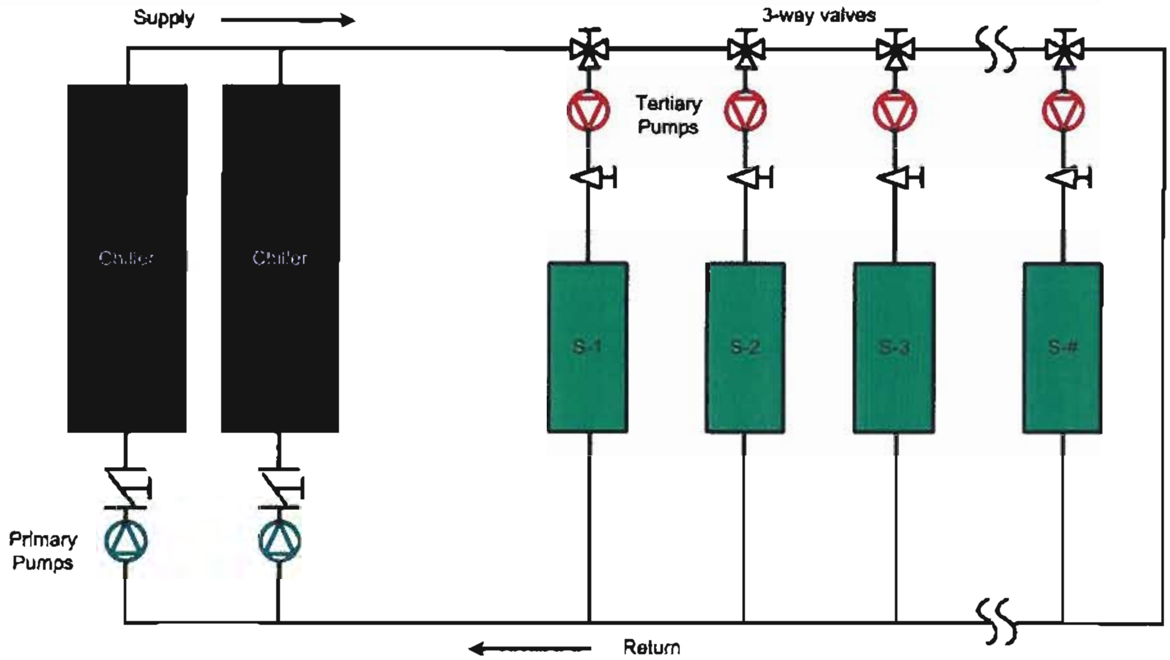


Figure 4-62: LMC Schematic of Existing Chilled Water Pumping

This EMC proposes to remove tertiary pumps located at each coil on the roof, replacing three-way valves with two-way valves, and installing variable frequency drives on the primary pumps to modulate pump horsepower to follow the building load.

Proposed Solution

Chevron ES recommends converting the constant-flow chilled water pumping system to a primary variable flow. This ECM would add new VFDs on the existing chilled water pumps, eliminate the tertiary pumps at the cooling coils and replace the existing three-way valves with two-way valves. To ensure minimum chilled water flow through the chillers, a new bypass across the chilled water supply and return pipe with an automatic modulating valve would be installed.

Scope of Work

Chevron ES recommends the following:

- Removing the existing tertiary pumps (see Table 4-20)
- Replacing the three way-valves with two-way (see Table 4-21)
- Installing VFDs on the primary chilled water pumps (see Table 4-22)
- Installing the chiller bypass

Phase 2 Project

Table 4-20: LMC Existing Cooling Coil Tertiary Pumps

Pump	GPM	HP	Head
P-9	21	0.3	10
P-10	203	1.0	10
P-11	39	0.5	14.5
P-12	142	1.0	13.5
P-13	134	1.0	13
P-14	135	1.0	13
P-15	97	0.8	14
P-16	138	1.0	13.5
P-17	28.6	0.3	12

Table 4-21: LMC Three-Way Valves on Cooling Coils

Type	Coil	GPM	C(v) (psi)	MBH	Convert?
Cooling	CH1	2.4	1.5	1285.0	Y
Cooling	CH2	21.0	1.5	125.8	Y
Cooling	CH3	204.0	1.5	1220.0	Y
Cooling	CH4	40.0	1.5	239.0	Y
Cooling	CH5	142.0	1.5	854.0	Y
Cooling	CH6	134.0	1.5	804.0	Y
Cooling	CH7	135.0	1.5	810.0	Y
Cooling	CH8	97.0	1.5	585.0	Y
Cooling	CH9	140.0	1.5	836.0	Y
Cooling	CH13	28.6	1.5	171.5	Y

Phase 2 Project

Table 4-22: LMC Chilled Water Pumps for VFD Addition

Pump	GPM	HP	Head	Electrical
P-3	600	20.0	80	460/3/60
P-4	600	20.0	80	460/3/60

Operation and Maintenance

The installation of this ECM is not expected to significantly affect maintenance. It is expected that the existing motors will have a longer life, however, due to reduced load.

- Follow the manufacturer's recommended maintenance schedules for the new VFD and motor.
- Regularly inspect the VFD cabinet and clean out dust and debris.

Heating, Ventilation and Air Conditioning

The calculated energy savings from upgrading and/or replacing the HVAC equipment are shown in Figure 4-63 and Figure 4-64. The existing energy consumption is compared to the energy consumption after the proposed changes. Note that the baseline and post-retrofit energy consumption is only for the HVAC equipment involved in this ECO. It does not represent the energy consumption of the HVAC equipment on campus.

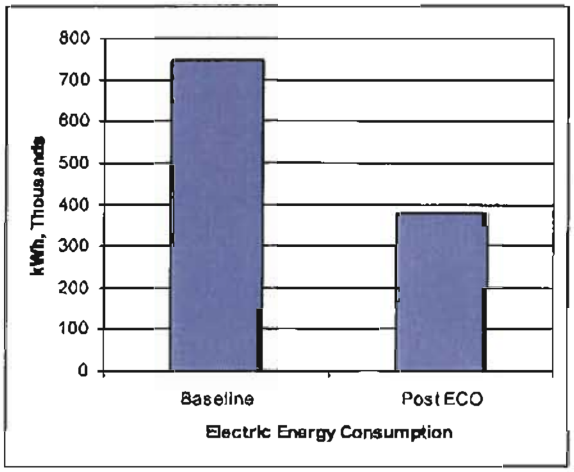


Figure 4-63: LMC Baseline and Post-ECO Central Plant ECM Electric Energy Consumption Comparison

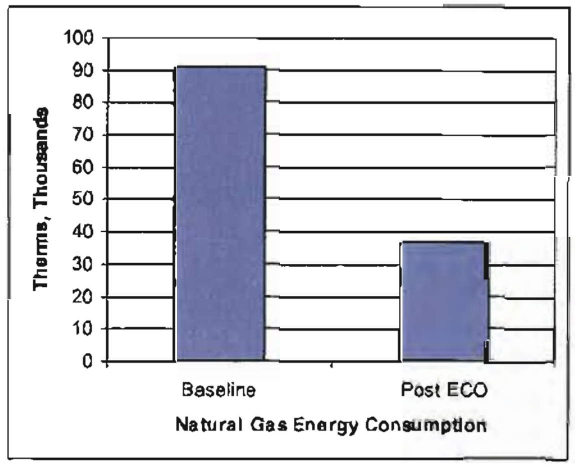


Figure 4-64: LMC Baseline and Post-ECO Central Plant ECM Natural Gas Energy Consumption Comparison

Existing Conditions

Twelve air handlers with chilled water and hot water condition the majority of the main building complex. One air handler with hot water conditions the maintenance area on the ground floor.

Past and future changes to the internal loads have made some units oversized and one slightly undersized. Of the twelve air handlers, eight have VFDs installed on the supply and return fans as part of a retrofit done in the 1990s. The static pressure sensors that control the VFDs on the fans of the air handlers were installed in the wrong location. As a result, the fan speed is not controlled properly and likely doesn't drop below 75 percent of maximum. Several VAV boxes have been forced open because of noise and/or comfort issues. As a result, many of these units operate close to constant volume.

In several locations, one air handler conditions several floors of differing usage, and systems are not currently capable of isolating areas that are unoccupied. An economizer retrofit performed on the air handler serving the Music building was done incorrectly; the outside air dampers were permanently shut to prevent the building from becoming over-pressurized.

Phase 2 Project

Figure 4-65: Typical Air Handler Located on Roof

Figure 4-66: LMC Economizer Retrofit on Unit S-8 Where Outside Dampers Are Manually Shut

Phase 2 Project

The motors for the supply and return fans on the air handlers were installed in a different location than where they were designed, and the resulting vibration has contributed to severe metal fatigue on many of the units and ductwork. The maintenance staff has already had to contend with portions of the duct disintegrating due to the constant and intense vibration.

The premium-efficiency motors that were installed on the supply and return fans during a retrofit several years prior were not rated for outdoor application and have experienced weathering. Several have already been replaced, and others have experienced decreased efficiency.

Eight packaged rooftop units with gas heating and DX cooling condition the Music addition building. These units were installed in the early 1990s and run at a constant volume. The units serving the Recital Hall have VFDs installed on the supply fans, controlled by a push-button override in the control room for the purpose of lowering fan speed during solo musical performances. Gas/DX heating and cooling systems are significantly less efficient than the existing central plant efficiencies currently installed.

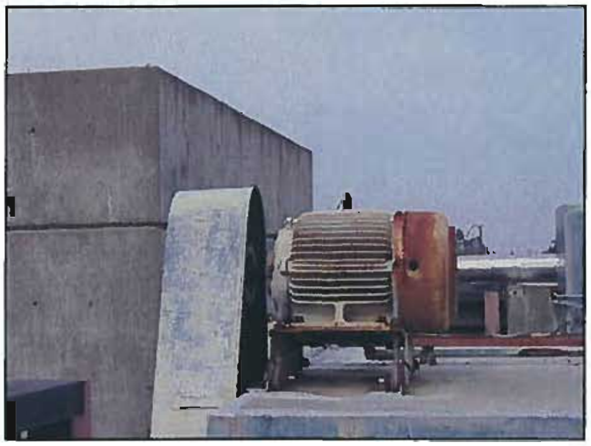


Figure 4-67: LMC Supply Fan Motor Installed on Air Handler; Motor Is 5 or 6 Years Old.

Figure 4-68: LMC Supply Fan Motor Installed on Air Handler; Motor Is 5 or 6 Years Old.

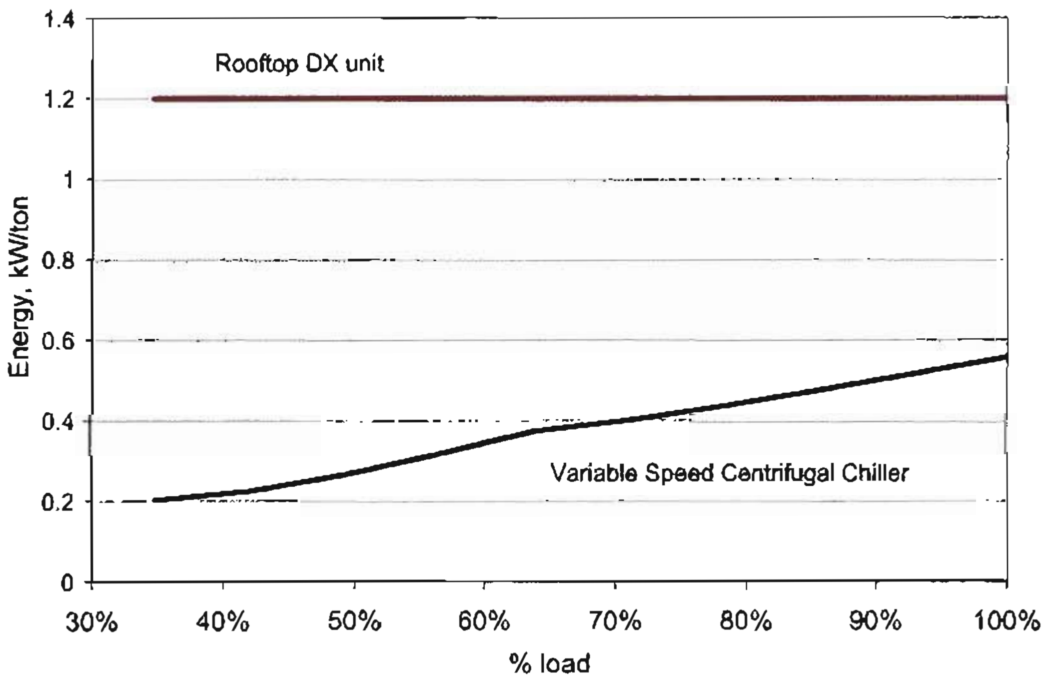


Figure 4-69: LMC Energy Consumption Comparison

Comparison between rooftop DX cooling energy consumption and VSD centrifugal chillers. Data for chiller performance taken from York HVAC&R Engineering Update: Chiller-Plant Energy Performance. Rooftop DX unit efficiency taken from Lennox cut sheets.

Figure 4-70: One of Eight Packaged Gas/DX Units Serving the LMC Music Addition Building

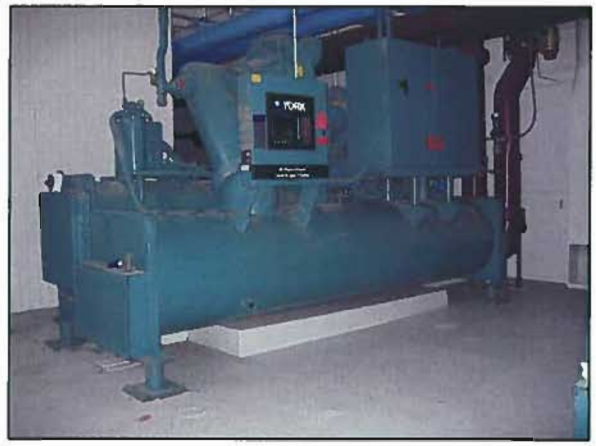


Figure 4-71: One of Two VSD Water-Cooled Chillers at LMC

Proposed Solution

Chevron ES recommends replacing the existing air handlers with new, properly sized air handlers with the supply and return fan motors located inside the unit and with VFDs installed to modulate the fan power. Each unit will have chilled and hot water coils, economizer capability and full electronic controls. The static pressure sensor will be relocated so that it can properly control the fan. The VAV boxes and reheat coils will be recommissioned and replaced with new VAV reheat boxes. In one location, two air-handlers will be consolidated into one.

Six of the eight packaged units on the roof of the Music addition building will be replaced with three new air handlers utilizing chilled and hot water from the central plant to provide cooling and heating, thereby taking advantage of the high plant efficiency. Two of the three units will have VFDs installed on the fans and VAV boxes installed in each zone.

Scope of Work

Chevron ES recommends the following:

- Remove the existing air handlers: S-2, S-3, S-4, S-5, S-6, S-7, S-8, S-9 and S-13.

  Existing tertiary chilled water pumps located at the air-handler unit will be removed. One new air handler with a chilled water coil, a hot water coil and most with VFDs on the supply and return fans will be installed in the place of each unit.

- Remove the existing air handler: S-12.

  One new air handler with a hot water coil will be installed.

- Remove the existing air handlers: S-5, N-1 and N-2.

  One new air handler will be installed to replace S-5 and N-1. The unit will be equipped with a chilled water coil, a hot water coil and VFDs on the supply and return fans. One new air handler will be installed to replace N-2. The unit will be equipped with a chilled water coil, a hot water coil and VFDs on the supply and return fans.

- Remove the existing packaged gas/DX units – HVAC-1 and HVAC-2 – serving the Recital Hall.

  One new air handler with a chilled water coil, a hot water coil and VFDs on the supply and return fans will be installed.

- Remove the existing packaged gas/DX units – HVAC-5, HVAC-6, HVAC-7 and HVAV-8 – serving the Music building.

  One new air handler with a chilled water coil, hot water coil and VFD on the supply and return fan serving three VAV boxes located on the roof will be installed in the place of HVAC-5, HVAC-6 and HVAC-7. One new fan coil with a chilled water coil and hot water coil will be installed in the place of HVAC-8.

  Note that HVAC-3 and HVAC-4 will be left as gas/DX because they serve space that requires conditioning 24 hours a day, seven days a week.

- VAV boxes and reheat coils will be replaced with new VAV reheat boxes that have two-way electronic valves on the coils.

Operation and Maintenance

The installation of this ECM is expected to significantly impact maintenance. Many of the existing rooftop units and reheat coils are 30 years old and at the end of their intended useful lives. Replacing them with new ones will significantly reduce the amount of time spent on maintenance. Additionally, installing systems designed for outdoor conditions and low vibration will reduce the rate of equipment wear and tear.

Phase 2 Project

Phase 2: Los Medanos College – Controls

Note: This subsection is also part of phase 2. It does not fall within the current scope.

Existing Conditions

Los Medanos College uses an existing EMS manufactured by Andover Controls and installed by various contractors through the years. The system covers the majority of the HVAC equipment on the campus, and most of the rooftop equipment has been equipped with status points in addition to enable/disable capability. Many buildings are limited to a single schedule for the entire building. There are limited monitoring points, and most of the actual controls are being performed pneumatically (no feedback or interface to the EMS).

The system, while not state of the art, is contemporary and upgradeable. Any additional points needed to expand existing controls and/or support the measures developed in this project can be added to this existing system.

Phase 2 Project

Proposed Solution

Recommissioning

This ECO proposes to recommission the existing Andover EMS at Los Medanos College. Each individual I/O (input and output) control point and existing sensors, relays, transducers, damper and valve actuators, etc., will be tested for function and accuracy. The scope of the recommission includes testing and refurbishment as necessary of the following:

- Off/on control of:
  - Air handlers
  - Chillers
  - Boilers
  - Pumps
- Space temperature control:
  - Cooling coil valves
  - Heating coil valves
  - VAVs and mixing boxes
- Economizer damper controls
- Variable-speed drive controls

In addition to checking each I/O point, the control strategies will be reviewed and modified, if necessary. Each HVAC system will be scheduled to operate when the building or occupied spaces are used. The proper scheduling and set points will be verified during recommissioning by Chevron ES and the Andover controls contractor.

New Controls

New upgraded controllers, sensors and programming will be added to accommodate the new equipment and any additional points proposed by this project. A "standard" will be established for every type of air and/or water system, and the existing systems will be retrofitted with additional points to meet the standard. In addition to start/stop, the standard will include:

- Discharge air and water temperature sensors for the monitoring and control of the equipment
- Mixed air temperature sensors for the monitoring and control of the refurbished economizer systems and equipment status through a current switch for positive feedback of equipment operation.

These additional points will provide facilities staff with valuable information that can be alarmed and trended to identify problems in a user-friendly format and support the overall effort of energy efficiency.

Commissioning

New controls will be formally commissioned in a manner similar to the recommissioning described above.

Training

Chevron ES will provide onsite training on the operation of the EMS. It is recommended that members of the facility maintenance staff participate in both the recommissioning and commissioning processes. Their participation will provide them with hands-on involvement in the entire system, from mechanical equipment to software control strategies. Onsite training under real-time conditions will allow the LMC staff to more effectively operate and maintain the system.

In addition, eight hours of classroom training will be provided for the appropriate LMC personnel by the EMS manufacturer or contractor. Basic troubleshooting and component replacement will be discussed during this training.

Los Medanos College Responsibilities

For the proposed solution to be a success, Chevron ES asks that LMC:

- Provide members of the maintenance staff to participate in the commissioning processes.
- Maintain temperatures and operating schedules that support the savings plan.

Scope of Work

The scope of work includes the following general tasks:

- Install new EMS controllers, points and software to provide expanded control capability and graphical user interface for the new HVAC equipment.
- Recommission existing controls, checking for operation and accuracy of devices and sequences (under the direction of and in participation with the Chevron ES representative).
- Engage the facility's staff in the recommissioning effort (as training for staff).
- Perform full formal commissioning of the new work (under the direction of and in participation with the Chevron ES representative).
- Perform eight hours of formal training for LMC staff on system operation and maintenance.
- Remove existing controls where being replaced, remove pneumatic tubing back to the panel of origin, and properly cap the main air lines.
- Install wiring in compliance with applicable codes.

The scope of work also includes the installation of devices in the following locations:

- **Campus-wide**

  Air handlers S-2, S-3, S-4, S-6, S-7, S-8, S-9, S-12 and S-13: Install controls and controls peripherals for air handlers. Install variable frequency drives on the supply and return fans where specified in the mechanical scope. Install two-way valves on the chilled water and hot water coils.

  Air handlers: S-5, N-1 and N-2: Install controls and control peripherals for air handlers. Install VFDs on the supply and return fans. (Combine S-5 and N-1 into one unit.) Install two-way valves on the chilled water and hot water coils.

  VAV box modification: Install automated DDC controls for VAV/reheat boxes specified for replacement as part of the mechanical scope. Install one two-way reheat valve for each box.

- **Recital Hall**

  Air handlers HVAC1 and HVAC2: Install the controls and control peripherals for air handlers. Install VFDs on the supply and return fans. Install two-way valves on the chilled water and hot water coils.

- **Music Building**

  Air handlers, multi-zone unit (see mechanical scope): Install the controls and controls peripherals for new air handler. Install VFDs on the supply and return fans and on the control mechanism of four heating and cooling zones. Install two-way valves on the chilled water and hot water coils.

- **Central Chiller Plant**

  Variable-flow chilled water retrofit: Provide parts and labor to control a chilled water system with VFDs on the two primary chilled water pumps. Provide a chilled water bypass valve and parts and labor to control a bypass valve on the chilled water loop. Provide engineering, project management, programming, validation and training required to complete a turnkey controls installation.

Note that the boiler management system (BMS) for the central plant that Aerco Boilers purchased by Los Medanos College is not being installed under this scope of work. It is understood that LMC has already arranged for that installation.

Operation and Maintenance

With an efficiently running EMS, maintenance costs are more likely to decrease than increase. Control of equipment from a central EMS maintenance location allows maintenance personnel to make more effective use of their time. Troubleshooting of HVAC systems can be done prior to sending any personnel into the field, enabling them to take the necessary tools to make any repairs that are needed.

Typical maintenance activities associated with control systems include the following:

- Periodic inspections of the entire working systems
- Review of daily alarms and trend logs
- Review and performance of manufacturer's recommended maintenance procedures

A recommended recommissioning check of the EMS should occur before the 10-year anniversary. Though these checks require an expenditure of time, the organization recoups the time through saved annual labor costs.

District Office – Lighting

T12/T8 Retrofit

Existing Conditions

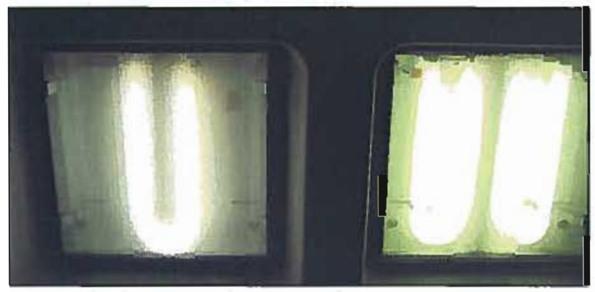


Figure 4-72: District Office Fixture

The existing linear fluorescent fixtures throughout the facility have either T12 lamps and magnetic ballasts or first-generation T8 lamps and electronic ballasts. Some of the buildings were retrofitted from T12 components to T8 components about 10 years ago during a previous energy conservation project. The T8 lamps in use are 700-series lamps, and the ballasts are standard electronic ballasts. The 700-series lamps have a color rendering index that is below 80 percent and their lumen output is less than 2,900 lumens. The existing ballasts catalog rating is 58 watts (two-lamp fixture). This system produces only 78 maintained lumens per watt. There are also several incandescent lamps in operation. The existing fixtures are in good condition and are good candidates for the recommended retrofits.

Proposed Solution

Chevron ES recommends that the District Office replace the T12 and standard grade T8 lamps with long-life, high-color rendering and high-efficiency lamps. Also, replace magnetic and standard electronic ballasts with premium efficiency third-generation ballasts. These new components will provide similar light levels with improved color qualities. The new lamp color rendering index is greater than 85 percent with similar lumen output while using less energy. The new third-generation low ballast factor ballasts use as low as 45 watts (two-lamp fixture). The new system produces as high as 99 maintained lumens per watt. Two-lamp fixtures will be retrofitted with two lamps, and three- and four-lamp fixtures may be de-lamped with higher power ballasts. Retrofit details are shown in the Appendix.

Scope of Work

Chevron ES recommends removing the existing light fixtures and replacing them with new fixtures as specified below:

- Fixture retrofits shall use high-efficiency lamps and ballasts with the ballast factor rating as specified on the lighting spreadsheet in the Appendix.
- Ballasts shall be GE, Sylvania, Advance, Universal, Howard or an approved equal.
- New lamps shall be third-generation premium efficiency T8 lamps.
- Lamps shall have a color-rendering index greater than 80 percent.

- Lamp life ratings shall be equal to or greater than 24,000 hours at 12 hours per start.
- Lamps shall be as manufactured by GE, Sylvania or Philips.

Operation and Maintenance

To maintain proper lighting levels within the facility, it is recommended that the lamps, lenses, reflectors and fixture housings be cleaned annually and at the time of any required service. At the conclusion of the implementation of this project, lamps and ballasts will be new. It is recommended that lamps be replaced in a group on a schedule at 75 percent of their rated lamp life. It is recommended that ballasts and sensors be replaced only upon failure. This measure will reduce the required stock on hand for lighting equipment. Actual maintenance requirements include the following:

- Clean reflector surfaces.
- Replace lamps prior to burning out.

District Office – Personal Computer Controls

Recommended Application of Computer Energy Management Software

The calculated energy savings from installing computer energy management software on the personal computers at the District Office is shown in Figure 4-73. The existing energy consumption is compared to the energy consumption after the proposed changes.

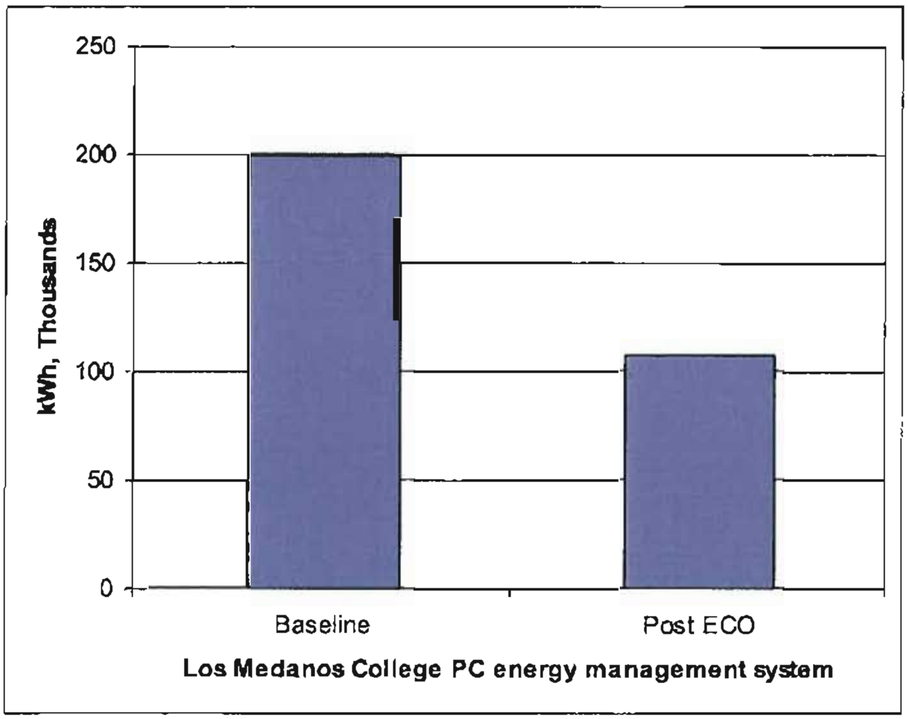


Figure 4-73: DO Baseline and Post-ECO Personal Computer Energy Management Software

Existing Conditions

The District Office has approximately 600 personal computers in use at the campus. These computers are deployed with standard settings for Suspend, Standby and Shutdown modes on each computer within the operating system. Computer keystroke activity and energy-saving modes utilization logging was performed for two weeks on a representative sample of the computers at this facility. A significant portion of the computers have had the standard settings modified with non-energy-saving screen savers or have had the energy-conserving modes disabled in the operating systems.

Proposed Solution

The personal computer energy management software is a supervisory system installed on the network. Once installed, the system listens for network connectivity between the computer and the network. Power management profiles are developed for groups of users on the server; these profiles are used to adjust the Standby, Hibernate, Sleep and Shutdown modes on each computer and its monitor as needed by each usage group. The user still has the ability to change the settings temporarily, if needed for a specific task, or permanently, if required. The system also records computer usage patterns, tracks energy conservation realized, and creates reports, if required. The system can be tailored to meet the needs of the site or user as required.

Scope of Work

Information about the installation of network-based personal computer energy management control systems, including annual site licenses, are displayed in Table 4-23:

Table 4-23: DO Units for Computer Controller Installations

Building/Area	Quantity of Personal Computers	Quantity of Software Site Licenses
All - DO	375	375

Operation and Maintenance

Installation and support of the system is included.

District Office – HVAC

Chiller and Cooling Tower Replacement

The calculated energy savings from replacing the chiller and cooling tower is shown in Figure 4-74. The existing energy consumption is compared to the energy consumption after the proposed changes.

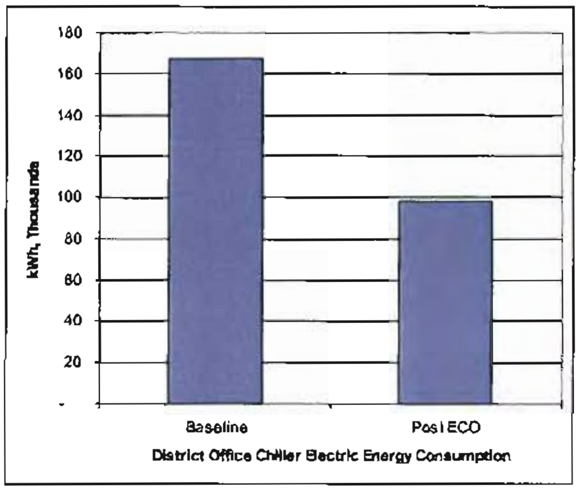


Figure 4-74: District Office Baseline and Post-ECO Chiller Electric Energy Consumption Comparison

Existing Conditions

The existing water-cooled reciprocating chiller is original to the building, installed in 1971, and has never been rebuilt. The existing cooling tower was installed in the early 1990s and shows signs of rusting in the base. The condenser water and chilled water pumps are original to the building and the motors are not premium efficiency.

Figure 4-75: District Office Water-Cooled Reciprocating Chiller

Figure 4-76: District Office Chilled Water Pump

Figure 4-77: District Office Cooling Tower and Condenser Water Pump

Proposed Solution

The existing chiller will be replaced with a new, high-efficiency water-cooled screw chiller. The cooling tower and pumps will also be replaced with a new cooling tower, condenser pump and chilled water pump, with premium-efficiency motors.

Scope of Work

Chevron ES recommends the following:

- Remove the existing chiller, cooling tower, condenser pump and chilled water pump.
- Install one new water-cooled screw chiller, one new cooling tower, one new condenser water pump and one new chilled water pump.
- Ensure that motors are premium efficiency.
- Connect the new chiller, pumps and cooling tower into the existing Andover EMS.

Operation and Maintenance

The installation of this ECM is expected to reduce maintenance time spent due to the age of the existing equipment.

Boiler and Hot Water Pump Replacement

The calculated energy savings from replacing the boiler is shown in Figure 4-78. The existing energy consumption is compared to the energy consumption after the proposed changes.

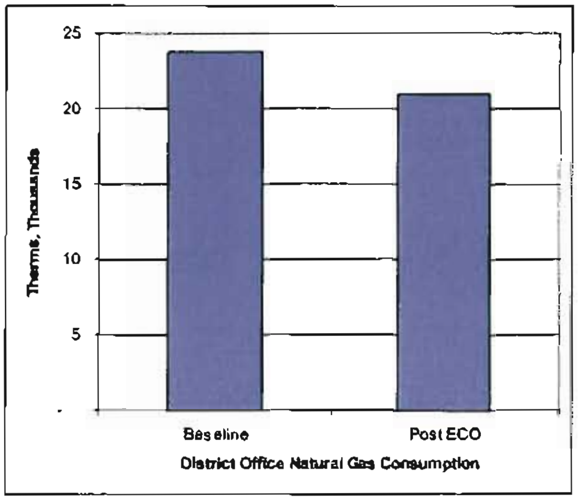


Figure 4-78: District Office Baseline and Post-ECO Natural Gas Energy Consumption Comparison

Existing Conditions

Installed in 1971, the existing gas-fired hot water boiler (Figure 4-79) serving the District Office is original to the building and has a rated efficiency of 80 percent. This has likely decreased due to the age of the equipment.

The hot water pump is original to the building and the motor is not premium efficiency.

Figure 4-79: District Office Gas-Fired Hot Water Boiler and Water Pump

Proposed Solution

The existing boiler and hot water pump will be replaced with new, high-efficiency equivalents.

Scope of Work

Chevron ES recommends the following:

- Remove the existing boiler and install in its place one new high-efficiency, gas-fired hot water boiler, 1460-MBH (thousands of BTUs per hour) input capacity.
- Remove the existing hot water pump and install one new primary hot water constant-flow pump with a premium-efficiency motor.

Operation and Maintenance

The installation of this ECM is expected to reduce maintenance time spent due to the age of the existing equipment.

District Office – Controls

Existing Conditions

The District Office uses an existing EMS manufactured by Andover Controls, which was installed by various contractors throughout the years. The system covers most of the HVAC equipment serving the building, but it is limited, in most cases, to enable/disable capability (start/stop, no status). There are limited monitoring points and most of the actual controls are being performed pneumatically (no feedback or interface to the EMS). Some of the existing points were observed, from the front end, to be nonfunctional at the time of the survey.

Due to the lack of information available to the EMS user from the existing pneumatic systems and due to limited monitoring capability, it is difficult for the building operators to understand and coordinate the building systems efficiently. Also, occupants have reported difficulty in maintaining consistent space comfort. This has resulted in many of the controls being manually overridden, causing increased energy expenses.

Space temperature logger data recorded during the survey showed some areas are conditioned during unoccupied hours. In one case, one area was being conditioned during unoccupied hours and unconditioned during occupied hours.

The system, while not state of the art, is contemporary and upgradeable. Any additional points needed to expand existing controls and/or support the measures developed in this project can be added to this existing system.

Proposed Solution

Recommissioning

This ECO proposes to recommission the existing Andover EMS system at the CCCCD District Office. Each individual I/O (input and output) control point and existing sensors, relays, transducers, damper and valve actuators, etc., will be tested for function and accuracy. The scope of the recommission includes testing and refurbishment as necessary of the following:

- Off/on control of:
  - Air handlers
  - Chillers
  - Boilers
  - Pumps
- Space temperature control
  - Cooling coil valves
  - Heating coil valves
  - VAVs and Mixing Boxes

- Economizer damper controls
- Variable-speed drive controls

In addition to checking each I/O point, the control strategies will be reviewed and modified if necessary. Each HVAC system will be scheduled to operate when the building or occupied spaces are used. The proper scheduling and set-points will be verified during recommissioning by Chevron ES and the Andover controls contractor.

New Controls

New upgraded controllers, sensors and programming will be added to accommodate the new boiler/chiller and any additional points proposed by this project. A "standard" will be established for every type of air and water system, and the existing systems will be retrofitted with additional points to meet the standard. In addition to start/stop, the standard will include:

- Discharge air and water temperature sensors for the monitoring and control of the equipment.
- Mixed air temperature sensors for the monitoring and control of refurbished economizer systems
- Equipment status through a current switch for positive feedback of equipment operation.

These additional points will provide facilities staff with valuable information that can be alarmed and trended to identify problems in a user-friendly format and support the overall effort of energy efficiency.

Commissioning

New controls will be formally commissioned in a manner similar to the recommissioning described above.

Training

Chevron ES will provide onsite training on the operation of the EMS. It is recommended that members of facility maintenance staff participate in both the recommissioning and commissioning processes. Their participation will provide them with hands-on involvement in the entire system, from mechanical equipment to software control strategies. Onsite training under real-time conditions will allow the CCCCD District Office staff to more effectively operate and maintain the system.

In addition, eight hours of classroom training will be provided for the appropriate CCCCD District Office personnel by the EMS manufacturer or contractor. Basic troubleshooting and component replacement will be discussed during this training.

CCCCD District Office Responsibilities

For the proposed solution to be a success, Chevron ES asks that the district:

- Provide members of the maintenance staff to participate in the commissioning processes.
- Maintain temperatures and operating schedules that support the savings plan.

Scope of Work

Chevron ES recommends the following:

- Install new EMS controllers, points and software to provide expanded control capability and graphic user interface for new HVAC equipment.
- Recommission existing controls, checking for operation and accuracy of the devices and sequences (under the direction of and in participation with the Chevron ES representative).
- Engage the facility's staff in the recommissioning effort (as training for staff).
- Perform full formal commissioning of the new work (under the direction of and in participation with the Chevron ES representative).
- Perform eight hours of formal training for District Office staff on system operation and maintenance.
- Remove existing controls where being replaced, move pneumatic tubing back to the panel of origin, and properly cap the main air lines.
- Install the wiring in compliance with the applicable codes.
- Install a new boiler and chiller, which entails the following:
    - Provide all parts and labor to control new chiller and boiler.
    - Provide all engineering, project management, programming, validation and training required to complete a turnkey controls installation.

Operation and Maintenance

With an efficiently running EMS, maintenance costs are more likely to decrease than increase. Control of equipment from a central EMS maintenance location allows maintenance personnel to make more effective use of their time. Troubleshooting of HVAC systems can be done prior to sending any personnel into the field, allowing them to take the necessary tools to make any repairs that are needed.

Typical maintenance activities associated with control systems include the following:

- Periodic inspections of the entire working systems
- Review of daily alarms and trend logs
- Review and performance of manufacturer's recommended maintenance procedures

A recommended recommissioning check of the EMS system should occur before the 10-year anniversary. Though these checks require an expenditure of time, the organization recoups the time through saved annual labor costs.

Section 5

Financial Summary

This section of the report describes the overall energy program financial proforma under two funding scenarios (Tables 1.1 & 1.2).

Financial Proforma

Table 1.1 illustrates the overall estimated program savings, costs and funding sources. This summary assumes that the PG&E SGIP rebates are temporarily funded by CCCCD until the rebates are paid by PG&E to the District.

Table 1.1
Financial Aspects of Performance Based Energy Program for
CCCCD Energy Program
Martinez, CA

Implementation Cost	$32,844,725	
CEA Fee	$0	
Total Project Fee	$32,844,725	
Rebates, Incentives & Grants	$8,025,000	*(not including PG&E /CCC IOU Partnership Program or other Rebates)*
Construction Period Savings	$0	
Bond Contribution	$19,000,000	
Cash Contribution to Project	**$27,025,000**	
Financed Amount of Project	**$5,819,725**	
Construction Period Interest	$233,031	
Financing Fees	$0	
Total Financing Costs during Construction	**$233,031**	
Total Amount Financed (10-year)	**$6,052,756**	
Project NPV - 20 year	**$6,779,877**	
Discounted Payback Period (years)	13.5	

1	2	3	4	5	6	7	8
Year	**Total Energy Savings**	**Operational and Maintenance Savings**	**Total Program Savings**	**Payment to Lessor**	**Monitoring Services**	**Total Program Costs**	**Net Savings**
1	$1,352,856	$83,515	$1,436,371	$742,298	$0	$742,298	$694,073
2	$1,420,499	$83,515	$1,504,014	$742,298	$0	$742,298	$761,716
3	$1,491,524	$83,515	$1,575,039	$742,298	$0	$742,298	$832,741
4	$1,566,100	$83,515	$1,649,615	$742,298	$0	$742,298	$907,317
5	$1,644,405	$83,515	$1,727,920	$742,298	$0	$742,298	$985,622
6	$1,726,625	$83,515	$1,810,140	$742,298	$0	$742,298	$1,067,842
7	$1,812,956	$83,515	$1,896,471	$742,298	$0	$742,298	$1,154,173
8	$1,903,604	$83,515	$1,987,119	$742,298	$0	$742,298	$1,244,821
9	$1,998,784	$0	$1,998,784	$742,298	$0	$742,298	$1,256,486
10	$2,098,723	$0	$2,098,723	$742,298	$0	$742,298	$1,356,425
11	$2,203,659	$0	$2,203,659	$0	$0	$0	$2,203,659
12	$2,313,842	$0	$2,313,842	$0	$0	$0	$2,313,842
13	$2,429,534	$0	$2,429,534	$0	$0	$0	$2,429,534
14	$2,551,011	$0	$2,551,011	$0	$0	$0	$2,551,011
15	$2,678,562	$0	$2,678,562	$0	$0	$0	$2,678,562
16	$2,812,490	$0	$2,812,490	$0	$0	$0	$2,812,490
17	$2,953,115	$0	$2,953,115	$0	$0	$0	$2,953,115
18	$3,100,771	$0	$3,100,771	$0	$0	$0	$3,100,771
19	$3,255,810	$0	$3,255,810	$0	$0	$0	$3,255,810
20	$3,418,601	$0	$3,418,601	$0	$0	$0	$3,418,601
21	$3,589,531	$0	$3,589,531	$0	$0	$0	$3,589,531
22	$3,769,008	$0	$3,769,008	$0	$0	$0	$3,769,008
23	$3,957,458	$0	$3,957,458	$0	$0	$0	$3,957,458
24	$4,155,331	$0	$4,155,331	$0	$0	$0	$4,155,331
25	$4,363,098	$0	$4,363,098	$0	$0	$0	$4,363,098
Totals	$64,567,897	$668,120	$65,236,017	$7,422,980	$0	$7,422,980	$57,813,037

Notes By Column:

(1) Years after implementing retrofit changes
(2) Energy Savings are escalated by 5% to account for energy price escalation.
(3) Operational and Maintenance Savings are stipulated.
(4) Total Program Savings are the sum of Columns (2) and (3)
(5) Payment to Lessor is based on an annual interest rate of 4.2%, 10 year term. Actual rate will be determined at closing.
(6) N/A
(7) Total Program Costs are the sum of Columns (5) and (6)
(8) Net Savings equals Total Program Savings less Total Program Costs, Columns (4) - (7).

Table 1.2 illustrates the overall estimated program savings, costs and funding sources. This summary assumes that the PG&E SGIP rebate payments are assigned to CES as a project payment which results in an interim carrying cost of funds.

Table 1.2
Financial Aspects of Performance Based Energy Program for
CCCCD Energy Program
Martinez, CA

Implementation Cost	$32,844,725	
SGIP Rebate Carrying Cost	$535,000	
Total Project Fee	$33,379,725	
Rebates, Incentives & Grants	$8,025,000	*(not including PG&E /CCC IOU Partnership Program or other Rebates)*
Construction Period Savings	$0	
Bond Contribution	$19,000,000	
Cash Contribution to Project	**$27,025,000**	
Financed Amount of Project	**$6,354,725**	
Construction Period Interest	$254,453	
Financing Fees	$0	
Total Financing Costs during Construction	**$254,453**	
Total Amount Financed (10-year)	**$6,609,178**	
Project NPV - 20 year	**$6,337,215**	
Discounted Payback Period (years)	13.9	

1	2	3	4	5	6	7	8
Year	Total Energy Savings	Operational and Maintenance Savings	Total Program Savings	Payment to Lessor	Monitoring Services	Total Program Costs	Net Savings
1	$1,352,856	$83,515	$1,436,371	$810,537	$0	$810,537	$625,834
2	$1,420,499	$83,515	$1,504,014	$810,537	$0	$810,537	$693,477
3	$1,491,524	$83,515	$1,575,039	$810,537	$0	$810,537	$764,502
4	$1,566,100	$83,515	$1,649,615	$810,537	$0	$810,537	$839,078
5	$1,644,405	$83,515	$1,727,920	$810,537	$0	$810,537	$917,383
6	$1,726,625	$83,515	$1,810,140	$810,537	$0	$810,537	$999,603
7	$1,812,956	$83,515	$1,896,471	$810,537	$0	$810,537	$1,085,934
8	$1,903,604	$83,515	$1,987,119	$810,537	$0	$810,537	$1,176,582
9	$1,998,784	$83,515	$2,082,299	$810,537	$0	$810,537	$1,271,762
10	$2,098,723	$83,515	$2,182,238	$810,537	$0	$810,537	$1,371,701
11	$2,203,659	$0	$2,203,659	$0	$0	$0	$2,203,659
12	$2,313,842	$0	$2,313,842	$0	$0	$0	$2,313,842
13	$2,429,534	$0	$2,429,534	$0	$0	$0	$2,429,534
14	$2,551,011	$0	$2,551,011	$0	$0	$0	$2,551,011
15	$2,678,562	$0	$2,678,562	$0	$0	$0	$2,678,562
16	$2,812,490	$0	$2,812,490	$0	$0	$0	$2,812,490
17	$2,953,115	$0	$2,953,115	$0	$0	$0	$2,953,115
18	$3,100,771	$0	$3,100,771	$0	$0	$0	$3,100,771
19	$3,255,810	$0	$3,255,810	$0	$0	$0	$3,255,810
20	$3,418,601	$0	$3,418,601	$0	$0	$0	$3,418,601
21	$3,589,531	$0	$3,589,531	$0	$0	$0	$3,589,531
22	$3,769,008	$0	$3,769,008	$0	$0	$0	$3,769,008
23	$3,957,458	$0	$3,957,458	$0	$0	$0	$3,957,458
24	$4,155,331	$0	$4,155,331	$0	$0	$0	$4,155,331
25	$4,363,098	$0	$4,363,098	$0	$0	$0	$4,363,098
Totals	$64,567,897	$835,150	$65,403,047	$8,105,370	$0	$8,105,370	$57,297,677

Notes By Column:

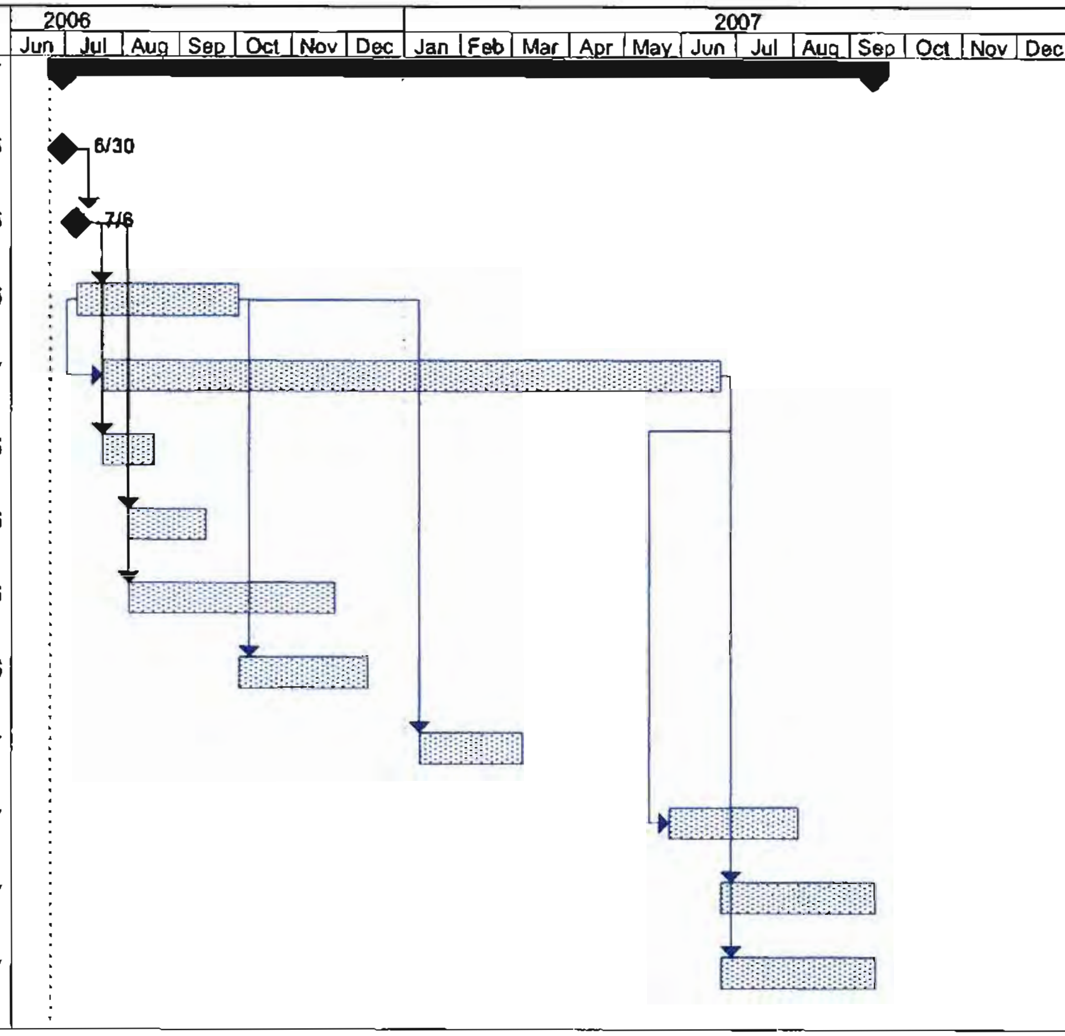
(1) Years after implementing retrofit changes
(2) Energy Savings are escalated by 5% to account for inflation.
(3) Operational and Maintenance Savings are stipulated.
(4) Total Program Savings are the sum of Columns (2) and (3)
(5) Payment to Lessor is based on an annual interest rate of 4.2%, 10 year term. Actual rate will be determined at closing.
(6) N/A
(7) Total Program Costs are the sum of Columns (5) and (6)
(8) Net Savings equals Total Program Savings less Total Program Costs, Columns (4) - (7).

Section 6

Project Schedule

The project implementation schedule is shown on the following page. The schedule is subject to changed based on coordination with the school district and equipment availability.

ID	Task Name	Duration	Start	Finish
1	**CCCCD PV-DSM Project**	**315 days**	**6/30/06**	**9/13/07**
2	Execution of Agreement	0 days	6/30/06	6/30/06
3	Notice to proceed	0 days	7/6/06	7/6/06
4	Engineering	62 days	7/7/06	10/2/06
5	PV panel procurement	12 mons	7/21/06	6/21/07
6	PC Mgmt. Software	20 days	7/21/06	8/17/06
7	A/C Controllers	30 days	8/4/06	9/14/06
8	Lighting Retrofit	4 mons	8/4/06	11/23/06
9	Electrical Equipment Procur	50 days	10/3/06	12/11/06
10	Substation Upgrade	40 days	1/9/07	3/5/07
11	PV Canopy Const.	50 days	5/25/07	8/2/07
12	PV Rooftop Const.	60 days	6/22/07	9/13/07
13	PV Ground Mount Const.	60 days	6/22/07	9/13/07



Project: Implementation schedule.mpp
Date: 6/22/06

Task		Milestone		External Tasks	
Split		Summary		External Milestone	
Progress		Project Summary		Deadline	

GOVERNING BOARD

CONTRA COSTA COMMUNITY COLLEGE DISTRICT

OF
CONTRA COSTA COUNTY
MARTINEZ, CALIFORNIA

REPORT NO. 96-C **DATE** June 28, 2006

PURPOSE Award of Contract No. 6530 for Districtwide Energy Conservation Services Contract for PV Solar and Energy Efficiency Projects

TO MEMBERS OF THE GOVERNING BOARD

RECOMMENDATION

It is recommended that the Governing Board approve execution of an agreement with Chevron Energy Solutions Company (Chevron) for design and installation of photovoltaic energy generation and energy conservation program, as detailed in the attached project list, Board Back-up No. 96-C, in an amount not to exceed $32,900,000.00.

The program budget is $32,900,000.00 with rebates of $8,500,000.00 yielding a net cost of $24,400,000.00. Energy and maintenance cost savings generated from completion of these projects are expected to reduce future impacts to our operating funds for energy by an estimated $1,456,000.00 annually. The discounted payback period for the $24,400,000.00 is expected to be 13 years. The projects will not commence until rebates are approved by PG&E.

FUNDING SOURCE

Funding is to be offset by annual energy savings. Funding sources include (1) 2002 Measure A bond funds, (2) PG&E rebates, (3) state scheduled maintenance funds, (4) Certificate of Participation (COP) financing, (5) Chevron financing and (6) other financing sources.

BACKGROUND

On January 12, 2006, by Purchase Order 8781, Chevron was authorized to develop a Comprehensive Energy Analysis (CEA) of the District's facilities as part of an energy maintenance management planning process. The analysis was conducted and, on April 26, 2006, (Board Report No. 80-D), the District facilities staff and Chevron representatives briefed the Board on the interim findings. The

Board conducted a public hearing and adopted a resolution approving the use of an energy services contract.

One of the stated goals of the CEA was preparation of the project list of recommended improvements to the energy infrastructure that would minimize ongoing expenses in the future for operation and maintenance of the District's energy systems. The attached project list has been created for each college. The project list, along with the PG&E rebate contract requirements, will be included as the scope, cost and terms of this contract.

Disposition **APPROVED** Governing Board Date JUN 2 8 2005 JoAnn Cookman Secretary

Summary of Energy Efficiency Solar PV by Campus

CCCCD Phase 1 Project Summary								
Site	ECO	Task Description	Phase 1	Phase 2	1st Year Utility Savings	Maint. Savings	Rebates	Draft Budget
Contra Costa College								
CCC	PV1	Photovoltaic System -	X		$ 249,000		$2,580,000	
CCC	L1	Lighting Retrofit	X		$ 53,000		$ 64,000	
CCC	EMS1	PC Energy Mgmt software	X		$ 15,000		$ 18,000	
CCC	EMS2	Compressor Controllers	X		$ 2,000		$ 2,400	
CCC	EMS3	New Energy Mgt Controls		X				
CCC	HVAC	Combined HVAC scope		X				
CCC				**subtotal**	**$ 319,000**	**$ -**	**$2,664,400**	**$ 9,450,000**
Diablo Valley College								
DVC	PV1	Photovoltaic System -	X		$ 261,000		$2,700,000	
DVC	L1	Lighting Retrofit	X		$ 183,000		$ 180,000	
DVC	EMS1	PC Energy Mgmt software	X		$ 35,000		$ 34,000	
DVC	EMS2	Compressor Controllers	X		$ 8,000		$ 7,800	
DVC	H2O	Water Conservation	X		$ 11,000			
DVC	TX1	Primary Tx Upgrade	X		$ 119,000	$ (5,000)		
DVC	UMP	Utility Master Plan	X					
DVC	HVAC1	Central Plant		X				
DVC	HVAC2	Combined HVAC		X				
DVC	EMS3	New Energy Mgt Controls		X				
DVC				**subtotal**	**$ 617,000**	**$ (5,000)**	**$2,921,800**	**$11,350,000**
Los Medanos College								
LMC	PV1	Photovoltaic System -	X		$ 265,000		$2,745,000	
LMC	L1	Lighting Retrofit	X		$ 41,000		$ 64,000	
LMC	POOL	New Pool Filtration System	X		$ -	$30,000		
LMC	EMS1	PC Energy Mgmt software	X		$ 13,000		$ 13,400	
LMC	EMS2	Compressor Controllers	X		$ 2,000		$ 2,400	
LMC	TX1	Primary Tx Upgrade	X		$ 95,000	$ (5,000)		
LMC	H2O	Water Conservation	X		$ 2,000			
LMC	EMS3	New Energy Mgt Controls		X				
LMC	ROOF	New Roofing		X				
LMC	HVAC	Combined HVAC		X				
LMC				**subtotal**	**$ 418,000**	**$25,000**	**$2,824,800**	**$11,280,000**
District Office								
DO	L1	Lighting Retrofit	X		$ 11,000		$ 53,000	
DO	EMS1	PC Energy Mgmt software	X		$ 8,000		$ 12,000	
DO	EMS3	New Energy Mgt Controls	X		$ 10,000	$10,000	$ 10,000	
DO	HVAC1	New Boiler, Chiller, Cooling Tower	X		$ 13,000	$30,000	$ 14,000	
DO				**subtotal**	**$ 42,000**	**$40,000**	**$ 89,000**	**$ 750,000**
All				**total**	**$ 1,396,000**	**$60,000**	**$8,500,000**	**$32,830,000**

Board Report No. 96-C – Award of Contract No. 6530 for Districtwide Energy Conservation Services Contract for PV Solar and Energy Efficiency Projects. On January 12, 2006, by Purchase Order 8781, Chevron was authorized to develop a Comprehensive Energy Analysis (CEA) of the District's facilities as part of an energy maintenance management planning process. The analysis was conducted and, on April 26, 2006, (Board Report No. 80-D), the District facilities staff and Chevron Energy Solutions Company (Chevron) representatives briefed the Board on the interim findings. The Board conducted a public hearing and adopted a resolution approving the use of an energy services contract.

One of the stated goals of the CEA was preparation of the project list of recommended improvements to the energy infrastructure that would minimize ongoing expenses in the future for operation and maintenance of the District's energy systems. The attached project list has been created for each college. The project list, along with the PG&E rebate contract requirements, will be included as the scope, cost and terms of this contract. Funding is to be offset by annual energy savings. Funding sources include (1) 2002 Measure A bond funds, (2) PG&E rebates, (3) state scheduled maintenance funds, (4) Certificate of Participation (COP) financing, (5) Chevron financing and (6) other financing sources.

The program budget is $32,900,000.00 with rebates of $8,500,000.00 yielding a net cost of $24,400,000.00. Energy and maintenance cost savings generated from completion of these projects are expected to reduce future impacts to our operating funds for energy by an estimated $1,456,000.00 annually. The discounted payback period for the $24,400,000.00 is expected to be 13 years. The projects will not commence until rebates are approved by PG&E.

On motion of Mr. MacDiarmid, seconded by Ms. Grilli, by unanimous vote (Student Trustee Advisory Vote – aye), the Governing Board approved execution of an agreement with Chevron for design and installation of photovoltaic energy generation and energy conservation program, as detailed in the attached project list, in an amount not to exceed $32,900,000.00.

Summary of Energy Efficiency
Solar PV by Campus

CCCCD Phase 1 Project Summary								
Site	ECO	Task Description	Phase 1	Phase 2	1st Year Utility Savings	Maint. Savings	Rebates	Draft Budget
Contra Costa College								
CCC	PV1	Photovoltaic System -	X		$ 249,000		$2,580,000	
CCC	L1	Lighting Retrofit	X		$ 53,000		$ 64,000	
CCC	EMS1	PC Energy Mgmt software	X		$ 15,000		$ 18,000	
CCC	EMS2	Compressor Controllers	X		$ 2,000		$ 2,400	
CCC	EMS3	New Energy Mgt Controls		X				
CCC	HVAC	Combined HVAC scope		X				
CCC				**subtotal**	**$ 319,000**	**$ -**	**$2,664,400**	**$ 9,450,000**
Diablo Valley College								
DVC	PV1	Photovoltaic System -	X		$ 261,000		$2,700,000	
DVC	L1	Lighting Retrofit	X		$ 183,000		$ 180,000	
DVC	EMS1	PC Energy Mgmt software	X		$ 35,000		$ 34,000	
DVC	EMS2	Compressor Controllers	X		$ 8,000		$ 7,800	
DVC	H2O	Water Conservation	X		$ 11,000			
DVC	TX1	Primary Tx Upgrade	X		$ 119,000	$ (5,000)		
DVC	UMP	Utility Master Plan	X					
DVC	HVAC1	Central Plant		X				
DVC	HVAC2	Combined HVAC		X				
DVC	EMS3	New Energy Mgt Controls		X				
DVC				**subtotal**	**$ 617,000**	**$ (5,000)**	**$2,921,800**	**$11,350,000**
Los Medanos College								
LMC	PV1	Photovoltaic System -	X		$ 265,000		$2,745,000	
LMC	L1	Lighting Retrofit	X		$ 41,000		$ 64,000	
LMC	POOL	New Pool Filtration System	X		$ -	$30,000		
LMC	EMS1	PC Energy Mgmt software	X		$ 13,000		$ 13,400	
LMC	EMS2	Compressor Controllers	X		$ 2,000		$ 2,400	
LMC	TX1	Primary Tx Upgrade	X		$ 95,000	$ (5,000)		
LMC	H2O	Water Conservation	X		$ 2,000			
LMC	EMS3	New Energy Mgt Controls		X				
LMC	ROOF	New Roofing		X				
LMC	HVAC	Combined HVAC		X				
LMC				**subtotal**	**$ 418,000**	**$25,000**	**$2,824,800**	**$11,280,000**
District Office								
DO	L1	Lighting Retrofit	X		$ 11,000		$ 53,000	
DO	EMS1	PC Energy Mgmt software	X		$ 8,000		$ 12,000	
DO	EMS3	New Energy Mgt Controls	X		$ 10,000	$10,000	$ 10,000	
DO	HVAC1	New Boiler, Chiller, Cooling Tower	X		$ 13,000	$30,000	$ 14,000	
DO				**subtotal**	**$ 42,000**	**$40,000**	**$ 89,000**	**$ 750,000**
All				**total**	**$ 1,396,000**	**$60,000**	**$8,500,000**	**$32,830,000**

Energy Program Savings

Overall Energy Program

Year	Total System Price	Rebates	IOU/CCC Program Energy Savings (KWh/yr)	SGIP Energy Production (kWh/yr)	CSI Energy Production (kWh/yr)	Annual Energy Savings	Possible RECs	Parking Revenues	Net Cash Flow
1	$33,156,464	$7,371,686	2,262,600	3,664,024	738,335	$1,446,380	$48,426	$0	-$24,289,971
2		$271,818	2,262,600	3,645,704	734,644	$1,499,796	$48,184	$0	$1,819,798
3		$270,459	2,262,600	3,627,475	730,971	$1,555,691	$47,943	$0	$1,874,093
4		$269,107	2,262,600	3,609,338	727,316	$1,614,181	$47,703	$0	$1,930,991
5		$267,761	2,262,600	3,591,291	723,679	$1,675,386	$47,465	$0	$1,990,612
6			2,262,600	3,573,335	720,061	$1,739,434	$47,227	$0	$1,786,661
7			2,262,600	3,555,468	716,460	$1,806,456	$46,991	$0	$1,853,447
8			2,262,600	3,537,691	712,878	$1,876,591	$46,756	$0	$1,923,347
9			2,262,600	3,520,002	709,314	$1,949,983	$46,522	$0	$1,996,506
10			2,262,600	3,502,402	705,767	$2,026,786	$46,290	$0	$2,073,076
11			2,262,600	3,484,890	702,238	$2,107,157	$46,058	$0	$2,153,215
12			2,262,600	3,467,466	698,727	$2,191,263	$45,828	$0	$2,237,091
13			2,262,600	3,450,129	695,233	$2,279,277	$45,599	$0	$2,324,876
14			2,262,600	3,432,878	691,757	$2,371,383	$45,371	$0	$2,416,754
15			2,262,600	3,415,714	688,299	$2,467,771	$45,144	$0	$2,512,915
16			2,262,600	3,398,635	684,857	$2,568,639	$44,918	$0	$2,613,558
17			2,262,600	3,381,642	681,433	$2,674,198	$44,694	$0	$2,718,892
18			2,262,600	3,364,734	678,026	$2,784,667	$44,470	$0	$2,829,137
19			2,262,600	3,347,910	674,635	$2,900,272	$44,248	$0	$2,944,520
20			2,262,600	3,331,170	671,262	$3,021,256	$44,027	$0	$3,065,283
21			2,262,600	3,314,515	667,906	$3,147,868	$43,807	$0	$3,191,675
22			2,262,600	3,297,942	664,566	$3,280,371	$43,588	$0	$3,323,958
23			2,262,600	3,281,452	661,244	$3,419,040	$43,370	$0	$3,462,409
24			2,262,600	3,265,045	657,937	$3,564,162	$43,153	$0	$3,607,315
25			2,262,600	3,248,720	654,648	$3,716,039	$42,937	$0	$3,758,976
TOTAL		$8,450,831				$59,684,048		$0	$36,119,135

After-tax IRR:	**7.7%**
Cumulative Positive Cash Flow From Year:	**13.1**
After-tax NPV (3%, 25yr):	**$15,879,980**
25-year Net Savings Benefit:	**$36,119,135**

Energy Program Savings

Solar PV Only

Year	Total System Price	Rebates	IOU/CCC Program Energy Savings (KWh/yr)	SGIP Energy Production (kWh/yr)	CSI Energy Production (kWh/yr)	Annual Energy Savings	Possible RECs	Parking Revenues	Net Cash Flow
1	$30,276,921	$7,084,312	0	3,664,024	738,335	$809,436	$48,426	$0	-$22,334,746
2		$271,818	0	3,645,704	734,644	$845,883	$48,184	$0	$1,165,885
3		$270,459	0	3,627,475	730,971	$883,960	$47,943	$0	$1,202,362
4		$269,107	0	3,609,338	727,316	$923,740	$47,703	$0	$1,240,550
5		$267,761	0	3,591,291	723,679	$965,302	$47,465	$0	$1,280,528
6			0	3,573,335	720,061	$1,008,723	$47,227	$0	$1,055,950
7			0	3,555,468	716,460	$1,054,087	$46,991	$0	$1,101,078
8			0	3,537,691	712,878	$1,101,481	$46,756	$0	$1,148,237
9			0	3,520,002	709,314	$1,150,996	$46,522	$0	$1,197,518
10			0	3,502,402	705,767	$1,202,727	$46,290	$0	$1,249,016
11			0	3,484,890	702,238	$1,256,772	$46,058	$0	$1,302,831
12			0	3,467,466	698,727	$1,313,237	$45,828	$0	$1,359,065
13			0	3,450,129	695,233	$1,372,228	$45,599	$0	$1,417,827
14			0	3,432,878	691,757	$1,433,859	$45,371	$0	$1,479,230
15			0	3,415,714	688,299	$1,498,248	$45,144	$0	$1,543,392
16			0	3,398,635	684,857	$1,565,518	$44,918	$0	$1,610,436
17			0	3,381,642	681,433	$1,635,799	$44,694	$0	$1,680,493
18			0	3,364,734	678,026	$1,709,224	$44,470	$0	$1,753,695
19			0	3,347,910	674,635	$1,785,936	$44,248	$0	$1,830,184
20			0	3,331,170	671,262	$1,866,080	$44,027	$0	$1,910,107
21			0	3,314,515	667,906	$1,949,811	$43,807	$0	$1,993,618
22			0	3,297,942	664,566	$2,037,289	$43,588	$0	$2,080,877
23			0	3,281,452	661,244	$2,128,681	$43,370	$0	$2,172,051
24			0	3,265,045	657,937	$2,224,164	$43,153	$0	$2,267,316
25			0	3,248,720	654,648	$2,323,919	$42,937	$0	$2,366,856
TOTAL		$8,163,457				$36,047,098		$0	$15,074,354

After-tax IRR:	**4.0%**
Cumulative Positive Cash Flow From Year:	**17.7**
After-tax NPV (3%, 25yr):	**$2,739,312**
25-year Net Savings Benefit:	**$15,074,354**

Energy Program Savings

Energy Measures Only

Year	Total System Price	Rebates	IOU/CCC Program Energy Savings (KWh/yr)	SGIP Energy Production (kWh/yr)	CSI Energy Production (kWh/yr)	Annual Energy Savings	Possible RECs	Parking Revenues	Net Cash Flow
1	$2,879,543	$287,374	2,262,600	0	0	$636,944	$0	$0	-$1,955,225
2		$0	2,262,600	0	0	$653,914	$0	$0	$653,914
3		$0	2,262,600	0	0	$671,731	$0	$0	$671,731
4		$0	2,262,600	0	0	$690,440	$0	$0	$690,440
5		$0	2,262,600	0	0	$710,085	$0	$0	$710,085
6			2,262,600	0	0	$730,711	$0	$0	$730,711
7			2,262,600	0	0	$752,369	$0	$0	$752,369
8			2,262,600	0	0	$775,110	$0	$0	$775,110
9			2,262,600	0	0	$798,988	$0	$0	$798,988
10			2,262,600	0	0	$824,059	$0	$0	$824,059
11			2,262,600	0	0	$850,385	$0	$0	$850,385
12			2,262,600	0	0	$878,026	$0	$0	$878,026
13			2,262,600	0	0	$907,050	$0	$0	$907,050
14			2,262,600	0	0	$937,524	$0	$0	$937,524
15			2,262,600	0	0	$969,523	$0	$0	$969,523
16			2,262,600	0	0	$1,003,121	$0	$0	$1,003,121
17			2,262,600	0	0	$1,038,400	$0	$0	$1,038,400
18			2,262,600	0	0	$1,075,442	$0	$0	$1,075,442
19			2,262,600	0	0	$1,114,337	$0	$0	$1,114,337
20			2,262,600	0	0	$1,155,176	$0	$0	$1,155,176
21			2,262,600	0	0	$1,198,057	$0	$0	$1,198,057
22			2,262,600	0	0	$1,243,082	$0	$0	$1,243,082
23			2,262,600	0	0	$1,290,358	$0	$0	$1,290,358
24			2,262,600	0	0	$1,339,998	$0	$0	$1,339,998
25			2,262,600	0	0	$1,392,121	$0	$0	$1,392,121
TOTAL		$287,374				$23,636,950		$0	$21,044,781

After-tax IRR:	**36.3%**
Cumulative Positive Cash Flow From Year:	**3.9**
After-tax NPV (3%, 25yr):	**$13,140,668**
25-year Net Savings Benefit:	**$21,044,781**