Energy Solutions

CSU East Bay
Hayward Campus

Investment Grade Audit 001

Presented to:

California State University East Bay
25800 Carlos Bee Blvd.
Hayward, CA 94542

Presented by:

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1.0 Executive Summary

Include a written description of the proposed project(s) overview including existing operational background assumptions based on interviews with campus personnel, energy usage data and cost information obtained as part of the assessment process, followed with the proposed energy measures and an estimation of the resultant avoided cost in energy operations expenses on an annualized basis. At a minimum the following items shall be included in the IGA Executive Summary:

1.a Summary table of recommended energy conservation measures (ECM), with each ECM estimated design and construction costs, annual maintenance costs, the first year cost avoidance (in dollars and energy units), and simple payback.

As a result of our detailed design and analysis efforts and in collaboration with CSU East Bay, we have determined that the following ECMs offer the campus the best return on investment and overall benefit:

IGA ECM Summary

ECM #	ECM	Installed Cost	Const. Fee %	Total Cost	Avoided kWh	Avoided kW	Avoided Therms	Avoided Water & Sewage CCF	Calculated Annual Cost Avoidance	Estimated Incentives	Simple Payback
1	Heating System Upgrades	$987,166	35%	$1,337,018	57,471	93	25,920	0	$31,161	$39,713	41.6
2	EMS Replacement & Air Side Retrofits	$4,590,808	35%	$6,217,790	2,646,513	6,534	112,540	0	$397,454	$747,703	13.8
3	Lighting Retrofits	$608,013	35%	$823,493	891,657	1,687	-7,240	0	$95,120	$206,758	6.5
4	Water Conservation Retrofits	$211,569	35%	$286,549	0	0	2,365	14,570	$48,504	$2,365	5.9
6	Verdiem Computer Power Management Software	$54,333	35%	$73,589	500,000	0	0	0	$62,500	$120,000	-0.7
	TOTAL	$6,451,889	35%	$8,738,438	4,095,641	8,314	133,585	14,570	$634,739	$1,116,539	12.0
*	PA & IGA Fee			$181,500							
	TOTAL with PA & IGA Fee			$8,919,938							

There were several iterations of this spreadsheet which represented Chevron ES' learning curve in working with the CSU forms and meeting both campus and Chancellor Office requirements. For reference purposes only, per request of the Chancellor's Office, we include the original IGA ECM Summary for this project, first presented to the campus on April 23, 2007 (shown on next page):

IGA ECM Summary											
ECM #	**ECM**	**Installed Cost**	**Const. Fee %**	**Total Cost**	**Avoided kWh**	**Avoided kW**	**Avoided Therms**	**Avoided Water & Sewage CCF**	**Calculated Annual Cost Avoidance**	**Estimated Incentives**	**Simple Payback**
1	Heating System Upgrades	$2,262,918	58.0%	$3,575,410	76,778	120	66,378	0	$69,337	$84,805	50.3
2	EMS Replacement & Air Side Retrofits	$4,590,808	60.0%	$7,345,293	2,643,567	5,855	92,400	0	$413,606	$726,856	16.0
3	Lighting Retrofits	$608,013	50.0%	$912,019	895,972	1,687	-7,240	0	$105,481	$207,793	6.7
4	Water Conservation Retrofits	$211,569	53.0%	$323,700	0	0	2,365	14,570	$40,750	$2,365	7.9
5	Swimming Pool Filtration System Upgrades	$319,382	53.0%	$488,655	55,676	0	994	427	$9,771	$14,356	48.5
	TOTAL	$7,992,690		$12,645,078	3,671,993	7,662	154,897	14,997	$638,945	$1,036,175	**18.2**

Note: Total cost valid for 180 calendar days from 5/1/07

The primary changes between the two are:

- The markup fees on top of "Installed Cost" now all fall well within the allowed range for fees;
- ECM #1 boiler replacement has been scaled back to the three boiler rooms in the most need of replacement. This work includes Warren Hall/Library, Meiklejohn Hall and the Art and Education building.
- ECM #2 does not include the cost for taking DDC controls to the zone level;
- Slight changes in energy savings on ECM #2 due to the application of TOU rates in the existing ECM Summary versus a blended utility rate for electricity that was formerly used;
- All planned MBCx work planned through Cogent was removed from ECM #2;
- The project now includes the addition of ECM #5 for Computer Energy Management Software (Verdiem);
- The pool filtration system replacement was removed due to the long payback making this an infrastructure renewal project and not an energy conservation
- Warren Hall was removed from the existing scope of work except for heating;

1.b Summary of annual energy use and costs of existing or base year condition.

Calendar year 2006	Total Usage	Total Cost	Unit Cost
Electricity* (PG&E Meter)	16,500,212 kWh	$2,062,527	$0.125
Natural Gas	598,117 therms	$538,305	$0.90
Water	59,667,960 gals	$179,004	$0.003
Sewer	29,056,974 gals	$96,492	$0.003

* Monthly electrical demand averages approximately 3,000 kW. This figure includes contribution by a 1.1 MW photovoltaic system which generates about 1,151,426 kWh annually, yielding a total campus electricity usage of 17,651,638 kWh.

1.c. Calculation of annual percentage savings expected if all recommended energy conservation measures were implemented.

The projected energy saving is 22% of electricity consumption and 29% of natural gas usage.

1.d Description of the existing facility, mechanical and electrical systems.

<u>Heating Systems:</u>

Each of the campus buildings has one or more boilers that provide heating water to the mechanical equipment within the building, with the exception of the Music, Theater and Robinson Hall which are all served from a common mechanical room containing four boilers. All existing boilers are copper fin tube manufactured by Lochinvar and are approximately 12 years old.

Most of these boilers were not piped and/or vented properly when originally installed and have been problematic from the beginning of their operation resulting in premature failure of flues and heat exchangers from acidic condensate; and improper boiler combustion causing foul smells in the boiler exhaust. The latter problem has been the source of many complaints to the Environmental Health and Safety department on campus dating back to 1998, and has resulted in at least one building evacuation. As a result of these factors and the age of the equipment the installed boilers are a huge maintenance burden, in terms of both material and labor cost.

In addition to the actual boiler installation, the systems have hydronic flow issues that cause inefficient distribution of the heating water to the mechanical rooms. The heating water system expansion tanks have also been problematic due to difficulty keeping the tanks from losing their air charge and becoming totally ineffective.

In summary, the heating system is in strong need of replacement, before the next heating season if at all possible.

<u>EMS Controls and Air-Side Systems</u>

Most of the existing controls at CSU East Bay were retrofit in the early 1990s and consist mainly of Robertshaw DMS panels that start/stop primary HVAC equipment and control original pneumatic devices via electric to pneumatic transducers. However, over the years, three additional control platforms have been installed at CSU East Bay which presents challenges for the campus staff to communicate, control and monitor the multiple systems. Additionally, Robertshaw no longer supports the DMS platform and new replacement parts are no longer available. Over the years, the controls system has been compromised (often operated in manual mode or limited to on/off control) in many locations and many devices are controlled manually and energy savings are difficult to obtain or track.

In addition to the hardware limitations of the current system, there is a distinct possibility of a software (hard drive) “crash”, which will leave the District facility staff with no options for recovery.

The air side mechanical systems that serve the various buildings are of three basic types: constant volume multi-zone; constant volume with zone reheat; or constant volume double duct. None of the systems in these building are allowed to be installed today under the current California Energy Code due to the inefficiency of the systems caused by the blending of conditioned airstreams or reheating previously cooled air without resetting air volume. Many of the components that are used to control the outside air and return/exhaust air volume are in need of repair or replacement.

Lighting

Most of the lighting systems were retrofitted in the early 1990s and consist mainly of T-12 energy saver lamps powered by hybrid electronic ballasts. A partial lighting retrofit was successfully performed by Chevron ES in the PE and A&E buildings in the spring of 2006. The remaining system is inefficient with lamps and ballasts being replaced on a regular basis. Also, scattered around the campus are T-8 lamps with electronic ballasts.

Water

The campus plumbing and irrigation systems presently consume approximately 60 million gallons of water, annually. Currently, most irrigated grounds are irrigated using the Rain Master™ central irrigation control system. However, at this time, there are still many stand-alone controllers that are not part of the central control system. Also, although site staff has central control, controller water schedules are set without the benefit of available weather data. Lastly, information on station areas and locations are not mapped or formatted so scheduling and maintenance are time-consuming. Plumbing retrofits will reduce water consumption throughout campus bathrooms.

Swimming Pool Filtration System

The swimming pools are heavily used by CSU East Bay and by the City of Hayward and nearby Chabot College. The existing filtration system for both the Competition and Training Pools consists of two hi-rate sand filters with a single 15 horsepower circulation pump. The 15 horsepower circulation pump is significantly undersized and provides approximately half the standard flow rate required to properly filter the pools. As a result, this system is currently having significant problems maintaining acceptable levels of Total Dissolved Solids (TDS) found in the pool water causing a potential Environmental Health and Safety issue. High levels of TDS can cause eye and skin irritation, cloudy water, algae growth, corrosion of metal equipment and decreased effectiveness of the pool's chemicals. The system is also requiring frequent maintenance and repairs on the filtration system and pool heating equipment due to being clogged with minerals.

1.e Summary description of energy conservation measures, including estimated costs and savings for each as detailed above.

1. **Heating System Upgrades**

The most cost effective heating system alternative of the three evaluated was to replace existing equipment, keeping a fully distributed boiler arrangement for the entire campus. The scope of work for this approach includes installing: new high efficiency Aerco boilers and water heaters and properly re-piping and venting; new Spirotherm air and dirt separators; new hot water pumps with premium efficiency motors and variable speed drives; new diaphragm style expansion tanks.

2. **Energy Management System (EMS) Control and Air Side Retrofits**

The proposed EMS solution will reduce the multiple control systems to a total of two and make both of them available through one BACnet interface. This involves replacing existing Robertshaw controls and user interface with a new web-enabled system that will provide access to EMS graphics and functions from multiple locations via a standard web browser. The system will have backup/restore capability from local and/or IT level.

Additionally this project measure will: replace, repair or refurbish economizer dampers and replace pneumatic damper actuators with electronic actuators; convert constant volume multi-zone systems variable air volume with new DDC controls at system level; convert constant volume dual duct systems to variable air volume with new DDC controls at system level; convert constant volume reheat quasi-variable air volume reheat system retrofit with new DDC controls; and convert constant volume single zone to variable air volume new DDC controls at system level; convert existing pneumatic zone controls to DDC. Pre-construction measurement of air balance and final recheck of air balance throughout the buildings included in this IGA scope will also be performed.

3. **Lighting Retrofits**

Replace remaining T-12 lamps, older T-8 lamps, hybrid electronic ballast and any remaining magnetic ballasts with a "standard retrofit" consisting of low ballast factor T-8 ballasts and T-8 lamps.

Occupancy sensors will be installed in select areas mutually agreed to with campus. Sensors will also be installed to minimize energy consumption of soda and snack vending machines when buildings are unoccupied.

4. **Water Conservation Upgrades**

Complete centralization of the irrigation systems with central control capability controllers and an on-site weather station so that all campus irrigation can be watered based on local weather conditions. This involves an audit for all irrigated areas to create maps and charts as to station locations, soil types, plant conditions, sprinkler types and efficiency, sun and shade conditions and degrees of slope in order to effectively schedule landscaped areas. These charts will be provided to site staff for maintenance use and integrated into central control programming.

Install water conserving plumbing technologies including low flow aerators and flush kits and waterless urinals.

5. **Computer Energy Management Software**

Verdiem's personal computer energy management software is a supervisory system installed on the network that listens for network connectivity between the computer and the network. Power management profiles are developed for groups of users on the server that are used to adjust the Standby, Hibernate, Sleep and Shutdown modes on each computer and its monitor as needed by each usage group. The scope of work for this measure provides this energy management software for the faculty and staff desktop computers, which totals approximately 2500 computers.

1.f Discussion of measures considered but not investigated in detail.

The following is a discussion of the measures that were considered as part of the IGA but not recommended. They were investigated in some level of detail, although not to the same level as the rest of the project. Additional information on these measures is also found in Section 6.0 Cost Benefit Analysis and Section 12.0 Technical Appendix.

1. **Heating System Upgrades (Alternatives #2 and #3)**

As part of the analysis of replacing the campus heating systems, Chevron ES considered three separate options and performed detailed cost and savings analysis on all three:

(1) Maintain the current 100% distributed boiler configuration with new equipment, consolidated where feasible;

(2) Maintain distributed boilers throughout much of the campus and developing a mini-central plant at the north end of campus with heating supplied by boilers only;

(3) Augment the mini-central plant at the north end of campus with a fuel cell.

The mini-central plant concept had been driven primarily by the opportunity to install a fuel cell with heat recovery as part of the plant. Installation of a fuel cell would bring ultra-clean and very efficient on-site generation to the campus which would be an environmentally sound decision. However, the economics of this technology are less compelling due to the current relative difference between the cost of fuel required and the value of base load electric savings (often referred to as “spark spread”) and the fact that the campus hit the cap for the Self-Generating Incentive Program (SGIP) rebate with a successful PV installation a few years ago.

Based on conversations we have had to date with PG&E, approval for CSU East Bay to receive SGIP incentive funds for a fuel cell will require an official SGIP program modification. There is a formal process for these program modifications which requires the sponsorship of a program administrator and approval by the CPUC. PG&E has stated it’s willingness to sponsor this modification request, but CSU East Bay and Chevron ES will have to write the justification documentation.

If pursued, we recommend that the case to be made in this documentation is that if it's possible to install a 1 MW fuel cell under SGIP, followed by a 1 MW PV system under CSI, then it should also be allowed that a site can install a 1 MW PV system first, then followed by a 1 MW fuel cell, given that the end results are identical, and that the SGIP rules should be modified to allow this.

Chevron ES successfully negotiated a program modification process previously for a somewhat similar issue on Alameda County's fuel cell project, and we could support CSU East Bay in this effort if the campus and CSU system is committed to installing a fuel cell. Please note that once the process is initiated it will likely take several months for approval, and approval is not guaranteed.

However, due to project economics and the length of time it can take to effect a rule change, with no guarantee of success, we do not recommend pursuing the fuel cell at this time, although we would be willing to work with the campus on a justification document for a later installation. CES and the campus will continue lobbying to get this ruling revised and the mini-central plant and fuel cell option will be revisited as a possible future construction project.

Absent the fuel cell, there remains little argument in favor of a mini-central plant. The detailed modeling and analysis indicate the mini-central plant provides only minor energy savings and very little initial capital cost advantage from reduced boiler quantity associated with load diversification factors. These small economic benefits are largely outweighed by the high cost and the potential disruption to campus activities associated with the underground piping. We do not recommend a central plant at this time. However, if in the future, the fuel cell economics improve significantly, it is still possible to create a mini-central plant by connecting the two boiler sites on the north end of campus.

2. HVAC Desiccant System Retrofit

As a result of our analysis, which included space measurements of temperature and humidity, we determined the desiccant system not to be cost effective, if only because it requires a difficult and costly modification of the air handling units to accommodate the wheel. Also, it carries net energy and maintenance penalties and is not appropriate for buildings with potentially toxic return/exhaust air. A complete discussion and analysis is included in Section 12.0 Technical Appendix.

3. Lighting Redesign

At the CSU Chancellor Office request we revisited the lighting scope of work and carefully considered converting the existing campus wide direct lighting systems to modernized direct/indirect lighting systems or other redesign approach. Both indirect lighting and direct/indirect (D/I) lighting create a pleasing, high quality light that comes more evenly from the entire ceiling surface rather than directly from the light fixtures themselves. D/I lighting is most effective at a University in classrooms, libraries and computer rooms, and can significantly enhance the quality of the learning environment in these settings.

Direct/indirect lighting as available today is designed to be used on a T-bar type ceiling that is between nine and sixteen feet above the floor. If the ceiling is too low, the fixture hangs uncomfortably low, and if it is too high too much light is lost. Indirect lighting can be used in applications with exposed wood or concrete ceilings as long as the ceilings are painted a light color to allow the necessary reflectance of light.

Most of the buildings on the East Bay campus are not good candidates for D/I lighting because they have either: 1) spline type ceilings or 2) concrete ceilings where the concrete is shaped into recessed coves. The first case requires disassembly and reconstruction of the ceiling in order to install D/I lighting. This work will be very costly and disruptive to the University. The second case is not desirable because the light would be lost in the recesses. Also, the presence of asbestos in the ceiling tile at the PE, Meiklejohn Hall and the Theatre pose a significant hazardous waste issue. Please refer to Section 2.0 Facility Assessment Process for a building by building Asbestos Impact Summary.

Select areas of the Library are the only real economical candidates for D/I lighting. And, this conversion comes at great additional expense, approximately $300,000, with modest additional energy savings. Please refer to Section 6.3 Lighting Retrofits for a building by building analysis of this aspect of the IGA. Unfortunately the payback for this measure extends beyond the existing schedule for the library seismic retrofit, rending this measure as unfeasible.

1.g Conclusions and recommendations.

The California State University Chancellor's Office has made a continuing commitment to conserving energy on its campuses and adopting sustainable building and physical plant maintenance practices. The newest Executive Order governing this, No. 987, reaffirms the need to conserve energy in order to achieve the goal originally set in 2001 and reevaluated in 2005. The new goal is stated to reduce consumption by 15% by the end of FY 2009/10, as compared to 2003/04, which is consistent with Governor Arnold Schwarzenegger's Executive Order S-12-04, which requests the CSU's active participation in statewide energy conservation and reduced electrical demand. The campus is to be commended in its commitment to renewable energy through the installation of its 1MW PV installation a few years ago. This leadership in the area of renewable energy can now be teamed with leadership in energy efficiency through the project being proposed in this IGA. **In fact, this project will position CSU East Bay to 100% attain the energy reduction goals outlined in EO No. 987.**

Chevron ES recommends funding and implementation of the ECMs described in this Executive Summary as they bring significant additional benefits to CSU East Bay. These benefits are detailed in Section 6.0 Cost Benefit Analysis and are summarized below:

- **Increased energy efficiency** from improved heating systems, EMS controls system upgrades, and lighting retrofits:
  - 22% reduction in power consumption; 29% reduction in natural gas use
- **Improved operational efficiency and decreased maintenance requirements**
  - Improved boiler operations by upgraded equipment; improved and piping and flue design
  - Replacement of obsolete EMS controls system; unification of the controls systems from four controls platforms; dramatically upgraded functionality for HVAC equipment; and improved comfort and air quality control
  - Improved pool filtration and pool pump operation

- **Resolved potential life / safety concerns**
    - Resolution of boiler fumes
    - Resolution of pool filtration concerns
- **Increased reliability**
- **Increased comfort and ability to anticipate and respond to comfort complaints**

Chevron ES is ready to implement the energy conservation and energy infrastructure renewal projects we have identified at CSU East Bay's earliest convenience. Chevron ES gives special thanks to all who were so helpful to this development process, especially Dan Franke, Mike Tadevich, Glenn Parks and Aaron Klemm from the Chancellor's Office.

2.0 Facility Audit Process

Describe how the IGA was performed including the individuals who performed the audit, time frame, and evaluation of results and presentation of findings. Describe the methods and means by which you interviewed key campus personnel and acquired pertinent data.

Following execution of the IGA Agreement in December 2006, the Chevron ES team mobilized a detailed audit of the campus facility in late December. The audit and analysis process was performed by our internal Chevron engineering and project management team: Jim Kozelka, Project Manager; Craig Shulenberger, Lead Project Engineer; Stephan Rank, Project Engineer; Patrick Yost, Project Engineer; Ted Chen, Project Engineer; Michael DeVries, Construction Manager (EMS Engineer) and Peter Pabalan, CAD. Valuable assistance was also provided by Ed Spivey and Rishabh Kasliwal of Cogent Energy, Inc.

We all want to thank the campus for the excellent assistance we received in developing this proposal. Special thanks goes to the campus facilities management staff including Mr. Randy Gale, Executive Director Special Projects; Dan Franke, Director Facilities Management; Michael Tadevich, Engineering Manager; Glenn Parks, EMS Systems and their teams for providing information that is the cornerstone of this IGA. We also want to thank Craig Ishida, Director of Environmental Health and Safety for valuable insight into health and environmental concerns and complaints relating to the existing heating system; and Thomas Dixon, Director of ABA Information Technology/Chief Information Security Coordinator for his assistance with guidance on how to securely integrate the EMS Control System with the campus IT network.

The auditing process included:

- A thorough review of all available drawings;
- Numerous site walks and facility reviews with above campus personnel and Building Service Engineers to develop a complete understanding of the existing systems and equipment/system issues, ongoing and future needs;
- Installation of sensors to provide runtime, temperature and humidity readings in selected spaces to record specific comfort problems;
- Field measurements including fan power and boiler combustion efficiency and flue gas analysis;
- eQUEST (DOE2) modeling of the buildings to identify opportunities for energy conservation and estimate operational improvement;
- Pre-qualification of subcontractors for bidding specific ECM scopes of work.

Weekly meetings were held on campus with the above core group of campus personnel to ensure a well structured audit took place. The purpose of these weekly meetings was to review progress of the IGA against our schedule; provide engineering updates on each ECM; identify new facility information or building access requirements; and discuss findings. Other campus personnel were included in these meetings on an as-needed basis in order to minimize impact to campus and individual schedules.

Additionally, we thank the campus leadership Barbara Haber, Associate VP, Facilities Planning & Operations and Dr. Mo Qayoumi, CSU East Bay President for providing direction to our efforts and providing insight into campus growth prospects; campus priorities; economic decision factors that are considered in evaluating the recommended IGA measures; campus IGA requirements; and campus decision process in evaluating this report.

The assessment process consisted of the following steps:

- Interview Meeting/Background information November 30 , 2006
  - This meeting included the above people from Chevron ES. The purpose of the meeting was for Chevron ES to confirm our understanding of the University's project goals for this Investment Grade Audit (IGA) relative to the information developed in the Preliminary Assessment.
  - After this meeting the Chevron ES team developed the scope of work best suited for this IGA. Along with the heating system improvements that were the basis for the project, several other areas ECMs were identified
- Project Planning
  - After the initial kick off meeting the Chevron ES team met internally to discuss the project scope, timing and necessary resources.
  - Engaged Cogent Energy, Inc. services for energy simulation modeling and campus specific knowledge.
- First site walk as part of the IGA was on December 20, 2006
  - This meeting was attended by Jim Kozelka, Craig Shulenberger and Patrick Yost of Chevron ES. We walked the entire campus to define most of the scope of work such as the Heating Systems, building HVAC systems, the controls/EMS Systems, and lighting systems.
- Next site walk occurred on January 4, 2007
  - The purpose of this visit was specifically to look at the potential orientation and configuration of a mini-central plant to encompass the north campus buildings.
- Subsequent site visits through present.
  - There have been many subsequent site visits from each of the Chevron ES team members and the Cogent Energy team to access the existing mechanical systems and buildings to build the energy simulation models, define mechanical issues that need correction and develop the energy conservation measures.

Asbestos Impact Summary

As explained by CSUEB's Asbestos Containing Material Report, February 2006, asbestos containing construction materials (ACCM) are found in many buildings on the CSUEB campus. These asbestos containing materials are currently listed in good condition and do not pose any threat of exposing building occupants at this time. However, if retrofit projects are to take place in areas that ACCM exists, then the material may have to be abated. The estimated pricing in the PA does not include asbestos abatement for any project and will be investigated during the IGA phase.

The seven sources of ACCM that are most likely found in buildings that could be impacted by energy saving retrofits are: floor tiles, drywall joint compound, piping insulation, tank insulation, ceiling tiles, acoustical insulation and fireproofing. The two largest sources of ACCM on the campus are floor tiles and drywall joint compound, which are found in classrooms, hallways, mechanical rooms and restrooms, in most buildings. The floor tiles and drywall joint compound may be disturbed during any retrofit project which will reroute piping, electrical conduit or ductwork. Also, found throughout many of the campus buildings is piping and tank insulation, which will be affected if any modifications are necessary to the piping or tank that it is insulated. The tank insulation is isolated to mechanical rooms but piping insulation can be found in classrooms, hallways, mechanical rooms and restrooms. The final three ACCM, ceiling tiles, acoustical insulation and fireproofing are found in a limited amount of buildings. These ACCM will only need to be disturbed if they are blocking areas that need to be accessed or if piping, conduit or ductwork needs to penetrate the material. In the Asbestos Containing Material Report, there were five materials that were assumed to be ACCM in all campus buildings: grout ceramic tile, vapor barriers, mirror mastic, fire door/frames and black lab countertops. The grout ceramic tile, vapor barriers, and mirror mastic are only found in restrooms and will only be disturbed during a restroom remodel. The asbestos containing fire door/frames and black lab countertops will only be affected during a classroom remodel.

	Floor tile/Mastic	Pipe Insulation/Lagging	Tank Insulation	Drywall Joint Compound	Ceiling Tiles	Fireproofing	Acoustical Insulation
Art and Education	CR, HW	CR,HW,MR	CR,HW,MR	CR		MR	
Field House	CR	MR	MR	CR			
KPE	CR, HW, RR	CR, MR			CR,HW,RR		
Library	CR, HW			CR, HW		All levels	
Meiklejohn Hall	CR, HW, RR	CR, MR		CR	CR		
Music and Business	CR, HW, RR	MR		CR			CR
Old Boiler Plant	MR						
Robinson Hall	CR, HW	MR		CR, HW			
Science Buildings	CR, HW	CR,HW, MR, RR			HW	MR	
Student Health Center	CR, HW, RR			CR, HW, RR			
Student Services	CR, HW			CR, HW, RR			
Theatre	CR, HW	MR		CR	CR, HW		
University Union	CR, HW	MR	MR				2nd/3rd Level
Warren Hall	CR, HW, RR	MR		CR, HW, RR		CR, HW, MR, RR	

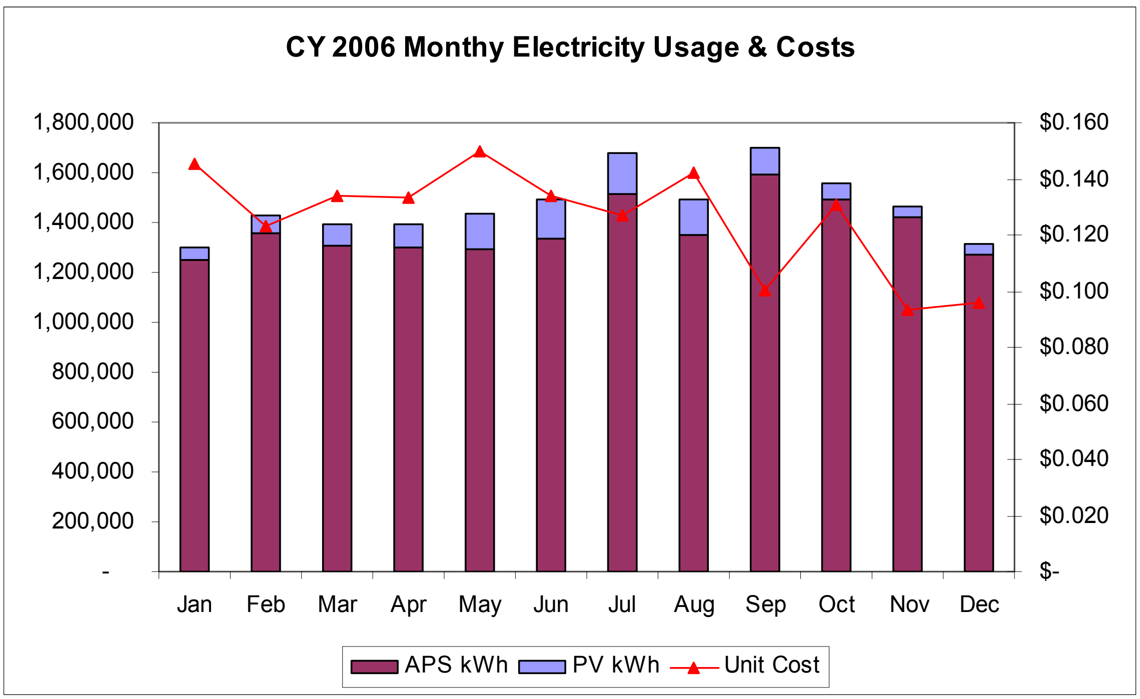
CR – Classrooms, HW – Hallways, MR – Mechanical Rooms, RR - Restrooms

Section 3.0 Utility Tariff Analysis

Examine utility bills for the past thirty-six (36) months and establish base year consumption for electricity, gas, steam, water, etc. in terms of energy units (kWh, kW, ccf, therms, gallons, or other units used in bills) and in terms of dollars. Describe the process used to determine the base year (averaging, selecting most representative contiguous 12 months, etc.). Consult with facility personnel to account for any anomalous billings that could skew the base year representation.

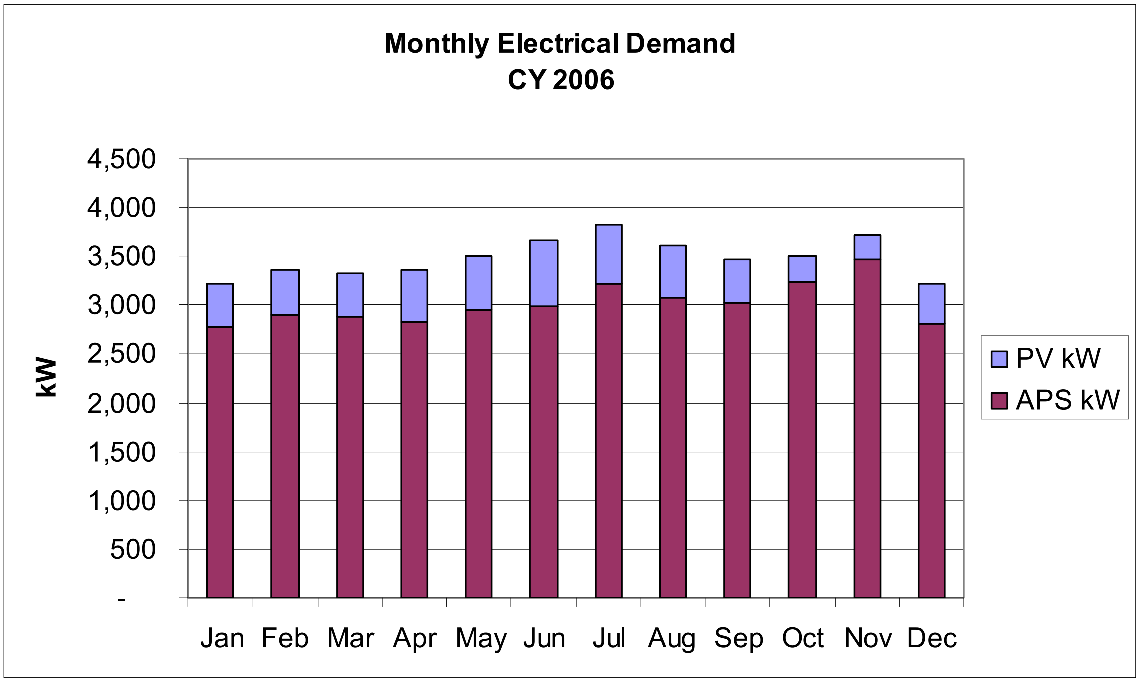
Gas and Electric:

The campus provided utility data in the form of paper copies of bills for the period of November 2004 through December 2006. Utilities included were electric, gas, sewer and water. Per campus guidance, 2006 data is the most representative, therefore only 2006 data was used to develop the baseline for this project. Following is a summary level graphical display of the various utility usages at the site.

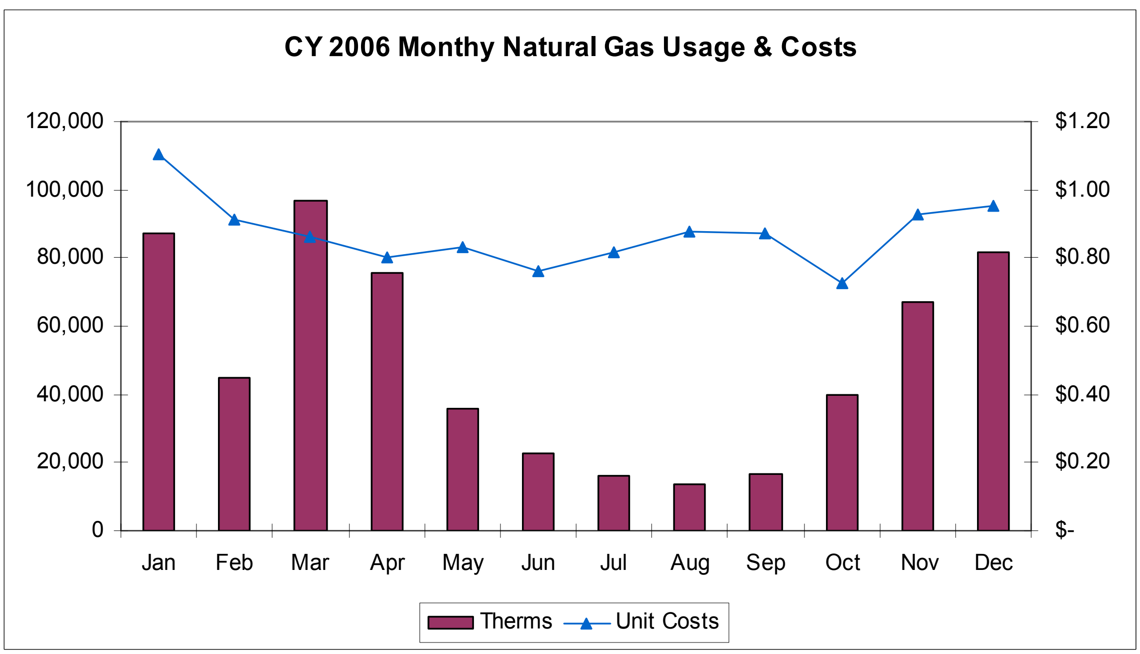


Note that the unit kWh costs for January, February, March and April where higher than what typically would be expected for those months due to the APS commodity contract having higher per kWh cost than later in the year (comparable Winter period months of November and December. The APS contract kWh costs did change in mid-2006 per our discussions with campus personnel.

Also of note is that two new buildings, the new Student Union and the Valley Business and Technology Building came on line in December 2006 which will add to the campus loads going forward.



Both the electricity usage and demand charts reflect the installed ~1MW installed PV at the campus as summertime demand and usages are offset significantly by the rooftop systems. The above chart reflects the maximum 15 minute average kW reading, so any PV system outage of any duration approaching 15 minutes near any peak usage time for the campus would skew the information presented in the above chart.



Gas usage data follows with the mild summertime climate typical for the Hayward area.

Calendar (baseline) year cost information for both power and gas consumption is shown in the below tables. PV production for the systems at the Campus is also summarized. Note that the average cost of power is for Utility/APS provided electricity only. The average unit cost shown below will be a representative number given that any additional new electrical load or new electrical savings will in effect add or subtract to the non-PV portion of the electricity supply to the campus.

The electricity and natural gas average unit cost shown below will be used to calculate avoided cost for ECMs that were not computer simulated.

Electricity Usage - CY 2006					
Date	**APS kWh**	**PV kWh**	**kW**	**Total Cost**	**Unit Cost**
Jan	1,249,060	50,272	3,095	$ 181,557	$ 0.145
Feb	1,357,919	68,056	3,095	$ 166,994	$ 0.123
Mar	1,309,327	83,448	2,846	$ 175,249	$ 0.134
Apr	1,300,058	95,999	2,838	$ 173,475	$ 0.133
May	1,292,609	142,239	2,910	$ 193,880	$ 0.150
Jun	1,337,888	155,963	3,299	$ 179,593	$ 0.134
Jul	1,517,813	162,924	3,216	$ 193,042	$ 0.127
Aug	1,353,157	141,514	3,107	$ 192,641	$ 0.142
Sep	1,592,425	105,161	3,001	$ 159,315	$ 0.100
Oct	1,496,111	61,082	3,248	$ 195,698	$ 0.131
Nov	1,418,906	46,992	3,400	$ 132,269	$ 0.093
Dec	1,274,939	37,777	2,960	$ 122,059	$ 0.096
	16,500,212			**$ 2,065,772**	**$ 0.125**
2006 PV Production		**1,151,426**			
2006 Total Usage	**17,651,638**				

Natural Gas Usage - CY 2006			
Date	**Therms**	**Cost**	**Unit Costs**
Jan	87,377	$ 96,351	$ 1.10
Feb	45,023	$ 41,005	$ 0.91
Mar	96,638	$ 83,335	$ 0.86
Apr	75,406	$ 60,580	$ 0.80
May	35,965	$ 29,831	$ 0.83
Jun	22,473	$ 17,061	$ 0.76
Jul	16,184	$ 13,201	$ 0.82
Aug	13,828	$ 12,101	$ 0.88
Sep	16,767	$ 14,638	$ 0.87
Oct	39,786	$ 28,970	$ 0.73
Nov	67,173	$ 62,168	$ 0.93
Dec	81,497	$ 77,778	$ 0.95
	598,117	**$ 537,019**	**$ 0.90**

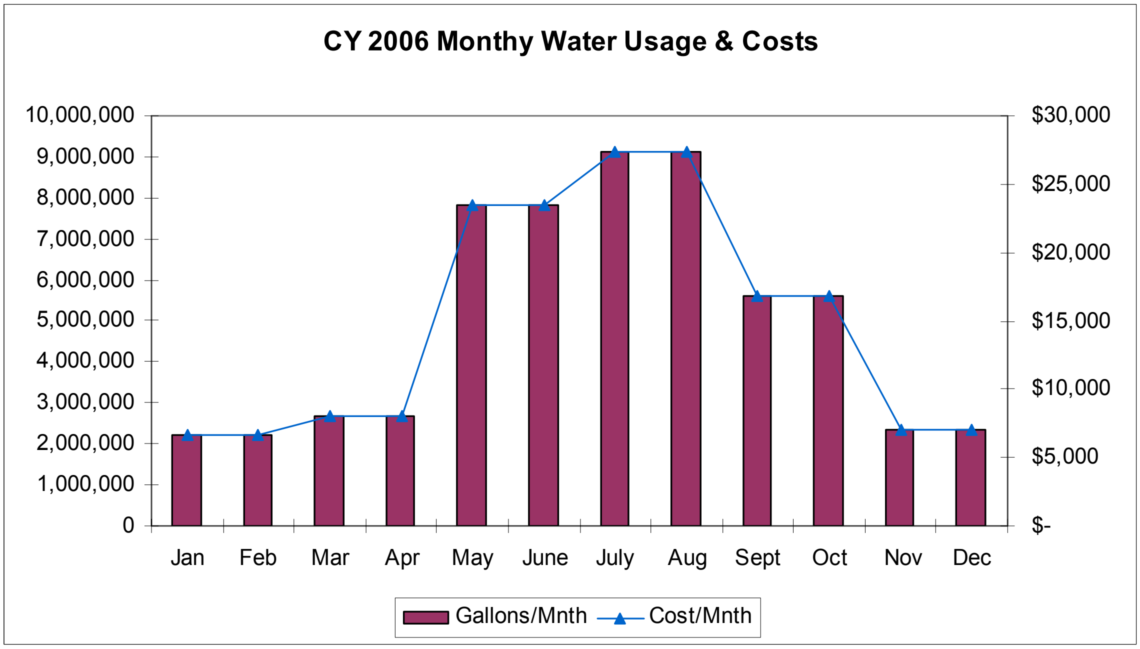
Per guidance of the Chancellor's Office the PG&E rates shown below were used to calculate electricity cost savings for computer simulated ECMs.

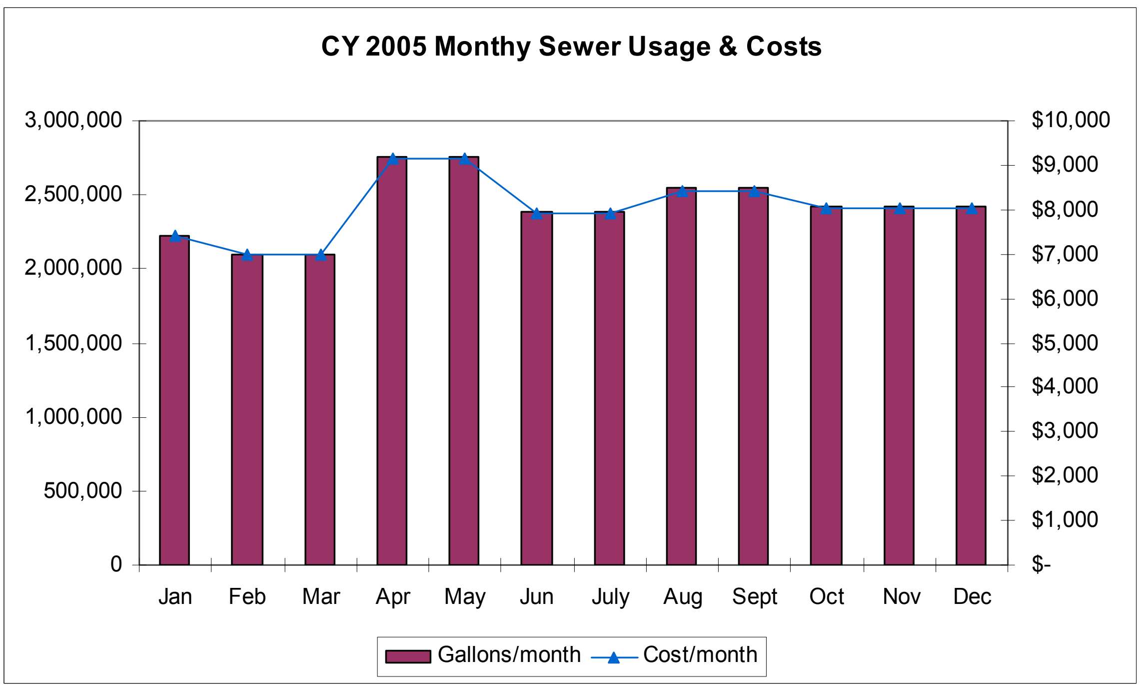
Tariff Structure - E-20P				
kWh		**Summer**		**Winter**
On	$	0.124		
Part	$	0.092	$	0.083
Off	$	0.065	$	0.068
kW				
On	$	11.88		
Part	$	2.72	$	0.80
Off	$	-	$	-
Max	$	5.04	$	5.04
Special Charges				
PG&E CRS		N/A		N/A
APS Misc Charges		N/A		N/A
Hrs/Mnth				
On		132		
Part		156		288
Off		442		442

Water and Sewer:

The following charts show the water and sewage usages and unit costs for the campus. Note that the sewer flow total is less than water use due to irrigation uses not going to sewer. Also, both water and sewer are billed bi-monthly.

The total cost of water for calendar year 2006 was $179,000 and the estimated total cost of sewer service at the Campus for calendar year 2005 is $96,500. Note that the sewer data was only available for the first nine months of 2005 so average values were used for the three remaining months of the year.


CY 2006 Monthy Water Usage & Costs
10,000,000
9,000,000
8,000,000
7,000,000
6,000,000
5,000,000
4,000,000
3,000,000
2,000,000
1,000,000
0
$30,000
$25,000
$20,000
$15,000
$10,000
$5,000
$-
Jan
Feb
Mar
Apr
May
June
July
Aug
Sept
Oct
Nov
Dec
Gallons/Mnth
Cost/Mnth


CY 2005 Monthy Sewer Usage & Costs
3,000,000
2,500,000
2,000,000
1,500,000
1,000,000
500,000
0
$10,000
$9,000
$8,000
$7,000
$6,000
$5,000
$4,000
$3,000
$2,000
$1,000
$-
Jan
Feb
Mar
Apr
May
Jun
July
Aug
Sept
Oct
Nov
Dec
Gallons/month
Cost/month

For the purposes of the evaluation of a cogeneration system at the campus, an additional assessment of the utility data was conducted in order to determine the effective value of power from such a system. This value is used in the fuel cell cogeneration system economics evaluation described in <u>Section 6.1 Cost Benefit Analysis / Heating Systems</u> and fully detailed in <u>Section 12.0 Technical Appendix</u>.

The key assumption is that the power generation in question is "base load", or in other words, a consistent output that will be supplemented by power from the local utility. This results in a value of electricity that is <u>less</u> than the average annual costs experienced by the University due to the fact that the demand charges are in effect completely leveled out, vs. the average annual electricity costs which sees the full impact of demand charges. Note that missed demand savings (when the power generation unit goes down for any reason) is accounted for in the fuel cell economics.

Below is a summary of the electricity tariff for CSU East Bay, which is a combination of PG&E and APS charges.

Tariff Structure - E-20P/APS				
kWh		**Summer**		**Winter**
On	$	0.134		
Part	$	0.054	$	0.071
Off	$	0.054	$	0.051
kW				
On	$	11.88		
Part	$	2.72	$	0.80
Off	$	-	$	-
Max	$	5.04	$	5.04
Special Charges				
PG&E CRS		$0.0150	$	0.0150
APS Misc Charges	$	0.005	$	0.005
Hrs/Mnth				
On		132		
Part		156		132
Off		442		598

Per guidance of the Chancellor's Office the PG&E rates shown below were used to calculate electricity cost savings for computer simulated ECMs.

Tariff Structure - E-20P		
kWh	**Summer**	**Winter**
On	$ 0.124	
Part	$ 0.092	$ 0.083
Off	$ 0.065	$ 0.068
kW		
On	$ 11.88	
Part	$ 2.72	$ 0.80
Off	$ -	$ -
Max	$ 5.04	$ 5.04
Special Charges		
PG&E CRS	N/A	N/A
APS Misc Charges	N/A	N/A
Hrs/Mnth		
On	132	
Part	156	288
Off	442	442

California State University
Capital Planning, Design and Construction
COBCP Project Description
Capital Outlay Program 2006/2007
(Form CPDC 1-4)

Campus: California State University, East Bay (Hayward Campus)
Project: Energy Services Infrastructure Improvements

SUMMARY OF PROPOSAL:

California State University, East Bay (Hayward Campus) proposes to proceed with the evaluation, design and implementation of the Energy Services Infrastructure Improvements project. This phase of work includes replacing the existing distributed heating plant with a new heating system. This phase of work also includes an upgraded/new DDC energy management system; lighting retrofit; water conservation measures; and a computer power management software program by Verdiem.

A. PURPOSE OF PROJECT: (problem, program need, infrastructure deficiency – please provide detailed information to support the project)

The existing heating plant is aging and requires replacement due to ongoing mechanical, reliability, and comfort problems; odor complaints due to poor design and equipment; energy inefficiency; and potential perceived life safety issues. The EMS is essentially obsolete, unable to be backed up, replacement parts difficult to find and expensive, user-unfriendly and limited in capability to control equipment for optimal comfort, energy efficiency and participation in demand reduction programs. A partial lighting retrofit has been performed but additional inefficient lighting exists.

Once implemented, this project will reduce current and future on-peak electrical consumption and help to reduce the energy use per gross square foot; enhance equipment reliability; lower operating and repair costs; reduce maintenance requirements; resolve real life safety issues; and provide greater comfort and safety for students, University administration, faculty and staff.

B. RELATIONSHIP TO STRATEGIC PLAN (relevance of problem/need to mission and goals)

CSUEB must replace aging and obsolete HVAC infrastructure as basis for a strategic plan to support its campus expansion plans and enrollment growth plans by providing a safe, comfortable environment for its students, faculty and staff.

C. PROJECT DATA

1. Background
   Chevron ES was selected to conduct an Investment Grade Audit (IGA) on a campus-wide basis after completing a Preliminary Assessment (PA) of CSU East Bay (CSUEB) in fall, 2006. The major concern for CSUEB is to replace its aging heating infrastructure and energy management system that serves the main campus in Hayward to allow for greater energy efficiency; lower operating costs; significantly increase reliability; resolution for life safety concerns and boiler emissions; and to allow for greater temperature and comfort control for students, faculty and staff. To augment these retrofit strategies, Chevron has identified additional energy conservation measures that provide short payback periods to improve overall project economics.

2. Detailed scope description

ECM	Description
ECM 1	Replace Heating Hot Water System with Distributed Boilers
ECM 2	Upgrade Campus Energy Management System and Air-Side Modifications
ECM 3	Lighting Retrofit-campus wide
ECM 4	Water Conservation Measures-campus wide
ECM 5	Verdiem Power Management Software

3. Proposed project schedule

Project Started	Date – Jan 07
Schematics Completed	Date – Mar 07
Preliminary Plans Completed	Date – Apr 07
Working Drawings Completed	Date – October 07
Construction Started	Date – October 07
Construction Completed	Date – October 08

D. ALTERNATIVES: (secondary effect for each, describe what is the alternative and secondary effect and provide a brief summary of scope, cost and funding source, program benefits, facility management benefits and, impact on support budget)

Alternative #1: Create mini-central plant in north end of campus with a fuel cell to further decrease energy consumption and introduce ultra-clean technology. The project economics were far worse than a straight boiler replacement and ongoing operational costs were unattractive due to current relative difference between cost of gas and cost of electricity (aka "spark spread") and current campus ineligibility for SGIP rebate without a rule change. Under current legislation CSU East Bay has reached cap level for rebate with its PV solar installation but PG&E has indicated a willingness to work with the campus and sponsor this modification request to the CPUC. Not recommended based on project economics.

E. RECOMMENDED SOLUTION:

1. Which alternative and why?
   Maintain current distributed boiler configuration for most cost effective solution.
2. Basis for cost information.
   Investment Grade Audit Report
3. Factors/benefits recommended other than the least expensive alternative.
   Increased reliability, reduced maintenance requirements, increased equipment expected life, lower overall operating costs, increased energy efficiency
4. Complete description of impact on support budget.
   Significantly reduce maintenance support for labor and materials.
5. Identify and explain any project risks.
   None identified at this writing.
6. List requested interdepartmental coordination and/or special project approval (including mandatory reviews and approvals, e.g. technology proposals).
   Fire Marshal, Division of State Architect Plan Check Firm, CSU Seismic Review Board, etc.

THE CALIFORNIA STATE UNIVERSITY
CAPITAL OUTLAY ESTIMATE (Form CPDC 2-7E)

Date:	10/03/06
Budget Year:	2006/07
CCCI	4633
EPI	2726
Fund	302

Campus *CSU Anywhere*
Project *Energy Services Infrastructure Improvements*
Arch./Engr: *MEA Company*
Budget X Schem. ___ CM at Risk ___ Prelim ___ WD
___ GMAX Award

Project Schedule/Duration

Project Started	@	Jan-07	
Schematics Completed	@	Oct-07	270
Preliminary Plans Completed............	@	Jan-07	-36,790
Working Drawings Completed..........	@	Apr-07	36,611
Construction Started.........................	@	Jun-07	54
Construction Completed..................	@	Jun-08	366
			511 Days

	New Const	Reno
Net Area		
Gross Area		852,733
Efficiency:	#DIV/0!	

			NEW CONSTRUCTION STATE	NEW CONSTRUCTION NONSTATE	RENOVATION STATE	RENOVATION NONSTATE	TOTAL	$/sq.ft.
BUILDING								
A10	Foundations		$					
A20	Basement Construction		$					
A	**SUBSTRUCTURE**		**$ 0**	**$ 0**	**$ 0**	**$ 0**	**$ 0**	
B10	Superstructure(Vertical, Floor, & Roof)		$					
B20	Exterior Enclosure		$					
B30	Roofing		$					
B	**SHELL**		**$ 0**	**$ 0**	**$ 0**	**$ 0**	**$ 0**	
C10	Interior Construction		$					
C20	Stairways		$					
C30	Interior Finishes		$					
C	**INTERIORS**		**$ 0**	**$ 0**	**$ 0**	**$ 0**	**$ 0**	
D10	Conveying Systems		$					
D20	Plumbing Systems		$		530,951			
D30	HVAC Systems		$		8,116,383			
D40	Fire Protection Systems		$					
D50	Electrical Systems		$		597,644			
D5050	Telecom		$					
D	**SERVICES**		**$ 0**	**$ 0**	**$ 9,245,000**	**$ 0**	**$ 9,245,000**	
E10	Group I Equipment		$					
E20	Furnishings (i.e.Group I casework)		$					
E	**EQUIPMENT AND FURNISHINGS**		**$ 0**	**$ 0**	**$ 0**	**$ 0**	**$ 0**	
F10	Special Construction		$					
F20	Selective Demolition (Excluding hazmat removal)		$					
F2020	Hazardous Material Removal		$					
F	**SPECIAL CONSTRUCTION & DEMOLITION**		**$ 0**	$ **0**	$ **0**	**$ 0**	**$ 0**	
TOTAL BUILDING			**$ 0**	**$ 0**	**$ 9,245,000**	**$ 0**	**$ 9,245,000**	
1. G1020	Site Prep & Site Improvements		$					
G3040	Utilities (Civil, Mechanical, Electrical & Telecom)		$					
G2050	Landscape Budget (design fee inc. in 6a & 6b)		$					
G60	Other Site Construction		$					
TOTAL SITEWORK			**$ 0**	**$ 0**	**$ 0**	**$ 0**	**$ 0**	
2.	**TOTAL BUILDING AND SITEWORK**		$ **0**	$ **0**	$ **9,245,000**	$ **0**		
3.	Escalation to midpoint of Construction		**$ 0**	**$ 0**	**$ 0**	**$ 0**		
4.	**TOTAL CONSTRUCTION**		**$ 0**	**$ 0**	**$ 9,245,000**	**$ 0**	**$ 9,245,000**	
5. Z10	GENERAL CONDITIONS OH & PROFIT (6-10%)	8.0%	$ **0**	$ **0**	**$ 739,600**	**$ 0**	**$ 739,600**	
6. a.	ESA Design (9-12%)	9.0%	$ **0**	$ **0**	**$ 832,050**	**$ 0**	**$ 832,050**	
c.	ESA Construction Management (5-10%)	8.0%	$ **0**	$ **0**	**$ 739,600**	**$ 0**	**$ 739,600**	
d.	ESA Commissioning (3-5%)	3.9%	$ **0**	$ **0**	**$ 363,329**	**$ 0**	**363,329**	
e.	ESA Schedule & Perf. Risk Value (6-8%)	6.5%	$ **0**	$ **0**	**$ 600,925**	**$ 0**	**600,925**	
7.	**TOTAL GMAX**	**35.4%**	**$ 0**	**$ 0**	**$ 12,520,504**	**$ 0**	$ **12,520,504**	

		%	STATE	NONSTATE	TOTAL
8.	**Fees & Contingency (**basic services**)**				
a.	PA & IGA Costs	2.4%	**300,000**		
b.	Contract Management Services	7.0%	$ **876,000**	$ 0	
c.	Contingency	3.7%	$ **462,000**	$ 0	
d.	**Total Fees & Contingency**	**10.69%**	**$ 1,638,000**	$ **0**	**1,638,000**
	TOTAL CONSTRUCTION COST, FEES & CONTINGENCY (Items 7 & 8e)		**$ 14,158,504**	$ **0**	**14,158,504**
9.	Required Additional Services During PW Phase		**$ 102,600**	**$ 0**	**$**
10.	Required Additional Services During Construction		$ **54,000**	**$ 0**	**$**
11.	**TOTAL PROJECT COST EXCLUDING GROUP II EQUIPMENT**		$ **14,315,104**	**$ 0**	
12.	Group II Equipment		$	**$**	
13.	**GRAND TOTAL**		$ **14,315,104**	$ **0**	$ **14,315,104**

14. Project Funds

15. a.	Campus Funds	$	0
b.	Equipment Lease Financing	$	0
c.	IOU Partnership Incentives	$	0
d.	Self Generation Incentive Program	$	0
e.	Capital Renewal Funds	$	0
	Additional Funds Required (Item 14 minus Items 14a & 14b)	$	**14,315,104**
16. a.	Projected 1st year Utility Cost Savings	$	**0**
b.	Simple Payback	Yrs	**#DIV/0!**

		State	Nonstate
17.	Project Fund Schedule		
18.	Received prior to 2008/2009	$	$
	Requested for 2008/2009	$	$
	Requested after 2008/2009	$	$

State		Nonstate	
449,000	P	0	P
469,000	W	0	W
13,080,454	C	0	C
13,998,454		0	
0	E	0	E

Elvyra F. San Juan, Assistant Vice Chancellor
Capital Planning, Design and Construction
The California State University

Version 2006-11-01

State Funded
THE CALIFORNIA STATE UNIVERSITY
CAPITAL OUTLAY ESTIMATE (FORM CPDC 2-7E)

Campus	***CSU Anywhere***	Date	10/3/2006
Project	***Energy Services Infrastructure Improvements***	**CCCI:**	**4633**
ARCHITECT FEE SCHEDULE		**A/E Design Basis CCCI:**	**4633**

	Construction Budget	**Building Type (1,2,3,4, or 5)**	**Engineering Fee**	**Fee %**	LOG Calculations & Coefficients	
New Construction	$0					
Less CC Program	$0					
A/E Design Basis (New)	$0	3	$0	6.62%		
A/E fee minus 1/2 %	$0	3	$0	6.12%		
Renovation	$9,245,000				New Construct	Renovation
Less CC Program	$92,000					
A/E Design Basis (Reno)	$9,153,000	3	N/A	8.62%	0.073192624	0.073192624
A/E fee minus 1/2%	$9,107,235	3	N/A	8.12%	0.06993007	0.06993007
					0.066192122	0.066192122
TOTAL	**$9,153,000**			**0.00%**	0.062835488	0.062835488
					0.05925924	0.05925924

FEE PAYMENT SCHEDULE

		Schematics	**Preliminary**	**WD**	**Bidding**	**Construction**	**Record Drawings**
Total 100%	**AE%**	**20%**	**14%**	**38%**	**2%**	**22%**	**4%**
$0	AE Fee						
Total 100% Costs	**ESA%**	**25%**	**25%**	**40%**	**10%**		
	PA	$0					
	IGA			$0			
$832,050	ESA Design Fee PW	$208,000	$208,000	$333,000	$83,000		
$739,600	ESA CM Fee C					739,600	
Total AE & CM Services		$1,571,650					

ARCHITECT REQUIRED BASIC SERVICES		**PWC**	**P**	**W**	**C**
Architect Fees	$	0	0	0	0
ESA service during PW	$	832,000	416,000	416,000	
ESA service during Construction	$	739,600			739,600
Total AE & CM Services	$	1,571,600	416,000	416,000	739,600

REQUIRED ADDITIONAL SERVICES		**PWC**	**P**	**W**	**C**
CEQA		0	0	0	0
Consultants		25,000	25,000	0	0
Soils		0	0	0	0
Hazardous Material Survey/Bid docs		0	0	0	0
Hazardous Material Monitoring		0	0	0	0
Field Investigation		0	0	0	0
Labor Commissioner		13,000	0	0	13,000
Commissioning (included in GMAX)		0	0	0	0
Mechanical Systems Review (MSR)		22,000	2,000	6,000	14,000
Plan Check		19,000	0	19,000	0
Fire Marshal		27,000	0	27,000	0
Seismic Peer Review		2,000	1,000	1,000	0
Sewer Capacity Fees		0	0	0	0
As/builts/reimb printing		5,000	5,000	0	0
Total Additional Services		113,000	33,000	53,000	27,000
Total Basic & Additional Services	$	1,684,600	449,000	469,000	766,600

REQUIRED ENERGY INFORMATION

		Current Cost/Unit	Current Utility Use	Utility Use After Project	Percent Avoided	Avoided Utilities	Avoided Costs
Electric	kWh				#DIV/0!	0	$0.00
Electric	kW				#DIV/0!	0	$0.00
Gas	Therms				#DIV/0!	0	$0.00
Water	CCF				#DIV/0!	0	$0.00
Sewer	CCF				#DIV/0!	0	$0.00
Total							$0.00

Section 6.0 Cost Benefit Analysis

Service Provider's future savings projections in the IGA report shall be based on Life Cycle Cost Analysis assumptions that are customarily used by the State of California, California Energy Commission. This includes inflation rates, discount rates, and fuel and electricity escalation rates. All analysis shall be performed on a nominal cash flow basis, with nominal discount rates for Life Cycle Cost analysis on a yearly basis. These assumptions will be provided by CSU. Future savings shall reasonably consider such factors as equipment life expectancy, degradation, expected usage factor, incremental increase in maintenance costs, if applicable, overhaul reserves, etc. as required for a project.

The following sub-sections describe the individual ECMs that this IGA analyzed and recommends. Each ECM sub-section provides the following information:

a. **Background**

   A brief synopsis of the existing conditions as relates to each ECM which provides insight as to what led to each scope of work.

b. **Recommended Scope of Work**

   A concise description of the recommended scope of work that is the basis for associated costs and savings. Complete details (such as point lists, building simulation parametric runs, site specific survey data, points lists. bid specifications and all calculations are included in <u>Section 12.0 Technical Appendix</u>.

c. **Cost Benefit ECM Detail Sheet**

   Completed spreadsheet provided by the CSU which details the savings and costs. It includes all major categories of cost including Design and Engineering; Project Management, including Incentive Management; Construction Management; Commissioning; Safety Planning; Overhead and Profit; and Schedule and Performance Risk Value. The savings are broken down by unit savings as well as cost savings; the spreadsheet separately lists the estimated incentives. Although the maintenance savings are very significant for most ECMs, no maintenance savings are factored into this analysis.

d. **Total Cost of Ownership Benefit**

   This table captures the total benefits to the campus of the recommended ECM.

e. **Life Cycle Cost Analysis**

   Completed spreadsheet provided by the CSU.

6.1 Heating System Upgrades

a. Background

Each of the campus buildings has two or more boilers that provide heating water to the mechanical equipment within the building, with the exception of the Music & Business, Theater and Robinson Hall which are all served from a common mechanical room containing four boilers. All of the existing boilers are copper fin tube manufactured by Lochinvar and are approximately 12 years old.

Most of these boilers were not piped and/or vented properly when originally installed and have been problematic from the beginning of their operation. Incorrect piping is causing many of the boilers to experience condensation of the flue gasses which produces a very corrosive acidic condensate that collects in the flue and the heat exchanger leading to premature failure of both. Improper installation of gas pressure regulators, regulator venting and flues are contributing to the improper combustion in the boilers that is causing the foul smell in the boiler exhaust. As a result of these factors and the age of the equipment the installed boilers are a huge maintenance burden.

The heating water system compression style expansion tanks (located within the boiler rooms in most all cases) are also problematic. The maintenance staff indicates that they have difficulty keeping the tanks from filling completely with water (losing their air charge). Without the air charge in the expansion tanks, the system becomes vulnerable to leaks because the expansion and contraction in the system fluid causes stresses that need to be absorbed within the distribution piping and the piping expansion devices.

Additionally, the boiler installations experience improper combustion which results in significant health and safety issues. The campus has documented numerous instances of complaints of noxious gasses entering buildings from the boiler flue stacks dating as far back as 1998. In at least a few instances students and staff were evacuated from the Meiklejohn Hall building and there has been a long history of campus complaints about the discharge from the boilers in the library Administration boiler room.

Furthermore, the heating hot water systems have hydronic flow issues that cause inefficient distribution of the heating water to the mechanical rooms. This is most noticeable in the library because of the larger distribution system.

In pursuing the scope of work associated with replacing the heating systems, three alternatives were considered:

1. Keeping a fully distributed boiler arrangement similar to existing with new high efficiency, superior quality, properly installed heating equipment.

2. Creating a mini-central plant (mini-CP) at the north end of the campus that would encompass Robinson Hall, Music Business, Theater and Physical Education. This mini-central plant was designed primarily to accommodate a fuel cell that would generate electricity with the ability to

recover heat that would be used to heat the pool and the domestic hot water for physical education.

3. Option (2) above augmented with a fuel cell.

The following provides background on each of the three alternatives to demonstrate the reasoning for the scope of work elected.

<u>Alternative #1: New Boilers Keeping Current Distributed Boiler Configuration</u>

This is the most cost effective option available to the campus as becomes clear in the following discussion of the other two options. Should the economics of the fuel cell technology become favorable, it is still possible to connect the Music & Business and Physical Education boiler plants together via underground piping at a later date and integrate the two systems so that they function as a single mini-central heating plant.

<u>Alternative #2: Mini-Central Plant *without* Fuel Cell</u>

The savings and cost analysis indicates a small cost advantage to the mini-CP due to the ability to reduce the quantity of boilers because of load diversification. However, the significant additional cost and risk associated with the underground piping required to connect the buildings to a mini-CP dwarfs the modest energy savings. Without apparent gain, after discussion with facilities staff, this alternative was eliminated.

<u>Alternative #3: Mini-Central Plant *with* Fuel Cell</u>

This alternative considered a 900 kW plant using three Fuel Cell Energy DFC300MA units (molten carbonate technology), which are the latest generation 300 kW units using a modular component approach (vs. the last generation which was mostly contained in a singular enclosure).

With the mini-CP concept, the cogeneration plant would have access to adequate thermal loads present for numerous buildings in the general area resulting in a very high utilization of the thermal output of the fuel cell units.

The fuel cell option was determined not to be cost effective at this time for a few reasons:

1. Current "spark spread" - i.e. the relative cost difference between the cost of fuel required (~$0.90/therm) and the value of base load electric savings (~$0.10 per/kWh) - is not robust enough to support the project once the ongoing maintenance allowance (mostly for future stack replacement) of ~$0.04 per kWh is factored in. A table showing how the cost of base load electricity is calculated can be found in <u>Section 12.0 Technical Appendix.</u>

2. High capital costs of the fuel cell technology, which in the campus's case, can not presently be offset with rebates due to recent legislative changes. Please see <u>Section 1.0 Executive Summary</u> for further explanation.

3. High cost and risk associated with underground piping required to build the mini-CP required to fully utilize the thermal output of the fuel cells. While the thermal output is not particularly significant with a fuel cell given their high electrical efficiency, any non-utilization of thermal output further degrades the already challenged economics of the fuel cell cogeneration project.

A conceptual layout of the fuel cell based cogeneration plant as well as preliminary economics of this option is provided for reference in Section 12.0 Technical Appendix.

b. Recommended Scope of Work

The most cost effective option evaluated is to replace existing equipment, keeping a fully distributed boiler arrangement for the entire campus. The scope of work for this approach follows:

Due to the long payback and the infrastructure renewal nature of this portion of the project the current scope of work will be limited to the boilers within the Art and education Building, Meiklejohn Hall and Warren Hall/Library buildings. This project will install 7 Aerco boilers in replacement of 10 Lochinvar boilers and 6 Polaris Water heaters to replace the existing. The remainder of the boiler rooms should be retrofitted at the Campus's earliest convenience.

- Replace the 32 (total 40.435 MMBH) existing Lochinvar boilers and 15 water heaters including related pumps, expansion tanks and hydronic accessories throughout the campus with 17 (total 43.0 MMBH) new high efficiency Aerco condensing capable boilers and Polaris water heaters. To provide redundancy, each boiler room will have a minimum of two boilers with three being installed in the Library/Administration. Also, increased efficiency is achieved by means of the manufacturer's Boiler Management System which provides the ability to stage the number of boilers operating at any one time to operate the boilers at their highest possible efficiency at the current operating condition. See Section 12.0 Technical Appendix for more detailed scope of work with quantity and sizing of boilers for each building. Installation of boilers piping and flues shall be in accordance with the manufacturer's recommendations.
- Install two (redundant) new heating hot water pumps with premium efficiency motors and variable speed drives in each mechanical room and convert system to variable flow.
- Replace existing compression style expansion tanks with new diaphragm style expansion tanks.
- Install new Spirotherm air and dirt separators for each heating water system to keep the boilers, piping and coils clean, maintain efficiency and extend equipment life expectancy.
- Install two new plate and frame heat exchangers in the pool mechanical room to heat the pools from the new combined heating water system.
- Install new 2-way control valves and correct piping issues at the air handling units and the boilers so that the heating water is utilized effectively and the boilers operate more efficiently.
-

c. Cost Benefit ECM Detail Sheet

IGA ECM Detail

ECM #	ECM	Installed Cost	Const. Fee %	Total Cost	Annual Energy Cost Avoidance	Estimated Incentives	Simple Payback
1	Heating System Upgrades	$987,166	35%	$1,337,018	$31,161	$39,713	41.6

Guidelines:	Construction Fee Schedule:		Const. Fee %
6-10%	Overhead & Profit	$78,973	8%
9-12%	Design	$78,973	8%
5-10%	Construction Management	$88,845	9%
3-5%	Commissioning	$43,830	4%
6-8%	Schedule & Performance Risk Value	$59,230	6%
29-45%	**Subtotal fee costs:**	$349,852	35%
	Grand Total Costs:	$1,337,018	

kWh Avoided	kW Avoided	Therms Avoided
57,471	93	25,920

Campus Cost/kWh	Campus Cost/kW*	Campus Cost/Therm
$ -	$ -	$ 0.90

d. Total Cost of Ownership Benefit

Benefit	Comments
Energy Savings	• >30% over current heating system
Maintenance Savings <u>(NOT REFLECTED IN ABOVE SAVINGS ANALYSIS)</u>	• Current Annual Budget, Boiler parts: $35,305 • Current Annual Budget, Boiler labor: $38,637 • Reduced quantity of boilers • Corrected water piping and flue installation deficiencies
Greater reliability	• Highest quality boiler
Enhanced comfort	• Significantly more effective heating is achieved by correcting piping issues and replacing control valves.
Life / Safety	• Elimination of existing boiler fumes and emissions • Reduced exposure to student, faculty and staff complaints and building evacuations

e. Life Cycle Cost Analysis

HEATING VENTILATING AND AIR CONDITIONING (HVAC)

ECM #1 - Heati	**ECM #1 - Heating System Upgrades** Replace distributed boilers with High Efficiency Condensing Boilers (Aerco). Replace pumps with premium efficiency pumps and variable speed drives, correct piping and flue installation deficiencies, and convert system to variable flow.					
Installed Cost	Initial Cost				Estimated Cost	Present Worth
	Installed Cost				$1,337,018	$1,337,018
	TOTAL INITIAL COST					$1,337,018
Replacement Costs	Replacement Costs		Life Years	Replacement Cost Factor	Replacement Cost	Present Worth
	81	7 Aerco H E Condensing Boilers	30	0.1122	$1,337,018	$149,950
	82	Pumps & VFDs (cost incl. above)	20	0.3027	$0	$0
	83	Expansion Tanks (cost incl. above)	35	0.0659	$0	$0
	84	Polaris HE water Heaters	20	0.3027	$0	$0
	0	N/ A	0	0.0000	$0	$0
	0	N/ A	0	0.0000	$0	$0
	0	N/ A	0	0.0000	$0	$0
	0	N/ A	0	0.0000	$0	$0
	0	N/ A	0	0.0000		$0
	0	N/ A	0	0.0000		$0
	Totals				$1,337,018	
	TOTAL PRESENT WORTH OF REPLACEMENT COST					$149,950
Annual Costs	Annual Costs		% of initial cost	Present Worth Factor	Annual cost	Present Worth
	Maintenance Cost			13.8007		
	81	7 Aerco H E Condensing Boilers	0.015		$20,055	$276,778
	82	Pumps & VFDs (cost incl. above)	0		$0	$0
	83	Expansion Tanks (cost incl. above)	0		$0	$0
	84	Polaris HE water Heaters	0		$0	$0
	0	N/ A	0		$0	$0
	0	N/ A	0		$0	$0
	0	N/ A	0		$0	$0
	0	N/ A	0		$0	$0
	0	N/ A	0		$0	$0
	0	N/ A	0		$0	$0
	Electrical Energy		399135	kwh	$47,896	$1,049,779
	Natural Gas		476610	therms	$357,458	$6,625,826
	TOTAL PRESENT WORTH OF ANNUAL COST					$7,952,382
LCC	**TOTAL PRESENT WORTH LIFE CYCLE COST**				**$9,439,350**	

6.2 EMS Control System and Air Side Retrofits

a. Background

EMS Controls

There are four EMS systems deployed across the CSU East Bay campus:

1. Robertshaw DMS – Installed in all buildings within the SOW of this IGA and upgraded in the early 1990s. It controls primary HVAC equipment and original pneumatic devices via electric to pneumatic transducers.
2. Alerton – Very recently installed in the new Business and Technology building and the new Student Union (currently not under the jurisdiction of CSU East Bay staff)
3. Invensys – Also, recently installed to control S-11 and S-13 and approximately 260 associated terminal boxes in the Library to replace a portion of the Robertshaw DMS that was destroyed in a partial building fire.
4. Automated Logic – Installed at individual buildings to provide gas and electric monitoring data.

Having to communicate with, control and monitor four distinct EMS controls systems presents significant challenges for CSU East Bay staff. One of the single biggest issues CSU East Bay faces is that while the Robertshaw DMS is currently functional, it is no longer supported by the manufacturer and new replacement parts are no longer available. For that reason, it is very difficult and expensive to replace parts (as they must be rebuilt) and perform repairs on a timely basis. This cost is evident in the very high maintenance and repair costs CSU East Bay has incurred for this system over the last few years. See the Total Cost of Ownership table below for EMS maintenance and repair costs. Also, the pneumatic control devices, which were common in the 1980's, are not generally well understood by today's typical facilities staff. The combination of these circumstances has, over the years, led to a system that is compromised (or manually "overridden") in many locations. While the staff is familiar with the system and utilizes it as much as possible, many devices are no longer under automatic control, and energy savings are difficult to obtain and track.

The Robertshaw DMS uses a graphic user interface called "UltiVist" which gives the user the ability to access all controllers across the network, providing all the graphics, alarming, and tracking abilities. "UltiVist" is no longer supported or available. In addition, if the existing "UltiVist" system server were to ever have a hardware or software crash, "UltiVist" could not be restored (even from existing disks and backups). This is due to some "codecs" required for install (or re-install), which are obtained from the manufacturer at the time of the install/re-install. This manufacturer no longer exists. To further complicate this situation, "UltiVist" is a product that runs on the "OS-2" operating system, and is incompatible with any Windows version. "OS-2" is no longer supported or obtainable.

Without "UltiVist", the user is limited to a "terminal" mode of operation, accessing one point at a time, in a "text" mode, with no graphics, alarming, or tracking.

The installed DDC "reach" of the Robertshaw DMS stops at the air handler level and simple start/stop of boilers and chillers. Essentially it directly provides only "on/off" control of the buildings. Many opportunities for increased comfort would be provided if the system DDC capabilities were fully extended to the zone level. However, detailed cost benefit analysis shows that the incremental energy savings gained by taking the control system to this level will be very minor compared to the cost to perform this additional work.

Air Side
Three basic types of air side mechanical systems serve the various buildings:

1. Constant volume multi-zone
2. Constant volume with zone reheat
3. Constant volume double duct

All of these systems are inherently inefficient (due to the blending of conditioned airstreams or reheating previously cooled air without resetting air volume) and none of these systems are allowed to be installed today under the current California Energy Code. Many of the components (dampers, linkages, actuators, etc.) that are used to control the outside air and return/exhaust air volume are in need of repair or replacement.

b. Scope of Work

Since the energy savings and construction associated with the EMS Control and Air Side scopes of work are highly interdependent they have been combined. Also, sound contracting practice indicates significant value in having the two disciplines executed by one subcontractor so as to optimize construction coordination and have single source accountability. Controls specifications, sequences of operation and points lists are contained in <u>Section 12.0 Technical Appendix.</u>

1. EMS Controls

There are two significant efforts in the EMS Controls system: (a) To reduce the number of EMS control systems on campus to two and integrate these two systems, making them accessible through one user interface; and (b) converting the pneumatic zone level controls to DDC.

<u>All zone level direct digital control work has been deferred to a later project and is left in the descriptions of control work for reference only. Zone level controls are excluded from the scope of the current project</u>.

(a) <u>EMS Control System Integration</u>

- Replace existing Robertshaw DMS and Invensys controls with Automated Logics EMS in all buildings except the two new buildings (Business and Technology, and Student Union) where the Alerton EMS will remain in place and Warren Hall which has Robertshaw controls, as this building is scheduled to be completely gutted or demolished in 2011/2012.

- Install user interface to Alerton EMS via BACnet over IP with new web-enabled system that will provide access to EMS graphics and functions from multiple locations via a standard web browser. The system will have backup/restore capability from local and/or IT level.

- Develop programming specific to each building to optimize comfort and savings.

- Add controls and variable speed drives for existing primary HVAC fan systems.

- Provide on site training for facilities staff that is specific to CSU East Bay building systems.

- Provide detailed, functional commissioning of the completed system.

(b) <u>Convert Pneumatic Zone Level Controls to DDC</u>

Converting zone level controls from pneumatic to DDC will result in a modest amount of additional electrical and gas savings. The even bigger issue for the future of the CSU East Bay campus is the improved occupant comfort that will result from implementing a system of zone level digital controls.

Also, the zone level DDC system provides improved operational and maintenance savings by allowing the operating engineers to trouble shoot any potential system problems and/or occupant complaints from a central location. This will enable them to determine if the system is operating within acceptable limits before having to waste the time necessary to walk across campus to visually inspect the system in question. This ability will substantially increase the effective time management of the operating engineering staff and allow them to focus on the most important issues at hand. Minor comfort related issues will, more often than not, be resolved without the engineer having to physically make adjustments to the mechanical systems and will reduce the amount of “tweaking” of the system that often results in an out of balance air system.

The zone level DDC system will also have the ability to send alarms to the operating engineering staff that will notify them of problems at the zone level that may affect occupant comfort and/or safety before the issue has actually resulted in a complaint from the faculty or students.

The installation of the zone level DDC controls will renew many of the components within the air systems that are old and frequently in need of repair or replacement. The true value of the zone level controls is to maximize the effectiveness and reliability of the existing HVAC systems without the extremely high cost of a wholesale replacement of the entire system.

Scopes of work (SOW) for this measure follow:
<u>Multi-Zone units with new DDC controls at zone level</u>

This SOW applies to the following buildings and air side systems:
- Meiklejohn Hall (Units S-5 and S-6)
- Theater (Units S-6 and S-7)
- Robinson Hall (Units S-1 and S-2)
- Physical Education (Units S-8 and S-9)

Local zone thermostats and zone VAV damper actuators will be converted to electronic control. Gaining electronic control of the zone VAV dampers will enable the EMS to determine the individual zone damper positions. This SOW will also include resetting the static pressure setpoint based on the individual zone damper positions, which will enable the fans to operate at lower speeds.

The existing mixing dampers would be fitted with electrically operated actuators and DDC controls. Having electronic control and dedicated actuators for each zone will enable the implementation of snap acting zone control and elimination of the mixing of the hot and cold air streams. This work will result in modest electrical and significant gas savings. Most of the gas savings are a result of eliminating mixing of cold and hot air streams as a result of implementing snap acting zone controls.

The majority of the costs associated with this ECM are driven by the electrically operated damper actuators, controllers and DDC local zone thermostats. These costs will be offset in part by the avoided costs of installing new pneumatically operated VAV dampers.

Dual Duct units with new DDC controls at zone level

The following units will have been retrofit to VAV by the base digital control installation, but the zone level controls would remain pneumatic in the base ECM.

This ECM is applicable to the following buildings and air side systems:
- Library (Units S-1 to S-10, S-12 and S-14)
- Art and Education (Units S-1 to S-6)
- Science buildings (Units S-1 to S-4)
- Physical Education (Unit S-7)

Local zone thermostats and zone terminal unit damper actuators will be converted to electronic control. Getting electronic control of the terminal unit VAV dampers will enable the EMS to determine the individual zone damper positions. This ECM will also include resetting the static pressure setpoint based on the individual zone damper positions, which will enable the fans to operate at lower speeds.

Gaining electronic control of the dedicated actuators for each zone will enable implementation of snap acting zone control and elimination of mixing of the hot and cold air streams.

Most of the savings are electrical savings from fan speed reduction any gas savings is minimal and would be a result of eliminating mixing of cold and hot air streams as a result of implementing snap acting zone controls. However the spreadsheet detail in the IGA conservatively shows an increase in gas consumption because of improved functionality which offsets the modest annual electrical savings of $8100.

Quasi-VAV reheat units with new DDC controls at zone level

The following units will have been retrofit to VAV in the base ECM to install digital controls, but the zone level controls would otherwise remain pneumatic.

This ECM is applicable to the following buildings and air side systems:
- Meiklejohn Hall (Units S-1 to S-4)
- Music & Business (Units S-1 to S-2)
- Theater (Unit S-4)

Local zone thermostats as well as reheat coil valve actuators will be converted to electronic control. Discharge air temperature (DAT) will be reset based on zone demand, which will be determined from the reheat valve position of the critical zones (i.e. high valve % open position).

2. Air Side

Several measures have been identified to improve the operation and energy efficiency of, and the comfort provided by, the air handling systems. For the most part these measures take advantage of low-cost methods to convert constant volume systems to variable volume.

- Replace, repair or refurbish economizer OA, RA and EA dampers and replace pneumatic damper actuators with electronic actuators.

- Convert constant volume multi-zone systems to variable air volume (VAV) with new DDC controls. This measure includes installing VFDs at the central supply and return fans and a pneumatically (or electronic) controlled damper and air flow sensor in the ductwork serving each zone. The VFD will vary the fan speed based on the static pressure setpoint in the hot and cold plenums. The damper will be controlled by the local zone thermostat. The static pressure in the hot and cold plenums of the multi-zone air handler will vary as a result of the stroking of the zone VAV dampers.

- Convert constant volume dual duct systems to VAV with new DDC controls. This measure will install VFDs at the central supply and return fans. Retrofitting the zone terminal boxes to provide for VAV will consist of adding a second actuator along with a new linkage to enable both decks to operate independently of each other. A bias relay will be installed in either the hot damper actuator branch line or cold damper branch line to establish minimum airflow to the space. The ~194 dual duct terminal boxes in the Library will be replaced by true dual duct VAV terminal boxes as they cannot be retrofitted by adding an additional actuator.

  The Science building complex operates somewhat as a VAV system; however the air flow turndown could be increased, resulting in additional energy savings. The airflow in the laboratory spaces of the Science building complex will remain unchanged and only the non-laboratory spaces will be converted to variable air volume. Isolation dampers will be added to the non-laboratory spaces and air flow to these spaces will be shut off during unoccupied hours.

- Convert constant volume reheat to quasi-VAV reheat system and retrofit with new DDC controls. This measure will install VFDs at the central supply and return fans and air volume will be controlled based on a surrogate of load such as OA or RA temperature.

- Convert constant volume single zone to VAV single zone and retrofit with new DDC controls. Install electronic zone sensors, install VFDs at the central Supply and Return Fans and Repair existing VFD controls (where applicable)

- Install Demand Control Ventilation (DCV) controls to gymnasium, theater and lecture hall air systems.

c. Cost Benefit ECM Detail Sheet

IGA ECM Detail

ECM #	ECM	Installed Cost	Const. Fee %	Total Cost	Annual Energy Cost Avoidance	Estimated Incentives	Simple Payback
2	EMS Replacement* & Air Side Improvements**	$5,819,132	35%	$7,881,432	$397,454	$747,703	17.9
	* Installed Cost						
	** Installed Cost						

Guidelines:	Construction Fee Schedule:		Const. Fee %
6-10%	Overhead & Profit	$465,531	8%
9-12%	Design	$465,531	8%
5-10%	Construction Management	$432,943	7%
3-5%	Commissioning	$290,957	5%
6-8%	Schedule & Performance Risk Value	$407,339	7%
29-45%	**Subtotal fee costs:**	$2,062,300	35%
	Grand Total Costs:	$7,881,432	

kWh Avoided	kW Avoided	Therms Avoided
2,646,513	6,534	112,540

Campus Cost/kWh	Campus Cost/kW*	Campus Cost/Therm
$ -	$ -	$ 0.90

d. Total Cost of Ownership Benefit

Benefit	Comments
Significant Energy Savings	• Over 2.6 million kWh and 90,000 therms saved • Improved control ability over energy consuming equipment • Minimize mixing of conditioned air streams • Minimize total air being mechanically moved
Maintenance Savings <u>(NOT REFLECTED IN ABOVE SAVINGS ANALYSIS)</u>	• Lower materials cost for repairs due to elimination of obsolescent controls and overall reduction of maintenance requirements due to new equipment • Current Annual Budget, Controls parts: $10,381 • Current Annual Budget, Controls labor: $38,769 • Standardization from four separate control platforms results in lower inventory costs, reduced training requirements and ease of maintenance
Improved reliability	• Major pieces of the system will be repaired or replaced like Variable Frequency Drives and Economizer and/or dampers
Enhanced comfort and response time	• Increased ability to monitor and control temperatures and respond to comforts problems faster
Improved troubleshooting	• Enhanced trending capability • Remote access capability
Enhanced comfort	• Improved zone level control

e. Life Cycle Cost Analysis

HEATING VENTILATING AND AIR CONDITIONING (HVAC)

Section	#	Item				
ECM #2 - EMS		**ECM #2 - EMS Control System and Air Side Retrofits** Install a campus wide digital energy management system (EMS). The EMS will provide an integrated control of all the major building systems monitored by the CSU East Bay plant operations staff. Make HVAC system modifications and repairs to make the existing systems more energy efficient.				
Installed Cost		Initial Cost			Estimated Cost	Present Worth
		Installed Cost			$7,881,432	$7,881,432
		TOTAL INITIAL COST				$7,881,432
Replacement Costs		Replacement Costs	Life Years	Replacement Cost Factor	Replacement Cost	Present Worth
	66	Electronic controls	15	0.5152	$7,881,432	$4,060,890
	85	Air Side Modifications (cost incl. above)	0	0.0000	$0	$0
	0	N/A	0	0.0000	$0	$0
	0	N/A	0	0.0000	$0	$0
	0	N/A	0	0.0000	$0	$0
	0	N/A	0	0.0000	$0	$0
	0	N/A	0	0.0000	$0	$0
	0	N/A	0	0.0000	$0	$0
	0	N/A	0	0.0000		$0
	0	N/A	0	0.0000		$0
		Totals			$7,881,432	
		TOTAL PRESENT WORTH OF REPLACEMENT COST				$4,060,890
Annual Costs		Annual Costs	% of initial cost	Present Worth Factor	Annual cost	Present Worth
		Maintenance Cost		13.8007		
	66	Electronic controls	0.015		$118,221	$1,631,545
	85	Air Side Modifications (cost incl. above)	0		$0	$0
	0	N/A	0		$0	$0
	0	N/A	0		$0	$0
	0	N/A	0		$0	$0
	0	N/A	0		$0	$0
	0	N/A	0		$0	$0
	0	N/A	0		$0	$0
	0	N/A	0		$0	$0
	0	N/A	0		$0	$0
		Electrical Energy	6399102	kwh	$767,892	$16,830,499
		Natural Gas	71501	therms	$53,626	$994,006
		TOTAL PRESENT WORTH OF ANNUAL COST				$19,456,050
LCC		**TOTAL PRESENT WORTH LIFE CYCLE COST**			**$31,398,372**	

6.3 Lighting Retrofits

a. Background

Most of the lighting systems at CSU East Bay were retrofitted in the early 1990s and consist mainly of T-12 energy saver lamps powered by hybrid electronic ballasts. A partial lighting retrofit was successfully performed by Chevron ES in the PE and A&E buildings in the spring of 2006. The remaining system is inefficient. Also, scattered around the campus are early generation T-8 lamps with electronic ballasts. Most of the areas with T-8 lamps are over lit with 35K lamps and will work with the prescribed retrofit.

- Library - the main stack area is over lit by 2'x4' (2) lamp parabolic fixtures
- Music & Business - four and eight-foot T-12s fixtures with remote ballasts throughout the practice rooms
- Physical Education - Sportlite compact fluorescent fixtures in the gym and eight-foot T-12HO fixtures in the two upper exercise rooms
- Robinson Hall, Theater and North and South Science - the majority of existing fixtures are T-12 fixtures
- Warren Hall and the Library - T-8 lamps with electronic ballasts
- Meiklejohn Hall - 3rd and 4th floor hallway lighting often "on" when not in use
- Student Health Center - surface mount box fixtures with white opal diffusers trap a lot of light
- Facilities Maintenance - over lit with T-8 lamps and ballasts
- Corporation Yard - eight-foot T-12 fixtures

b. Scope of Work

This ECM brings significant improvements to lighting throughout the campus. Generally, a "standard retrofit" consisting of low ballast factor T-8 ballasts and 41K 28 watt T-8 lamp will replace the T-12 energy saver lamp powered by hybrid electronic ballast.

- Library – retrofit the main stack areas with standard retrofit; replace the existing T-8 lamps with electronic ballasts with latest generation, more efficient T-8 lamps and ballasts
- Music and Business - retrofit the four-foot lamps in the practice rooms with latest generation T-8 lamps while retaining remote ballast, and retrofit the eight-foot slimline lamps with a reflector kit to accept four-foot T-8 lamps while retaining the remote ballast
- Physical Education - replace the Sportlite compact fluorescent fixtures and the eight-foot T-12 HO fixtures with new T-8 fixtures
- Robinson Hall, Theater and Science buildings - replace all T-12 fixtures with the standard retrofit
- Meiklejohn Hall - install occupancy sensors to control the 3rd and 4th floor hall lighting
- Student Health Center - replace the white opal diffusers with new clear prismatic diffusers and reflectors
- Facilities Maintenance - replace T-8 lamps with the standard retrofit

- Corporation Yard – replace the eight-foot T-12 fixtures with new T-8 fixtures with four-foot lamps and ballasts
- General - install sensors to control soda and snack machines when buildings are unoccupied
- General - recycle/properly dispose of lamps and ballasts

c. Scope of Work Considered in Detail but Not Included in Current Scope

At the CSU Chancellor's Office request we revisited the lighting scope of work and carefully considered lighting redesign opportunities such as converting the existing campus wide direct lighting systems to modernized direct/indirect lighting systems. Both indirect lighting and direct/indirect (D/I) lighting create a pleasing, high quality light that comes more evenly from the entire ceiling surface rather than directly from the light fixtures themselves. D/I lighting is most effective at a University in classrooms, libraries and computer rooms, and can significantly enhance the quality of the learning environment in these settings.

Direct/indirect lighting as available today is designed to be used on a T-bar type ceiling that is between nine and sixteen feet above the floor. If the ceiling is too low, the fixture hangs uncomfortably low, and if it is too high too much light is lost. Indirect lighting can be used in applications with exposed wood or concrete ceilings as long as the ceilings are painted a light color to allow the necessary reflectance of light.

Most of the buildings on this campus are not good candidates for D/I lighting because they have either: 1) spline type ceilings or 2) concrete ceilings where the concrete is shaped into recessed coves. The first case requires disassembly and reconstruction of the ceiling in order to install D/I lighting. This work will be very costly and disruptive to the University. The second case is not desirable because the light would be lost in the recesses.

- <u>Library</u> – The first floor computer lab area would benefit from indirect lighting because of the heavy use of computers in the area. Unfortunately, the ceiling is a spline type. The second floor stack area, however, is potentially an opportunity for indirect lighting. This area has T-bar ceilings that are of desirable height and D/I lighting in this area will improve the quality of light. Instead of a straight lamp and ballast retrofit in this area the campus could install Finelite™ Series 12 D/I fixtures.

  The below table illustrates the impact on the cost and savings of a retrofit with direct / indirect lighting; the lowest line represents a redesign that includes an approximately 25% fixture reduction in that area of the library. The associated additional savings and cost moves the simple payback on the overall lighting project from 5.6 years to 7.3 years.

	Existing Fixture						**Retrofit Description**						**Retrofit Savings**				**Costs**		**Rebate**	Years
Room #	Fixture Type	Qty	W	Total kW	Hours	Total KWH	Retrofit Description	Qty	W	Hours	Total kW	Total KWH	Total KW Saved	Total KWH Saved	Total $ Saved (W/O AC)	Total $ Saved (W/ AC)	Unit Cost	Installed Cost	Total Rebate	Simple Payback (W/ AC)
Library	2F32T8, EB	1257	58	72.9	4680	341,200	**2F32T8L**	**1257**	42	4680	52.8	247,076	20.1	94,124	$11,766	$12,942	$44	$55,534	$22,590	2.5
Library	2F32T8, EB	1257	58	72.9	4680	341,200	**2-lamp Finelite**	**1257**	42	4680	52.8	247,076	20.1	94,124	$11,766	$12,942	$233	$293,371	$22,590	20.9
Library	2F32T8, EB	1257	58	72.9	4680	341,200	**2-lamp Finelite**	**950**	42	4680	39.9	186,732	33.0	154,468	$19,309	$21,239	$233	$221,721	$37,072	8.7

While there are significant benefits in the quality of light being provided with direct / indirect lighting, the Library is slated for seismic upgrade in the 2011-2012 fiscal year. Since this project would potentially be removed during the seismic upgrade before it could pay back, we did not pursue this retrofit further. However, if the campus would prefer to pursue this alternative for other benefits, we would be happy to provide a detailed proposal.

- Physical Education – The space type and use of this facility is not appropriate for D/I lighting.
- Robinson Hall – This building has many classrooms that could benefit from indirect lighting, but the ceilings are cast concrete coves that would absorb the indirect light.
- Theater – This building has lab and shop type spaces that are not good candidates for indirect lighting.
- Science buildings – This buildings houses primarily labs and offices with spline type ceilings.
- Meiklejohn Hall – This building has classrooms and lecture halls that would benefit from indirect lighting, but the ceiling is spline type.
- Student Health Center – This buildings has small offices and exam rooms that are not good candidates for D/I lighting and the ceilings are drywall.
- Facilities Maintenance and the Corporation Yard – These areas contain shop and office spaces that are not good candidates for D/I lighting.

d. Cost Benefit ECM Detail Sheet

IGA ECM Detail							
ECM #	ECM	Installed Cost	Const. Fee %	Total Cost	Annual Energy Cost Avoidance	Estimated Incentives	Simple Payback
3	Lighting Retrofits	$597,644	35%	$809,449	$95,120	$206,758	6.3

Guidelines:	Construction Fee Schedule:		Const. Fee %
6-10%	Overhead & Profit	$47,812	8%
9-12%	Design	$53,788	9%
5-10%	Construction Management	$47,812	8%
3-5%	Commissioning	$20,559	3%
6-8%	Schedule & Performance Risk Value	$41,835	7%
29-45%	**Subtotal fee costs:**	$211,805	35%
	Grand Total Costs:	$809,449	

kWh Avoided	kW Avoided	Therms Avoided
891,657	1,687	-7,240

Campus Cost/kWh	Campus Cost/kW*	Campus Cost/Therm
$ -	$ -	$ 0.90

e. Total Cost of Ownership Benefit

Benefit	Comments
Energy Savings	• Approximately 30% over present lighting energy consumption
Maintenance Savings (NOT REFLECTED IN ABOVE SAVINGS ANALYSIS)	• New lamps and ballasts with warranties • Standardization of equipment results in lower inventory costs and ease of maintenance
Enhanced comfort	• Significantly improved light levels • Replacement of T12 fixtures with T8 fixtures provides favorable light quality (CRI increases from 65 to 85) • Retrofit of existing T8 35k lamps to 41k lamps will improve brightness, making visual tasks easier

f. Life Cycle Cost Analysis

ELECTRICAL LIGHTING

ECM #3 - Light	**ECM #3 - Lighting Retrofits** This ECM includes a campus wide lighting retrofit including replacement of lamps and ballasts with more energy efficient equipment.					
Installed Cost	Initial Cost				Estimated Cost	Present Worth
	Installed Cost				$809,449	$809,449
	TOTAL INITIAL COST					$809,449
Replacement Costs	Replacement Costs		Life Years	Replacement Cost Factor	Replacement Cost	Present Worth
	15	T8 Lamps	20	0.3027	$809,449	$245,014
	81	Electronic ballasts (cost incl. above)	0	0.0000	$0	$0
	82	Occupancy Sensors (cost incl. above)	0	0.0000	$0	$0
	0	N/A	0	0.0000	$0	$0
	0	N/A	0	0.0000	$0	$0
	0	N/A	0	0.0000	$0	$0
	0	N/A	0	0.0000	$0	$0
	0	N/A	0	0.0000	$0	$0
	0	N/A	0	0.0000		$0
	0	N/A	0	0.0000		$0
	Totals				$809,449	
	TOTAL PRESENT WORTH OF REPLACEMENT COST					$245,014
Annual Costs	Annual Costs		% of initial cost	Present Worth Factor	Annual cost	Present Worth
	Maintenance Cost			13.8007		
	15	T8 Lamps	0.03		$24,283	$335,130
	81	Electronic ballasts (cost incl. above)	0		$0	$0
	82	Occupancy Sensors (cost incl. above)	0		$0	$0
	0	N/A	0		$0	$0
	0	N/A	0		$0	$0
	0	N/A	0		$0	$0
	0	N/A	0		$0	$0
	0	N/A	0		$0	$0
	0	N/A	0		$0	$0
	0	N/A	0		$0	$0
	Electrical Energy		3263932	kwh	$391,672	$8,584,580
	Natural Gas		-7230	therms	-$5,423	-$100,511
	TOTAL PRESENT WORTH OF ANNUAL COST					$8,819,199
LCC	**TOTAL PRESENT WORTH LIFE CYCLE COST**				**$9,873,662**	

6.4 Water Conservation Upgrades

The CSU East Bay campus plumbing and irrigation systems presently consume approximately 60 million gallons of water, annually. Implementing plumbing and irrigation retrofits, will complete the University's centralized irrigation control and reduce water consumption by about 8 million gallons, the average daily water use of approximately 110,000 people and cut water and sewer costs by approximately $30,000, annually.

a. Background

Plumbing Retrofit
Throughout the surveyed buildings, many of the existing urinals are older 1.5 gallon per flush fixtures. Also, based on field measurements, many of these buildings have 2.2 GPM sinks. In Student Health all toilets are 3.5 gallon per flush.

Irrigation Retrofit
Currently, most irrigated grounds around the campus are watered using the Rain Master™ central irrigation control system. This is a reliable and water efficient system, and campus staff has embraced a sophisticated control system to reduce water use and maintenance. However, there are still many stand-alone controllers that are not part of the central control system. Also, although site staff has central control, controller water schedules are set without the benefit of available weather data. Lastly, information on station areas and locations are not mapped or formatted so scheduling and maintenance are time-consuming.

b. Scope of Work

Plumbing Retrofit

- Replace existing 2.2 GPM sink aerators with 1.0 GPM aerators.
- Replace existing 1.5 gallon per flush urinals with new waterless urinals. CSU East Bay has already installed many waterless urinals and this ECM will further the program staff has initiated. This ECM includes new product, basic installation, cap of old supply lines and necessary aesthetic work. The program also includes the cost of the "trap" technology which allows up to 10,000 uses for each trap and an inventory of 20 traps.
- Replace existing 3.5 gallon per flush toilets in Student Health Center with new 1.6 gallon toilet bowl and valve.

Fixtures To Be Replaced			
Building	Sinks	Urinals	Toilets
Physical Education	21	18	
Student Health	13	1	15
Library	26	11	
Meiklejohn	28	22	
A&E	23	20	
Theater	4	2	
Robinson	6	1	
Music & Business	16	2	
Science Buildings	36	13	
Total	173	90	15

Irrigation Retrofit

- Complete the centralization of the irrigation systems by replacing 17 controllers with central control capability controllers.
- Provide and install on-site weather station as part of the central control system so that all campus irrigation can be watered based on local weather conditions and plant water needs, maximizing watering efficiency.
- Audit all irrigated areas to create maps and charts of station locations, soil types, plant conditions, sprinkler types and efficiency, sun and shade conditions and degrees of slope in order to effectively schedule landscaped areas. These charts will be provided to site staff for maintenance use and integrated into central control programming.
- Provide system wide, site specific training so that systems will be functionally sound and staff can operate at maximum value.

c. Cost Benefit ECM Detail Sheet

IGA ECM Detail

ECM #	ECM	Installed Cost	Const. Fee %	Total Cost	Annual Energy Cost Avoidance	Estimated Incentives	Simple Payback
4	Water Conservation	$211,569	35%	$286,549	$48,504	$2,365	5.9

Guidelines:	Construction Fee Schedule:		Const. Fee %
6-10%	Overhead & Profit	$16,926	8%
9-12%	Design	$19,041	9%
5-10%	Construction Management	$16,926	8%
3-5%	Commissioning	$7,278	3%
6-8%	Schedule & Performance Risk Value	$14,810	7%
29-45%	**Subtotal fee costs:**	$74,980	35%
	Grand Total Costs:	$286,549	

Low Flow Retrofit CCF Avoided	Irrigation Retrofit CCF Avoided	Therms Avoided
2,660	11,910	2,365

Campus Water & Sewage Cost/CCF	Campus Water Cost/CCF	Campus Cost/Therm
$ 5.39	$ 2.69	$ 0.90

d. Total Cost of Ownership Benefit

Benefit	Comments
Significant Water Savings	• Eliminate urinal water costs and minimize sewage costs • ~50% water and sewage savings for sinks and toilets • ~25% water savings from centralization of irrigation system
Maintenance Savings <u>(NOT REFLECTED IN ABOVE SAVINGS ANALYSIS)</u>	• Standardization of urinals results in lower inventory costs and ease of maintenance • Centrally controlled irrigation translates into reduced labor hours and maintenance vehicle expenses

6.5 Computer Energy Management Software

a. Background

CSU East Bay has approximately 2500 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. 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.

b. Scope of Work

Verdiem's 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.

The scope of work for this measure provides this energy management software for the faculty and staff desktop computers, which is what the campus uses for sizing its software site licensing. It is possible that a good opportunity for this software could also exist for the campus lab computers as well. We are currently in the process of verifying this but would prefer at this writing to utilize the 2500 quantity to be conservative.

Installation and support of the system is included.

c. Cost Benefit ECM Detail Sheet

IGA ECM Detail

ECM #	ECM	Installed Cost	Const. Fee %	Total Cost	Annual Energy Cost Avoidance	Estimated Incentives	Simple Payback
5	Verdiem Computer Power Management Software (for 2500 PC)	$54,333	35%	$73,589	$62,500	$120,000	-0.7

Guidelines:	Construction Fee Schedule:		Const. Fee %
6-10%	Overhead & Profit	$4,347	8%
9-12%	Design	$5,433	10%
5-10%	Construction Management	$4,347	8%
3-5%	Commissioning	$1,869	3%
6-8%	Schedule & Performance Risk Value	$3,260	6%
29-45%	**Subtotal fee costs:**	$19,256	35%
	Grand Total Costs:	$73,589	

kWh Avoided	kW Avoided	Therms Avoided
500,000	0	0

Campus Cost/kWh	Campus Cost/kW*	Campus Cost/Therm
$ 0.125	$ -	$ 0.90

* cost/kW included in blended cost/kWh

* Electrical savings calculations assume baseline energy consumed by a 30HP motor, which is the size required to provide proper pool circulation.

d. Total Cost of Ownership Benefit

Benefit	Comments
Energy Savings	• Significant energy savings

Section 7.0 Savings Calculations

The basis for project savings must be provided in sufficient detail to enable the campus, CSU Office of the Chancellor and its consultants to make an independent evaluation on the reasonableness of the savings projections. ***Inclusion of maintenance and labor explicitly specified by the campus in the project specific solicitation.*** *However, these may be presented as an information item for the Campus' consideration. Specifically, the savings estimates must state the following:*

a. Base year energy use, cost, and selection methodology for a 36-month period.

2006	Total Usage	Total Cost	Unit Cost
Electricity* (PG&E Meter)	16,500,212 kWh	$2,062,527	$ Variable**
Gas	598,117 Therms	$538,305	$ 0.90

**Total electricity usage for campus including PV production was 17,651,638 kWh*
***Variable unit cost was due to different summer and winter rates for TOU which is reflected in Section 3.0 Utility Analysis*

Refer to section 3.0 for additional information.

b. Post-retrofit energy use and cost.

Post-retrofit	Total Usage	Total Cost	Unit Cost
Electricity	12,918,069 kWh	$1,771,558	$ Variable
Gas	423,549 Therms	$ 381,194	$ 0.90

c. Savings estimates including analysis methodology, supporting calculations and assumptions used.

To accurately estimate energy savings, comprehensive computer models were built to simulate and analyze the real energy use before and after retrofit. Because the project scope covers about 82% of the total area of the campus, and historical utility data of individual buildings (sub meter readings) are not available, baseline energy consumption is created by pro-ration and extrapolation of short term survey data. (Also see item j below.) Since utility rates are an ever changing commodity and it is uncertain what supplier would be delivering gas and power to the campus over the life of this project it was decided by the CSU Chancellor's Office, and agreed to by the campus and Chevron ES, that PG&E utility rates would be entered into the computer simulation model. Current E-20P electricity rates were used for the energy savings calculations. See Section 3.0 Utility Tariff Analysis for details.

Natural Gas Blended Energy Rates

The natural gas savings mainly occur in the winter. As such, the blended energy rate selected for the natural gas savings is based on an average of the on-peak and off-peak rates per therm. This blended rate is $0.90/therm.

d. Savings estimates must be limited to savings allowed by the Campus as described above.

Yes they are.

e. Percent cost-avoidance projected.

The projected energy saving is 22% of current electricity consumption and 29% of current natural gas usage.

f. Description and calculations for any proposed rate changes.

No rate change was considered in order to reflect cost-avoidance conservatively.

g. Explanation of how savings duplication or interactions between retrofit options is avoided.

The impact of (1) photovoltaic electricity production to total electricity bill and (2) lighting power savings to heating load are modeled to avoid duplications of energy savings. Also, ECMs modeled with eQuest are cascaded one from another and properly account for savings interactions and avoid savings duplication.

h. Operation and maintenance savings, including detailed calculations and description.

There are maintenance and operation savings that the campus will see from most of the ECMs recommended in this IGA, as seen in the Total Cost of Ownership tables in each sub-section of <u>Section 6.0 Cost Benefit Analysis</u>. Maintenance and operation savings are quantified for the Heating System Upgrades and EMS Controls System & Air Side Upgrades ECMs only. These savings were not included in the ECM Detail Sheets or ECM Summary Sheet in this document.

CSU East Bay facilities provided Chevron ES with spreadsheets itemizing its costs for both labor and materials from 2004 to present for the campus heating and control systems. In order to determine an approximate conservative estimate of the savings the campus will realize going forward by installing new heating equipment and controls system, we averaged the last two years of data provided for both labor and materials. These estimated savings are:

Category of Savings	Savings
Heating Systems Material	$35,305
Heating Systems Labor	$38,637
Controls Systems Material	$10,381
Controls Systems Labor	$38,769

i. A computer simulation is required and shall, include a short description and statement of key input data. If requested by Campus, access shall be provided to the program and all assumptions and inputs used, and/or printouts shall be provided of all input files and important output files and included in the Investment Grade Assessment with documentation that explains how the final savings figures are derived from the simulation program output printouts.

Computer Simulation Modeling

Five separate energy models were developed to analyze the nine buildings in this study: individual models for Arts and Education Building, Library and Warren Hall, Meiklejohn Hall, Science Building Complex, and a North Campus model encompassing Music and Business, Physical Education, Robinson Hall, Theater, and Student Health buildings. The models were developed using eQUEST, a graphical user interface to DOE 2.2 whole building energy analysis software tool. In each model, the buildings were divided into individual thermal zones, which were also categorized by function.

Because the project scope covers only about 82% of the total area of the campus, and long term historical utility data of individual buildings (sub meter readings) was not available, baseline energy consumption is created by pro-ration and extrapolation of short term survey data. The electricity and gas consumption of the buildings was monitored and recorded at fifteen minute intervals over the course of up to twenty-one days. From this data, one typical weekday and one typical weekend hourly electrical demand profile and gas consumption profile was generated for each building. The total electric and gas consumption for the monitored period was then extrapolated to a full year to yield the baseline electricity and gas consumption. Gas consumption profiles were not created based on monitored data for Robinson Hall and Theater since these buildings do not have gas sub meters.

Three ECMs, were evaluated in all building simulation models.

- Heating System Upgrades
- EMS Replacement and Air side and EMS Modifications
- Lighting Retrofits

These ECMs were broken down to 14 parametric runs in eQuest and modeled in a cascaded fashion such that every subsequent parametric run is executed based on the results of the preceding ones. For example, if a zone level DDC conversion ECM is listed immediately after the constant to variable air volume conversion, then at the time of evaluating the zone level DDC ECM, it is assumed that the VAV retrofit has already occurred. Thus the savings are calculated at the reduced VAV airflow rather than the higher constant airflow in the base system.

The modeled inputs include averaged 30-year TMY2 weather data, occupancy schedules, building loads, building parameters, zone, and equipment performance specifications.

Measured average lighting densities on a per building basis were used. Industry standard equipment densities (in watts/square foot) were used based on campus data and building usage type. Thorough inspections of the mechanical systems in each building were conducted noting the condition of each unit, and instantaneous power (kW) measurements were taken for most air handler fan motors rated at or above 5hp. The sequences of operations for the mechanical systems in the buildings were obtained in interviews with the campus controls specialist.

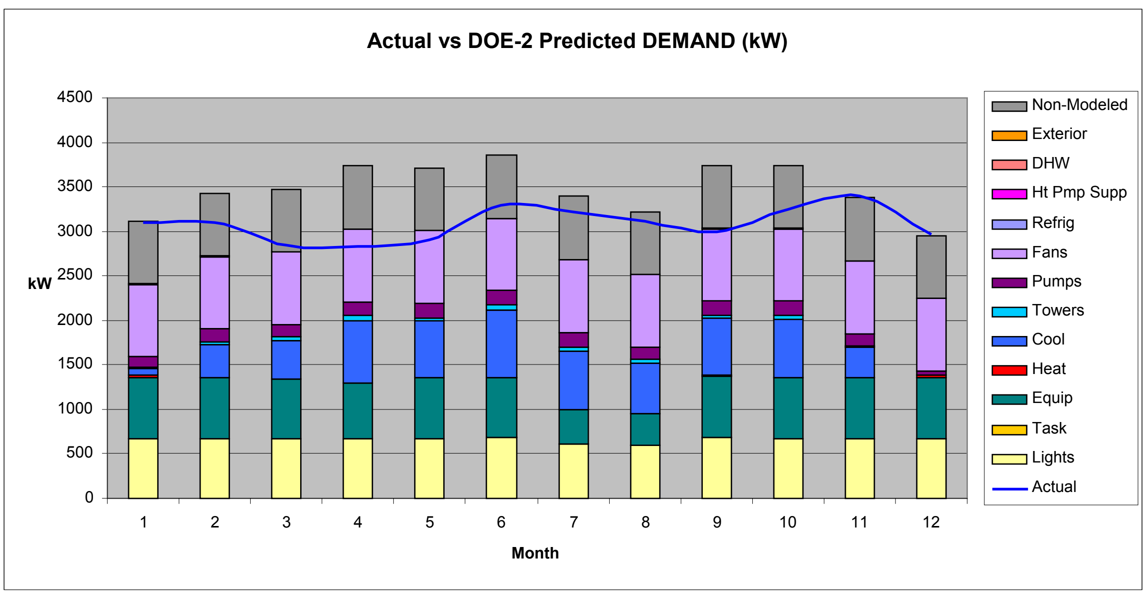
For the baseline models, the input boiler efficiencies were obtained from the nameplate data from the boilers. The default eQUEST efficiency curves were used for the performance curves. For the parametric runs, it was found that eQUEST could not function properly with the actual new boiler efficiency curve. So the default eQUEST efficiency curve was retained in the parametric run. As a result, the calculated savings for the boiler ECMs are conservative because the new condensing boilers have better greater efficiencies at partial load.

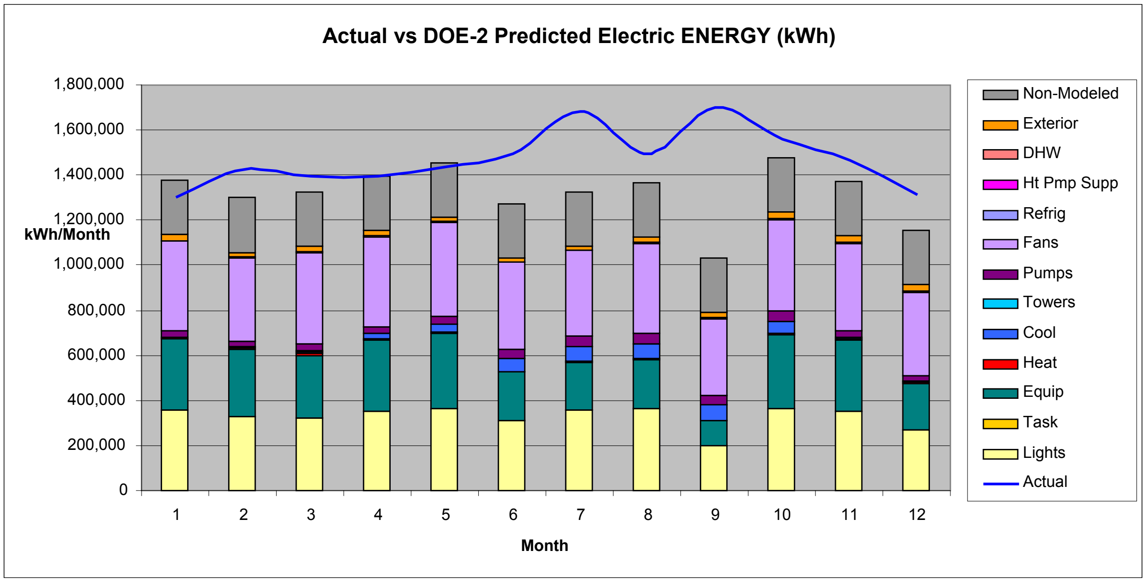
Proposed % Efficiency	Modeled Existing % Efficiency	Surveyed % Efficiency	Building
93.5	84	78.7-82.7	North Campus
93.5	80	75.2-78.5	Library/Admin
93.5	80	78.3	Meiklejohn Hall
93.5	80	78.4-82.0	Science
93.5	84	77.4-80.09	Art/Education

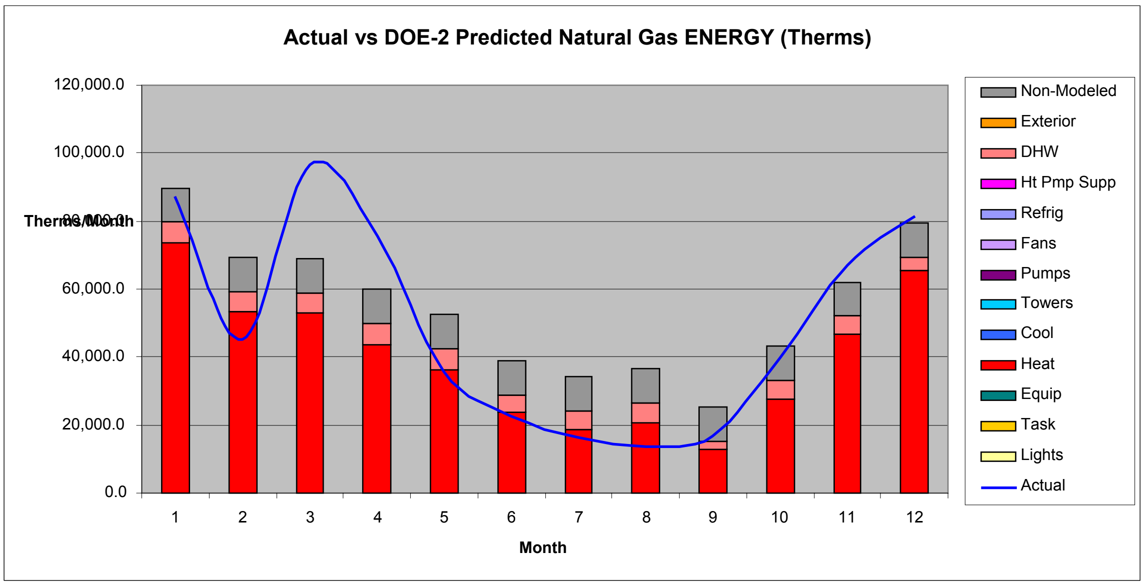
Table: Boiler Efficiency

The models were simulated for the monitored period using actual weather data for this trended period and calibrated to the weekday and weekend hourly demand profiles, respectively. To verify accurate modeling of these components in the models, the calculated fan kW demand in the models were verified with the field measurements. The models were then simulated for an entire year and calibrated to within 10% of the baseline annual electric consumption, except for Arts and Education, which electric data was not reliable to calibrate to. Thus, the fan power demands were calibrated to the field measured values and the interior load profiles were taken to be the same as a building with a similar type of usage. The Science Building was calibrated to gas trend data and the remaining models were calibrated to within 10% of the pro-rated gas consumption due to the inconsistency of trend data.

The following graphs show a monthly comparison of the campus' actual 2006 electric and gas usage as compared to the eQuest modeled usage.







j. Where manual calculations are employed, formulas, assumptions and key data shall be stated.

Lighting Retrofit Calculations

A detailed lighting audit was conducted at each building on the CSU East Bay campus. The audit includes individual fixture details, fixture counts, and average annual run time by room usage group 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 kW is typically accomplished by using higher efficiency equipment. Reduction in hours typically relates to lighting control modifications, such as occupancy sensors.

The kW savings were determined as peak demand savings as opposed to annual demand savings. The equation used to determine the kW savings is:

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

The equation used to determine the kWh savings is:

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

The lighting audit and preceding equations were then used to produce an existing and post-retrofit lighting power density (LPD), which was entered into the building simulations to produce lighting savings. For buildings that were not simulated using eQuest, spreadsheets were used to produce savings.

The lighting audit, detailed calculations and buildings simulations are included in Section 12.0 Technical Appendix.

Water Conservation Calculations

Water conservation measures are proposed for nine buildings. The net savings for this ECM were calculated by estimating 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.

The equation used to determine the water savings is:

$$\sum Water_{savings} = \sum \left[\left(\left(Flowrate_{fixture} \right)_{baseline} - \left(Flowrate_{fixture} \right)_{retrofit} \right) \times Usage \right]$$

The detailed calculations and fixture audit are included in the Section 12.0 Technical Appendix.

Swimming Pool Filtration System Calculations

The pool filtration system ECM will save gas, water and electricity by replacing the filtration system with a diatomaceous earth filter and by installing a VFD on the circulation pump. The diatomaceous earth filter will provide water savings by requiring significantly fewer backwashes each year as compared to a hi-rate sand system. Gas will be saved by not having to heat the additional water the hi-rate sand filter system uses in backwashing. The water and gas savings were calculated using the following equations:

$$Water_{savings} = \left(Gallons_{backwash} \times Backwashes_{year} \right)_{Sand} - \left(Gallons_{backwash} \times Backwashes_{year} \right)_{DE}$$

$$Gas_{savings} = \frac{Water_{savings} \times 8.3 \times \Delta T}{Efficiency_{system}}$$

The installation of a VFD on the filtration system's circulation pump will allow the pump to operate at less than full speed the majority of operating time, decreasing the electrical consumption of the pump. The speed of the pump will be determined by the total dynamic head requirements of the filtration system, which is dependant on the cleanliness of the filter. The electrical savings from the VFD was calculated using the following Pump Affinity Laws:

$$\frac{H_{baseline}}{H_{retrofit}} = \frac{(N_{baseline})^2}{(N_{retrofit})^2}$$

$$\frac{BHP_{baseline}}{BHP_{retrofit}} = \frac{(N_{baseline})^3}{(N_{retrofit})^3}$$

Specific detailed calculations are included in the Section 12.0 Technical Appendix.

Computer Energy Management Software (Verdiem)

This software will save the campus electricity by listening for network connectivity between the computer and the network and adjusting the computer Standby, Hibernate, Sleep, and Shutdown modes on each computer based on power management profiles developed for groups of users on the server.

The base assumption in estimating energy savings is that each computer uses 70 watts on average per Verdiem. Verdiem also feels this is conservative particularly for computers running Vista, as it is considered a large energy consumer.

Based on information provided to Chevron ES by Verdiem, which is backed by their in-field testing and installed base of experience, the energy savings were calculated at $20 per computer per year ($0.12 / kWh blended rate X 2500 computer count provided by the campus IT Department).

Section 8.0 Grant / Rebate Incentive Applications

Identify and list any and all rebate and incentive programs the proposed projects are eligible for including all related documentation necessary to successfully complete the application process. Service Provider is responsible for identifying and initiating the rebate and incentive process and shall provide the campus with a Ghant Chart (Microsoft Project) schedule identifying key milestones and responsible parties and task functions assigned.

Chevron ES has extensive experience in working with Utilities, large and small, to secure energy incentives, tax credits and rate reductions. Specifically, over the last several months we have worked closely with SFSU campus and the Chancellor's Office in connection to a controls retrofit to apply for rebates under the UC/CSU/IOU Energy Efficiency Partnership Program. This process has involved providing detailed calculations of energy savings and working with the campus, the Chancellor's Office and EMCOR to substantiate those savings. We will follow the same process for all rebate incentives under this program for CSU East Bay.

Under the IOU Partnership Program which is coordinated through Aaron Klemm in the CSU Chancellor's Office, we will be submitting applications and back up calculations required in order to obtain rebates for the following ECMs once they are approved by the campus:

- Heat System Upgrades
- EMS Control Systems and Air Side Retrofits
- Lighting Retrofit
- Water Conservation Upgrades (for therms saved only)
- Swimming Pool Filtration System Upgrades
- Verdiem Computer Power Management Software

2006/2008 UC/CSU/IOU Partnership Program - FORM B: Retrofit Project Application Form

Milestone	Responsible	Duration (Days)	Planned Date	Note
Application Submitted	Campus		1-Aug-07	Date application submitted to IOU and NAM
IOU Technical Approval	IOU	14	15-Aug-07	Large, complex projects may take longer
Management Team Approval	Mgt. Team	14	29-Aug-07	
Co-funding Signed	Campus		1-Aug-07	CSU requirement
Notice of Project Approval & RPCP Sent	IOU	7	5-Sep-07	
RPCP Signed and Returned	Campus	7	12-Sep-07	
Invoice #1 Submitted	Campus		12-Sep-07	Invoice #1 should be submitted with signed RPCP
Invoice #1 Paid	IOU	30	12-Oct-07	
Eng./Design Contract Executed	Campus		n/a	If applicable. (CSU guideline: 14 calendar days)
Construction Contract Executed	Campus		1-Oct-07	If applicable. (CSU guideline: 28 calendar days)
Construction 50% Complete	Campus		1-Apr-08	(CSU Guideline: SOW <$200,000 schedule 6 weeks, SOW $200,001-$500,000 schedule 10 weeks, SOW >$500,001 schedule 16 weeks)
Construction 100% Complete	Campus		1-Aug-08	(CSU Guideline: SOW <$200,000 schedule 6 weeks, SOW $200,001-$500,000 schedule 10 weeks, SOW >$500,001 schedule 16 weeks)
Project Complete, Notify IOU and NAM	Campus		1-Sept-08	
Project Verified	IOU	14	15-Sept-08	
Invoice #2 Submitted	Campus	1	16-Sept-08	
Invoice #2 Paid	IOU	30	15-Oct-08	

Section 9.0 Project Performance Measurement Criteria

Identify the measurement points and describe the calculation methods that will be used to determine the avoided energy costs that will occur after installing and/or implementing the energy conservation measures for the project. Provide a Measurement and Verification (M&V) Plan in accordance with International Protocol for Measurement & Verification standards including a schedule of metered points, frequency of measurement recording and data acquisition and a sample of the report format and baseline comparison data that will be used to calculate the Schedule and Performance Risk Value.

For the CSU East Bay energy conservation program, an Option D based measurement and verification (M&V) plan is recommended. An Option D M&V involves verifying savings though the use of calibrated whole building simulation models. This is the most cost effective approach since simulation models have already been developed for most of the buildings on campus, covering most of the ECMs. Some ECMs, namely Water, Pool Filtration and non-modeled Lighting, were estimated though spreadsheets. For these ECMs, representing ~10% of the overall savings value, stipulation is recommended.

Computer Simulation Modeling for the IGA Report
The eQuest program was used to produce simulation models representing nine of the largest buildings on campus. These nine buildings cover 82% of the campus square footage. Savings were calculated using the Oakland Area CZ03 TMY weather data and version 3.60.5200 of the eQuest program.

Further details can be found in Section 7.0 Savings Calculations and complete eQuest simulations are included on CD in Section 12.0 Technical Appendix.

ECM Descriptions
Three ECMs, were evaluated in all building models.

- Heating System Upgrades
- EMS Replacement and Air side and EMS Modifications
- Lighting Retrofits

These ECMs were broken down to 14 parametric runs in eQuest and modeled in a cascaded fashion such that every subsequent parametric run is executed based on the results of the preceding ones.

Further details can be found in Section 6.0 Cost Savings Analysis, Section 7.0 Savings Calculations and Section 12.0 Technical Appendix.

Baseline and Baseyear Conditions
After discussion with and at direction from CSU East Bay the baseline is based on the 2006 baseyear conditions and energy usage. These conditions are reflected as eQuest baseline model parameters transcribed from information gathered during the

detailed auditing process. After all of the ECMs have been installed, the original baseline models will be regenerated from the calibrated post-installation models.

Measurements

Electricity submeters have been installed on the following buildings:
Arts and Education Building, Library and Warren Hall, Meiklejohn Hall, Science Building Complex, Music and Business, Physical Education, Theater, and Student Health buildings. (All modeled buildings except for Robinson Hall.)

Gas submeters have been installed on the following buildings:
Arts and Education Building, Library and Warren Hall, Meiklejohn Hall, Science Building Complex, Music and Business, Physical Education, and Student Health buildings. (All modeled buildings except for the Theater and Robinson Hall.)

The submeter data files will be collected from the EMS system on a monthly basis after all of the ECMs have been installed and deemed operational. After collection, each data file will be analyzed to ensure data quality and to make sure that the expected savings are taking place.

Data will be gathered for up to 12 months. This time series data will be used to produce monthly usage summaries as well as 24 hour load shapes, required for model calibration.

Post-Installation and Calibration

After the ECMs have been installed, the post-installation models will be updated with as-built information and site data. These models will be re-run using the actual weather data from station CZ03, and calibrated using the submetered data summaries.

The calibrated post-installation models will then be adjusted to remove the ECMs to recreate the baseyear conditions. This will be the new baseline model.

Final Avoided Cost Calculation

The new baseline models and the calibrated post-installation models will be re-run on a parametric basis using TMY averaged weather data from station CZ03. This will produce the new savings results for each ECM category presented in the IGA report.

The same utility rates will be utilized to calculate avoided cost savings.

Reporting
The final results will be presented using the following table format:

ECM Summary										
				Measurement and Verification Results						
ECM #	ECM	M&V Option	IGA Annual Cost Avoidance	Avoided kWh	Avoided kW	Avoided Therms	Avoided Water & Sewage CCF	Realized Annual Cost Avoidance	Performance (80% limit)
1	Heating System Upgrades	Option D	**$72,071**	76,778	120	66,378	0	**$72,071**	**100.0%**
2	EMS Replacement & Air Side Retrofits	Option D	**$397,454**	2,646,513	6,534	112,540	0	**$397,454**	**100.0%**
3a	Lighting Retrofits	Option D	**$71,405**	701,939	1,648	-7,240	0	**$71,405**	**100.0%**
3b	Lighting Retrofits (Non-modeled)	Stipulated	**$23,715**	189,718	39	0	0	**$23,715**	**100.0%**
4	Water Conservation Retrofits	Stipulated	**$48,504**	0	0	2,365	14,570	**$48,504**	**100.0%**
5	Swimming Pool Filtration System Upgrades	Stipulated	**$10,156**	0	0	994	427	**$10,156**	**100.0%**
6	Verdiem Computer Power Management Software	Stipulated	**$62,500**	500,000	0	0	0	**$62,500**	**100.0%**
	TOTAL	$9,244,978	**$685,804**	4,114,948	8,341	175,037	14,997	**$685,804**	**100.0%**

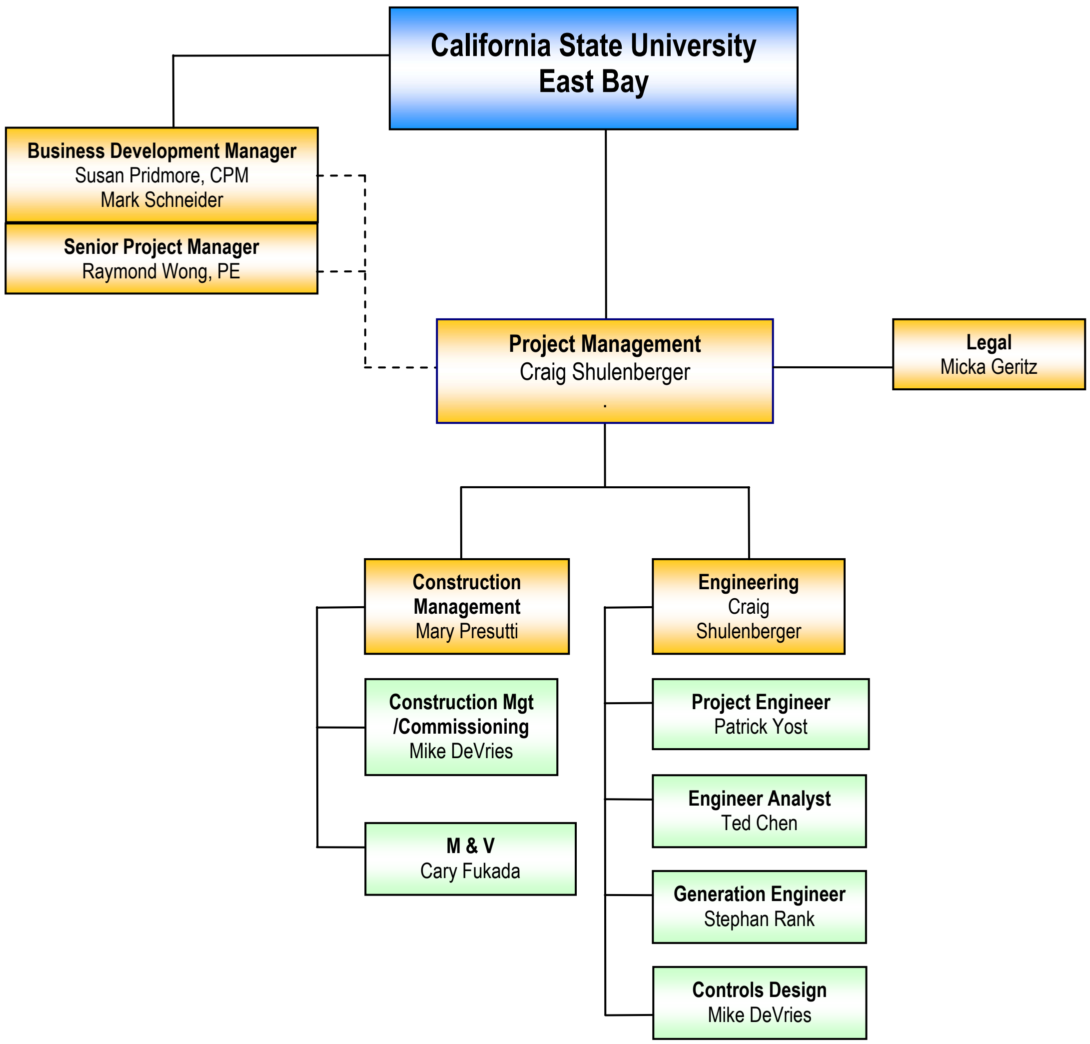
Note: Table above is exemplary of format for presentation of M&V results.
Values (shown with 100% performance) are indicative only.

Since each ECM produces a combination of electricity and gas savings, performance will be evaluated on a total cost avoidance basis.

The final M&V report submittal will include all model input and output files as well as a narrative and calibration notes. The submetered data files and summaries will also be included.

10.0 Service Provider's Staff Experience

Provide Project Organization Chart including, resumes for each of the individuals who will be assigned to this IGA or to construct the project. Include name, current duties, specific relevant experience, and role this person will play on this IGA or to construct the project.



Name and Title	JAMES L. KOZELKA, Project Manager
Years at CES / Overall years of experience in industry	2 / 27
Education-Degrees, schools and years obtained	Hobart College, Geneva, NY, BA, Maths and Psychology HVAC Certificate, UC Berkeley Extension
Role I will play for CSU East Bay project	Manage all elements of project development, implementation and cost control of energy conservation measures for the CSU East Bay campus that are aligned with the CSU master plan and strategic energy reduction program Work with the CES team and CSU EB campus staff to ensure the highest overall project integrity and safe implementation of all work.
Current overall duties with CES	**Focus**: Leading project teams to analyze and implement energy efficiency and HVAC infrastructure upgrade projects. **Perform**: Manage all elements of project development and implementation involved with taking projects from conceptual design through construction and commissioning. **Responsibility**: On-budget, on-time completion of energy savings projects including duties such as: preliminary and detailed energy surveys, project engineering, purchasing, subcontracting, construction administration, scheduling and commissioning.
Specific experience related to Higher Education Markets	Provided mechanical design services for institutions for over 15 years. Experience in energy conservation retrofit projects for colleges, counties and cities throughout California. Involved in developing design/build and plan/spec retrofit projects.
At least two client references with name and number	**Solectron Corporation**, David Gunter, Sr. Facility Mgr. (408) 956-7507 **John Muir Mount Diablo Health System**, Vince Scoccia, Director of Plant Services (925) 947-5306 **US Postal Service**, Joe Vandenberg, Environmental Specialist (562) 494-2272
Short description of projects worked on in last five years	**US Postal Service**: Manage all auditing, design/engineering and retrofit implementation of HVAC and lighting efficiency projects at multiple facilities. Scopes of work include replace central heating and cooling plants, upgrade HVAC systems and install new DDC control systems. **Solectron Corp.**: Manage all auditing, design/engineering and retrofit implementation of HVAC & lighting efficiency projects at multiple facilities. Scope of work includes lighting upgrades, compressor/ dryer and motor replacement, new DDC controls installation. **John Muir Mount Diablo Health System**: Managed all auditing, design/engineering and retrofit implementation of HVAC efficiency projects. Scopes of work include unique project to add return/exhaust fans to existing packaged rooftop equipment to resolve gross building over-pressurization problem, upgrade central cooling plant and expand existing DDC controls system **Sutter Solano Medical Center**: Performed evaluation of HVAC systems and Primary Essential Power serving 40 year old hospital. Developed and wrote Master Plan including scopes of work and budget featuring replacement of central chiller and boiler plants, 700-kW Emergency Power System, operating room suite electrical and Air Handling Systems. **Multiple Cogeneration Systems, Greater SF Bay Area**: Performed all facets of project development, design/engineering and implementation including all Mechanical, Electrical and DDC Controls design for over 30 cogeneration projects.

Name and Title	CRAIG SHULENBERGER, Lead Project Engineer
Years at CES / Overall years of experience in industry	2 / 26
Education-Degrees, schools and years obtained	University of California, Davis, BA Art/Architecture, 1977 LEED v2 Accredited Professional
Role I will play for CSU East Bay project	Developing energy conservation measures for the mechanical systems while making sure East Bay's needs are met. Provide Mechanical Engineering design and design review services for energy conservation measures implemented.
Current overall duties with CES	Duties include performing mechanical system surveys; this information is used to prepare detailed comprehensive energy conservation opportunity assessments for the facility. Perform cost analysis, modeling, HVAC retrofit design, and construction management.
Specific experience related to Higher Education Markets	Provided mechanical design services for institutions for over 15 years. Experience in energy conservation retrofit projects for Colleges, Counties and Cities throughout California. Involved in developing design/build and plan/spec retrofit projects.
At least two client references with name and number	**Los Rios Community College District**, Mike Goodrich, Director, Energy/Utility Resources (916) 856-3403 **U.C. Davis Medical Center**, Michael Lewis, Senior Engineer (916) 734-8685 **John Muir Medical Center**, Vince Scoccia, Director of Plant Services (925) 947-5306 **County of Marin**, Rich Wallace, Maintenance Supervisor (415) 499-6576
Short description of projects worked on in last five years	**Los Rios Community College District**: Developed and implemented a project to install hydronic boilers to supply a newly remodeled building. Currently developing the project to connect that heating water system to additional buildings on the campus. **US Postal Service**: Developed energy conservation retrofit projects at fifteen facilities in northern California. **San Ramon Unified School District:** Designed the mechanical systems for science and classroom buildings for the new Dougherty Valley High School in San Ramon with the architectural firm of Akol and Yoshi. **U.C. Davis Medical Center**: Design and construction supervision of the following: Underground steam distribution system to supply the main hospital from the new central plant. New chilled water and heating water supply to main hospital from the central plant distribution systems. Conversion of the chilled water and heating water systems to variable flow. **City of Sacramento**: Designed the replacement of the chilled water system for the Sacramento Convention Center. **County of Marin**: Designed the replacement of the chilled water plants for both the Administration Building and the Hall of Justice at the Marin County Civic Center, a historical Frank Lloyd Wright designed building.

Name and Title	STEPHAN RANK, Lead Project Engineer
Years at CES / Overall years of experience in industry	5 / 9
Education-Degrees, schools and years obtained	Cal Poly SLO, BS Mechanical Engineering, 1991
Role I will play for CSU East Bay project	Developing energy conservation measures for the CSU East Bay campus that meet the needs of the facility and staff. Work with the CES team and campus staff to ensure safe implementation of all work at the campus.
Current overall duties with CES	Duties include project management and project development for a wide range of customers included waste water treatment plants, water districts, various commercial/industrial customers and educational facilities.
Specific experience related to Higher Education Markets	Provided account management and project management services to Cal Poly SLO for a large lighting project in 2000/20001 while I was with a previous employer.
At least two client references with name and number	**City of Millbrae WPCP**, Dick York, Plant Superintendent, Water Pollution Control Plant (650) 259-2388 **Montara Water & Sanitary District**, George Irving, District Manager (650) 728-3545
Short description of projects worked on in last five years	**Millbrae WPCP Cogeneration Project**: Development and ongoing project management of a unique project which involves a new 250-kW Microturbine fired by methane gas produced at the host wastewater treatment facility. The project also involves significant civil improvements which will improve methane production as well as a grease receiving station which will receive kitchen grease trap waste to be injected into the plants digesters. This will result in a substantial increase in the amount of methane generated for use by the microturbine. **Inergy Services Cogeneration Project**: Conceptual design and project economics modeling for a 1.2 MW gas turbine project which utilizes a large duct firing heat recovery unit to heat the host facilities process thermal media (high temperature oil). **General Chemical Cogeneration Project**: Conceptual design and construction support, commissioning and training. The project utilized a 1.3 MW natural gas fired engine with exhaust used to supplement an existing thermal process at the sulfuric acid re-processing plant. **TRM Manufacturing Cogeneration Project**: Conceptual design and construction support of a 1.5 MW cogeneration project at a plastic products manufacturing plant in Corona, CA. **Chevron Corporation Energy Efficiency Projects**: Worked on a wide variety of energy efficiency projects at a variety of facilities. Main effort (ongoing) involves developing a new modeling tool that will simulate pumping energy so that the Chevron Pipeline company can better manage energy costs.

Name and Title	MIKE DeVRIES / Construction Manager
Years at CES / Overall years of experience in industry	7 / 22
Education-Degrees, schools and years obtained	Associate Degree in Electronic Communication, South Dakota Technical School, 1975
Role I will play for CSU East Bay project	Developing Chevron's energy savings plans with regard to HVAC controls and Energy Management Systems. During construction phase of project, act as liaison between contractors and campus to ensure needs are being met. At completion, commission all systems for quality and correctness.
Current overall duties with CES	Development of Energy Management Systems and savings. Coordination and Commissioning of contractor's work. Installation of web-based utility monitoring systems.
Specific experience related to Higher Education Markets	21 years of experience in the commercial buildings/energy management field, incorporating systems design, installation, and service in community, county and state educational facilities.
At least two client references with name and number	**Foothill-De Anza Community College District**, John E. Schultze, Director of Facilities Construction 408-949-6150 **Community College District of San Mateo**, Jose Nunez and Linda DaSilva, Directors of Facilities, 650-358-6836 and 6726
Short description of projects worked on in last five years	**Foothill-De Anza Community College District**: New Central Plants, new controls and mechanical upgrades to all buildings, solar and microturbine cogeneration. Over 3000 EMS points covering two million square feet over two campuses. **San Mateo Community College District**: New Central Plants, new controls and mechanical upgrades to all buildings, solar and natural gas cogeneration. Over 4000 EMS points covering two and a half million square feet over three campuses. **Los Angeles City College**: New Central Plant installation. Retrofit/ upgrade all existing mechanical systems. Over 1800 points covering 1.3 million square feet. **Alameda County, Santa Rita Jail**: Conversion of central plant to variable flow, installation of 1 megawatt solar system and 1-MW fuel cell cogeneration system **Moscone Convention Center**: Recommissioning of entire energy management system, complete retrofit of lighting systems, installation of 500-kW solar system. **St. Mary's College**: Comprehensive retrofit of lighting, HVAC, and energy management systems.

Name and Title	MARY PRESUTTI, Construction Manager
Overall years of experience in industry	35 years, last 5 with Chevron Energy Solutions
Education-Degrees, schools and years obtained	California State University Long Beach, CA ,3 years
Role I will play for CSU East Bay project	Lead Construction Project Manager responsible for the day to day activities at the site, scheduling of projects, man power for the project, interface with the client, engineers, and subcontractors to bring each aspect of the project to fruition with scope, schedule and budget in mind.
Current overall duties	Responsible for the design and technical coordination and development of construction documents, the coordination and procurement of subcontractors and equipment and the construction activities related to the various types of projects. Meeting with the client to discuss scope, management of all parties to reach the desired goal of the client.
Specific experience related to Higher Education Markets	Construction Manager on site on the **Health Sciences Campus, USC** for their chilled water site distribution project. CM on site for the **CSULB Summer Initiative Program** for the energy upgrades to numerous buildings. Lead Construction Manager, **Long Beach Unified School District Seismic Upgrade of lighting** on 71 campuses and over 500 buildings. From 2002 to present, as the Construction Project Manager on site for the **San Mateo County Community College District** to complete $26mm worth of energy upgrades to their three campuses and main Administrative Building.
At least two client references with name and number	Jose Nunez, **Vice Chancellor in charge of Facilities, SMCCCD**, 650-642-7151 Linda daSilva, **Executive Director & Facilities Transition**, SMCCCD, 650-642-7143
Short description of projects worked on in last five years	**San Mateo County Community College District – 4 year project** Central Plant Heating and Hot Water Conversion to Primary/Secondary systems on each of the three SMCCCD campuses. Lighting upgrade to all of the buildings, including motion sensors and energy efficient lamps and ballasts. Complete building management system, District wide, controlling all HVAC equipment and the majority of the exterior lighting on the campuses. Chilled Water plant, with campus wide underground distribution, on one of the 3 campuses Construction of two emergency generator plants, one to support the radio/TV station on the CSM campus and one to backup the District Administrative building. Construction of a new radio/TV administrative space along with new control room, transmission facilities and ancillary spaces, and the renovation of existing control rooms and studios. Repair and replacement of sanitary sewer and heating and hot water underground piping on all three campuses. Construction of a transmitting station at Sutro Tower, San Francisco CA for the KCSM radio and TV stations, with redundant power sources and innovative cooling systems. Numerous projects involving the complete renovation and repurposing of spaces on the campuses, including general, mechanical, electrical and control system renovations.

Name and Title	TED CHEN, Project Engineer
Years at Chevron & Engineering Overall years of experience in industry	1 / 12
Education-Degrees, schools and years obtained	Tong Ji University, Shanghai, China, BSME, 1994 LEED v2 Accredited Professional
Role I will play for CSU East Bay project	Assist in developing energy conservation measures for the mechanical systems while making sure East Bay's needs are met. Provide Mechanical Engineering design and design review services for energy conservation measures implemented.
Current overall duties with Chevron.	Perform mechanical system surveys, prepare detailed comprehensive energy analysis report, perform cost analysis, modeling and HVAC system design.
Specific experience related to Higher Education Markets	None
At least two client references with name and number	Jon Riddle, Herman & Coliver Architecture, 415-552-9210 Jonace Bascon, WRN Studio, 415-489-2246
Short description of projects worked on in last five years	**Stanford Outpatient Center**: participated in design development and prepared construction documents of the 250,000 OSHPD facility using 100% outside air and indirect evaporative cooling. **Walnut Creek Library**: schematic design and design development of the 45,000 sf library using underfloor air supply aiming for LEED Accreditation. **Hillsborough School District**: design and construction administration of various renovation projects as well as new construction. **Bruce Nuclear Power** (8 units totaling 7000 MW): Amenities building (100,000 sf) heat recovery system design review Critical room cooling analysis and site CFC phase-out strategy Bruce A chillers overhaul and reactor vault coolers replacement

Name and Title	PATRICK YOST, Project Engineer
Years at CES / Overall years of experience in industry	2/2
Education-Degrees, schools and years obtained	California Polytechnic State University, San Luis Obispo, CA, Bachelor of Science in Mechanical Engineering, 2005 LEED v2 Accredited Professional
Role I will play for CSU East Bay project	Assist in development of energy conservation measures for mechanical systems and implementation of these measures to ensure CSU East Bay's needs are met.
Current overall duties with CES	Duties include design of mechanical systems and construction management duties at the San Mateo Community College District. Construction management duties include verification of energy conservation measures' implementation and management of contractors to ensure the client's needs are met.
Specific experience related to Higher Education Markets	Assistant construction manager for a large energy conservation retrofit project at the San Mateo Community College District. Involved in energy conservation projects from initial design to final construction.
At least two client references with name and number	**San Mateo Community College District,** Jose Nunez and Linda DaSilva, Directors of Facilities, 650-358-6836 and 6726
Short description of projects worked on in last five years	**San Mateo Community College District**: Assisted with construction of a central chiller plant, electrical infrastructure improvements and HVAC retrofits, including a retrofit at KCSM 's studios.

Name and Title	RAYMOND WONG, Senior Project Manager
Years at CES / Overall years of experience in industry	8 / 12
Education-Degrees, schools and years obtained	University of California at Berkeley, BSME, 1994 Santa Clara University, MBA, 2005
Role I will play for CSU East Bay project	Overseeing the CSU East Bay project team making sure East Bay's needs are met.
Current overall duties with CES	Team leader for a team of 9 project managers, construction managers and project engineers.
Specific experience related to Higher Education Markets	Experience in energy conservation for Community College Districts, Counties and Cities throughout California. Projects include San Mateo CCD, Sacramento CCD, and Solano Community College.
At least two client references with name and number	**USPS, San Francisco**, Ted Chin, Facility Manager, San Francisco (415) 550-5442 **City of Richmond,** CA, Ralph Lloyd, Electric Shop Supervisor (510) 231-3033
Short description of projects worked on in last five years	**San Jose City College/Evergreen Valley City College**: HVAC and EMS design, Construction Management **City of Manteca**: Project development and management of a comprehensive energy services project consisting of lighting retrofits, new energy management system, water supply system upgrade (new SCADA system and new industrial VFD's and check valves for city's pump stations), waste water treatment plant retrofits (ultra fine bubbles diffusers, new aeration blowers, digester pumps and co-generation system). **City of Richmond:** Project development and management of a comprehensive energy services project consisting of lighting retrofits, new energy management system, central hot water plant repairs, modernization and variable flow pumping upgrades, central chilled water plant expansion and modernization, air handling system refurbishment and replacement, underground piping repairs, and the construction of two reciprocating engine based cogeneration system including medium voltage electrical system integration. **USPS San Francisco Processing Center and Postal Center:** Project development and management of a comprehensive energy services project consisting of lighting retrofits, new energy management system, air compressor system retrofit, modernization and variable flow pumping upgrades, central chilled water plant modernization, air handling system refurbishment and replacement, photovoltaic and cogeneration system (250-kW fuel cell)

Name and Title	SUSAN PRIDMORE, Business Development Manager
Years at CES / Overall years of experience in industry	4 (total) / 17
Education-Degrees, schools and years obtained	Ohio University, BS, 1976 Project Management Certificate at University of Phoenix, 2006
Role I will play for CSU East Bay project	Developing Chevron's offerings while making sure East Bay's needs are met. During construction phase of project act as liaison between Chevron and campus to ensure quality of work is being met
Current overall duties with CES	Business Development throughout CA in the education and State of California sectors
Specific experience related to Higher Education Markets	Business development for institutions for over 17 years. Experience in energy conservation projects for several Community College Districts, K–12 school districts, and counties in northern California. Involved in developing design/build energy projects that affect an institution's bottom line economically, developing financial structures for the projects.
At least two client references with name and number	**Stockton Unified School District**, Mitch Slate, Mgr. Mechanical Division (209) 933-7050 **County of Calaveras**, Tom Mitchell, CAO (209) 754-6633
Short description of projects worked on in last five years	**Stockton Unified School District**: Energy Audit and project development for $12M project involving complete controls retrofit including web access; new rooftop units; and some lighting. **County of Calaveras**: $2.0M project converting small central plant to fully distributed with new equipment at each served building; small lighting project; and controls. **County of Sacramento**: $1.5M project for HVAC retrofit, lighting, and controls. Hot water solar was proposed but not implemented.

Name and Title	MARK SCHNEIDER, Business Development Manager
Years at CES / Overall years of experience in industry	6½ / 12
Education-Degrees, schools and years obtained	West Virginia University, BA, 1990
Role I will play for CSU East Bay project	Developing Chevron's offerings while making sure East Bay's needs are met. During construction phase of project act as liaison between Chevron and campus to insure quality of work is being met
Current overall duties with CES	Business Development throughout CA in the higher education sector
Specific experience related to Higher Education Markets	Business development for institutions for over 10 years. Experience in energy conservation for Community College Districts, Counties and Cities throughout California. Involved in developing design/build energy projects that affect an institution's bottom line economically. Experience in "green" renewable power as well as cogeneration and distributed generation.
At least two client references with name and number	**San Diego Community College District**, Richard Burkhart, Construction Manager, 619-388-6546 **College of the Canyons**, James Schrage, Dean Physical Plant, 661-362-3222
Short description of projects worked on in last five years	**California State Universities, Campus-wide Lighting Retrofit (4 campuses)**: Audit/design/construct a 2.5 million dollar lighting retrofit at 4 northern CA CSU campuses one of which was East Bay. Extreme deadline of June 30, 2006, needs to be met to ensure PG&E incentive money of $2 million dollars to pay for the project. **College of Canyons**: Complete bond-funded energy conservation program which included a pool cogeneration system and football stadium lighting retrofit. **San Diego Community College District**: Two campuses served. Two cogeneration projects. One campus is a 60-kW microturbine and the campus is a 1.5-MW cogeneration system. Both campuses also had electrical upgrades on their switchgear. **County of Santa Clara**: Energy audits of 120 facilities owned by the County which included two jails and a hospital. We have been doing construction work in four phases and we continue to get work from the County. We are currently in discussions with the County for a program of fuel cells, approximately seven fuel cells. **Albertsons Grocers**: Sold and completed an entire lighting retrofit of all 17 Albertsons Distribution Centers throughout the Country.

Section 11.0 Service Provider's Project Experience

State the number of years your firm has provided services similar in size, scope and complexity. Provide three (3) representative projects completed within the past five (5) years. Include a description of the firm including size, organizational structure and office locations.

Chevron Energy Solutions Company (Chevron ES) is a division of Chevron USA, Inc., a wholly owned subsidiary of Chevron. It was formed through Chevron's acquisition of several premiere legacy energy services companies with roots dating back to the early 1970's, and is today one of the largest providers of comprehensive, high-quality conservation performance projects in the country. Headquartered in San Francisco, Chevron ES has a large presence specifically in California with a large number of successful public agency projects installed, particularly in education facilities. Scopes of work implemented includes energy management / controls installations and mechanical / central plant renovations similar to what is being proposed by CSU East Bay. Additionally Chevron ES has significant experience with power systems, cogeneration / distributed generation, photovoltaic solar and fuel cell design and installation.

Chevron ES is a powerful solution along with the campus mechanical engineering firm, Cogent Energy Inc, to bring CSU East Bay this proposed project to successful fruition. Below is a list of representative projects Chevron ES has individually completed:

Project Title	Location	Project Description
Chevron Energy Solutions		
San Mateo Community College District	San Mateo, CA	• Performing $30M of projects from 2004 to present • Lighting retrofit campus wide • Campus wide EMS system including zone controls • Campus wide chilled water piping • New chillers • Underground utilities upgrade and electrical panel upgrades • HVAC unit replacements and VFDs • New backup generation units, • New access controls at CSM campus
Foothill Community College District	Los Altos Hills, CA	• Performed $13M projects from 2001-2005 • New 170 ton chiller • Campus wide lighting retrofit • Economizers • Pool filtration and solar covers • EMS expansion • (8) 60kW microturbines; 201kW tracking solar PV; 100kW stationary solar PV; new and upgraded structural, electrical and mechanical systems

Project Title	Location	Project Description
California State University, Northern CA Lighting Retrofit	Northern, CA	• Project totaled $2.6 million dollars • 4 campus project (Sonoma, SF State, SJSU and East Bay) • Lighting retrofit for special PG&E Incentive project
San Diego Community College District	San Diego, CA	• Contract value to date over $13 Million dollars 2 campuses involved (Mesa, Miramar) • Central Plant Expansion project • 725kW cogeneration project • Boiler expansion project • Complete Electric Utility Infrastructure project

12.0 Technical Appendix

This section contains technical information for utility data, survey data, building simulation analysis and recommended/not recommended ECMs. The detailed descriptions for each ECM includes: scope of work, equipment audits, drawings, primary equipment cut-sheets, and white papers on proposed technologies.

All supporting technical information is contained on the accompanying CD according to the following file structure:

Technical Appendix

1. Utility Data

2. Survey Data

3. Building Simulation Analysis
   1) eQuest Models
   2) Building Model Input Data
   3) ECM Summary Files
   4) Calibration Sheet
   5) eQuest Output Data

4. Recommended ECMs - Detailed Descriptions
   1) Heating System Upgrades
   2) EMS Controls and Air Side Retrofits
   3) Lighting Retrofits
   4) Water Conservation Upgrades
   5) Swimming Pool Filtration System Upgrades

5. Not Recommended ECMs - Detailed Descriptions
   1) Desiccant System Retrofit
   2) Fuel Cell