Deep Energy Efficiency and Cogeneration Study Findings Report

September 12, 2014

Prepared for University of California, Office of the President

Prepared by ARC Alternatives
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Acknowledgements

This study was conducted by ARC Alternatives and TRC Energy Services.

We would like to acknowledge the following UC staff who contributed valuable input and time to this study:

George Getgen, Eric Eberhardt, Dirk van Ulden, John Rolle, Rashmi Sahai, David Stone, Kevin Ng, Joshua Morejohn, Justin Lewis, John Danby, Michael Mosca, Matt Gudorf, Bill Cowdell, Greg Eikam, Doug Koehler, Lewis Rosman, Jon Smithers, John Dilliott, Anna Levitt, Maric Munn, Bruce Shapiro, Winifred Kwofie, Jamie Hand, Zuhair Mased, Ken Mueller, Jordan Sager, Sukhi Sandu, Mike Dayton, Val Padilla and all others who participated in the discussions regarding deep energy efficiency and potential cogeneration system improvements.

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1. Executive Summary

In early 2014, UC President Janet Napolitano announced an initiative for UC to become carbon neutral by 2025. The initiative relies on four strategies to achieve its goal, including one centered on campus energy efficiency and another on natural gas and biogas. In order to continue progress toward the aggressive new carbon neutrality goal, there is a need to pursue bold new approaches. Two areas that offer potential greenhouse gas (GHG) reductions are the subject of this study: deep energy efficiency retrofits and improvements to cogeneration facilities.

This potential study identified opportunities in both areas, however the bulk of the opportunity is in deep energy efficiency. Taken together, identified projects could require investment of approximately $773 million dollars and result in substantial energy, cost and GHG savings.

For deep energy efficiency, in the most aggressive case, just under $766 million dollars are needed to fund retrofits which could save the University nearly $68 million dollars per year in utility costs, avoiding over 243,000 metric tons of CO2e annually. An additional investment of approximately $7 million in cogeneration efficiency improvements could result in additional annual utility cost savings and CO2e emissions reductions. Note that avoided compliance costs of the GHG reductions are not included in this study, but could represent further material financial benefit to the University.

Exhibit 1-1 Deep Energy Efficiency Potential Summary Estimate

	Low Estimate	*High Estimate*	*Average Estimate*
Investment Needed	$535,620,000	$765,835,000	$650,727,500
Utility Savings ($/year)	$50,913,000	$67,750,000	$59,331,500
CO_2e savings (tonnes/year)	179,239	243,444	211,342
Energy Savings			
kWh/year	368,701,000	484,915,000	426,808,000
Therms/year	12,949,000	18,485,000	15,717,000

Ideas for replicable deep efficiency projects came from two primary sources: campus interviews and past UC Energy Efficiency Partnership projects. Three standard deep energy efficiency projects resulted:

- Smart Labs
- Deep HVAC
- Deep Lighting

To estimate the deep efficiency potential associated with these three project types throughout the system, our analysis used cost and savings data from previously completed projects to develop ranges of savings and costs on a per gross square foot (gsf) basis that we designated the "deep project metrics." With the help of campus energy mangers to select candidate buildings and appropriate projects in each, these metrics were then applied to the buildings to determine potential savings.

Underpinning the deep energy efficiency portion of the study are the following working criteria for identifying projects from the historical analysis of UC's efficiency programs:

- Projects must represent a comprehensive, integrated retrofit approach at a building level targeting multiple energy end-uses.
- Projects must have savings of 50% or more from current building (site) energy use in at least one commodity, or, reduce building (site) EUI to below 50% of the UC Building Specific Benchmark (defined in the study).

Not surprisingly, deep energy efficiency costs significantly more on an annual per unit saved basis than typical projects. This study finds that UC's future potential deep efficiency retrofits have an overall average simple payback of 11 years. Other comparative cost metrics are presented in the conclusion. In order to achieve returns consistent with previous efficiency investments, a cost-based definition of deep energy efficiency for UC emerges:

> *Deep energy efficiency projects are those technically sound efficiency projects requiring a minimum 33% external equity contribution in order to match the previous portfolio's internal rate of return, independent of financing approach.*

For the cogeneration portion of the investigation, five of the UC campuses that operate a cogen plant were considered. The configuration and operation of the individual plants were discussed, disconnects between campus loads and plant capabilities were explored, and potential projects were investigated. In many cases, the campuses had previously identified cogeneration improvements and these particular projects comprise the majority of the identified opportunities. The projects are divided in two groups: efficiency improvements and capacity expansions. Because the focus of this study is saving GHG, we are primarily concerned with the efficiency improvements here. However, capacity expansion projects are also itemized in the cogen section for future reference and represent significant potential investment. We developed or compiled calculations of energy, monetary, and GHG savings based on plant configurations, identified operating conditions, historical utility consumption and spend, and emissions factors.

Exhibit 1-2 – Cogeneration Efficiency Improvement Opportunities Summary

	Estimate
Investment Needed	$7,010,100
Utility Savings, annual	$1,653,323
CO_2e savings (tonnes/year)	3,834

This planning study provides an initial identification and analysis of potential efficiency projects in candidate buildings and cogeneration plants. It is a potential study, unconstrained by economic or other implementation considerations. Additional investigation, auditing and engineering is required to confirm the feasibility, scope and investment-grade costs and savings of any specific project. However, taken as a portfolio of projects across the system, and at any given campus, the findings demonstrate that significant deep savings are available if the required investment is made.

2. Introduction

In early 2014, UC President Janet Napolitano announced an initiative for UC to become carbon neutral by 2025. The initiative relies on four strategies to achieve its goal, including one centered on campus energy efficiency and another on natural gas and biogas. UC has been successfully implementing energy retrofits for many years; however, in order to continue progress toward the aggressive new systemwide carbon neutrality goal, there is a need to pursue new approaches. Two areas that offer potential greenhouse gas (GHG) reductions, and are aligned with President Napolitano's initiative, are the subject of this study: deep energy efficiency retrofits and improvements to cogeneration facilities.

This is a potential study, providing initial identification and analysis of potential projects in candidate buildings and cogeneration plants. As such, it is unconstrained by economic or other implementation considerations. Additional investigation, auditing and engineering is required to confirm the feasibility, scope and investment-grade costs and savings of any specific project.

Deep energy efficiency is a term used with increasing frequency in California's energy policy circles, but its definition remains ambiguous and the criteria by which a project is considered "deep" is not standardized. This study defines deep efficiency criteria for purposes of analyzing historical projects and then quantifying the deep retrofit potential across the UC system. Buildings that are candidates for deep efficiency retrofits, and their corresponding potential, are characterized in terms of energy savings, GHG emissions reductions, dollar savings, and project costs.

The deep energy efficiency portion of this study relies in part on analysis of projects completed since 2006 under the UC/CSU/IOU Energy Efficiency Partnership ("Partnership"), as well as input from Campus energy managers. Many of the projects in the Partnership from 2009 and later were developed from the UC Strategic Energy Plan (SEP) which was completed in early 2009. It identified energy efficiency measures in buildings 50,000 gross square feet (gsf) and over. Of all identified measures in the 2009 SEP, campuses selected a subset for implementation, often grouping them together to form a distinct "project" in a building or multiple buildings. Additionally, new projects identified outside of the SEP, as well as projects completed from 2006 to 2008 were used in this analysis. As a result, references to "Partnership Projects" incorporate a greater set of projects than the SEP alone, including projects from other sources, projects completed earlier than the 2009 SEP, as well as projects currently underway. Furthermore, this study expands the set of buildings considered in the 2009 SEP by going deeper into the building stock and looking at buildings down to 40,000 gsf. As a result, the buildings where this study finds potential deep energy projects represent approximately 60% of total gsf systemwide.

UC's other interest in this study is to develop an understanding of potential cogeneration facility efficiency improvements that could deliver more energy output for the same or lower energy input, resulting in a net decrease in the total energy consumed by a campus. The projects identified are divided in two groups: efficiency improvements and capacity improvements.

Because the focus of this study is saving GHG, we are primarily concerned with the cogen efficiency improvements. However, capacity improvement projects are also itemized and represent significant potential investment, an order of magnitude greater than the efficiency improvements. There can be tradeoffs between electric and thermal outputs in considering cogen improvements, but particularly when combined with the biogas initiative, these improvements could generate net carbon reductions in line with UC policy. This study catalogs cogen improvement projects currently under consideration by the campuses and characterizes the purchased energy impacts, project costs and associated economics, as well as the impact on GHG emissions.

The report structure generally follows the sequence of the study. It starts by defining deep energy efficiency, then goes through the methodology to estimate deep efficiency potential. Results of the deep efficiency analysis are presented for the overall system in Section 5. Results for individual campuses follow in Sections 6 through 20. The analysis and results for potential cogeneration improvements are all contained in Section 21 followed by the conclusion and supporting appendices.

3. Defining Deep Energy Efficiency

The first step in this study was to perform a quick literature review to assess current thinking around characteristics of deep energy efficiency. The term has become commonplace in the last several years, but interestingly, there is little published that contains definitive information about what constitutes "deep." There were a few common and recurring themes, however, and we have provided some select extracts from papers dealing with the topic in Exhibit 3-1.

The first theme observed was the idea of comprehensiveness. Rather than the typical one-off, approach to efficiency projects, there is wide recognition that in order to achieve deep savings, no single solution will allow one to harvest all the energy savings potential. Multiple measures, targeting multiple end-uses in a deliberate strategy are required not only to achieve greater savings, but also to avoid stranding longer payback measures. The trend toward a more comprehensive approach is also facilitated by technology advancements. There are many integrated solutions in the marketplace today, such as shared control systems for HVAC and lighting that argue for addressing multiple efficiency opportunities as part of a comprehensive approach.

The second theme that emerged was that "deep" is typically equated with savings in the 50% range. The papers we reviewed applied their savings ranges, which covered the spectrum of 30% to 75%, to a variety of underlying conditions, from energy cost to energy savings, and from actual conditions to code requirements. Despite all this variability, what emerges is a fairly strong concept that the potential to save 50% is achievable and that aiming any lower than that, while certainly worthy, is not reaching deep enough.

Exhibit 3-1 – Select Quotations Concerning Deep Energy Efficiency

"Deep savings are possible (of 30-60%) and are demonstrated and documented in existing commercial buildings of various types, sizes and ownerships. However these represent a small fraction of the existing building energy saving potential. More comprehensive savings in existing buildings and wider market impact are critical to meeting targets and policies." *(Higgins, Cathy, "The 12 Themes of Retrofit," New Buildings Institute Blog, December 21, 2011)*	*"We define deep energy retrofits as a whole-building analysis and construction process that achieves much larger energy cost savings—sometimes over 50% reduction—than those of conventional, simple retrofits and fundamentally enhances the building value. Deep energy retrofits create deep energy savings but not necessarily all at once."* *(Retrofit Depot: Managing Deep Energy Retrofits. Rocky Mountain Institute, 2012. www.retrofitdepot.org)*
"Deep energy retrofit: A retrofit to increase energy efficiency that uses integrative design to improve the economics of efficiency and achieve bigger energy savings at equal or lower cost, driving much larger savings (more than 50%) than conventional, isolated energy retrofits" And "A deep energy retrofit is the process that yields buildings that save at least 50% annual energy	*"To achieve significant reductions in overall energy use by buildings, considerable effort will need to be directed at existing buildings due to the fact that most of the buildings that will exist in 2030 and even in 2050 in some countries already exist today. However, even long-lived buildings require periodic major renovations (and certainly at least once between now and 2050), which*

costs (compared with the average energy use of similar-type buildings with an attractive net present value (NPV)" while "A conventional retrofit will achieve 15–25% energy savings and thus will give attractive financial returns." *(Zhai, John, Nicole LeClaire, and Michael Bendewald. "Deep energy retrofit of commercial buildings: a key pathway toward low-carbon cities." Carbon Management 2.4 (2011): 425-430.)*	*provide opportunities for achieving deep (50–75%) reductions in energy use."* *(Harvey, LD Danny. "Reducing energy use in the buildings sector: measures, costs, and examples." Energy Efficiency 2.2 (2009): 139-163.)*
"The paper describes the application of a methodology and tools for early assessment of integrated system solutions for deep retrofit with a potential of 30-50% energy reductions across large building portfolio as well as at an individual building..." *(Surana, Amit; Taylor, Russell D.; Narayanan, Satish; and Otto, Kevin, "Rapid Assessment of Deep Retrofit System Solutions to Improve Energy Efficiency in DoD Installations and Buildings" (2012). International High Performance Buildings Conference. Paper 97. http://docs.lib.purdue.edu/ihpbc/97)*	*"A small but growing number of new commercial buildings incorporate these design approaches to reach a 50 percent savings in energy use—mainly in heating, cooling, air-conditioning, water heating, and lighting—compared with prevailing building codes. With appropriate policies and programs in place, such energy-efficient buildings could become the norm in new construction."* *(National Research Council, Real Prospects for Energy Efficiency in the United States, "Summary." Washington, DC: The National Academies Press, 2010.)*
"A good starting point for understanding the concept of zero net energy is a simple definition often ascribed to ASHRAE: "ASHRAE defines net-zero-energy buildings as those which, on an annual basis, use no more energy from the utility grid than is provided by on-site renewable energy sources. These buildings use 50 to 70 percent less energy than comparable traditional buildings, and the remaining energy use comes from renewable sources, like solar panels or wind turbines incorporated into the facility itself…" (Harrison2008). Some experienced practitioners would argue for even deeper efficiency (for example, 75% less than traditional buildings to reduce the cost of on-site renewable energy)." *(Elliott, John, and K. Brown. "Not Too Fast, Not Too Slow: A Sustainable University Campus Community Sets an Achievable Trajectory toward Zero Net Energy." Proceedings of. 2010.)*	

Determining the criteria for what constitutes deep energy efficiency for this study is complicated by a challenge common to many universities - there is inconsistent or missing information on whole building energy use across campuses. While UC has made great strides in this area over the past several years, thanks to programs like the Partnership's Monitoring Based Commissioning (MBCx) initiative, the fact remains that actual energy consumption at the building level for the target buildings is known and tracked in only a subset of the buildings systemwide. There is also a great deal of variation in metering infrastructure among campuses. The criteria for deep energy efficiency needs to take this fact into account if it is to be applicable in practice. The solution was to develop a benchmark-based approach and develop customized "building specific benchmarks" as described in Section 4. Ultimately, when building level metering is ubiquitous, and the resulting data is consistently and readily accessible, the criteria for Deep Energy Efficiency retrofits should move to one based on actual building energy use.

The literature review, research and discussions with UCOP and campus energy managers lead to the following working criteria for identifying projects from the historical analysis of UC's efficiency programs:

- Projects must represent a comprehensive, integrated retrofit approach at a building level targeting multiple energy end-uses.
- Projects must have savings of 50% or more from current building (site) energy use in at least one commodity, or, reduce building (site) EUI to below 50% of the UC Building Specific Benchmark (defined in the study).

For the second criteria, in either case, building potential savings are reduced for efficiency retrofits previously completed to acknowledge the comprehensive approach and to provide a more realistic assessment of remaining potential. Again, when the savings criteria for Deep Energy Efficiency retrofits ultimately moves to one based on actual building energy use, this type of adjustment will be unnecessary because past projects will automatically be reflected in the actual data.

Not surprisingly, deep energy efficiency costs significantly more on an annual per unit saved basis than typical projects. However, the expected useful life of such deep retrofits are also longer, thereby delivering savings over a longer period. This study finds that UC's future potential deep efficiency retrofits have an overall average simple payback of 11 years.

Based on our analysis and comparison to UC's previously successful energy efficiency investments, in order to achieve returns consistent with the 2006-2014 portfolio, a cost-based definition of deep energy efficiency for UC emerges:

> *Deep energy efficiency projects are those technically sound efficiency projects requiring a minimum 33% external equity contribution in order to match the previous portfolio's internal rate of return, independent of financing approach.*

The "external equity" can take the form of utility incentives, grants, or other external funding to directly offset the capital investment required for the deep measures. Additional illustrative unit costs are presented in the conclusion.

Other ideas to define deep efficiency were considered, but were ultimately discarded because they either over complicated the analysis, duplicated elements of the criteria, or were practically unworkable when it came to applying or assessing them. The discarded criteria included:

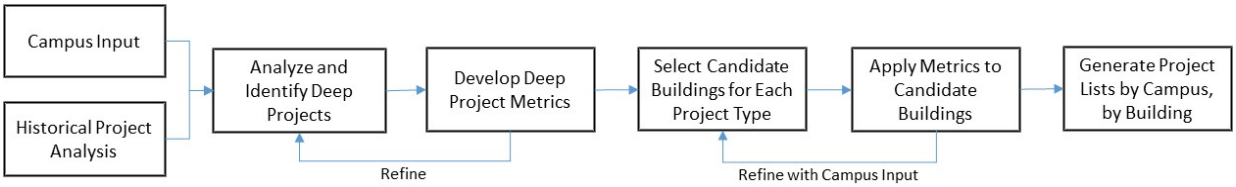
- Projects must effect at least 80% of gsf
- Projects must achieve a projected Energy Star building rating of 90 or better
- Project includes one or more energy savings measures that would not otherwise stand on their own from typical economic criteria, or that might normally be removed through "value engineering."

4. Estimating Deep Efficiency Potential - Methodology

4.1. Introduction

The process to identify and define deep efficiency projects, and then apply those projects to candidate buildings at each campus and medical center was an iterative one. Exhibit 4-1 provides a graphical representation of the overall methodology.

Exhibit 4-1 – Overall Methodology



Our analysis uses cost and savings data from completed deep energy projects to develop "deep project metrics" which are then applied to appropriate campus buildings to determine the potential savings of a deep energy efficiency program. The pool of potential deep efficiency projects came from two primary sources: campus interviews and past UC Partnership projects. The projects were analyzed and then characterized by the measures they included, the range of savings they could achieve on a per gsf basis, and a range of cost on a per gsf basis. These ranges of savings and cost are the deep project metrics and form the basis of the quantitative estimates in the study.

Once deep project metrics were determined, they were applied back to the target building stock to create candidate deep projects and determine energy savings potential and estimated cost. During this stage of the analysis, all previously implemented energy efficiency projects of the same type as the candidate deep measures in each building were subtracted out in order to avoid overestimating remaining potential and to inject some degree of conservatism into the calculations for both savings and cost.

4.2. Deep Energy Efficiency Project Descriptions

Our analysis of past projects and interviews with campus staff identified three main deep efficiency project types:

- Smart Lab
  - Deep Lab Retrofits
  - Exhaust Stack Discharge Velocity Reduction (ESDVR)
- Deep HVAC
- Deep Lighting

Deep Lab and ESDVR projects are combined in the final analysis under the more familiar "Smart Lab" name.

Deep Lab Retrofits. Deep Labs represent all portions of the holistic approach, as pioneered at UC Irvine, to retrofit lab space with the goal of reducing the air changes per hour (ACH) through air quality sensing (e.g. Aircuity) and/or occupancy based controls (a non-proprietary option), less the ESDVR portion described below. The project involves reduced fan, filtration and duct air speeds as well as reducing internal heat loads (e.g., low illumination power density, daylighting sensors, Energy Star equipment, and exhaust grilles directly above heat-discharging equipment). ACH reductions are achieved and controlled at the zone level, and are typically two ACH unoccupied to four ACH during occupied conditions. Experience in the UC system shows that these projects can cut lab energy use by half. This project type applies only to lab space.

Exhaust Stack Discharge Velocity Reduction (ESDVR). ESDVR is employed as part of the Smart Labs concept, either at the same time as the Deep Labs portion or following, as it requires variable air volume (VAV) systems. We evaluated it separately in this study because some campuses need only to complete the ESDVR portion of their Smart Lab projects. ESDVR involves a wind tunnel study to determine the optimal relationship between exhaust stack height and discharge velocity to allow reduced stack discharge velocity while meeting dispersion and entrainment requirements based on wind speeds. The exhaust stacks are heightened accordingly, and the exhaust fans and bypass are controlled to maintain the minimal discharge velocity, often in conjunction with a local weather station providing wind speeds as a control input, and to minimize bypass. This project only applies to buildings with lab space.

Deep HVAC Retrofits. Deep HVAC is a comprehensive retrofit of the building HVAC to include an integrative approach to all building systems and incorporate as many innovative technologies (fans, ductwork, VAV boxes, extending controls, pressure independent valves, heat pipes, occupancy sensor integration, and even cutting edge innovative ideas such as chilled beams, etc.) as possible. Target savings of 50% of the building HVAC energy can be achieved, and often requires the project be approached from a ground-up, best-practices approach which may be different than the business as usual case that seeks to minimize interruptions and maximize the simple payback of a project. The Deep HVAC can be delivered as a pure retrofit project, but may also have synergy if delivered in conjunction with an MBCx project to ensure optimization between systems and proper commissioning. This project applies to any building except where a Smart Lab project has been, or could be done.

Deep Lighting Retrofit. Deep Lighting consists of a comprehensive lighting retrofit that targets 50% reduction in building lighting energy through lighting and controls retrofits. While the measure is not technology specific, two main categories of projects are potential candidates. The first is a LED lighting retrofit with advanced controls, maximizing occupancy sensors, daylighting harvesting and automatically adjusting light levels based on conditions and occupancy. The second is an approach similar to the UC Davis Smart Lighting Initiative where retrofit designs consist of highly efficient lamp and ballast replacements and advanced lighting

controls, potentially delivered through a design-build contract that maximizes energy savings within the acceptable payback period.

A note about Monitoring Based Commissioning (MBCx). MBCx is not a deep project in and of itself. However, an expanded MBCx approach where retrofits would be combined with MBCx in a comprehensive building-based project, is a desirable delivery method for any project in some future program design scenarios. There are several potential advantages to using an MBCx approach, and special program rules would need to be developed to provide flexibility beyond current Partnership program constraints. Although we believe incremental savings are likely in such an approach, due to the uncertainty of future program design, and to be conservative in this estimate, we have not assumed any incremental savings attributable to an MBCx delivery approach.

As you can see, the deep project definitions provide for flexibility in the way a campus can implement a type of project. This variability, as well as the variability in the target building stock, are intentionally accommodated through our analysis approach by providing ranges for key metrics of cost and savings rather than single point estimates which imply a degree of precision inconsistent with the level of analysis. The ranges are applied to each project at the building level and carried through to campus and systemwide summary results, ultimately resulting in a statewide portfolio level range of savings and costs.

4.3. Initial Campus and Medical Center Input

All campus and medical centers (collectively "campuses") provided input at the beginning of the study, either through teleconferences or in-person meetings. Primary contacts were energy managers, and they brought other staff into the discussions as they deemed necessary. Background on the study was provided, including its purpose for UC and the working definition of deep energy efficiency. We also emphasized that the study was not bound by current Partnership or financial constraints, and that the timeframe for projects was 2016 and beyond.

Campuses identified past projects that they considered deep. These projects were flagged in the Partnership historical project analysis for further investigation. Campuses also provided ideas of projects that they would like to do more of, or things that they would do if they had additional funding. In some cases, these were projects with which the campus did not yet have direct experience.

Campuses also identified large, campus specific, projects that had large savings potential, but may not necessarily be applicable to other campuses. These types of projects are included in the discussion section of each campus, but are not added into the campus potential savings or cost summary.

4.4. Building Specific Benchmarks

In addition to projects highlighted by campuses, we needed a way to systematically highlight past projects for further investigation to determine if they could be classified as deep. The target

building set for this deep efficiency analysis was approximately 660 buildings systemwide over 40,000 gsf. Given that building-level energy consumption information was not readily available in the majority of these buildings, the analysis needed to rely on some other method to estimate savings as a percentage of building energy use. Several existing sources that were considered had significant limitations. The DOE Buildings Performance Database (BPD) is fairly new and has limited relevant data points. Available benchmarks, such as the California Commercial End-Use Survey (CEUS) and the Commercial Buildings Energy Consumption Survey (CBECS) are not granular enough to be useful. UC, however, had previously developed a set of benchmark-based, whole-building energy performance targets for each of its campuses based on 1999 actual energy use (see table in Appendix A[1]).

The 1999 UC Benchmarks that went into developing the performance targets (not the *performance targets* themselves) provided a good starting point for our analysis because they were, by definition, customized to each campus in the UC system. Each campus had benchmarks on a per gsf basis for three building types:

- Academic/Administrative Non-complex
- Housing Non-complex
- Lab/Complex

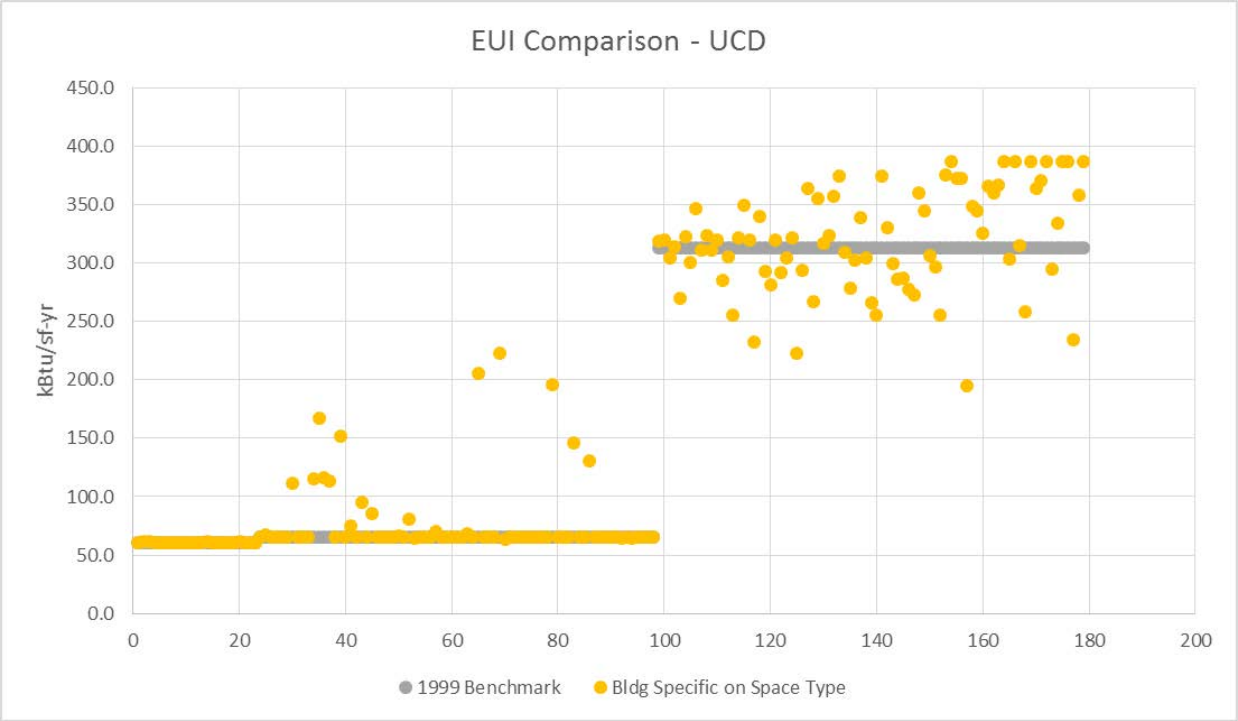
However, recognizing these benchmarks represent typical UC mixed-used buildings, for example a "complex" building would have some lab space and some office space, we sought a way to disaggregate these benchmarks and then reconstitute them at a building level to provide a greater level of granularity. We felt that classifying an entire building as only one of these three categories would not provide sufficient insight when assessing past projects for their deep potential in specific buildings.

UCOP provided their space type database, which assigns all buildings up to three main space types each, and the respective percentage of each type. We then classified the UCOP designated space types as non-complex, housing non-complex, and complex. By applying the corresponding percentage of each space type (i.e., complex vs. non-complex) at the campus level for all complex buildings, we backed into an estimated EUI for complex-only space within the mixed use. We checked the results to ensure that the average complex EUI for the campus remained at the overall 1999 UC Benchmark level. Then, applying the non-complex EUI and the derived complex-only EUI to the respective space types within a building, we created a "building specific benchmark" that would more closely estimate the energy profile of a given building based on its actual space profile. An illustration of this analysis for UC Davis is provided in Exhibit 4-2. Each orange point represents a specific building from the data set. The three gray horizontal lines correspond to the three different benchmark levels for each space category in the original 1999 Benchmarks. This analysis was repeated for each campus, and each building in

[1] Sahai, Rashmi, Catherine Kniazewycz, and Karl Brown. *Benchmark-based, Whole-Building Energy Performance Targets for UC Buildings. California Institute for Energy and Environment, March 2014.*

the data set. Section 4.5 further describes how these building specific benchmarks were employed in the study.

Exhibit 4-2 – Building Specific Benchmark vs. 1999 UC Benchmark



4.5. Historical Project Analysis

As of April 2014, UC had completed over 600 energy efficiency projects in the Partnership since 2006, not including new construction projects. Another 150 projects were in various stages of implementation, expected to be completed in 2014-2015. Many of these projects contained multiple measures and affected multiple buildings. We analyzed this set of approximately 750 historical projects to identify those that could be considered deep.

In order to develop a comprehensive, building-by-building view of past work, the first step was to split out large campus-wide and multiple building projects and assign them to their respective buildings if they were in our target building set. The savings for these projects were allocated to individual buildings where there was enough specific information to do so (e.g., from information in the Investor Owned Utility (IOU) review of the project provided by UCOP). In instances where there was not specific information, projects were allocated on a relative gsf basis, that is, by the building's gsf out of total project gsf.

Once the multiple building projects were allocated to individual buildings, the savings for all projects completed in a given building were totaled. The building savings totals were then compared to the building specific benchmarks described previously to screen those buildings

with comprehensive projects that achieved 50% or better reduction (i.e., the "deep screen"). A particular focus for further investigation was the Deep HVAC projects, and to a lesser degree, the Deep Lab projects. For ESDVR projects, since the number of projects completed was so limited, we could identify them readily without the need to flag them from the building benchmarking exercise. For Deep Lighting, we faced the opposite problem – there were so many lighting projects that using the total savings achieved at an individual building from past efficiency projects compared to the benchmark proved to be unfruitful. Ultimately, we used the UCD Smart Lighting project, which covered approximately 40 buildings, as the sample. That said, it was still important to understand the historical lighting projects completed in each building in order to adjust the potential future savings due to deep measures after we applied the metrics as described in Section 4.5

For a study of this scale, and considering the potential variability at this level of analysis, we developed ranges for savings and cost, on a per gsf basis, for each deep project type. In general, a set of historical projects for each deep project type was analyzed to calculate the deep metrics. To remove outliers both on the high and low end, the full project set for Deep Lab, Deep HVAC and Deep Lighting was plotted on a scree plot (see Appendix C). The projects above the highest knee, and below the lowest knee, were removed based on both the savings and cost plots. The remaining projects formed a solid data set for further analysis. For ESDVR projects, the entire data set was used because the sample set was small and well defined.

Next, the average and standard deviation were calculated for the projects remaining in the data set. The high/low range for the metric was set at ±0.25 standard deviation. Because the data set was already particularly focused on deep efficiency projects, we felt a tight range around the average was justified. In practical terms, the range of savings and cost provides for flexibility, and the resulting variability in the specific implementation of measures within a deep project, as well as the variability in the target building stock. Specific analytical considerations for determining metrics for each deep project type are discussed below.

Exhaust Stack Discharge Velocity Reduction. All instances of ESDVR projects are considered in our analysis due to the limited number of projects and all were implemented at UC Irvine. The savings and cost metrics were determined per gsf of lab space only. The lab space was determined from the UCOP Space Type database (for this and Deep Labs). Although the gsf of actual lab space is estimated based on the method by which UC allocates gsf, both the derivation of the metric and the application back to candidate buildings uses the same space allocation method, so there should be parity within this exercise. However, as mentioned before, although the savings and cost metrics are valid for the purposes of this study, they should not be applied outside of this exercise without careful consideration and probable adjustment.

Deep Lab. Although there are fewer historical Deep Lab projects than HVAC, a good number of campuses have done some Deep Lab projects or parts of them, including UCD, UCI, UCLA, UCSD, UCSF, and UCSB. All projects that passed the deep screen and had a Deep Lab component were initially included and then the scree analysis was used to remove outliers. The savings and costs metrics were determined per gsf of lab space only. The lab space was

determined from the UCOP Space Type database just as for ESDVR and therefore the same considerations described above apply.

Deep HVAC. Historically, there were hundreds of different HVAC projects across nearly all the campuses. Clearly, not all of them are deep, even when screened against the building specific benchmarks. Those projects that passed the deep screening exercise were further compared to Utility project reviews to confirm details. Deep HVAC projects were also identified based on description provided by campus; for example, if a campus believed it was a deep retrofit, but it didn't get flagged through the benchmark analysis, it was included. The resulting project set was then subjected to the scree analysis to remove outliers. The savings and costs metrics were determined per gsf of non-complex buildings (primarily non-lab buildings), and no Smart Lab projects were included in the data set.

Deep Lighting. While a great deal of lighting has been retrofitted through the Partnership, little has been deep by current standards. As such, we used the Smart Lighting Initiative currently underway at UCD in approximately 40 buildings as the set of projects best representing achievable savings and real implementation costs. The project set was subjected to the scree analysis to remove outliers. The savings and costs metrics were determined per gsf of total building space. Note that exterior lighting and parking garages are not included in the Deep Lighting category.

The methodology results in the metrics presented in Exhibit 4-3 associated with each deep project type. A note of caution – these metrics should not be interpreted as general rules of thumb applicable to any building, even within the UC system. We took care to develop and then apply these metrics in a consistent manner so there is a degree of parity between the derivation of the numbers based on a space type and their subsequent application to space types within each candidate building.

Exhibit 4-3 – Deep Project Metrics

	Deep Project Metrics for Calculations							
	Electricity		Natural Gas		Demand		Cost	
	kWh/applicable gsf		thrms/applicable gsf		kW/applicable gsf		$/applicable gsf	
	Low	High	Low	High	Low	High	Low	High
ESDVR	5.7	7.5	-	-	0.6	0.9	$3.51	$3.85
Deep Lab	9.8	13.4	0.5	0.6	0.5	0.9	$15.82	$25.34
HVAC	3.0	3.9	0.2	0.4	0.3	0.7	$3.42	$4.85
Lighting	1.9	2.2	-	-	0.3	0.4	$2.06	$2.40

4.6. Characterizing the Potential Deep Projects

Once the estimates of savings and costs for deep projects had been estimated on a per gsf basis (see Exhibit 4-3) the next step was to apply these metrics to buildings where such projects could make sense and determine the total energy savings potential for the building's applicable gsf.

ESDVR and Deep Lab projects obviously apply only to lab space. Deep HVAC and Deep Lighting can apply to all spaces. However, because Deep Lab implementations cover HVAC, and some also include lighting measures, we avoid over estimating by applying these metrics only to non-lab space when the building is also a Deep Lab candidate. So, in an untouched building, with both lab and non-lab spaces, the most comprehensive deep project can include all four of the deep projects, applied to the appropriate spaces. If previous retrofits in the deep retrofit categories have been done in a building, those were accounted for by subtracting their savings from the deep project potential.

A key step in determining which deep retrofits are applicable in which buildings was to engage the campuses again for input. To prepare for their input, we took a first pass at candidate buildings by applying the deep project metrics to all buildings and their applicable gsf (i.e., ESDVR and Deep Lab only to lab space). We then subtracted out past projects. Accounting for past projects was done on a project type basis for each building. All retrofit (but not MBCx) Partnership projects since 2006 were aggregated by ESDVR, Deep Lab, HVAC, and Lighting categories, by building. The total savings already achieved in each category was subtracted from the total deep savings potential in each of four deep project types as calculated above. On the cost side, to adjust for past projects we calculated the effective cost to achieve the remaining savings directly from our metric rather than subtracting out past project costs.

If the remaining potential was negative or negligible, we assumed it was not a candidate for further retrofit and marked it as such. If remaining potential was large, we flagged it as a candidate. If the potential was small, or for some other reason questionable, we highlighted the projects to make sure the campuses reviewed them. This initial list, without the estimated savings or cost, was then provided to the campuses requesting their input to confirm or change the designation of each deep project type in each candidate building based their specialized knowledge (e.g., building age, potential demolition, material change in use, master planning considerations, or other showstoppers).

With campus feedback by building, we again applied the metrics and evaluated the resulting projects. If after accounting for past projects the remaining savings potential was negative or small (less than 50,000 kWh), we removed that particular deep project from the candidate building.

Campus feedback also included some deep projects still flagged as questionable, or as a "maybe." Although the campuses erred on the side of inclusiveness, after discussion on the topic, we determined that we needed two categories of candidate projects:

- Tier 1 – those that were good candidates
- Tier 2 – those that were possible candidates, but had uncertainty either in the campus ability to do a particular project in a particular building, or in the project's outcome

We designated any "questionable" or "maybe" feedback as Tier 2 projects and carried that distinction through the analysis. We assigned a discount factor of 80% to the Tier 2 project

savings and costs to account for the uncertainty associated with their implementation and scope.

Prior to finalizing the report, we conducted a final campus feedback loop. The building list, this time including savings and cost estimates, was circulated to campuses. Campuses were asked to:

- Confirm that the right projects were in the right buildings and identify any additional deep project candidates or flag any projects that were questionable. In some cases, campuses put back in project candidates that we removed if there was small remaining potential after accounting for past projects. In these specific instances, we now removed the small project threshold cutoff discussed above so that the project, however small, would remain a candidate as long as it had positive remaining potential.
- Move projects between Tier 1 and Tier 2
- Spot check potential savings estimates against the actual building energy use.
- Review the cost factors applied at the campus level.
- Confirm average utility rates (used 2011 rates) or provide updated rates

Specific considerations when applying the deep project metrics to buildings are described below, with one of the overarching objectives to maintain parity with the way the deep project metrics were generated in the first place.

Exhaust Stack Discharge Velocity Reduction. Applicable only to lab buildings with VAV. The metric is applied only to lab space, and only if a previous ESDVR project had not been completed in the building.

Deep Labs. Applicable only to lab buildings and the metric is applied only to lab space. If a previous full Smart Lab project has been completed, for example those at some UCI labs, then this project is not applicable. However, if only some components of Smart Lab had been completed, then this project is still applicable as the previous project savings were subtracted as part of the calculation to determine remaining potential.

Deep HVAC. Applicable to all buildings, but the metric is applied only to non-lab space if the building is also a candidate for Deep Lab, or if any previous Smart Lab measures have been completed. This is to avoid double counting HVAC related savings from a Smart Lab project. Otherwise, the metric is applied to the full building. Parking space is excluded in all cases.

Deep Lighting. Applicable to all buildings but the metric is applied only to non-lab space if the building is a candidate for Deep Lab, or if any previous Smart Lab measures have been completed. This is to avoid double counting lighting related savings from a Smart Lab project, even though such lighting is possibly a small overall impact in the lab space. Parking space is excluded in all cases.

4.7. Adjustments to the Deep Metrics

Before applying the metrics to the candidate building stock, two other adjustments were necessary. The first was to recognize the potential differences in cost to implement energy efficiency among the campuses. The second applies specifically to medical centers to adjust their savings potential at some types of medical center buildings.

In our discussions with campuses and medical centers, we asked for feedback on appropriate cost factors. As expected, older, urban campus such as UCB and UCSF reported that energy efficiency retrofits are particularly challenging and costly. We have included UCLA in this group as well. The reasons for higher costs at these three campuses include:

- High cost of construction in urban areas
- High rise buildings
- Older buildings and greater presence of hazardous materials, such as asbestos
- Lack of space for student surge and project staging
- Complexity of research space vs. undergraduate campuses (UCSF)

As expected, medical centers face additional unique challenges and all reported increased cost as compared to similar projects on the main campuses. The primary drivers for increased costs at medical centers are similar to those above, but also include:

- Added complexity for accommodation and staging considering patients
- Added accommodation for bio-hazards and medical equipment
- Significant added requirements due to OSHPD, particularly in OSHPD-1 areas (Acute Care, In-Patient)

To accommodate the varied conditions across campuses, we assigned the following cost factors in Exhibit 4-4. The factors themselves are based on information provided by campuses, as well as engineering judgment, consistent with the high-level nature of this study.

Exhibit 4-4 – Cost Factors

UCB	1.25
UCD	1
UCI	1
UCLA	1.25
UCM	1
UCR	1
UCSB	1
UCSC	1
UCSD	1
UCSF	1.5
UCD MC OSHPD 1	2.25
UCD MC non-OSHPD/OSHPD 3	1.5
UCI MC OSHPD 1	2.25
UCi MC non-OSHPD/OSHPD 3	1.5
UCLA MC OSHPD 1	2.25
UCLA MC non-OSHPD/OSHPD 3	1.5
UCSD MC OSHPD 1	2.25
UCSD MC non-OSHPD/OSHPD 3	1.5
UCSF MC OSHPD 1	2.25
UCSF MC non-OSHPD/OSHPD 3	2.25

The other adjustment needed for medical centers has to do with the savings achievable in OSHPD-1 buildings. Deep HVAC retrofits are severely limited in OSHPD-1 spaces because only constant air volume systems are allowed. The inability to go to VAV systems precludes a good deal of the potential savings. There is also a challenge in even getting into some areas to do any retrofits at all. To be conservative in accommodating these challenges, we reduced the potential HVAC savings by ½ in OSHPD-1 buildings.

4.8. CO_2e Calculation

The potential GHG impact from the energy savings was calculated according to the default emissions factors published by The Climate Registry (see Appendix B) and Equation 12j from The Climate Registry General Reporting Protocol guidebook.

The default emissions factors used were:

- Natural Gas - US Weighted Average
  - 53.02 kg CO2/MMBTU
  - 0.001048 kg CH4/MMBTU
  - 0.000991 kg N2O/MMBTU

- Electricity – eGRID WECC California
  - 658.68 lbs CO2/MWh
  - 0.02894 lbs CH4/MWh
  - 0.00617 lbs N2O/MWh

Applying the formulas from Exhibit 4-5 results in the following CO_2e values, which in turn were applied to the energy savings estimated in this study to determine the GHG savings:

- 0.000299916 metric tons CO_2e/kWh
- 0.005302204 metric tons CO_2e/therm

Exhibit 4-5 CO_2e Conversion Formula[2]

Equation 12j	**Converting to CO_2e and Determining Total Emissions**			
CO_2 Emissions (metric tons CO_2e)	=	CO_2 Emissions **x** (metric tons)	1 (GWP)	
CH_4 Emissions (metric tons CO_2e)	=	CH_4 Emissions **x** (metric tons)	21 (GWP)	
N_2O Emissions (metric tons CO_2e)	=	N_2O Emissions **x** (metric tons)	310 (GWP)	
Total Emissions (metric tons CO_2e)	=	CO_2 + (metric tons CO_2e)	CH_4 + (metric tons CO_2e)	N_2O (metric tons CO_2e)

[2] "General Reporting Protocol Version 2.0." The Climate Registry, Mar. 2013. Web.

5. Deep Energy Efficiency – Systemwide Results

5.1. Systemwide Deep Efficiency Potential

The total University of California systemwide potential is tabulated in the table below for all projects identified in this investigation. The savings, along with project economics and a resulting aggregate simple payback, are shown for the range of savings for each project type, as well as the systemwide potential.

Table 5.1: University of California System Potential Savings Summary, All Projects

	Total Building Deep Potential								Economics			
	Electricity (kWh/yr)		Gas (th/yr)		Demand (kW)		Cost ($000)		Utility Savings ($000)		Simple Payback (yrs)	
	Low	High	Low	High	Low	High	Low	High	Low	High	Low	High
SmartLab	210,183,630	285,432,806	5,850,462	7,805,547	15,457	23,865	$ 302,434	$ 456,610	$ 27,195	$ 36,860	11.1	12.4
Deep HVAC	91,184,929	120,794,027	7,098,818	10,679,323	9,866	22,398	$ 135,280	$ 193,834	$ 15,481	$ 21,275	8.7	9.1
Deep Lighting	67,332,011	78,688,006	-	-	10,748	12,515	$ 97,907	$ 115,392	$ 8,236	$ 9,615	11.9	12.0
Total	368,700,570	484,914,839	12,949,280	18,484,870	36,072	58,778	$ 535,620	$ 765,835	$ 50,913	$ 67,750	10.5	11.3

Based on campus reviews and input into the potential deep efficiency projects in the identified buildings, the total potential is further broken down into the Tier 1 (reasonably certain candidate projects) and Tier 2 (questionable candidate projects) categories. Tier 1 projects comprise the majority of the potential. The resulting savings and economics are presented in the following two tables.

Table 5.2: University of California System Potential Savings Summary, Tier 1

	Total Building Deep Potential								Economics			
	Electricity (kWh/yr)		Gas (th/yr)		Demand (kW)		Cost ($000)		Utility Savings ($000)		Simple Payback (yrs)	
	Low	High	Low	High	Low	High	Low	High	Low	High	Low	High
SmartLab	201,611,104	273,829,730	5,575,042	7,440,573	14,839	22,908	$ 287,221	$ 433,673	$ 26,033	$ 35,293	11.0	12.3
Deep HVAC	68,255,693	90,396,051	5,252,883	7,912,803	7,378	16,746	$ 100,840	$ 144,421	$ 11,689	$ 16,048	8.6	9.0
Deep Lighting	55,020,239	63,879,502	-	-	8,913	10,348	$ 79,288	$ 92,909	$ 6,810	$ 7,903	11.6	11.8
Total	324,887,036	428,105,284	10,827,925	15,353,376	31,130	50,003	$ 467,349	$ 671,004	$ 44,532	$ 59,244	10.5	11.3

Table 5.3: University of California System Potential Savings Summary, Tier 2

	Total Building Deep Potential								Economics			
	Electricity (kWh/yr)		Gas (th/yr)		Demand (kW)		Cost ($000)		Utility Savings ($000)		Simple Payback (yrs)	
	Low	High	Low	High	Low	High	Low	High	Low	High	Low	High
SmartLab	8,572,526	11,603,075	275,420	364,973	618	957	$ 15,213	$ 22,936	$ 1,162	$ 1,567	13.1	14.6
Deep HVAC	22,929,236	30,397,976	1,845,935	2,766,521	2,489	5,651	$ 34,440	$ 49,413	$ 3,792	$ 5,227	9.1	9.5
Deep Lighting	12,311,772	14,808,504	-	-	1,835	2,167	$ 18,618	$ 22,483	$ 1,427	$ 1,711	13.1	13.1
Total	43,813,534	56,809,555	2,121,355	3,131,494	4,942	8,775	$ 68,271	$ 94,832	$ 6,381	$ 8,505	10.7	11.1

Results by campus are shown in the table below, and details of savings by project type, tier and buildings can be found in the individual campus portion of this report, sections 6 through 20.

Table 5.4: University of California System Potential by Campus, All Projects

	Total Building Deep Potential											
	Electricity (kWh/yr)		Gas (th/yr)		Demand (kW)		Cost ($000)		Utility Savings ($000)		Simple	
	Low	High	Low	High	Low	High	Low	High	Low	High	Low	High
UC Berkeley	68,717,734	91,098,179	2,560,041	3,698,900	6,519	11,272	$ 102,079	$ 147,920	$ 9,174	$ 12,387	11.1	11.9
UC Davis	31,821,553	42,631,287	1,059,846	1,479,087	2,822	4,519	$ 37,969	$ 55,859	$ 2,949	$ 3,989	12.9	14.0
UC Irvine	8,614,470	11,584,870	392,202	562,885	773	1,446	$ 10,970	$ 15,985	$ 1,408	$ 1,913	7.8	8.4
UCLA	93,345,786	121,086,913	3,393,127	4,831,656	9,559	15,289	$ 138,345	$ 195,886	$ 13,436	$ 17,631	10.3	11.1
UC Merced	4,820,634	6,274,167	180,823	257,715	490	793	$ 5,628	$ 7,963	$ 926	$ 1,224	6.1	6.5
UC Riverside	29,510,823	38,881,814	1,004,868	1,397,713	2,710	4,276	$ 35,470	$ 51,385	$ 2,890	$ 3,847	12.3	13.4
UC San Diego	34,689,839	46,336,807	910,766	1,305,254	3,453	5,315	$ 38,535	$ 55,664	$ 4,837	$ 6,526	8.0	8.5
UC San Francisco	26,402,750	35,712,835	736,880	1,038,259	2,012	3,244	$ 47,682	$ 71,335	$ 4,064	$ 5,529	11.7	12.9
UC Santa Barbara	19,623,426	26,002,400	607,674	853,598	1,829	3,081	$ 23,799	$ 34,727	$ 2,203	$ 2,948	10.8	11.8
UC Santa Cruz	14,721,929	19,626,132	592,374	835,821	1,330	2,253	$ 17,837	$ 26,218	$ 2,266	$ 3,049	7.9	8.6
UC Davis MC	16,976,234	21,312,344	698,837	1,028,519	2,114	3,405	$ 33,779	$ 44,941	$ 3,651	$ 4,686	9.3	9.6
UC Irvine MC	4,234,578	5,312,817	166,885	245,043	527	836	$ 7,856	$ 10,451	$ 888	$ 1,137	8.8	9.2
UCLA MC	6,568,019	8,082,525	259,233	386,272	896	1,406	$ 14,441	$ 18,639	$ 779	$ 990	18.5	18.8
UC San Diego MC	5,061,935	6,448,108	157,321	223,812	575	858	$ 12,173	$ 16,812	$ 783	$ 1,018	15.6	16.5
UC San Francisco MC	3,590,860	4,523,639	228,404	340,335	464	785	$ 9,055	$ 12,049	$ 660	$ 875	13.7	13.8
Total	**368,700,570**	**484,914,839**	**12,949,280**	**18,484,870**	**36,072**	**58,778**	**$ 535,620**	**$ 765,835**	**$ 50,913**	**$ 67,750**	**10.5**	**11.3**

The total impacts on greenhouse gas (GHG) emissions at the system level have also been tabulated for all range of potential project savings. The metric tons of carbon dioxide equivalent are presented in the table below, including details attributable to the two tiers of projects.

Table 5.5: University of California System GHG Impact Summary

	GHG Savings (Metric Tons C02e/yr*)	
	Low	High
All Deep Projects	179,239	243,444
Tier 1	154,851	209,802
Tier 2	24,388	33,642

*eGrid average factors used, including CH_4 & N_2O impacts:

0.000299916 metric tons CO_2e/kWh

0.005302204 metric tons CO_2e/therm

5.2. Overall Result Comparisons

The total resulting energy savings for the deep efficiency projects were checked against historical utility purchases to ensure the overall sensibility of the potential savings found. The total savings in site energy on a kBTU basis was calculated to account for the impacts of cogeneration at campuses, and compared to the total kBTU of purchased utilities for the most recent year data was available systemwide, which is 2012. At the system level, the high deep energy potential could save up to 17% of the total energy systemwide, or 13% using the low estimated potential. At the campus level, the savings range between 5% and 25% for the low estimate and 6% to 34% for the high estimate, excluding UC Merced. UC Merced is an outlier at 38% to 52%, which upon investigation has little gas use and is already very efficient with therms; it has less than 40% of the expected EUI from the 1999 benchmark and the deep energy potential is projected to save a significant percentage of remaining campus gas purchases. Like all projects, additional investigation and engineering is necessary to confirm detailed project opportunities along with savings and costs, however, for purposes of this report, because Merced is relatively small percent of the total system gross square feet, the gas savings for Merced is approximately 1.5% of the total deep potential, and any incremental adjustment to its deep savings potential has a minimal impact on the overall results.

The buildings where this study finds potential deep energy projects represent approximately 60% of total gsf systemwide.

6. UC Berkeley – Deep Efficiency Potential

6.1. Campus Deep Efficiency Potential

The total campus potential is tabulated in the table below for all projects identified in this investigation. The savings, along with project economics and a resulting aggregate simple payback, are shown for the range of savings for each project type, as well as the campuswide potential.

Table 6.1: UC Berkeley Potential Savings Summary, All Projects

	Total Building Deep Potential								Economics			
	Low	High	Low	High	Low	High	Low	High	Low	High	Low	High
	Electricity (kWh/yr)	Electricity (kWh/yr)	Gas (th/yr)	Gas (th/yr)	Demand (kW)	Demand (kW)	Cost (x$1000)	Cost (x$1000)	Utility Savings (x$1000)	Utility Savings (x$1000)	SPB (yrs)	SPB (yrs)
SmartLab	35,995,885	48,843,648	1,024,290	1,359,249	2,628	4,065	$ 56,096	$ 84,948	$ 4,572	$ 6,181	12.3	13.7
Deep HVAC	20,885,282	28,017,690	1,535,751	2,339,651	2,125	5,117	$ 29,943	$ 43,500	$ 3,347	$ 4,697	8.9	9.3
Deep Lighting	11,836,567	14,236,841	-	-	1,766	2,090	$ 16,040	$ 19,473	$ 1,255	$ 1,509	12.8	12.9
Total	68,717,734	91,098,179	2,560,041	3,698,900	6,519	11,272	$ 102,079	$ 147,920	$ 9,174	$ 12,387	11.1	11.9

Based on campus review and input into the potential deep efficiency projects in the identified buildings, the total potential is further broken down into the Tier 1 (reasonably certain candidate projects) and Tier 2 (questionable candidate projects) categories. The resulting savings and economics are presented in the following two tables, respectively.

Table 6.2: UC Berkeley Potential Savings Summary, Tier 1

	Total Building Deep Potential								Economics			
	Low Electricity (kWh/yr)	High Electricity (kWh/yr)	Low Gas (th/yr)	High Gas (th/yr)	Low Demand (kW)	High Demand (kW)	Low Cost (x$1000)	High Cost (x$1000)	Low Utility Savings (x$1000)	High Utility Savings (x$1000)	Low SPB (yrs)	High SPB (yrs)
SmartLab	31,306,003	42,511,319	904,445	1,200,436	2,260	3,512	$ 49,336	$ 74,971	$ 3,986	$ 5,392	12.4	13.9
Deep HVAC	9,595,365	12,839,414	620,045	959,226	909	2,260	$ 13,757	$ 19,934	$ 1,475	$ 2,069	9.3	9.6
Deep Lighting	7,508,292	8,743,887	-	-	1,206	1,399	$ 10,174	$ 11,960	$ 796	$ 927	12.8	12.9
Total	48,409,660	64,094,620	1,524,490	2,159,662	4,374	7,172	$ 73,267	$ 106,865	$ 6,257	$ 8,388	11.7	12.7

Table 6.3: UC Berkeley Potential Savings Summary, Tier 2

	Total Building Deep Potential								Economics			
	Low Electricity (kWh/yr)	High Electricity (kWh/yr)	Low Gas (th/yr)	High Gas (th/yr)	Low Demand (kW)	High Demand (kW)	Low Cost (x$1000)	High Cost (x$1000)	Low Utility Savings (x$1000)	High Utility Savings (x$1000)	Low SPB (yrs)	High SPB (yrs)
SmartLab	4,689,882	6,332,329	119,845	158,813	369	552	$ 6,760	$ 9,977	$ 586	$ 788	11.5	12.7
Deep HVAC	11,289,917	15,178,275	915,706	1,380,425	1,216	2,857	$ 16,186	$ 23,566	$ 1,873	$ 2,628	8.6	9.0
Deep Lighting	4,328,274	5,492,954	-	-	560	691	$ 5,865	$ 7,513	$ 459	$ 582	12.8	12.9
Total	20,308,074	27,003,559	1,035,551	1,539,238	2,144	4,100	$ 28,812	$ 41,056	$ 2,917	$ 3,999	9.9	10.3

The total impacts on greenhouse gas (GHG) emissions at the campus level have also been tabulated for all range of potential project savings. The metric tons of carbon dioxide equivalent are presented in the table below, including details attributable to the two tiers of projects.

Table 6.4: UC Berkeley GHG Impact Summary

	Low	High
	GHG Savings (Metric Tons C02e/yr*)	GHG Savings (Metric Tons C02e/yr)*
All Deep Projects	34,183	46,934
Tier 1	22,602	30,674
Tier 2	11,581	16,260

*eGrid average factors used, including CH_4 & N_2O i

0.000299916 metric tons CO_2e/kWh

0.005302204 metric tons CO_2e/therm

6.2. Deep Efficiency Project Summary by Building

The table beginning on the following page provides a view of the project applicability for each of the four deep efficiency project categories by building, and the savings and cost ranges for the buildings.

Table 6.5: UC Berkeley Projects by Building

Building Key	Building Name	Basic Gross Area	Projects by Building				Total Building Deep Potential							
							Low Electricity (kWh/yr)	High Electricity (kWh/yr)	Low Gas (th/yr)	High Gas (th/yr)	Low Demand (kW)	High Demand (kW)	Low Cost (x$1000)	High Cost (x$1000)
			ESDVR	Deep Lab	Deep HVAC	Deep Lighting								
01C1002	CLEARY	58,355			Tier 2	Tier 1	158,413	196,399	7,008	10,443	21.1	34.4	$ 222	$ 290
01C1024A	REGATTA3200A	380,461			Tier 2	Tier 1	1,631,441	2,022,642	72,177	107,548	217.3	354.3	$ 2,282	$ 2,986
01C1072	MANVILLE	71,614			Tier 2	Tier 1	251,768	312,139	11,139	16,597	33.5	54.7	$ 352	$ 461
01C1092	CHANNIN2535	71,994			Tier 2	Tier 1	308,715	382,741	13,658	20,351	41.1	67.0	$ 432	$ 565
01C1095	WARREN	69,032			Tier 1	Tier 2	303,980	399,796	16,370	24,392	24.5	56.8	$ 428	$ 597
01C1098	RESSTUSRVBLD	85,906			Tier 1	Tier 1	419,670	523,782	20,372	30,355	54.7	92.3	$ 589	$ 778
01C1142	JACKSON	47,694			Tier 2	Tier 1	204,515	253,555	9,048	13,482	27.2	44.4	$ 286	$ 374
01C1145	RH1 CHRSTIAN	66,391			Tier 2	Tier 1	284,689	352,954	12,595	18,767	37.9	61.8	$ 398	$ 521
01C1146	RH1 SLOTTMAN	70,051			Tier 2	Tier 1	300,383	372,412	13,289	19,802	40.0	65.2	$ 420	$ 550
01C1147	RH2 TOWLE	67,155			Tier 2	Tier 1	287,965	357,016	12,740	18,983	38.4	62.5	$ 403	$ 527
01C1148	RH2 WADA	68,791			Tier 2	Tier 1	294,980	365,713	13,050	19,446	39.3	64.1	$ 413	$ 540
01C1149	STANLEY	304,333	Tier 1	Tier 1		Tier 2	3,826,415	5,159,717	112,780	149,450	285.3	435.1	$ 5,962	$ 8,958
01C1202	WELLMAN	43,910	Tier 1	Tier 1	Tier 2	Tier 2	219,469	288,498	6,941	9,572	20.2	31.0	$ 332	$ 480
01C1210	SPROUL	110,919			Tier 2	Tier 2	289,030	396,570	21,042	31,354	29.0	63.6	$ 412	$ 606
01C1220	BIRGE	97,768	Tier 1	Tier 1			1,170,329	1,583,950	35,379	46,883	84.6	130.8	$ 1,830	$ 2,763
01C1225	LS ADDITION	201,824	Tier 1	Tier 1		Tier 2	2,793,155	3,793,827	84,303	111,714	202.5	315.1	$ 4,366	$ 6,610
01C1229	NW AN FACIL	52,845	Tier 1	Tier 1		Tier 2	587,195	792,875	17,470	23,151	43.3	66.4	$ 916	$ 1,379
01C1230	BOWLES	73,700			Tier 2	Tier 2	230,426	287,590	11,185	16,667	30.0	50.7	$ 323	$ 427
01C1231	LAW	230,716		Tier 2	Tier 1	Tier 2	1,146,141	1,474,231	60,273	89,951	129.6	235.1	$ 1,727	$ 2,427
01C1234	HAAS STU BLD	95,712			Tier 1	Tier 2	712,630	929,142	45,394	67,639	97.7	179.0	$ 1,005	$ 1,396
01C1236	HAAS FAC BLD	106,295			Tier 1	Tier 2	413,482	581,502	25,207	37,559	34.7	76.2	$ 585	$ 872
01C1237	SODA	109,014			Tier 2	Tier 1	709,380	1,026,694	20,681	30,816	117.5	232.2	$ 981	$ 1,496
01C1247	SANPABL6701	527,633			Tier 1	Tier 1	2,577,607	3,217,057	125,122	186,438	335.8	567.0	$ 3,617	$ 4,781
01C1270	CALIFORNIA	56,343			Tier 2	Tier 2	173,320	227,947	10,689	15,927	14.7	33.3	$ 245	$ 344
01C1271	STADIUM	288,653			Tier 1	Tier 1	1,410,136	1,759,961	68,450	101,995	183.7	310.2	$ 1,979	$ 2,616
01C1286	TANG CENTER	75,228			Tier 2	Tier 1	462,651	617,355	14,271	21,265	46.6	89.5	$ 641	$ 898
01C1292	LEWIS	68,146	Tier 1	Tier 1		Tier 2	859,228	1,164,811	25,602	33,926	62.8	97.3	$ 1,341	$ 2,025
01C1295	DWINELLE	305,268			Tier 2	Tier 2	833,828	1,115,654	57,912	86,293	79.7	175.1	$ 1,187	$ 1,702
01C1298	DOE ANNEX	132,394			Tier 2	Tier 2	621,204	780,646	12,865	25,174	90.2	141.6	$ 859	$ 1,126
01C1301	DOE LIBRARY	166,514				Tier 2	600,900	715,828	-	-	75.5	94.3	$ 814	$ 979
01C1302	MINOR ADDITN	55,516	Tier 1	Tier 2	Tier 1	Tier 2	595,142	802,335	20,082	28,783	73.5	129.5	$ 860	$ 1,256
01C1302F	MINOR	46,204	Tier 1	Tier 1	Tier 1	Tier 2	577,493	776,110	18,718	25,292	44.8	70.8	$ 894	$ 1,336
01C1318	EDWARDS FLD	59,326				Tier 2	90,148	104,075	-	-	14.7	17.0	$ 122	$ 142
01C1321	MCLAUGHLIN	49,388			Tier 2	Tier 2	175,786	221,008	9,369	13,961	22.3	39.2	$ 247	$ 331
01C1323	DAVIS	137,806	Tier 1	Tier 1	Tier 2	Tier 2	580,040	798,197	20,092	27,588	42.1	70.4	$ 890	$ 1,350
01C1325	CORY	206,054	Tier 1	Tier 2	Tier 2	Tier 2	2,203,381	2,950,907	84,472	118,384	191.8	323.9	$ 3,257	$ 4,787
01C1346	MULFORD	93,420	Tier 1	Tier 1	Tier 2	Tier 2	298,074	397,148	9,699	13,236	24.9	39.0	$ 457	$ 675
01C1355	GIANNINI	68,410	Tier 1		Tier 2	Tier 2	250,280	365,191	12,978	19,338	26.8	51.1	$ 306	$ 462
01C1356	GILMAN	44,182	Tier 2	Tier 2	Tier 2	Tier 2	189,861	255,846	7,965	11,246	17.7	30.5	$ 287	$ 426
01C1360	HAAS PAVIL	238,065			Tier 1	Tier 2	1,584,492	2,133,580	-	20,265	111.1	308.3	$ 2,218	$ 3,167
01C1365	REC SPRT FAC	250,736			Tier 1	Tier 2	460,158	631,786	32,031	47,728	51.8	112.3	$ 655	$ 962
01C1371	HAVILAND	51,020			Tier 2	Tier 2	180,330	237,160	9,036	13,779	13.3	29.3	$ 254	$ 354

Building Key	Building Name	Basic Gross Area	Projects by Building				Total Building Deep Potential							
							Low Electricity (kWh/yr)	High Electricity (kWh/yr)	Low Gas (th/yr)	High Gas (th/yr)	Low Demand (kW)	High Demand (kW)	Low Cost (x$1000)	High Cost (x$1000)
			ESDVR	Deep Lab	Deep HVAC	Deep Lighting								
01C1373	HEARST MIN	141,461	Tier 1	Tier 1			1,514,526	2,049,795	45,785	60,671	109.5	169.3	$ 2,368	$ 3,575
01C1375	HESSE	41,363	Tier 2		Tier 1	Tier 2	290,427	382,119	9,809	14,616	32.9	55.2	$ 312	$ 400
01C1376	HILGARD	77,055	Tier 1	Tier 1		Tier 2	518,799	698,417	15,116	20,030	39.2	59.4	$ 807	$ 1,210
01C1377	O'BRIEN	41,297			Tier 2	Tier 2	126,379	161,008	7,834	11,674	15.3	28.9	$ 179	$ 244
01C1382	MORGAN	56,637	Tier 2	Tier 2	Tier 2		257,389	345,877	10,443	14,547	20.6	35.7	$ 395	$ 590
01C1390	I HOUSE	185,200			Tier 2	Tier 1	794,150	984,578	35,134	52,352	105.8	172.5	$ 1,111	$ 1,454
01C1405	LE CONTE	148,032	Tier 1	Tier 1		Tier 2	416,950	556,759	11,457	15,182	33.6	49.5	$ 644	$ 955
01C1406	VALLEY LSB	418,707	Tier 1	Tier 1			3,671,082	5,094,899	115,913	155,512	291.2	450.4	$ 5,576	$ 8,664
01C1419	DONNER LAB	53,234	Tier 1	Tier 2	Tier 1	Tier 2	585,570	797,305	18,138	24,556	45.3	71.8	$ 874	$ 1,309
01C1486	KROEBER	117,814	Tier 1	Tier 1	Tier 2	Tier 2	384,913	516,043	12,157	16,602	27.3	46.2	$ 588	$ 870
01C1488	STEPHENS	58,733			Tier 2	Tier 1	199,869	247,933	8,914	13,282	26.6	43.5	$ 280	$ 366
01C1495	STERN	86,959			Tier 2	Tier 1	372,886	462,300	16,497	24,581	49.7	81.0	$ 522	$ 683
01C1498	CARLETO2000	113,589			Tier 2	Tier 2	214,535	282,933	10,774	16,055	14.8	33.2	$ 301	$ 420
01C1520	UCB ART MUSE	102,794			Tier 1	Tier 2	463,122	581,668	24,376	36,322	59.1	103.1	$ 652	$ 870
01C1552	WHEELER	139,436			Tier 2	Tier 2	224,140	291,734	13,226	19,708	26.5	50.9	$ 317	$ 439
01C1594	UNIVERSITY	150,887			Tier 1	Tier 1	619,899	799,042	27,335	44,870	51.7	117.2	$ 868	$ 1,185
01C1760	CAMPBELL	63,719	Tier 1	Tier 2	Tier 2	Tier 2	378,811	489,478	16,139	23,380	40.8	68.5	$ 546	$ 763
01C1761	BARROWS	193,202			Tier 2	Tier 1	297,209	490,492	18,774	36,736	35.7	96.1	$ 426	$ 752
01C1762	MCCONE	123,612			Tier 1	Tier 2	794,242	1,051,892	29,313	43,678	81.5	183.0	$ 1,134	$ 1,617
01C1763	RH1 FREEBORN	40,751			Tier 2	Tier 1	174,743	216,644	7,731	11,519	23.3	38.0	$ 244	$ 320
01C1764	RH1 CHENEY	40,751			Tier 2	Tier 1	174,743	216,644	7,731	11,519	23.3	38.0	$ 244	$ 320
01C1765	RH1 DEUTSCH	45,335			Tier 2	Tier 1	194,399	241,014	8,600	12,815	25.9	42.2	$ 272	$ 356
01C1766	RH1 PUTNAM	40,751			Tier 2	Tier 1	174,743	216,644	7,731	11,519	23.3	38.0	$ 244	$ 320
01C1768	RH2 CUNNINHM	40,751			Tier 2	Tier 1	174,743	216,644	7,731	11,519	23.3	38.0	$ 244	$ 320
01C1769	RH2 DAVIDSON	40,751			Tier 2	Tier 1	174,743	216,644	7,731	11,519	23.3	38.0	$ 244	$ 320
01C1770	RH2 GRIFFITH	40,751			Tier 2	Tier 1	174,743	216,644	7,731	11,519	23.3	38.0	$ 244	$ 320
01C1771	RH2 EHRMAN	45,335			Tier 2	Tier 1	194,399	241,014	8,600	12,815	25.9	42.2	$ 272	$ 356
01C1774	TOLMAN	240,884			Tier 2		575,388	752,383	45,698	68,093	62.9	138.1	$ 825	$ 1,168
01C1776	OXFORD RES	66,240			Tier 1		593,341	775,859	15,708	23,406	64.9	142.4	$ 851	$ 1,205
01C1782	LATIMER	182,943	Tier 2	Tier 1		Tier 2	2,085,596	2,820,434	66,636	88,303	145.6	228.2	$ 3,379	$ 5,138
01C1783	ETCHEVERRY	177,281	Tier 1	Tier 1	Tier 2		990,603	1,337,527	33,359	45,115	74.2	119.6	$ 1,540	$ 2,316
01C1784	CHAVEZ	105,470			Tier 2	Tier 2	330,686	432,943	20,009	29,814	29.3	66.3	$ 468	$ 653
01C1788	BECHTEL CNTR	47,954			Tier 2	Tier 2	179,681	224,980	9,097	13,556	23.2	39.8	$ 252	$ 335
01C1790	EVANS	276,206			Tier 1	Tier 2	815,909	1,152,455	46,472	78,570	90.2	198.0	$ 1,165	$ 1,763
01C1791	KING UNION	110,558				Tier 2	77,424	116,357	-	-	3.7	10.1	$ 105	$ 159
01C1793	BARKER	86,091	Tier 1	Tier 1	Tier 1		1,087,362	1,468,991	35,738	48,122	80.8	129.0	$ 1,692	$ 2,548
01C1796	KOSHLAND	153,700	Tier 1	Tier 1			3,037,277	4,110,721	61,212	81,115	219.5	339.5	$ 4,748	$ 7,170
01C1797	WURSTER	222,434			Tier 2		325,761	489,200	40,384	61,063	0.7	70.2	$ 467	$ 760
01C1800	LAWRENCE	128,540			Tier 1	Tier 1	515,678	671,459	30,482	45,419	48.0	104.3	$ 729	$ 1,011
01C1802	ZELLERBACH	153,118			Tier 2		365,745	478,253	29,048	43,283	40.0	87.8	$ 524	$ 743
01C1804	RH3 SPROUL	47,924			Tier 2	Tier 1	205,501	254,778	9,092	13,547	27.4	44.6	$ 287	$ 376
01C1805	RH3 NORTON	45,390			Tier 2	Tier 1	194,635	241,307	8,611	12,831	25.9	42.3	$ 272	$ 356
01C1806	RH3 SPENSBLK	40,851			Tier 2	Tier 1	175,172	217,176	7,750	11,548	23.3	38.0	$ 245	$ 321

Building Key	Building Name	Basic Gross Area	Projects by Building				Total Building Deep Potential							
			ESDVR	Deep Lab	Deep HVAC	Deep Lighting	Low Electricity (kWh/yr)	High Electricity (kWh/yr)	Low Gas (th/yr)	High Gas (th/yr)	Low Demand (kW)	High Demand (kW)	Low Cost (x$1000)	High Cost (x$1000)
01C1807	RH3 PRIESTLY	40,851			Tier 2	Tier 1	175,172	217,176	7,750	11,548	23.3	38.0	$ 245	$ 321
01C1808	TAN	116,121	Tier 2	Tier 1			1,469,547	1,991,329	47,934	63,519	101.5	159.8	$ 2,389	$ 3,644
01C1809	HILDEBRAND	128,126	Tier 2	Tier 1		Tier 2	1,409,812	1,900,252	44,337	58,754	102.1	157.3	$ 2,278	$ 3,451
01C1810A	SILVER	44,316	Tier 1	Tier 1	Tier 1	Tier 2	611,495	824,663	19,163	25,657	45.9	71.7	$ 951	$ 1,429
01C1813	SPACESCI ADD	43,252	Tier 1	Tier 1	Tier 1	Tier 2	604,197	815,153	18,859	25,220	45.1	70.5	$ 940	$ 1,414
01C1831	CKC 12	43,510			Tier 2	Tier 1	186,574	231,312	8,254	12,299	24.9	40.5	$ 261	$ 341
01C1902	BANCROF2111	46,928			Tier 2	Tier 1	164,386	203,804	7,273	10,837	21.9	35.7	$ 230	$ 301
01C1950	SHATTUC2150	64,670			Tier 2	Tier 1	251,034	313,470	12,269	18,281	32.6	55.3	$ 352	$ 466
01C1968	CENTER2000	42,697	Tier 1		Tier 2	Tier 1	221,844	282,129	8,100	12,070	27.8	44.9	$ 275	$ 354
01C1977	UNIVERS1995	106,482			Tier 1	Tier 1	456,276	585,324	25,251	37,625	33.0	59.4	$ 638	$ 866
01C1979	SHATTUC2484	45,058			Tier 2	Tier 1	193,212	239,542	8,548	12,737	25.7	42.0	$ 270	$ 354
01C2330	MARKET425	43,243			Tier 2	Tier 1	176,530	219,618	8,204	12,224	23.2	38.6	$ 247	$ 325
01C3625	ADDISON2108	49,000			Tier 2	Tier 1	210,115	260,498	9,296	13,851	28.0	45.6	$ 294	$ 385
01C3629	ALLSTON2121	42,900			Tier 2	Tier 1	183,958	228,069	8,139	12,127	24.5	40.0	$ 257	$ 337
01C3631	THIRDSTREET	56,400			Tier 2	Tier 1	241,847	299,839	10,700	15,943	32.2	52.5	$ 338	$ 443
01C9525	NOR REG LIB	253,660			Tier 2	Tier 1	912,358	1,173,178	48,122	71,704	138.2	229.5	$ 1,270	$ 1,719
01C1444	LI KA SHING	220,703	Tier 1	Tier 1	Tier 2		3,878,132	5,242,232	86,594	116,614	285.6	451.8	$ 6,044	$ 9,108
01C1022	ENERGY BIOSCIENCE	120,694	Tier 2	Tier 2			985,099	1,333,256	29,780	39,463	71.2	110.1	$ 1,540	$ 2,326
Campus Total			33	31	86	89	68,717,734	91,098,179	2,560,041	3,698,900	6,518.5	11,271.6	$ 102,079	$ 147,920

6.3. Deep Efficiency Projects by Type

The table beginning on the following page provides a list of all the buildings for each type of deep efficiency project, including the project savings and cost ranges for each building.

Table 6.6: UC Berkeley Project by Type

Building Key	Building Name	Total Building Deep Potential							
		Low Electricity (kWh/yr)	High Electricity (kWh/yr)	Low Gas (th/yr)	High Gas (th/yr)	Low Demand (kW)	High Demand (kW)	Low Cost (x$1000)	High Cost (x$1000)
ESDVR Projects									
01C1149	STANLEY	1,365,484	1,819,721	-	-	154.3	205.4	$ 1,059	$ 1,163
01C1202	WELLMAN	56,578	75,399	-	-	6.4	8.5	$ 44	$ 48
01C1220	BIRGE	428,356	570,851	-	-	48.4	64.4	$ 332	$ 365
01C1225	LS ADDITION	1,020,695	1,360,236	-	-	115.3	153.6	$ 792	$ 869
01C1229	NW AN FACIL	211,521	281,885	-	-	23.9	31.8	$ 164	$ 180
01C1292	LEWIS	309,972	413,087	-	-	35.0	46.6	$ 240	$ 264
01C1302	MINOR ADDITN	104,688	139,514	-	-	11.8	15.8	$ 81	$ 89
01C1302F	MINOR	190,783	254,248	-	-	21.6	28.7	$ 148	$ 162
01C1323	DAVIS	172,582	229,993	-	-	19.5	26.0	$ 134	$ 147
01C1325	CORY	686,815	915,288	-	-	77.6	103.3	$ 533	$ 585
01C1346	MULFORD	89,323	119,037	-	-	10.1	13.4	$ 69	$ 76
01C1355	GIANNINI	79,092	105,402	-	-	8.9	11.9	$ 61	$ 67
01C1356	GILMAN	45,692	60,891	-	-	5.2	6.9	$ 35	$ 39
01C1373	HEARST MIN	554,337	738,741	-	-	62.6	83.4	$ 430	$ 472
01C1375	HESSE	156,667	208,783	-	-	17.7	23.6	$ 122	$ 133
01C1376	HILGARD	183,011	243,891	-	-	20.7	27.5	$ 142	$ 156
01C1382	MORGAN	74,401	99,151	-	-	8.4	11.2	$ 58	$ 63
01C1405	LE CONTE	138,715	184,860	-	-	15.7	20.9	$ 108	$ 118
01C1406	VALLEY LSB	1,474,539	1,965,055	-	-	166.6	221.8	$ 1,144	$ 1,256
01C1419	DONNER LAB	226,749	302,179	-	-	25.6	34.1	$ 176	$ 193
01C1486	KROEBER	111,125	148,091	-	-	12.6	16.7	$ 86	$ 95
01C1760	CAMPBELL	61,302	81,694	-	-	6.9	9.2	$ 48	$ 52
01C1782	LATIMER	645,437	860,146	-	-	72.9	97.1	$ 501	$ 550
01C1783	ETCHEVERRY	337,179	449,344	-	-	38.1	50.7	$ 261	$ 287
01C1793	BARKER	376,657	501,955	-	-	42.6	56.7	$ 292	$ 321
01C1796	KOSHLAND	1,111,684	1,481,493	-	-	125.6	167.3	$ 862	$ 947
01C1808	TAN	464,286	618,734	-	-	52.5	69.9	$ 360	$ 395
01C1809	HILDEBRAND	429,452	572,312	-	-	48.5	64.6	$ 333	$ 366
01C1810A	SILVER	212,741	283,511	-	-	24.0	32.0	$ 165	$ 181
01C1813	SPACESCI ADD	211,448	281,788	-	-	23.9	31.8	$ 164	$ 180
01C1968	CENTER2000	58,343	77,751	-	-	6.6	8.8	$ 45	$ 50
01C1444	LI KA SHING	1,367,349	1,822,208	-	-	154.5	205.7	$ 1,060	$ 1,164
01C1022	ENERGY BIOSCIENCES	360,559	480,502	-	-	40.7	54.2	$ 280	$ 307
Campus Total, ESDVR Projects		13,317,564	17,747,742	-	-	1,505	2,004	$ 10,328	$ 11,341
Deep Lab Projects									
01C1149	STANLEY	2,365,212	3,229,488	112,780	149,450	115.4	211.6	$ 4,773	$ 7,644
01C1202	WELLMAN	98,001	133,812	4,673	6,192	4.8	8.8	$ 198	$ 317
01C1220	BIRGE	741,973	1,013,099	35,379	46,883	36.2	66.4	$ 1,497	$ 2,398
01C1225	LS ADDITION	1,767,989	2,414,032	84,303	111,714	86.3	158.2	$ 3,568	$ 5,714
01C1229	NW AN FACIL	366,384	500,265	17,470	23,151	17.9	32.8	$ 739	$ 1,184
01C1231	LAW	184,877	252,434	8,815	11,682	9.0	16.5	$ 373	$ 598
01C1292	LEWIS	536,916	733,112	25,602	33,926	26.2	48.0	$ 1,084	$ 1,735
01C1302	MINOR ADDITN	145,068	198,078	6,917	9,166	7.1	13.0	$ 293	$ 469
01C1302F	MINOR	330,463	451,218	15,757	20,881	16.1	29.6	$ 667	$ 1,068
01C1323	DAVIS	298,937	408,171	14,254	18,889	14.6	26.7	$ 603	$ 966
01C1325	CORY	951,729	1,299,501	45,381	60,137	46.4	85.1	$ 1,921	$ 3,076
01C1346	MULFORD	154,721	211,257	7,378	9,776	7.5	13.8	$ 312	$ 500
01C1356	GILMAN	79,144	108,064	3,774	5,001	3.9	7.1	$ 160	$ 256
01C1373	HEARST MIN	960,190	1,311,054	45,785	60,671	46.8	85.9	$ 1,938	$ 3,103
01C1376	HILGARD	317,002	432,838	15,116	20,030	15.5	28.4	$ 640	$ 1,025
01C1382	MORGAN	128,874	175,965	6,145	8,143	6.3	11.5	$ 260	$ 417
01C1405	LE CONTE	240,274	328,073	11,457	15,182	11.7	21.5	$ 485	$ 777
01C1406	VALLEY LSB	2,196,542	3,129,845	115,913	155,512	124.6	228.5	$ 4,433	$ 7,409
01C1419	DONNER LAB	314,209	429,025	14,982	19,854	15.3	28.1	$ 634	$ 1,016

Building Key	Building Name	Total Building Deep Potential							
		Low Electricity (kWh/yr)	High Electricity (kWh/yr)	Low Gas (th/yr)	High Gas (th/yr)	Low Demand (kW)	High Demand (kW)	Low Cost (x$1000)	High Cost (x$1000)
01C1486	KROEBER	192,484	262,820	9,178	12,162	9.4	17.2	$ 388	$ 622
01C1760	CAMPBELL	84,947	115,988	4,051	5,368	4.1	7.6	$ 171	$ 275
01C1782	LATIMER	1,397,486	1,908,143	66,636	88,303	68.2	125.0	$ 2,820	$ 4,517
01C1783	ETCHEVERRY	584,042	797,458	27,849	36,904	28.5	52.3	$ 1,179	$ 1,888
01C1793	BARKER	652,424	890,827	31,109	41,225	31.8	58.4	$ 1,317	$ 2,109
01C1796	KOSHLAND	1,925,594	2,629,228	61,212	81,115	93.9	172.3	$ 3,886	$ 6,224
01C1808	TAN	1,005,261	1,372,596	47,934	63,519	49.0	89.9	$ 2,029	$ 3,249
01C1809	HILDEBRAND	929,839	1,269,614	44,337	58,754	45.4	83.2	$ 1,877	$ 3,005
01C1810A	SILVER	368,498	503,152	17,571	23,284	18.0	33.0	$ 744	$ 1,191
01C1813	SPACESCI ADD	366,258	500,093	17,464	23,143	17.9	32.8	$ 739	$ 1,184
01C1444	LI KA SHING	2,368,443	3,233,900	75,289	99,770	115.6	211.9	$ 4,780	$ 7,655
01C1022	ENERGY BIOSCIENCES	624,540	852,754	29,780	39,463	30.5	55.9	$ 1,260	$ 2,019
Campus Total, Deep Lab Projects		22,678,322	31,095,906	1,024,290	1,359,249	1,124	2,061	$ 45,768	$ 73,606
Deep HVAC Projects									
01C1002	CLEARY	88,243	115,388	7,008	10,443	9.6	21.2	$ 127	$ 179
01C1024A	REGATTA3200A	908,788	1,188,342	72,177	107,548	99.4	218.2	$ 1,303	$ 1,845
01C1072	MANVILLE	140,246	183,387	11,139	16,597	15.3	33.7	$ 201	$ 285
01C1092	CHANNIN2535	171,969	224,868	13,658	20,351	18.8	41.3	$ 247	$ 349
01C1095	WARREN	206,117	269,520	16,370	24,392	22.5	49.5	$ 296	$ 418
01C1098	RESSTUSRVBLD	256,499	335,401	20,372	30,355	28.0	61.6	$ 368	$ 521
01C1142	JACKSON	113,924	148,969	9,048	13,482	12.5	27.3	$ 163	$ 231
01C1145	RH1 CHRSTIAN	158,585	207,367	12,595	18,767	17.3	38.1	$ 227	$ 322
01C1146	RH1 SLOTTMAN	167,327	218,799	13,289	19,802	18.3	40.2	$ 240	$ 340
01C1147	RH2 TOWLE	160,410	209,754	12,740	18,983	17.5	38.5	$ 230	$ 326
01C1148	RH2 WADA	164,318	214,864	13,050	19,446	18.0	39.4	$ 236	$ 334
01C1202	WELLMAN	28,557	37,341	2,268	3,379	3.1	6.9	$ 41	$ 58
01C1210	SPROUL	264,947	346,447	21,042	31,354	29.0	63.6	$ 380	$ 538
01C1230	BOWLES	140,835	184,157	11,185	16,667	15.4	33.8	$ 202	$ 286
01C1231	LAW	646,515	858,420	51,457	78,269	69.2	159.3	$ 927	$ 1,333
01C1234	HAAS STU BLD	502,976	678,793	45,394	67,639	54.7	129.4	$ 721	$ 1,054
01C1236	HAAS FAC BLD	317,377	415,006	25,207	37,559	34.7	76.2	$ 455	$ 644
01C1237	SODA	257,243	497,545	20,681	30,816	47.4	149.5	$ 369	$ 772
01C1247	SANPABL6701	1,575,414	2,060,028	125,122	186,438	172.3	378.2	$ 2,259	$ 3,198
01C1270	CALIFORNIA	134,584	175,983	10,689	15,927	14.7	32.3	$ 193	$ 273
01C1271	STADIUM	861,864	1,126,983	68,450	101,995	94.2	206.9	$ 1,236	$ 1,750
01C1286	TANG CENTER	176,873	287,424	14,271	21,265	-	35.7	$ 254	$ 446
01C1295	DWINELLE	729,179	953,482	57,912	86,293	79.7	175.1	$ 1,045	$ 1,480
01C1298	DOE ANNEX	218,850	316,130	12,865	25,174	24.5	65.8	$ 314	$ 491
01C1302	MINOR ADDITN	232,900	334,880	13,165	19,616	36.2	79.6	$ 334	$ 520
01C1302F	MINOR	37,276	48,743	2,961	4,411	4.1	8.9	$ 53	$ 76
01C1321	MCLAUGHLIN	117,971	154,260	9,369	13,961	12.9	28.3	$ 169	$ 240
01C1323	DAVIS	73,510	96,122	5,838	8,699	8.0	17.6	$ 105	$ 149
01C1325	CORY	492,191	643,594	39,090	58,247	53.8	118.2	$ 706	$ 999
01C1346	MULFORD	29,234	38,227	2,322	3,460	3.2	7.0	$ 42	$ 59
01C1355	GIANNINI	163,408	213,674	12,978	19,338	17.9	39.2	$ 234	$ 332
01C1356	GILMAN	52,768	69,000	4,191	6,245	5.8	12.7	$ 76	$ 107
01C1360	HAAS PAVIL	906,588	1,343,899	-	20,265	-	179.0	$ 1,300	$ 2,087
01C1365	REC SPRT FAC	403,307	527,369	32,031	47,728	44.1	96.8	$ 578	$ 819
01C1371	HAVILAND	121,869	159,357	9,036	13,779	13.3	29.3	$ 175	$ 247
01C1375	HESSE	123,502	161,493	9,809	14,616	13.5	29.6	$ 177	$ 251
01C1377	O'BRIEN	98,644	128,988	7,834	11,674	10.8	23.7	$ 141	$ 200
01C1382	MORGAN	54,114	70,761	4,298	6,404	5.9	13.0	$ 78	$ 110
01C1390	I HOUSE	442,378	578,458	35,134	52,352	48.4	106.2	$ 634	$ 898
01C1419	DONNER LAB	39,737	51,960	3,156	4,703	4.3	9.5	$ 57	$ 81
01C1486	KROEBER	37,510	49,049	2,979	4,439	4.1	9.0	$ 54	$ 76
01C1488	STEPHENS	112,234	146,759	8,914	13,282	12.3	26.9	$ 161	$ 228
01C1495	STERN	207,715	271,610	16,497	24,581	22.7	49.9	$ 298	$ 422

Building Key	Building Name	Total Building Deep Potential							
		Low Electricity (kWh/yr)	High Electricity (kWh/yr)	Low Gas (th/yr)	High Gas (th/yr)	Low Demand (kW)	High Demand (kW)	Low Cost (x$1000)	High Cost (x$1000)
01C1498	CARLETO2000	135,662	177,393	10,774	16,055	14.8	32.6	$ 194	$ 275
01C1520	UCB ART MUSE	306,924	401,337	24,376	36,322	33.6	73.7	$ 440	$ 623
01C1552	WHEELER	166,532	217,759	13,226	19,708	18.2	40.0	$ 239	$ 338
01C1594	UNIVERSITY	357,384	495,969	27,335	44,870	8.9	67.8	$ 512	$ 770
01C1760	CAMPBELL	152,202	199,022	12,088	18,012	16.6	36.5	$ 218	$ 309
01C1761	BARROWS	295,663	437,623	18,774	36,736	35.7	96.1	$ 424	$ 679
01C1762	MCCONE	738,165	965,232	29,313	43,678	80.7	177.2	$ 1,058	$ 1,499
01C1763	RH1 FREEBORN	97,340	127,283	7,731	11,519	10.6	23.4	$ 140	$ 198
01C1764	RH1 CHENEY	97,340	127,283	7,731	11,519	10.6	23.4	$ 140	$ 198
01C1765	RH1 DEUTSCH	108,289	141,600	8,600	12,815	11.8	26.0	$ 155	$ 220
01C1766	RH1 PUTNAM	97,340	127,283	7,731	11,519	10.6	23.4	$ 140	$ 198
01C1768	RH2 CUNNINHM	97,340	127,283	7,731	11,519	10.6	23.4	$ 140	$ 198
01C1769	RH2 DAVIDSON	97,340	127,283	7,731	11,519	10.6	23.4	$ 140	$ 198
01C1770	RH2 GRIFFITH	97,340	127,283	7,731	11,519	10.6	23.4	$ 140	$ 198
01C1771	RH2 EHRMAN	108,289	141,600	8,600	12,815	11.8	26.0	$ 155	$ 220
01C1774	TOLMAN	575,388	752,383	45,698	68,093	62.9	138.1	$ 825	$ 1,168
01C1776	OXFORD RES	593,341	775,859	15,708	23,406	64.9	142.4	$ 851	$ 1,205
01C1783	ETCHEVERRY	69,382	90,724	5,510	8,211	7.6	16.7	$ 99	$ 141
01C1784	CHAVEZ	251,931	329,428	20,009	29,814	27.5	60.5	$ 361	$ 511
01C1788	BECHTEL CNTR	114,545	149,781	9,097	13,556	12.5	27.5	$ 164	$ 233
01C1790	EVANS	755,772	1,009,458	46,472	78,570	90.2	198.0	$ 1,084	$ 1,567
01C1793	BARKER	58,281	76,209	4,629	6,897	6.4	14.0	$ 84	$ 118
01C1797	WURSTER	325,761	489,200	40,384	61,063	0.7	70.2	$ 467	$ 760
01C1800	LAWRENCE	383,796	501,856	30,482	45,419	42.0	92.1	$ 550	$ 779
01C1802	ZELLERBACH	365,745	478,253	29,048	43,283	40.0	87.8	$ 524	$ 743
01C1804	RH3 SPROUL	114,474	149,687	9,092	13,547	12.5	27.5	$ 164	$ 232
01C1805	RH3 NORTON	108,421	141,772	8,611	12,831	11.9	26.0	$ 155	$ 220
01C1806	RH3 SPENSBLK	97,579	127,595	7,750	11,548	10.7	23.4	$ 140	$ 198
01C1807	RH3 PRIESTLY	97,579	127,595	7,750	11,548	10.7	23.4	$ 140	$ 198
01C1810A	SILVER	20,051	26,219	1,592	2,373	2.2	4.8	$ 29	$ 41
01C1813	SPACESCI ADD	17,557	22,957	1,394	2,078	1.9	4.2	$ 25	$ 36
01C1831	CKC 12	103,930	135,900	8,254	12,299	11.4	25.0	$ 149	$ 211
01C1902	BANCROF2111	91,571	119,739	7,273	10,837	10.0	22.0	$ 131	$ 186
01C1950	SHATTUC2150	154,474	201,992	12,269	18,281	16.9	37.1	$ 221	$ 314
01C1968	CENTER2000	101,988	133,361	8,100	12,070	11.2	24.5	$ 146	$ 207
01C1977	UNIVERS1995	254,022	351,823	25,251	37,625	-	21.3	$ 364	$ 546
01C1979	SHATTUC2484	107,628	140,735	8,548	12,737	11.8	25.8	$ 154	$ 219
01C2330	MARKET425	103,292	135,066	8,204	12,224	11.3	24.8	$ 148	$ 210
01C3625	ADDISON2108	117,044	153,048	9,296	13,851	12.8	28.1	$ 168	$ 238
01C3629	ALLSTON2121	102,473	133,995	8,139	12,127	11.2	24.6	$ 147	$ 208
01C3631	THIRDSTREET	134,720	176,161	10,700	15,943	14.7	32.3	$ 193	$ 274
01C9525	NOR REG LIB	430,552	616,936	48,122	71,704	59.6	138.8	$ 617	$ 958
01C1444	LI KA SHING	142,339	186,124	11,305	16,845	15.6	34.2	$ 204	$ 289
Campus Total, Deep HVAC		20,885,282	28,017,690	1,535,751	2,339,651	2,125	5,117	$ 29,943	$ 43,500
Deep Lighting Projects									
01C1002	CLEARY	70,170	81,011	-	-	11.5	13.2	$ 95	$ 111
01C1024A	REGATTA3200A	722,653	834,301	-	-	117.9	136.2	$ 979	$ 1,141
01C1072	MANVILLE	111,521	128,751	-	-	18.2	21.0	$ 151	$ 176
01C1092	CHANNIN2535	136,746	157,873	-	-	22.3	25.8	$ 185	$ 216
01C1095	WARREN	97,864	130,276	-	-	2.0	7.3	$ 133	$ 178
01C1098	RESSTUSRVBLD	163,171	188,381	-	-	26.6	30.7	$ 221	$ 258
01C1142	JACKSON	90,591	104,587	-	-	14.8	17.1	$ 123	$ 143
01C1145	RH1 CHRSTIAN	126,104	145,587	-	-	20.6	23.8	$ 171	$ 199
01C1146	RH1 SLOTTMAN	133,056	153,613	-	-	21.7	25.1	$ 180	$ 210
01C1147	RH2 TOWLE	127,555	147,262	-	-	20.8	24.0	$ 173	$ 201
01C1148	RH2 WADA	130,663	150,850	-	-	21.3	24.6	$ 177	$ 206
01C1149	STANLEY	95,720	110,508	-	-	15.6	18.0	$ 130	$ 151

Building Key	Building Name	Total Building Deep Potential							
		Low Electricity (kWh/yr)	High Electricity (kWh/yr)	Low Gas (th/yr)	High Gas (th/yr)	Low Demand (kW)	High Demand (kW)	Low Cost (x$1000)	High Cost (x$1000)
01C1202	WELLMAN	36,333	41,946	-	-	5.9	6.8	$ 49	$ 57
01C1210	SPROUL	24,083	50,123	-	-	-	-	$ 33	$ 69
01C1225	LS ADDITION	4,471	19,559	-	-	0.9	3.4	$ 6	$ 27
01C1229	NW AN FACIL	9,290	10,726	-	-	1.5	1.8	$ 13	$ 15
01C1230	BOWLES	89,592	103,433	-	-	14.6	16.9	$ 121	$ 141
01C1231	LAW	314,749	363,377	-	-	51.4	59.3	$ 427	$ 497
01C1234	HAAS STU BLD	209,654	250,349	-	-	43.0	49.6	$ 284	$ 342
01C1236	HAAS FAC BLD	96,105	166,496	-	-	-	-	$ 130	$ 228
01C1237	SODA	452,137	529,149	-	-	70.1	82.6	$ 613	$ 724
01C1247	SANPABL6701	1,002,194	1,157,030	-	-	163.6	188.8	$ 1,358	$ 1,583
01C1270	CALIFORNIA	38,736	51,964	-	-	-	1.0	$ 52	$ 71
01C1271	STADIUM	548,272	632,978	-	-	89.5	103.3	$ 743	$ 866
01C1286	TANG CENTER	285,778	329,930	-	-	46.6	53.8	$ 387	$ 451
01C1292	LEWIS	12,339	18,612	-	-	1.6	2.7	$ 17	$ 25
01C1295	DWINELLE	104,649	162,172	-	-	-	-	$ 142	$ 222
01C1298	DOE ANNEX	402,354	464,516	-	-	65.7	75.8	$ 545	$ 635
01C1301	DOE LIBRARY	600,900	715,828	-	-	75.5	94.3	$ 814	$ 979
01C1302	MINOR ADDITN	112,485	129,863	-	-	18.4	21.2	$ 152	$ 178
01C1302F	MINOR	18,970	21,901	-	-	3.1	3.6	$ 26	$ 30
01C1318	EDWARDS FLD	90,148	104,075	-	-	14.7	17.0	$ 122	$ 142
01C1321	MCLAUGHLIN	57,815	66,748	-	-	9.4	10.9	$ 78	$ 91
01C1323	DAVIS	35,012	63,911	-	-	-	-	$ 47	$ 87
01C1325	CORY	72,647	92,523	-	-	14.0	17.2	$ 98	$ 127
01C1346	MULFORD	24,796	28,627	-	-	4.0	4.7	$ 34	$ 39
01C1355	GIANNINI	7,780	46,115	-	-	-	-	$ 11	$ 63
01C1356	GILMAN	12,258	17,890	-	-	2.9	3.9	$ 17	$ 24
01C1360	HAAS PAVIL	677,904	789,681	-	-	111.1	129.3	$ 919	$ 1,080
01C1365	REC SPRT FAC	56,851	104,417	-	-	7.7	15.5	$ 77	$ 143
01C1371	HAVILAND	58,461	77,802	-	-	-	-	$ 79	$ 106
01C1375	HESSE	10,258	11,843	-	-	1.7	1.9	$ 14	$ 16
01C1376	HILGARD	18,786	21,688	-	-	3.1	3.5	$ 25	$ 30
01C1377	O'BRIEN	27,735	32,020	-	-	4.5	5.2	$ 38	$ 44
01C1390	I HOUSE	351,772	406,119	-	-	57.4	66.3	$ 477	$ 555
01C1405	LE CONTE	37,961	43,826	-	-	6.2	7.2	$ 51	$ 60
01C1419	DONNER LAB	4,875	14,142	-	-	-	-	$ 7	$ 19
01C1486	KROEBER	43,793	56,082	-	-	1.3	3.3	$ 59	$ 77
01C1488	STEPHENS	87,635	101,175	-	-	14.3	16.5	$ 119	$ 138
01C1495	STERN	165,171	190,690	-	-	27.0	31.1	$ 224	$ 261
01C1498	CARLETO2000	78,873	105,540	-	-	-	0.6	$ 107	$ 144
01C1520	UCB ART MUSE	156,199	180,331	-	-	25.5	29.4	$ 212	$ 247
01C1552	WHEELER	57,608	73,975	-	-	8.3	11.0	$ 78	$ 101
01C1594	UNIVERSITY	262,515	303,072	-	-	42.8	49.5	$ 356	$ 415
01C1760	CAMPBELL	80,359	92,775	-	-	13.1	15.1	$ 109	$ 127
01C1761	BARROWS	1,546	52,868	-	-	-	-	$ 2	$ 72
01C1762	MCCONE	56,078	86,660	-	-	0.8	5.8	$ 76	$ 119
01C1763	RH1 FREEBORN	77,403	89,362	-	-	12.6	14.6	$ 105	$ 122
01C1764	RH1 CHENEY	77,403	89,362	-	-	12.6	14.6	$ 105	$ 122
01C1765	RH1 DEUTSCH	86,110	99,414	-	-	14.1	16.2	$ 117	$ 136
01C1766	RH1 PUTNAM	77,403	89,362	-	-	12.6	14.6	$ 105	$ 122
01C1768	RH2 CUNNINHM	77,403	89,362	-	-	12.6	14.6	$ 105	$ 122
01C1769	RH2 DAVIDSON	77,403	89,362	-	-	12.6	14.6	$ 105	$ 122
01C1770	RH2 GRIFFITH	77,403	89,362	-	-	12.6	14.6	$ 105	$ 122
01C1771	RH2 EHRMAN	86,110	99,414	-	-	14.1	16.2	$ 117	$ 136
01C1782	LATIMER	42,673	52,145	-	-	4.5	6.1	$ 58	$ 71
01C1784	CHAVEZ	78,755	103,515	-	-	1.8	5.8	$ 107	$ 142
01C1788	BECHTEL CNTR	65,136	75,199	-	-	10.6	12.3	$ 88	$ 103
01C1790	EVANS	60,137	142,997	-	-	-	-	$ 81	$ 196

Building Key	Building Name	Total Building Deep Potential							
		Low Electricity (kWh/yr)	High Electricity (kWh/yr)	Low Gas (th/yr)	High Gas (th/yr)	Low Demand (kW)	High Demand (kW)	Low Cost (x$1000)	High Cost (x$1000)
01C1791	KING UNION	77,424	116,357	-	-	3.7	10.1	$ 105	$ 159
01C1800	LAWRENCE	131,882	169,602	-	-	6.0	12.2	$ 179	$ 232
01C1804	RH3 SPROUL	91,028	105,091	-	-	14.9	17.2	$ 123	$ 144
01C1805	RH3 NORTON	86,214	99,534	-	-	14.1	16.2	$ 117	$ 136
01C1806	RH3 SPENSBLK	77,593	89,581	-	-	12.7	14.6	$ 105	$ 123
01C1807	RH3 PRIESTLY	77,593	89,581	-	-	12.7	14.6	$ 105	$ 123
01C1809	HILDEBRAND	50,521	58,326	-	-	8.2	9.5	$ 68	$ 80
01C1810A	SILVER	10,204	11,781	-	-	1.7	1.9	$ 14	$ 16
01C1813	SPACESCI ADD	8,935	10,315	-	-	1.5	1.7	$ 12	$ 14
01C1831	CKC 12	82,644	95,412	-	-	13.5	15.6	$ 112	$ 131
01C1902	BANCROF2111	72,816	84,065	-	-	11.9	13.7	$ 99	$ 115
01C1950	SHATTUC2150	96,560	111,478	-	-	15.8	18.2	$ 131	$ 152
01C1968	CENTER2000	61,513	71,017	-	-	10.0	11.6	$ 83	$ 97
01C1977	UNIVERS1995	202,253	233,501	-	-	33.0	38.1	$ 274	$ 319
01C1979	SHATTUC2484	85,584	98,806	-	-	14.0	16.1	$ 116	$ 135
01C2330	MARKET425	73,237	84,552	-	-	12.0	13.8	$ 99	$ 116
01C3625	ADDISON2108	93,071	107,451	-	-	15.2	17.5	$ 126	$ 147
01C3629	ALLSTON2121	81,485	94,074	-	-	13.3	15.4	$ 110	$ 129
01C3631	THIRDSTREET	107,127	123,678	-	-	17.5	20.2	$ 145	$ 169
01C9525	NOR REG LIB	481,805	556,243	-	-	78.6	90.8	$ 653	$ 761
Campus Total, Deep Lighting		11,836,567	14,236,841	-	-	1,766	2,090	$ 16,040	$ 19,473

6.4. Campus Specific Projects

Additionally, during discussions with the campus, staff identified projects that have deep efficiency potential but do not fall into savings quantified for the four project categories above. These include campuswide EMS standardization and addressing the auxiliary boilers and the steam plant. These project are discussed below, but require additional engineering to determine scope, costs or savings.

6.4.1. Campuswide EMS Standardization

The campus currently has multiple EMS control system brands across the campus, and aside from energy savings that would be achieved from a well-functioning system, the campus would capture a benefit in the ability to maintain the controls. The standardization of the EMS could be conducted in conjunction with Deep HVAC Retrofits on a building by building basis, but a campuswide approach may have additional benefits and could be considered as a standalone project.

6.4.2. Auxiliary Boiler/Steam Plant Project

The campus currently purchases steam from a third-party operated cogeneration plant, and supplements the purchased steam with from auxiliary boilers owned and operated by the campus. However, there is a possibility that this arrangement may end at the end of the current contract, and the campus may benefit from retrofitting the plant.

7. UC Davis – Deep Efficiency Potential

7.1. Campus Deep Efficiency Potential

The total campus potential is tabulated in the table below for all projects identified in this investigation. The savings, along with project economics and a resulting aggregate simple payback, are shown for the range of savings for each project type, as well as the campuswide potential.

	Total Building Deep Potential								Economics			
	Low Electricity (kWh/yr)	High Electricity (kWh/yr)	Low Gas (th/yr)	High Gas (th/yr)	Low Demand (kW)	High Demand (kW)	Low Cost (x$1000)	High Cost (x$1000)	Low Utility Savings (x$1000)	High Utility Savings (x$1000)	Low SPB (yrs)	High SPB (yrs)
SmartLab	24,898,680	33,668,673	709,352	939,998	1,858	2,839	$ 30,236	$ 45,293	$ 2,231	$ 3,005	13.6	15.1
Deep HVAC	3,618,919	5,135,237	350,494	539,089	437	1,068	$ 4,151	$ 6,378	$ 482	$ 711	8.6	9.0
Deep Lighting	3,303,954	3,827,376	-	-	527	612	$ 3,582	$ 4,188	$ 236	$ 273	15.2	15.3
Total	31,821,553	42,631,287	1,059,846	1,479,087	2,822	4,519	$ 37,969	$ 55,859	$ 2,949	$ 3,989	12.9	14.0

Based on campus review and input into the potential deep efficiency projects in the identified buildings, the total potential is further broken down into the Tier 1 (reasonably certain candidate projects) and Tier 2 (questionable candidate projects) categories. However, all of the projects at UC Davis are Tier 1 projects, which are shown below.

Table 7.2: UC Davis Potential Savings Summary, Tier 1

	Total Building Deep Potential								Economics			
	Low	High	Low	High	Low	High	Low	High	Low	High	Low	High
	Electricity (kWh/yr)	Electricity (kWh/yr)	Gas (th/yr)	Gas (th/yr)	Demand (kW)	Demand (kW)	Cost (x$1000)	Cost (x$1000)	Utility Savings (x$1000)	Utility Savings (x$1000)	SPB (yrs)	SPB (yrs)
SmartLab	24,898,680	33,668,673	709,352	939,998	1,858	2,839	$ 30,236	$ 45,293	$ 2,231	$ 3,005	13.6	15.1
Deep HVAC	3,618,919	5,135,237	350,494	539,089	437	1,068	$ 4,151	$ 6,378	$ 482	$ 711	8.6	9.0
Deep Lighting	3,303,954	3,827,376	-	-	527	612	$ 3,582	$ 4,188	$ 236	$ 273	15.2	15.3
Total	31,821,553	42,631,287	1,059,846	1,479,087	2,822	4,519	$ 37,969	$ 55,859	$ 2,949	$ 3,989	12.9	14.0

Table 7.3: UC Davis Potential Savings Summary, Tier 2

	Total Building Deep Potential								Economics			
	Low	High	Low	High	Low	High	Low	High	Low	High	Low	High
	Electricity (kWh/yr)	Electricity (kWh/yr)	Gas (th/yr)	Gas (th/yr)	Demand (kW)	Demand (kW)	Cost (x$1000)	Cost (x$1000)	Utility Savings (x$1000)	Utility Savings (x$1000)	SPB (yrs)	SPB (yrs)
SmartLab	-	-	-	-	-	-	$ -	$ -	$ -	$ -	n/a	n/a
Deep HVAC	-	-	-	-	-	-	$ -	$ -	$ -	$ -	n/a	n/a
Deep Lighting	-	-	-	-	-	-	$ -	$ -	$ -	$ -	n/a	n/a
Total	-	-	-	-	-	-	$ -	$ -	$ -	$ -	n/a	n/a

The total impacts on greenhouse gas (GHG) emissions at the campus level have also been tabulated for all range of potential project savings. The metric tons of carbon dioxide equivalent are presented in the table below, including details attributable to the two tiers of projects.

Table 7.4: UC Davis GHG Impact Summary

	Low	High
	GHG Savings (Metric Tons C02e/yr*)	GHG Savings (Metric Tons C02e/yr)*
All Deep Projects	15,163	20,628
Tier 1	15,163	20,628
Tier 2	-	-

*eGrid average factors used, including CH_4 & N_2O impacts:

0.000299916 metric tons CO_2e/kWh

0.005302204 metric tons CO_2e/therm

7.2. Deep Efficiency Project Summary by Building

The table beginning on the following page provides a view of the project applicability for each of the four deep efficiency project categories by building, and the savings and cost ranges for the buildings.

Table 7.5: UC Davis Projects by Building

Building Key	Building Name	Basic Gross Area	Projects by Building				Total Building Deep Potential							
							Low Electricity (kWh/yr)	High Electricity (kWh/yr)	Low Gas (th/yr)	High Gas (th/yr)	Low Demand (kW)	High Demand (kW)	Low Cost (x$1000)	High Cost (x$1000)
			ESDVR	Deep Lab	Deep HVAC	Deep Lighting								
03C3201	WALKER	44,415			Tier 1		132,615	173,409	10,532	15,694	14.5	31.8	$ 152	$ 215
03C3207	HART	71,511			Tier 1		213,518	279,199	16,958	25,268	23.3	51.3	$ 245	$ 347
03C3237	ROBBNS	80,748	Tier 1	Tier 1		Tier 1	486,501	649,523	13,352	17,693	39.2	57.8	$ 601	$ 891
03C3266	YOUNG	87,134	Tier 1	Tier 1	Tier 1		351,622	494,574	10,584	14,026	25.3	40.2	$ 440	$ 687
03C3331	HICKEY GYM	82,842			Tier 1		42,539	95,801	13,751	20,490	18.9	41.6	$ 49	$ 119
03C3351	WICKSN	116,760	Tier 1	Tier 1		Tier 1	1,401,839	1,886,049	40,671	53,895	106.5	161.0	$ 1,744	$ 2,612
03C3390	LIB	400,710			Tier 1		440,563	808,603	81,188	127,755	115.0	271.4	$ 505	$ 1,004
03C3421	HUNT	64,080				Tier 1	51,300	59,226	-	-	8.4	9.7	$ 56	$ 65
03C3460	MU	144,588			Tier 1	Tier 1	629,219	804,449	32,583	49,386	77.4	140.8	$ 704	$ 952
03C3493	HARING	154,801	Tier 1	Tier 1	Tier 1	Tier 1	976,095	1,310,343	31,372	42,388	76.5	120.1	$ 1,208	$ 1,802
03C3607	HOAGLD	52,140			Tier 1	Tier 1	128,262	159,996	6,182	9,212	16.7	28.2	$ 144	$ 190
03C3745	VRHIES	48,816			Tier 1	Tier 1	232,660	290,923	11,576	17,249	30.1	51.4	$ 261	$ 347
03C3770	SEG GILMORE	42,946				Tier 1	81,572	94,175	-	-	13.3	15.4	$ 88	$ 103
03C3771	SEG BIXBY	42,946				Tier 1	81,572	94,175	-	-	13.3	15.4	$ 88	$ 103
03C3772	SEG MALCOLM	42,946				Tier 1	81,572	94,175	-	-	13.3	15.4	$ 88	$ 103
03C3788	HUTCH	113,440	Tier 1	Tier 1		Tier 1	741,881	995,335	21,098	27,959	57.6	86.3	$ 921	$ 1,374
03C3793	SEG RYERSON	42,946				Tier 1	81,572	94,175	-	-	13.3	15.4	$ 88	$ 103
03C3815	SPROUL	50,578			Tier 1	Tier 1	162,577	199,256	5,997	8,936	22.5	34.5	$ 181	$ 233
03C3842	MRAK	91,720				Tier 1	90,254	117,170	-	-	2.2	6.5	$ 98	$ 128
03C3961	CHEM	125,675	Tier 1	Tier 1			1,536,517	2,079,557	46,449	61,552	111.1	171.8	$ 1,922	$ 2,902
03C3961B	CHEM ANX	97,905	Tier 1	Tier 1			1,335,078	1,806,925	40,360	53,483	96.5	149.2	$ 1,670	$ 2,521
03C4004	BAINER	168,999	Tier 1	Tier 1			970,115	1,312,976	29,327	38,862	70.1	108.4	$ 1,213	$ 1,832
03C4023	TEC COMMUNIT	58,007			Tier 1	Tier 1	283,377	353,677	13,756	20,497	36.9	62.3	$ 318	$ 420
03C4051	KING	95,597				Tier 1	181,578	209,632	-	-	29.6	34.2	$ 197	$ 229
03C4073	STORER	91,708	Tier 1	Tier 1		Tier 1	373,172	497,867	10,188	13,501	30.3	44.5	$ 461	$ 682
03C4266	PHYGEO	114,234	Tier 1	Tier 1		Tier 1	1,130,705	1,512,622	31,492	41,731	89.8	133.2	$ 1,399	$ 2,080
03C4267	PRITCHARD	82,944	Tier 1	Tier 1	Tier 1	Tier 1	464,357	626,090	6,728	16,053	39.0	77.8	$ 547	$ 802
03C4273	BRIGGS	195,005				Tier 1	73,682	85,065	-	-	12.0	13.9	$ 80	$ 93
03C4302	KERR	54,923				Tier 1	101,112	116,733	-	-	16.5	19.1	$ 110	$ 128
03C4427	TUPPER HALL	253,166	Tier 1		Tier 1	Tier 1	1,391,061	1,831,705	12,685	18,901	161.7	227.5	$ 994	$ 1,157
03C4428	MED SCI I B	50,151				Tier 1	190,515	219,949	-	-	31.1	35.9	$ 207	$ 241
03C4444	ARC PAVILION	145,681			Tier 1	Tier 1	235,235	323,512	15,619	24,084	22.6	48.2	$ 261	$ 378
03C4466	VET MED 2	45,000	Tier 1				130,184	173,491	-	-	14.7	19.6	$ 81	$ 89
03C4556	MEYER	208,224	Tier 1	Tier 1			2,485,454	3,363,871	75,136	99,566	179.6	277.8	$ 3,108	$ 4,694
03C4632	ACADMC SURGE	125,590	Tier 1	Tier 1			1,295,725	1,753,665	39,170	51,906	93.7	144.8	$ 1,621	$ 2,447
03C4633	KEMPER	197,388	Tier 1	Tier 1			1,939,731	2,625,276	58,639	77,705	140.2	216.8	$ 2,426	$ 3,663
03C4656	SOCSCI&HUMAN	143,094			Tier 1		427,252	558,679	33,933	50,562	46.7	102.6	$ 490	$ 694
03C4683	LIF-SCI ADN	134,304	Tier 1	Tier 1		Tier 1	1,647,368	2,217,639	47,985	63,587	124.5	188.8	$ 2,050	$ 3,074
03C4722	CFA MONDAVI	106,370			Tier 1	Tier 1	447,470	576,382	22,631	34,993	47.7	94.3	$ 501	$ 681
03C4786	GENOME & BIO	228,955	Tier 1	Tier 1			2,798,808	3,787,970	84,609	112,119	202.3	312.9	$ 3,500	$ 5,286
03C4792	SCIENCES LAB	139,724	Tier 1	Tier 1			942,919	1,276,168	28,505	37,773	68.2	105.4	$ 1,179	$ 1,781
03C4793	VET MED 3A	128,979	Tier 1	Tier 1	Tier 1		1,374,567	1,853,580	48,845	66,669	104.8	172.7	$ 1,704	$ 2,557

Building Key	Building Name	Basic Gross Area	Projects by Building				Total Building Deep Potential							
			ESDVR	Deep Lab	Deep HVAC	Deep Lighting	Low Electricity (kWh/yr)	High Electricity (kWh/yr)	Low Gas (th/yr)	High Gas (th/yr)	Low Demand (kW)	High Demand (kW)	Low Cost (x$1000)	High Cost (x$1000)
03C4799	ARC	172,130			Tier 1		513,948	672,044	40,818	60,822	56.2	123.4	$ 589	$ 835
03C4806	SEGN THOMPSN	42,071				Tier 1	39,955	46,128	-	-	6.5	7.5	$ 43	$ 50
03C4821	MATH SCI	65,643			Tier 1		195,998	256,289	15,566	23,195	21.4	47.1	$ 225	$ 318
03C4824	TECS1KEARNEY	56,968				Tier 1	108,206	124,923	-	-	17.7	20.4	$ 117	$ 137
03C4825	TECS2 LABEN	56,385				Tier 1	107,098	123,645	-	-	17.5	20.2	$ 116	$ 135
03C4854	RMI NORTH	54,754	Tier 1	Tier 1			628,473	850,590	18,999	25,176	45.4	70.3	$ 786	$ 1,187
03C4855	RMI SOUTH	58,070	Tier 1	Tier 1			710,993	962,275	21,494	28,482	51.4	79.5	$ 889	$ 1,343
03C4865	EQUES C ARNA	45,000				Tier 1	85,474	98,679	-	-	13.9	16.1	$ 93	$ 108
03C8124	TAHOE ENVSCI	46,946	Tier 1				173,782	231,592	-	-	19.6	26.1	$ 108	$ 118
03C9524	EMERSON	114,950				Tier 1	218,338	252,070	-	-	35.6	41.1	$ 237	$ 276
03C9525	WEBSTER	48,329				Tier 1	91,797	105,979	-	-	15.0	17.3	$ 100	$ 116
03C9527	THOREAU	45,757				Tier 1	86,912	100,339	-	-	14.2	16.4	$ 94	$ 110
03C9912	NEUROSCI BLD	48,539	Tier 1	Tier 1			696,861	943,148	21,066	27,916	50.4	77.9	$ 872	$ 1,316
Campus Total			24	21	19	33	31,821,553	42,631,287	1,059,846	1,479,087	2,821.9	4,519.1	$ 37,969	$ 55,859

7.3. Deep Efficiency Projects by Type

The table beginning on the following page provides a list of all the buildings for each type of deep efficiency project, including the project savings and cost ranges for each building.

Table 7.6: UC Davis Project by Type

Building Key	Building Name	Total Building Deep Potential							
		Low Electricity (kWh/yr)	High Electricity (kWh/yr)	Low Gas (th/yr)	High Gas (th/yr)	Low Demand (kW)	High Demand (kW)	Low Cost (x$1000)	High Cost (x$1000)
ESDVR Projects									
03C3237	ROBBNS	161,655	215,431	-	-	18.3	24.3	$ 100	$ 110
03C3266	YOUNG	128,148	170,777	-	-	14.5	19.3	$ 80	$ 87
03C3351	WICKSN	492,425	656,233	-	-	55.6	74.1	$ 306	$ 335
03C3493	HARING	319,994	426,442	-	-	36.2	48.1	$ 199	$ 218
03C3788	HUTCH	255,450	340,427	-	-	28.9	38.4	$ 158	$ 174
03C3961	CHEM	562,385	749,467	-	-	63.5	84.6	$ 349	$ 383
03C3961B	CHEM ANX	488,656	651,211	-	-	55.2	73.5	$ 303	$ 333
03C4004	BAINER	355,075	473,193	-	-	40.1	53.4	$ 220	$ 242
03C4073	STORER	123,352	164,386	-	-	13.9	18.6	$ 77	$ 84
03C4266	PHYGEO	381,286	508,124	-	-	43.1	57.4	$ 237	$ 260
03C4267	PRITCHARD	81,462	108,561	-	-	9.2	12.3	$ 51	$ 55
03C4427	TUPPER HALL	1,129,739	1,505,555	-	-	127.6	170.0	$ 701	$ 770
03C4466	VET MED 2	130,184	173,491	-	-	14.7	19.6	$ 81	$ 89
03C4556	MEYER	909,709	1,212,330	-	-	102.8	136.9	$ 564	$ 620
03C4632	ACADMC SURGE	474,253	632,016	-	-	53.6	71.4	$ 294	$ 323
03C4633	KEMPER	709,967	946,142	-	-	80.2	106.8	$ 440	$ 484
03C4683	LIF-SCI ADN	580,976	774,241	-	-	65.6	87.4	$ 360	$ 396
03C4786	GENOME & BIO	1,024,400	1,365,174	-	-	115.7	154.1	$ 636	$ 698
03C4792	SCIENCES LAB	345,121	459,927	-	-	39.0	51.9	$ 214	$ 235
03C4793	VET MED 3A	448,853	598,167	-	-	50.7	67.5	$ 278	$ 306
03C4854	RMI NORTH	230,029	306,550	-	-	26.0	34.6	$ 143	$ 157
03C4855	RMI SOUTH	260,233	346,801	-	-	29.4	39.2	$ 161	$ 177
03C8124	TAHOE ENVSCI	173,782	231,592	-	-	19.6	26.1	$ 108	$ 118
03C9912	NEUROSCI BLD	255,060	339,908	-	-	28.8	38.4	$ 158	$ 174
Campus Total, ESDVR Projects		10,022,196	13,356,147	-	-	1,132	1,508	$ 6,218	$ 6,828
Deep Lab Projects									
03C3237	ROBBNS	280,010	382,329	13,352	17,693	13.7	25.1	$ 452	$ 724
03C3266	YOUNG	221,971	303,081	10,584	14,026	10.8	19.9	$ 358	$ 574
03C3351	WICKSN	852,950	1,164,628	40,671	53,895	41.6	76.3	$ 1,377	$ 2,205
03C3493	HARING	554,275	756,813	26,429	35,023	27.0	49.6	$ 895	$ 1,433
03C3788	HUTCH	442,475	604,161	21,098	27,959	21.6	39.6	$ 714	$ 1,144
03C3961	CHEM	974,131	1,330,091	46,449	61,552	47.5	87.2	$ 1,573	$ 2,519
03C3961B	CHEM ANX	846,422	1,155,714	40,360	53,483	41.3	75.7	$ 1,367	$ 2,189
03C4004	BAINER	615,040	839,783	29,327	38,862	30.0	55.0	$ 993	$ 1,590
03C4073	STORER	213,663	291,738	10,188	13,501	10.4	19.1	$ 345	$ 552
03C4266	PHYGEO	660,442	901,775	31,492	41,731	32.2	59.1	$ 1,066	$ 1,708
03C4267	PRITCHARD	141,104	192,666	6,728	8,916	6.9	12.6	$ 228	$ 365
03C4556	MEYER	1,575,745	2,151,541	75,136	99,566	76.9	141.0	$ 2,544	$ 4,074
03C4632	ACADMC SURGE	821,473	1,121,649	39,170	51,906	40.1	73.5	$ 1,326	$ 2,124
03C4633	KEMPER	1,229,764	1,679,134	58,639	77,705	60.0	110.0	$ 1,985	$ 3,180
03C4683	LIF-SCI ADN	1,006,332	1,374,058	47,985	63,587	49.1	90.0	$ 1,625	$ 2,602
03C4786	GENOME & BIO	1,774,407	2,422,796	84,609	112,119	86.6	158.8	$ 2,865	$ 4,588
03C4792	SCIENCES LAB	597,798	816,240	28,505	37,773	29.2	53.5	$ 965	$ 1,546
03C4793	VET MED 3A	777,477	1,061,576	37,072	49,126	37.9	69.6	$ 1,255	$ 2,010
03C4854	RMI NORTH	398,444	544,040	18,999	25,176	19.4	35.6	$ 643	$ 1,030
03C4855	RMI SOUTH	450,760	615,473	21,494	28,482	22.0	40.3	$ 728	$ 1,165
03C9912	NEUROSCI BLD	441,801	603,240	21,066	27,916	21.6	39.5	$ 713	$ 1,142
Campus Total, Deep Lab Projects		14,876,484	20,312,526	709,352	939,998	726	1,331	$ 24,018	$ 38,465
Deep HVAC Projects									
03C3201	WALKER	132,615	173,409	10,532	15,694	14.5	31.8	$ 152	$ 215
03C3207	HART	213,518	279,199	16,958	25,268	23.3	51.3	$ 245	$ 347
03C3266	YOUNG	1,503	20,716	-	-	-	1.0	$ 2	$ 26
03C3331	HICKEY GYM	42,539	95,801	13,751	20,490	18.9	41.6	$ 49	$ 119
03C3390	LIB	440,563	808,603	81,188	127,755	115.0	271.4	$ 505	$ 1,004

Building Key	Building Name	Total Building Deep Potential							
		Low Electricity (kWh/yr)	High Electricity (kWh/yr)	Low Gas (th/yr)	High Gas (th/yr)	Low Demand (kW)	High Demand (kW)	Low Cost (x$1000)	High Cost (x$1000)
03C3460	MU	354,587	487,386	32,583	49,386	32.6	89.1	$ 407	$ 605
03C3493	HARING	62,235	81,380	4,943	7,365	6.8	14.9	$ 71	$ 101
03C3607	HOAGLD	77,840	101,785	6,182	9,212	8.5	18.7	$ 89	$ 126
03C3745	VRHIES	145,755	190,591	11,576	17,249	15.9	35.0	$ 167	$ 237
03C3815	SPROUL	75,508	98,735	5,997	8,936	8.3	18.1	$ 87	$ 123
03C4023	TEC COMMUNIT	173,198	226,476	13,756	20,497	18.9	41.6	$ 199	$ 281
03C4267	PRITCHARD	111,593	174,550	-	7,137	1.7	28.4	$ 128	$ 217
03C4427	TUPPER HALL	159,718	208,849	12,685	18,901	17.5	38.3	$ 183	$ 259
03C4444	ARC PAVILION	96,881	163,783	15,619	24,084	-	22.1	$ 111	$ 203
03C4656	SOCSCI&HUMAN	427,252	558,679	33,933	50,562	46.7	102.6	$ 490	$ 694
03C4722	CFA MONDAVI	245,429	343,126	22,631	34,993	14.7	56.2	$ 281	$ 426
03C4793	VET MED 3A	148,237	193,837	11,773	17,543	16.2	35.6	$ 170	$ 241
03C4799	ARC	513,948	672,044	40,818	60,822	56.2	123.4	$ 589	$ 835
03C4821	MATH SCI	195,998	256,289	15,566	23,195	21.4	47.1	$ 225	$ 318
Campus Total, Deep HVAC		3,618,919	5,135,237	350,494	539,089	437	1,068	$ 4,151	$ 6,378
Deep Lighting Projects									
03C3237	ROBBNS	44,836	51,763	-	-	7.3	8.4	$ 49	$ 57
03C3351	WICKSN	56,464	65,188	-	-	9.2	10.6	$ 61	$ 71
03C3421	HUNT	51,300	59,226	-	-	8.4	9.7	$ 56	$ 65
03C3460	MU	274,633	317,062	-	-	44.8	51.7	$ 298	$ 347
03C3493	HARING	39,591	45,708	-	-	6.5	7.5	$ 43	$ 50
03C3607	HOAGLD	50,422	58,212	-	-	8.2	9.5	$ 55	$ 64
03C3745	VRHIES	86,905	100,331	-	-	14.2	16.4	$ 94	$ 110
03C3770	SEG GILMORE	81,572	94,175	-	-	13.3	15.4	$ 88	$ 103
03C3771	SEG BIXBY	81,572	94,175	-	-	13.3	15.4	$ 88	$ 103
03C3772	SEG MALCOLM	81,572	94,175	-	-	13.3	15.4	$ 88	$ 103
03C3788	HUTCH	43,956	50,747	-	-	7.2	8.3	$ 48	$ 56
03C3793	SEG RYERSON	81,572	94,175	-	-	13.3	15.4	$ 88	$ 103
03C3815	SPROUL	87,069	100,521	-	-	14.2	16.4	$ 94	$ 110
03C3842	MRAK	90,254	117,170	-	-	2.2	6.5	$ 98	$ 128
03C4023	TEC COMMUNIT	110,179	127,202	-	-	18.0	20.8	$ 119	$ 139
03C4051	KING	181,578	209,632	-	-	29.6	34.2	$ 197	$ 229
03C4073	STORER	36,157	41,743	-	-	5.9	6.8	$ 39	$ 46
03C4266	PHYGEO	88,977	102,723	-	-	14.5	16.8	$ 96	$ 112
03C4267	PRITCHARD	130,197	150,312	-	-	21.2	24.5	$ 141	$ 164
03C4273	BRIGGS	73,682	85,065	-	-	12.0	13.9	$ 80	$ 93
03C4302	KERR	101,112	116,733	-	-	16.5	19.1	$ 110	$ 128
03C4427	TUPPER HALL	101,604	117,301	-	-	16.6	19.1	$ 110	$ 128
03C4428	MED SCI I B	190,515	219,949	-	-	31.1	35.9	$ 207	$ 241
03C4444	ARC PAVILION	138,354	159,730	-	-	22.6	26.1	$ 150	$ 175
03C4683	LIF-SCI ADN	60,060	69,340	-	-	9.8	11.3	$ 65	$ 76
03C4722	CFA MONDAVI	202,041	233,255	-	-	33.0	38.1	$ 219	$ 255
03C4806	SEGN THOMPSN	39,955	46,128	-	-	6.5	7.5	$ 43	$ 50
03C4824	TECS1KEARNEY	108,206	124,923	-	-	17.7	20.4	$ 117	$ 137
03C4825	TECS2 LABEN	107,098	123,645	-	-	17.5	20.2	$ 116	$ 135
03C4865	EQUES C ARNA	85,474	98,679	-	-	13.9	16.1	$ 93	$ 108
03C9524	EMERSON	218,338	252,070	-	-	35.6	41.1	$ 237	$ 276
03C9525	WEBSTER	91,797	105,979	-	-	15.0	17.3	$ 100	$ 116
03C9527	THOREAU	86,912	100,339	-	-	14.2	16.4	$ 94	$ 110
Campus Total, Deep Lighting		3,303,954	3,827,376	-	-	527	612	$ 3,582	$ 4,188

7.4. Campus Specific Projects

Additionally, during discussions with the campus, staff identified projects that have deep efficiency potential but do not fall into savings quantified for the four project categories above. These include campuswide scheduling and setpoint optimization, and a demand flow chilled water (CHW) optimization. These project are discussed below, but require additional engineering to determine scope, costs or savings.

7.4.1. Central Plant Demand Flow CHW Optimization

The campus has investigated a project that uses proprietary control loop to optimize the campus chilled water loop flow based on building demand. Specifically, the Demand Flow product from Siemens controls and sequences the operation of the central chilled water plant, optimizing temperature set points for chilled water and condenser water, while controlling pump and cooling fan speeds. The campus estimates this project will save approximately 4 million kWh per year.

7.4.2. Campuswide Scheduling & Setpoint Optimization Project

The campus is interested in employing the existing control system to optimize space temperature setpoints by widening the deadbands and more tightly scheduling units across the campus. The campus estimates this project will save approximately 1 million kWh per year.

8. UC Irvine – Deep Efficiency Potential

8.1. Campus Deep Efficiency Potential

The total campus potential is tabulated in the table below for all projects identified in this investigation. The savings, along with project economics and a resulting aggregate simple payback, are shown for the range of savings for each project type, as well as the campuswide potential.

Table 8.1: UC Irvine Potential Savings Summary, All Projects

	Total Building Deep Potential								Economics			
	Low Electricity (kWh/yr)	High Electricity (kWh/yr)	Low Gas (th/yr)	High Gas (th/yr)	Low Demand (kW)	High Demand (kW)	Low Cost (x$1000)	High Cost (x$1000)	Low Utility Savings (x$1000)	High Utility Savings (x$1000)	Low SPB (yrs)	High SPB (yrs)
SmartLab	5,386,290	7,267,713	130,487	172,915	433	643	$ 6,062	$ 8,881	$ 817	$ 1,101	7.4	8.1
Deep HVAC	3,228,180	4,317,157	261,715	389,970	340	803	$ 4,908	$ 7,105	$ 591	$ 812	8.3	8.7
Deep Lighting	-	-	-	-	-	-	$ -	$ -	$ -	$ -	n/a	n/a
Total	8,614,470	11,584,870	392,202	562,885	773	1,446	$ 10,970	$ 15,985	$ 1,408	$ 1,913	7.8	8.4

Based on campus review and input into the potential deep efficiency projects in the identified buildings, the total potential is further broken down into the Tier 1 (reasonably certain candidate projects) and Tier 2 (questionable candidate projects) categories. The resulting savings and economics are presented in the following two tables, respectively.

Table 8.2: UC Irvine Potential Savings Summary, Tier 1

	Total Building Deep Potential								Economics			
	Low	High	Low	High	Low	High	Low	High	Low	High	Low	High
	Electricity (kWh/yr)	Electricity (kWh/yr)	Gas (th/yr)	Gas (th/yr)	Demand (kW)	Demand (kW)	Cost (x$1000)	Cost (x$1000)	Utility Savings (x$1000)	Utility Savings (x$1000)	SPB (yrs)	SPB (yrs)
SmartLab	5,179,344	6,991,924	130,487	172,915	409	612	$ 5,934	$ 8,740	$ 789	$ 1,063	7.5	8.2
Deep HVAC	3,041,893	4,073,567	249,777	372,182	319	758	$ 4,474	$ 6,490	$ 559	$ 769	8.0	8.4
Deep Lighting	-	-	-	-	-	-	$ -	$ -	$ -	$ -	n/a	n/a
Total	8,221,237	11,065,491	380,264	545,097	729	1,370	$ 10,408	$ 15,230	$ 1,347	$ 1,832	7.7	8.3

Table 8.3: UC Irvine Potential Savings Summary, Tier 2

	Total Building Deep Potential								Economics			
	Low	High	Low	High	Low	High	Low	High	Low	High	Low	High
	Electricity (kWh/yr)	Electricity (kWh/yr)	Gas (th/yr)	Gas (th/yr)	Demand (kW)	Demand (kW)	Cost (x$1000)	Cost (x$1000)	Utility Savings (x$1000)	Utility Savings (x$1000)	SPB (yrs)	SPB (yrs)
SmartLab	206,947	275,789	-	-	23	31	$ 128	$ 141	$ 29	$ 38	4.5	3.7
Deep HVAC	186,286	243,590	11,938	17,788	20	45	$ 434	$ 614	$ 32	$ 44	13.4	14.1
Deep Lighting	-	-	-	-	-	-	$ -	$ -	$ -	$ -	n/a	n/a
Total	393,233	519,379	11,938	17,788	44	76	$ 562	$ 755	$ 61	$ 82	9.2	9.2

The total impacts on greenhouse gas (GHG) emissions at the campus level have also been tabulated for all range of potential project savings. The metric tons of carbon dioxide equivalent are presented in the table below, including details attributable to the two tiers of projects.

Table 8.4: UC Irvine GHG Impact Summary

	Low	High
	GHG Savings (Metric Tons C02e/yr*)	GHG Savings (Metric Tons C02e/yr)*
All Deep Projects	4,663	6,459
Tier 1	4,482	6,209
Tier 2	181	250

*eGrid average factors used, including CH_4 & N_2O impacts:

0.000299916 metric tons CO_2e/kWh

0.005302204 metric tons CO_2e/therm

8.2. Deep Efficiency Project Summary by Building

The table beginning on the following page provides a view of the project applicability for each of the four deep efficiency project categories by building, and the savings and cost ranges for the buildings.

Table 8.5: UC Irvine Projects by Building

Building Key	Building Name	Basic Gross Area	Projects by Building				Total Building Deep Potential							
			ESDVR	Deep Lab	Deep HVAC	Deep Lighting	Low Electricity (kWh/yr)	High Electricity (kWh/yr)	Low Gas (th/yr)	High Gas (th/yr)	Low Demand (kW)	High Demand (kW)	Low Cost (x$1000)	High Cost (x$1000)
09C9001	LANGSON LIBR	142,353			Tier 1		425,039	555,786	33,757	50,300	46.5	102.0	$ 488	$ 690
09C9003	ALDRICH HALL	96,924			Tier 1		231,518	302,735	11,492	17,124	25.3	55.6	$ 797	$ 1,128
09C9005	UCI STU CNTR	214,156			Tier 1		639,430	836,125	50,784	75,672	69.9	153.5	$ 733	$ 1,039
09C9024	IRV THEATRE	75,524			Tier 1		225,501	294,867	17,910	26,686	24.7	54.1	$ 259	$ 366
09C9025	KRIEGER HALL	41,455			Tier 2		90,349	118,141	7,176	10,692	9.9	21.7	$ 104	$ 147
09C9030	HUMANITIES H	58,185			Tier 1		151,117	204,558	13,798	20,560	15.4	38.1	$ 173	$ 254
09C9073	SCILIBRARY	189,590			Tier 1		322,751	496,884	44,959	66,991	25.5	99.6	$ 370	$ 617
09C9075	STEINHAUS H	107,972	Tier 1	Tier 1			1,271,254	1,720,545	38,430	50,926	91.9	142.1	$ 1,590	$ 2,401
09C9079	BIO SCI 3	108,730	Tier 1				334,857	446,249	-	-	37.8	50.4	$ 208	$ 228
09C9100	ROWLAND HALL	234,071	Tier 2				206,947	275,789	-	-	23.4	31.1	$ 128	$ 141
09C9118	CAL (IT)2	111,187	Tier 1				528,047	703,705	-	-	59.7	79.4	$ 328	$ 360
09C9125	ENG TOWER	129,158	Tier 1	Tier 1			1,452,764	1,966,205	43,917	58,197	105.0	162.4	$ 1,817	$ 2,744
09C9126	COMP SCI BLD	61,594			Tier 1		183,908	240,480	14,606	21,764	20.1	44.2	$ 211	$ 299
09C9132	IRVINE HALL	53,365	Tier 1	Tier 1			354,302	479,520	10,711	14,193	25.6	39.6	$ 443	$ 669
09C9134	BREN HALL	125,301			Tier 1		374,125	489,210	29,714	44,275	40.9	89.8	$ 429	$ 608
09C9203	SOCSCI LAB	50,205			Tier 2		95,938	125,449	4,762	7,096	10.5	23.0	$ 330	$ 467
09C9204	SOCSCI TOWER	81,753			Tier 1		198,107	273,195	9,693	14,444	19.4	51.3	$ 682	$ 1,018
09C9314	BREN EVENTS	97,259			Tier 1		290,397	379,727	23,064	34,366	31.8	69.7	$ 333	$ 472
09C9322	MED SCI C	55,853	Tier 1	Tier 1			635,510	860,114	19,212	25,458	45.9	71.0	$ 795	$ 1,200
09C9323	MED SCI D	51,343	Tier 1	Tier 1			602,609	815,585	18,217	24,140	43.6	67.4	$ 754	$ 1,138
Campus Total			8	5	12	0	8,614,470	11,584,870	392,202	562,885	772.7	1,446.1	$ 10,970	$ 15,985

8.3. Deep Efficiency Projects by Type

The table below provides a list of all the buildings for each type of deep efficiency project, including the project savings and cost ranges for each building.

Table 8.6: UC Irvine Project by Type

Building Key	Building Name	Total Building Deep Potential							
		Low Electricity (kWh/yr)	High Electricity (kWh/yr)	Low Gas (th/yr)	High Gas (th/yr)	Low Demand (kW)	High Demand (kW)	Low Cost (x$1000)	High Cost (x$1000)
ESDVR Projects									
09C9075	STEINHAUS H	465,296	620,080	-	-	52.6	70.0	$ 289	$ 317
09C9079	BIO SCI 3	334,857	446,249	-	-	37.8	50.4	$ 208	$ 228
09C9100	ROWLAND HALL	206,947	275,789	-	-	23.4	31.1	$ 128	$ 141
09C9118	CAL (IT)2	528,047	703,705	-	-	59.7	79.4	$ 328	$ 360
09C9125	ENG TOWER	531,731	708,615	-	-	60.1	80.0	$ 330	$ 362
09C9132	IRVINE HALL	129,679	172,818	-	-	14.7	19.5	$ 80	$ 88
09C9322	MED SCI C	232,605	309,983	-	-	26.3	35.0	$ 144	$ 158
09C9323	MED SCI D	220,563	293,935	-	-	24.9	33.2	$ 137	$ 150
Campus Total, ESDVR Projects		2,649,724	3,531,173	-	-	299	399	$ 1,644	$ 1,805
Deep Lab Projects									
09C9075	STEINHAUS H	805,959	1,100,465	38,430	50,926	39.3	72.1	$ 1,301	$ 2,084
09C9125	ENG TOWER	921,033	1,257,590	43,917	58,197	44.9	82.4	$ 1,487	$ 2,381
09C9132	IRVINE HALL	224,623	306,702	10,711	14,193	11.0	20.1	$ 363	$ 581
09C9322	MED SCI C	402,905	550,132	19,212	25,458	19.7	36.0	$ 650	$ 1,042
09C9323	MED SCI D	382,046	521,650	18,217	24,140	18.6	34.2	$ 617	$ 988
Campus Total, Deep Lab Projects		2,736,566	3,736,539	130,487	172,915	134	245	$ 4,418	$ 7,076
Deep HVAC Projects									
09C9001	LANGSON LIBR	425,039	555,786	33,757	50,300	46.5	102.0	$ 488	$ 690
09C9003	ALDRICH HALL	231,518	302,735	11,492	17,124	25.3	55.6	$ 797	$ 1,128
09C9005	UCI STU CNTR	639,430	836,125	50,784	75,672	69.9	153.5	$ 733	$ 1,039
09C9024	IRV THEATRE	225,501	294,867	17,910	26,686	24.7	54.1	$ 259	$ 366
09C9025	KRIEGER HALL	90,349	118,141	7,176	10,692	9.9	21.7	$ 104	$ 147
09C9030	HUMANITIES H	151,117	204,558	13,798	20,560	15.4	38.1	$ 173	$ 254
09C9073	SCILIBRARY	322,751	496,884	44,959	66,991	25.5	99.6	$ 370	$ 617
09C9126	COMP SCI BLD	183,908	240,480	14,606	21,764	20.1	44.2	$ 211	$ 299
09C9134	BREN HALL	374,125	489,210	29,714	44,275	40.9	89.8	$ 429	$ 608
09C9203	SOCSCI LAB	95,938	125,449	4,762	7,096	10.5	23.0	$ 330	$ 467
09C9204	SOCSCI TOWER	198,107	273,195	9,693	14,444	19.4	51.3	$ 682	$ 1,018
09C9314	BREN EVENTS	290,397	379,727	23,064	34,366	31.8	69.7	$ 333	$ 472
Campus Total, Deep HVAC		3,228,180	4,317,157	261,715	389,970	340	803	$ 4,908	$ 7,105

8.4. Campus Specific Projects

Additionally, during discussions with the campus, staff identified projects that have deep efficiency potential but do not fall into savings quantified for the four project categories above. These projects have been preliminarily investigated by the campus, and the preliminary project savings and economics are below. These costs and savings are not included in the campus level summary.

Table 8.7: UC Irvine Campus Specific Projects

Project	Savings				Project Cost	SPB (yrs)
	kWh/yr	kW	th/yr	Cost ($)		
Campuswide-Implement ANSI Z9.5 minimum FH airflow	250,000	5	2,000	$27,810	$250,000	9.0
Engineering Lab-MBCx	150,000	50	10,000	$23,550	$215,000	9.1
Beckman Laser-Extend HTW, add HX to replace boiler system	-	-	53,500	$41,730	$430,000	10.3
Plumwood House-Extend HTW, add HX to replace boiler system	-	-	83,000	$64,740	$680,000	10.5
Med Sci C-Steam Condensate Recovery Project	-	-	16,911	$13,191	$297,435	22.5
Irvine Hall-Extend HTW, add HX to replace boiler system	-		53,000	$41,340	$710,000	17.2
Campuswide-Extend CHW piping to various DX buildings	750,000	20	-	$78,750	$1,500,000	19.0
PSCB & LH-Extend CHW to replace DX cooling coils	180,000		-	$18,900	$400,000	21.2
Med Ed-Extend HTW, add HX to replace boiler system	-		18,500	$14,430	$640,000	44.4
Campuswide-Install CHW FCU for High internal equipment loads	800,000	15	-	$84,000	$800,000	9.5

9. UC Los Angeles – Deep Efficiency Potential

9.1. Campus Deep Efficiency Potential

The total campus potential is tabulated in the table below for all projects identified in this investigation. The savings, along with project economics and a resulting aggregate simple payback, are shown for the range of savings for each project type, as well as the campuswide potential.

Table 9.1: UCLA Potential Savings Summary, All Projects

	Total Building Deep Potential								Economics			
	Low Electricity (kWh/yr)	High Electricity (kWh/yr)	Low Gas (th/yr)	High Gas (th/yr)	Low Demand (kW)	High Demand (kW)	Low Cost (x$1000)	High Cost (x$1000)	Low Utility Savings (x$1000)	High Utility Savings (x$1000)	Low SPB (yrs)	High SPB (yrs)
SmartLab	47,254,785	63,955,713	1,360,166	1,802,425	3,416	5,283	$ 73,875	$ 111,557	$ 6,633	$ 8,959	11.1	12.5
Deep HVAC	25,597,156	33,471,121	2,032,961	3,029,231	2,799	6,145	$ 36,699	$ 51,967	$ 4,203	$ 5,671	8.7	9.2
Deep Lighting	20,493,845	23,660,079	-	-	3,345	3,861	$ 27,771	$ 32,362	$ 2,599	$ 3,001	10.7	10.8
Total	93,345,786	121,086,913	3,393,127	4,831,656	9,559	15,289	$ 138,345	$ 195,886	$ 13,436	$ 17,631	10.3	11.1

Based on campus review and input into the potential deep efficiency projects in the identified buildings, the total potential is further broken down into the Tier 1 (reasonably certain candidate projects) and Tier 2 (questionable candidate projects) categories. All potential housing projects were assigned a Tier 2 status pending feedback from that department. The resulting savings and economics are presented in the following two tables, respectively.

Table 9.2: UCLA Potential Savings Summary, Tier 1

	Total Building Deep Potential								Economics			
	Low	High	Low	High	Low	High	Low	High	Low	High	Low	High
	Electricity (kWh/yr)	Electricity (kWh/yr)	Gas (th/yr)	Gas (th/yr)	Demand (kW)	Demand (kW)	Cost (x$1000)	Cost (x$1000)	Utility Savings (x$1000)	Utility Savings (x$1000)	SPB (yrs)	SPB (yrs)
SmartLab	47,254,785	63,955,713	1,360,166	1,802,425	3,416	5,283	$ 73,875	$ 111,557	$ 6,633	$ 8,959	11.1	12.5
Deep HVAC	18,891,782	24,703,101	1,500,411	2,235,701	2,066	4,535	$ 27,085	$ 38,354	$ 3,102	$ 4,185	8.7	9.2
Deep Lighting	15,243,217	17,598,246	-	-	2,488	2,872	$ 20,656	$ 24,071	$ 1,933	$ 2,232	10.7	10.8
Total	81,389,784	106,257,060	2,860,577	4,038,125	7,969	12,690	$ 121,616	$ 173,982	$ 11,669	$ 15,377	10.4	11.3

Table 9.3: UCLA Potential Savings Summary, Tier 2

	Total Building Deep Potential								Economics			
	Low	High	Low	High	Low	High	Low	High	Low	High	Low	High
	Electricity (kWh/yr)	Electricity (kWh/yr)	Gas (th/yr)	Gas (th/yr)	Demand (kW)	Demand (kW)	Cost (x$1000)	Cost (x$1000)	Utility Savings (x$1000)	Utility Savings (x$1000)	SPB (yrs)	SPB (yrs)
SmartLab	-	-	-	-	-	-	$ -	$ -	$ -	$ -	n/a	n/a
Deep HVAC	6,705,374	8,768,020	532,550	793,531	733	1,610	$ 9,614	$ 13,613	$ 1,101	$ 1,486	8.7	9.2
Deep Lighting	5,250,628	6,061,833	-	-	857	989	$ 7,115	$ 8,291	$ 666	$ 769	10.7	10.8
Total	11,956,001	14,829,853	532,550	793,531	1,590	2,599	$ 16,729	$ 21,904	$ 1,767	$ 2,254	9.5	9.7

The total impacts on greenhouse gas (GHG) emissions at the campus level have also been tabulated for all range of potential project savings. The metric tons of carbon dioxide equivalent are presented in the table below, including details attributable to the two tiers of projects.

Table 9.4: UCLA GHG Impact Summary

	Low	High
	GHG Savings (Metric Tons C02e/yr*)	GHG Savings (Metric Tons C02e/yr)*
All Deep Projects	45,987	61,934
Tier 1	39,577	53,279
Tier 2	6,409	8,655

*eGrid average factors used, including CH_4 & N_2O impacts:

0.000299916 metric tons CO_2e/kWh

0.005302204 metric tons CO_2e/therm

9.2. Deep Efficiency Project Summary by Building

The table beginning on the following page provides a view of the project applicability for each of the four deep efficiency project categories by building, and the savings and cost ranges for the buildings.

Table 9.5: UCLA Projects by Building

Building Key	Building Name	Basic Gross Area	Projects by Building				Total Building Deep Potential							
							Low Electricity (kWh/yr)	High Electricity (kWh/yr)	Low Gas (th/yr)	High Gas (th/yr)	Low Demand (kW)	High Demand (kW)	Low Cost (x$1000)	High Cost (x$1000)
			ESDVR	Deep Lab	Deep HVAC	Deep Lighting								
04C404B	X5767CENTURY	81,195			Tier 2	Tier 1	348,169	431,656	15,403	22,952	46.4	75.6	$ 487	$ 637
04C404H	UNEX 1010 WW	49,128			Tier 2	Tier 1	193,980	241,917	9,320	13,887	25.3	42.6	$ 272	$ 359
04C4051	HAMMER MUSM	102,412			Tier 1	Tier 1	385,999	481,758	18,737	27,919	50.3	84.9	$ 542	$ 716
04C4057	XOPPENHEIMER	48,504			Tier 2	Tier 1	207,988	257,862	9,202	13,711	27.7	45.2	$ 291	$ 381
04C410R	X924 WSTWOOD	84,773			Tier 2	Tier 1	363,512	450,678	16,082	23,964	48.4	79.0	$ 509	$ 665
04C410T	X10880 WILSH	45,436			Tier 2	Tier 1	194,833	241,551	8,620	12,844	26.0	42.3	$ 273	$ 357
04C412H	X2020 SM BLV	47,183			Tier 2	Tier 1	202,324	250,839	8,951	13,338	26.9	43.9	$ 283	$ 370
04C4200	MURPHY HALL	220,188			Tier 1	Tier 1	1,075,668	1,342,519	52,215	77,803	140.1	236.6	$ 1,509	$ 1,995
04C4203	YOUNG LIBRY	305,919			Tier 1	Tier 1	1,494,484	1,865,234	72,545	108,096	194.7	328.8	$ 2,097	$ 2,772
04C4204	PAULEY	204,465			Tier 1	Tier 1	998,858	1,246,654	48,486	72,247	130.1	219.7	$ 1,402	$ 1,853
04C4206	BROAD CTR	140,213			Tier 1	Tier 1	486,017	625,206	33,250	49,544	56.8	113.2	$ 692	$ 956
04C4211	PARKG ST CHS	652,811			Tier 2	Tier 1	260,139	326,196	13,417	19,993	33.4	57.7	$ 366	$ 487
04C4213	DODD HALL	78,303			Tier 1	Tier 1	365,308	457,545	18,569	27,668	47.0	80.9	$ 513	$ 682
04C4216	ROLFE HALL	73,276			Tier 1	Tier 1	337,047	422,620	17,376	25,892	43.2	74.8	$ 474	$ 631
04C4217	LA TENNIS CT	57,859			Tier 2	Tier 1	248,103	307,595	10,976	16,356	33.0	53.9	$ 347	$ 454
04C4221	MORGAN CTR	70,507			Tier 2	Tier 1	302,339	374,836	13,376	19,931	40.3	65.7	$ 423	$ 553
04C4223	ACOSTA CTR	66,291			Tier 2	Tier 1	284,260	352,422	12,576	18,739	37.9	61.7	$ 398	$ 520
04C4225	HAINES HALL	133,851			Tier 1	Tier 1	619,306	776,179	31,741	47,296	79.5	137.3	$ 871	$ 1,158
04C4226	DRAKE STAD	70,589				Tier 1	134,078	154,792	-	-	21.9	25.3	$ 182	$ 212
04C4227	SLICHTER	62,557	Tier 1	Tier 1			765,639	1,036,234	23,145	30,671	55.3	85.6	$ 1,197	$ 1,807
04C4228A	GEOLOGY	182,149	Tier 1	Tier 1	Tier 1	Tier 1	2,170,392	2,906,048	71,071	96,567	174.2	274.9	$ 3,345	$ 4,973
04C4228B	YOUNG HALL	297,589	Tier 1	Tier 1	Tier 1	Tier 1	3,963,105	5,332,748	125,196	168,260	303.5	474.9	$ 6,148	$ 9,207
04C4228C	MOLECULR SCI	178,666	Tier 1	Tier 1	Tier 1	Tier 1	2,419,451	3,257,874	7,680	11,443	184.1	287.6	$ 3,757	$ 5,632
04C4233	CSB1	53,334			Tier 2	Tier 1	228,700	283,539	10,118	15,076	30.5	49.7	$ 320	$ 419
04C4235	WOODEN	189,839			Tier 2	Tier 1	814,042	1,009,240	36,014	53,663	108.4	176.8	$ 1,139	$ 1,490
04C4246	DYKSTRA HALL	163,262				Tier 2	248,082	286,410	-	-	40.5	46.7	$ 336	$ 392
04C4247	SPROUL HALL	195,246				Tier 2	248,922	287,379	-	-	40.6	46.9	$ 337	$ 393
04C4250	MOORE HALL	88,505			Tier 1	Tier 1	407,806	511,272	20,988	31,273	52.3	90.5	$ 573	$ 763
04C4256A	ENGR BLDG 4	294,124	Tier 1	Tier 1	Tier 1	Tier 1	3,817,912	5,131,779	121,582	163,810	295.5	463.2	$ 5,915	$ 8,843
04C4260	FACMGMT BLDG	189,197			Tier 1	Tier 1	924,270	1,153,562	44,866	66,852	120.4	203.3	$ 1,297	$ 1,714
04C4262	KINROSS	75,121			Tier 1	Tier 1	345,725	433,482	17,814	26,544	44.3	76.7	$ 486	$ 647
04C4266	ENGR BLDG 5	100,000	Tier 1	Tier 1	Tier 2	Tier 1	1,200,676	1,609,967	38,153	51,525	94.9	148.2	$ 1,855	$ 2,764
04C4270	WILSHIRE CTR	455,912			Tier 2	Tier 1	1,193,466	1,479,645	52,801	78,676	159.0	259.2	$ 1,670	$ 2,184
04C4271	BRADLEY HALL	46,907			Tier 2	Tier 1	197,548	245,224	8,899	13,260	26.2	43.0	$ 277	$ 362
04C4273	DE NEVE B	46,945				Tier 2	71,334	82,355	-	-	11.6	13.4	$ 97	$ 113
04C4274	DE NEVE C	42,512				Tier 2	64,598	74,579	-	-	10.5	12.2	$ 88	$ 102
04C4275	DE NEVE D	42,519				Tier 2	64,609	74,591	-	-	10.5	12.2	$ 88	$ 102
04C4276	DE NEVE E	56,693				Tier 2	86,147	99,456	-	-	14.1	16.2	$ 117	$ 136
04C4277	DE NEVE F	43,027				Tier 2	65,381	75,482	-	-	10.7	12.3	$ 89	$ 103
04C4278	DE NEVE CMNS	101,044			Tier 2	Tier 2	394,898	492,864	19,169	28,563	51.4	86.9	$ 554	$ 732
04C4279	STRATHMORE	63,920			Tier 1	Tier 1	312,264	389,730	15,158	22,586	40.7	68.7	$ 438	$ 579
04C4285	MARGAN APTS	44,137				Tier 2	67,068	77,429	-	-	10.9	12.6	$ 91	$ 106

Building Key	Building Name	Basic Gross Area	Projects by Building				Total Building Deep Potential							
							Low Electricity (kWh/yr)	High Electricity (kWh/yr)	Low Gas (th/yr)	High Gas (th/yr)	Low Demand (kW)	High Demand (kW)	Low Cost (x$1000)	High Cost (x$1000)
			ESDVR	Deep Lab	Deep HVAC	Deep Lighting								
04C4286A	KEYSTONE A	72,317				Tier 2	66,489	76,761	-	-	10.9	12.5	$ 90	$ 105
04C4286B	KEYSTONE B	79,352				Tier 2	73,035	84,318	-	-	11.9	13.8	$ 99	$ 115
04C4286C	KEYSTONE C	72,317				Tier 2	66,489	76,761	-	-	10.9	12.5	$ 90	$ 105
04C4286D	KEYSTONE D	72,317				Tier 2	66,489	76,761	-	-	10.9	12.5	$ 90	$ 105
04C4287	VILLAGE TERR	105,139				Tier 2	141,292	163,121	-	-	23.1	26.6	$ 191	$ 223
04C4288	FAC APTS-GLY	73,073				Tier 2	111,037	128,192	-	-	18.1	20.9	$ 150	$ 175
04C4289	WW CHATEAU	126,500				Tier 2	192,221	221,918	-	-	31.4	36.2	$ 260	$ 304
04C4294	CAMPBELL	54,844			Tier 1	Tier 1	255,796	320,388	13,006	19,379	32.9	56.7	$ 359	$ 478
04C4295	VENICE BARRY	130,000				Tier 2	197,539	228,058	-	-	32.2	37.2	$ 268	$ 312
04C4297	FAC APTS-LEV	122,390				Tier 2	185,975	214,708	-	-	30.4	35.0	$ 252	$ 294
04C4298	RIEBER HALL	199,076				Tier 2	302,502	349,238	-	-	49.4	57.0	$ 410	$ 478
04C4299	HEDRICK HALL	198,485				Tier 2	301,604	348,201	-	-	49.2	56.8	$ 409	$ 476
04C4300A	11140 ROSE	74,188				Tier 2	70,184	81,027	-	-	11.5	13.2	$ 95	$ 111
04C4302A	CANYON POINT	107,419				Tier 2	163,227	188,445	-	-	26.6	30.8	$ 221	$ 258
04C4302B	DELTA TERR	131,118				Tier 2	199,238	230,020	-	-	32.5	37.5	$ 270	$ 315
04C4302C	COURTSIDE/PK	364,888			Tier 2	Tier 2	317,454	396,208	15,410	22,961	41.4	69.8	$ 445	$ 589
04C4302D	COVEL COMMON	144,067			Tier 2	Tier 1	617,769	765,902	27,331	40,725	82.3	134.2	$ 864	$ 1,131
04C4310	KERCKHOFF	70,820			Tier 2	Tier 1	303,681	376,500	13,435	20,019	40.5	66.0	$ 425	$ 556
04C4315	GONDA CENTER	125,202	Tier 1	Tier 1	Tier 1	Tier 1	1,603,097	2,153,493	51,274	69,174	124.8	195.8	$ 2,482	$ 3,707
04C4317	LAW	275,439			Tier 1	Tier 1	1,287,881	1,612,777	65,317	97,326	165.9	285.1	$ 1,810	$ 2,405
04C4318A	POWELL LIB	166,846			Tier 1	Tier 1	782,990	980,236	39,565	58,955	101.0	173.3	$ 1,100	$ 1,461
04C4319	FRANZ HALL	238,054			Tier 2	Tier 1	735,785	936,526	45,161	67,293	89.5	168.0	$ 1,042	$ 1,418
04C4320	LIFE SCIENCE	214,613	Tier 1	Tier 1	Tier 1	Tier 1	2,842,539	3,824,038	89,950	120,954	218.2	341.5	$ 4,409	$ 6,600
04C4329	REED RESRCH	70,936	Tier 1	Tier 1	Tier 1	Tier 1	804,158	1,074,134	26,784	36,574	66.0	104.5	$ 1,236	$ 1,830
04C4331	PUBLIC HLTH	140,563	Tier 1	Tier 1	Tier 1	Tier 1	1,142,566	1,496,227	43,257	61,133	110.2	179.2	$ 1,710	$ 2,456
04C4332B	BRAIN RSCH	86,578	Tier 1	Tier 1	Tier 1		1,114,203	1,505,530	36,322	48,835	82.5	131.4	$ 1,735	$ 2,613
04C4332G	VIVARIUM	126,390	Tier 1	Tier 1	Tier 1	Tier 1	1,610,728	2,163,299	51,595	69,640	125.6	197.2	$ 2,493	$ 3,722
04C4335	SCHOENBERG	122,552			Tier 1	Tier 1	483,393	614,103	29,062	43,304	59.2	110.0	$ 684	$ 928
04C4336	FACTOR	199,857	Tier 1	Tier 1	Tier 1	Tier 1	2,134,846	2,842,886	72,613	99,755	179.9	286.4	$ 3,267	$ 4,817
04C4337	DREW-COBB	54,389			Tier 2	Tier 1	233,224	289,148	10,318	15,375	31.1	50.7	$ 326	$ 427
04C4343	BOELTER HALL	373,904	Tier 1	Tier 1	Tier 1	Tier 1	3,912,129	5,203,853	134,067	184,568	332.8	530.7	$ 5,978	$ 8,799
04C4348	MACDONALDLAB	144,611	Tier 1	Tier 1	Tier 1		1,919,679	2,594,675	61,751	82,819	141.6	224.3	$ 2,991	$ 4,507
04C4352	SYCAMORE CT	140,526				Tier 2	145,798	168,324	-	-	23.8	27.5	$ 198	$ 230
04C4353	PALM COURT	121,371				Tier 2	128,877	148,788	-	-	21.0	24.3	$ 175	$ 204
04C4357	OLIVE COURT	140,008				Tier 2	150,668	173,945	-	-	24.6	28.4	$ 204	$ 238
04C4358	JACARANDA CT	125,398				Tier 2	149,528	172,630	-	-	24.4	28.2	$ 203	$ 236
04C4359	MATH SCIENCE	224,078			Tier 2	Tier 1	843,782	1,056,097	42,510	63,342	108.9	186.6	$ 1,185	$ 1,574
04C4360	SAC	113,383			Tier 1	Tier 1	548,867	685,500	26,887	40,064	71.3	120.9	$ 770	$ 1,019
04C4361	KAUFMAN	73,553				Tier 1	57,820	66,753	-	-	9.4	10.9	$ 78	$ 91
04C4362	HUMANITIES	125,077			Tier 1	Tier 1	564,822	709,267	29,660	44,196	72.1	125.7	$ 795	$ 1,060
04C4363	KNUDSEN HALL	164,702	Tier 1	Tier 1	Tier 1	Tier 1	1,884,372	2,518,148	62,563	85,352	153.9	243.7	$ 2,897	$ 4,294
04C4374	FOWLER MUSM	101,995			Tier 1	Tier 1	431,248	544,504	24,187	36,040	54.0	97.0	$ 608	$ 818
04C4375	ROYCE HALL	184,673			Tier 1	Tier 1	884,920	1,106,065	43,793	65,254	114.7	195.2	$ 1,242	$ 1,646

Building Key	Building Name	Basic Gross Area	Projects by Building				Total Building Deep Potential							
							Low Electricity (kWh/yr)	High Electricity (kWh/yr)	Low Gas (th/yr)	High Gas (th/yr)	Low Demand (kW)	High Demand (kW)	Low Cost (x$1000)	High Cost (x$1000)
			ESDVR	Deep Lab	Deep HVAC	Deep Lighting								
04C4376	CYPRESS CT	128,057				Tier 2	125,411	144,786	-	-	20.5	23.6	$ 170	$ 198
04C4377	ALOE COURT	98,323			Tier 2	Tier 2	186,864	233,220	9,071	13,516	24.3	41.1	$ 262	$ 347
04C4378	MAGNOLIA CT	131,987				Tier 2	139,200	160,706	-	-	22.7	26.2	$ 189	$ 220
04C4394	PHYS ASTRO	132,845	Tier 1	Tier 1	Tier 1	Tier 1	1,225,028	1,617,654	44,043	61,428	110.7	178.4	$ 1,854	$ 2,698
04C4400A	U ELEM SCH 1	47,303			Tier 1		141,238	184,684	11,217	16,714	15.4	33.9	$ 202	$ 287
04C4403	BOYER HALL	133,042	Tier 1	Tier 1	Tier 1	Tier 1	1,731,838	2,328,102	55,102	74,219	133.9	209.8	$ 2,683	$ 4,013
04C4410	UEBERROTH	65,737			Tier 2	Tier 1	257,584	321,422	12,471	18,582	33.6	56.6	$ 361	$ 478
04C4415	UNEX	95,065			Tier 2	Tier 1	397,970	494,223	18,035	26,873	52.7	86.7	$ 557	$ 731
04C4461	BIOMED SCI	133,000	Tier 1	Tier 1	Tier 1		1,762,055	2,381,582	56,728	76,095	130.0	206.0	$ 2,746	$ 4,137
04C4463	NEUROSCI RCH	128,676	Tier 1	Tier 1	Tier 1	Tier 1	1,490,551	1,993,079	49,278	67,145	121.1	191.5	$ 2,293	$ 3,402
04C4464	OHRC	95,000	Tier 1	Tier 1			1,031,992	1,396,721	31,197	41,341	74.6	115.4	$ 1,613	$ 2,436
04C4469	GAYLEY TWRS	57,075				Tier 2	86,727	100,126	-	-	14.2	16.3	$ 118	$ 137
04C4475	GLENROCK WST	40,776				Tier 2	61,960	71,533	-	-	10.1	11.7	$ 84	$ 98
04C4486	CNSI	188,289	Tier 1	Tier 1	Tier 1	Tier 1	2,587,304	3,485,979	80,950	108,467	195.7	305.4	$ 4,021	$ 6,032
04C4501	STRB	49,512			Tier 1		147,834	193,309	11,741	17,495	16.2	35.5	$ 212	$ 300
04C4540	HEDRK SUMIT	200,716				Tier 2	304,994	352,115	-	-	49.8	57.5	$ 413	$ 482
04C4541	RIEBER TERRC	185,200				Tier 2	281,417	324,895	-	-	45.9	53.0	$ 381	$ 444
04C4542	RIEBER VISTA	179,637				Tier 2	272,964	315,136	-	-	44.5	51.4	$ 370	$ 431
04C4562	SRLF	228,306			Tier 1	Tier 1	1,115,327	1,392,016	54,140	80,672	145.3	245.4	$ 1,565	$ 2,069
04C4577A	MELNITZ HALL	61,827			Tier 1		184,604	241,390	14,661	21,846	20.2	44.3	$ 265	$ 375
04C4578	MACGOWAN	129,542			Tier 1	Tier 1	451,259	580,199	30,719	45,773	52.8	105.0	$ 642	$ 887
04C4579	PUB AFFAIRS	201,667			Tier 1	Tier 1	907,301	1,139,672	47,823	71,259	115.6	202.1	$ 1,277	$ 1,704
04C4580	BUNCHE HALL	229,248			Tier 1	Tier 1	1,039,275	1,304,645	54,363	81,004	132.7	231.2	$ 1,462	$ 1,950
04C4581	WARREN HALL	102,205	Tier 1	Tier 1	Tier 1		1,276,917	1,724,886	42,170	56,831	95.0	152.0	$ 1,987	$ 2,991
04C4582	ACKERMAN	213,264			Tier 2	Tier 1	914,490	1,133,774	40,458	60,285	121.8	198.6	$ 1,279	$ 1,674
04C4594	REHAB CENTER	142,566	Tier 1	Tier 1	Tier 1	Tier 1	1,596,108	2,130,629	53,392	73,001	131.7	208.8	$ 2,450	$ 3,626
04C515B	GOLD HALL	55,344			Tier 2	Tier 1	231,897	287,965	10,499	15,645	30.7	50.5	$ 325	$ 426
04C515C	ENTREP HALL	72,591			Tier 2	Tier 1	302,388	375,655	13,771	20,520	40.0	65.9	$ 423	$ 556
04C515D	CORNELL HALL	71,737			Tier 2	Tier 1	291,924	363,263	13,609	20,279	38.4	63.9	$ 409	$ 538
04C515E	ROSNFLD LIBR	51,046			Tier 2	Tier 1	207,891	258,679	9,684	14,430	27.4	45.5	$ 291	$ 383
04C4006	MED PLZA 100	50,903				Tier 1	96,686	111,624	-	-	15.8	18.2	$ 131	$ 153
04C4325	DORIS STEIN	94,309			Tier 1	Tier 1	460,721	575,016	22,364	33,324	60.0	101.4	$ 646	$ 855
04C4332D	HEALTH SCI	1,191,122	Tier 1	Tier 1	Tier 1	Tier 1	8,709,176	11,314,894	345,379	493,569	889.6	1,458.7	$ 12,897	$ 18,292
04C4332E	M DAVIES CC	70,228	Tier 1	Tier 1		Tier 1	422,615	553,501	9,968	13,209	39.0	54.4	$ 641	$ 925
04C4332F	SEMEL INST	294,992	Tier 1	Tier 1	Tier 1	Tier 1	2,008,900	2,594,716	82,314	118,515	213.6	352.1	$ 2,952	$ 4,146
04C4333	JULES STEIN	87,905			Tier 1	Tier 1	403,562	506,098	20,846	31,061	51.7	89.6	$ 567	$ 756
04C4334	DENTISTRY	204,369	Tier 1	Tier 1	Tier 1	Tier 1	1,887,432	2,492,592	67,818	94,572	170.5	274.6	$ 2,857	$ 4,158
Campus Total			28	28	83	113	93,345,786	121,086,913	3,393,127	4,831,656	9,559.1	15,289.0	$ 138,345	$ 195,886

9.3. Deep Efficiency Projects by Type

The table beginning on the following page provides a list of all the buildings for each type of deep efficiency project, including the project savings and cost ranges for each building.

Table 9.6: UCLA Project by Type

Building Key	Building Name	Total Building Deep Potential							
		Low Electricity (kWh/yr)	High Electricity (kWh/yr)	Low Gas (th/yr)	High Gas (th/yr)	Low Demand (kW)	High Demand (kW)	Low Cost (x$1000)	High Cost (x$1000)
ESDVR Projects									
04C4227	SLICHTER	280,234	373,456	-	-	31.7	42.2	$ 217	$ 239
04C4228A	GEOLOGY	685,260	913,216	-	-	77.4	103.1	$ 531	$ 584
04C4228B	YOUNG HALL	1,342,805	1,789,499	-	-	151.7	202.0	$ 1,041	$ 1,144
04C4228C	MOLECULR SCI	827,644	1,102,965	-	-	93.5	124.5	$ 642	$ 705
04C4256A	ENGR BLDG 4	1,274,167	1,698,027	-	-	143.9	191.7	$ 988	$ 1,085
04C4266	ENGR BLDG 5	390,968	521,026	-	-	44.2	58.8	$ 303	$ 333
04C4315	GONDA CENTER	530,556	707,049	-	-	59.9	79.8	$ 411	$ 452
04C4320	LIFE SCIENCE	960,077	1,279,453	-	-	108.5	144.4	$ 745	$ 818
04C4329	REED RESRCH	244,885	326,348	-	-	27.7	36.8	$ 190	$ 209
04C4331	PUBLIC HLTH	243,956	325,110	-	-	27.6	36.7	$ 189	$ 208
04C4332B	BRAIN RSCH	388,174	517,302	-	-	43.9	58.4	$ 301	$ 331
04C4332G	VIVARIUM	531,534	708,353	-	-	60.0	80.0	$ 412	$ 453
04C4336	FACTOR	619,945	826,174	-	-	70.0	93.3	$ 481	$ 528
04C4343	BOELTER HALL	1,116,022	1,487,274	-	-	126.1	167.9	$ 866	$ 950
04C4348	MACDONALDLAB	674,961	899,492	-	-	76.3	101.5	$ 523	$ 575
04C4363	KNUDSEN HALL	577,813	770,026	-	-	65.3	86.9	$ 448	$ 492
04C4394	PHYS ASTRO	308,261	410,806	-	-	34.8	46.4	$ 239	$ 263
04C4403	BOYER HALL	578,954	771,547	-	-	65.4	87.1	$ 449	$ 493
04C4461	BIOMED SCI	619,184	825,160	-	-	70.0	93.2	$ 480	$ 527
04C4463	NEUROSCI RCH	461,248	614,685	-	-	52.1	69.4	$ 358	$ 393
04C4464	OHRC	377,723	503,375	-	-	42.7	56.8	$ 293	$ 322
04C4486	CNSI	892,310	1,189,143	-	-	100.8	134.2	$ 692	$ 760
04C4581	WARREN HALL	440,820	587,462	-	-	49.8	66.3	$ 342	$ 375
04C4594	REHAB CENTER	481,423	641,572	-	-	54.4	72.4	$ 373	$ 410
04C4332D	HEALTH SCI	1,546,667	2,061,177	-	-	174.7	232.7	$ 2,159	$ 2,371
04C4332E	M DAVIES CC	120,689	160,837	-	-	13.6	18.2	$ 168	$ 185
04C4332F	SEMEL INST	303,844	404,920	-	-	34.3	45.7	$ 424	$ 466
04C4334	DENTISTRY	475,752	634,014	-	-	53.7	71.6	$ 664	$ 729
Campus Total, ESDVR Projects		17,295,875	23,049,466	-	-	1,954	2,602	$ 14,932	$ 16,396
Deep Lab Projects									
04C4227	SLICHTER	485,405	662,778	23,145	30,671	23.7	43.4	$ 980	$ 1,569
04C4228A	GEOLOGY	1,186,967	1,620,699	56,598	75,001	57.9	106.2	$ 2,395	$ 3,836
04C4228B	YOUNG HALL	2,325,930	3,175,852	110,907	146,968	113.5	208.1	$ 4,694	$ 7,517
04C4228C	MOLECULR SCI	1,433,596	1,957,449	-	-	69.9	128.3	$ 2,893	$ 4,633
04C4256A	ENGR BLDG 4	2,207,037	3,013,515	105,238	139,456	107.7	197.5	$ 4,454	$ 7,133
04C4266	ENGR BLDG 5	677,211	924,672	32,291	42,791	33.0	60.6	$ 1,367	$ 2,189
04C4315	GONDA CENTER	918,999	1,254,812	43,820	58,069	44.8	82.2	$ 1,855	$ 2,970
04C4320	LIFE SCIENCE	1,662,989	2,270,665	79,296	105,079	81.1	148.8	$ 3,356	$ 5,375
04C4329	REED RESRCH	424,176	579,175	20,226	26,802	20.7	38.0	$ 856	$ 1,371
04C4331	PUBLIC HLTH	422,567	576,978	20,149	26,701	20.6	37.8	$ 853	$ 1,366
04C4332B	BRAIN RSCH	672,372	918,064	32,061	42,485	32.8	60.2	$ 1,357	$ 2,173
04C4332G	VIVARIUM	920,693	1,257,125	43,901	58,176	44.9	82.4	$ 1,858	$ 2,976
04C4336	FACTOR	1,073,833	1,466,225	51,203	67,852	52.4	96.1	$ 2,167	$ 3,471
04C4343	BOELTER HALL	1,933,109	2,639,489	92,176	122,147	94.3	173.0	$ 3,901	$ 6,248
04C4348	MACDONALDLAB	1,169,128	1,596,342	55,747	73,874	57.0	104.6	$ 2,359	$ 3,779
04C4363	KNUDSEN HALL	1,000,854	1,366,577	47,723	63,241	48.8	89.5	$ 2,020	$ 3,235
04C4394	PHYS ASTRO	533,952	729,064	25,460	33,739	26.1	47.8	$ 1,078	$ 1,726
04C4403	BOYER HALL	1,002,830	1,369,276	47,818	63,366	48.9	89.7	$ 2,024	$ 3,241
04C4461	BIOMED SCI	1,072,515	1,464,424	51,140	67,769	52.3	96.0	$ 2,164	$ 3,466
04C4463	NEUROSCI RCH	798,947	1,090,892	38,096	50,483	39.0	71.5	$ 1,612	$ 2,582
04C4464	OHRC	654,269	893,347	31,197	41,341	31.9	58.5	$ 1,320	$ 2,115
04C4486	CNSI	1,545,607	2,110,390	73,699	97,662	75.4	138.3	$ 3,119	$ 4,995
04C4581	WARREN HALL	763,563	1,042,577	36,409	48,247	37.3	68.3	$ 1,541	$ 2,468
04C4594	REHAB CENTER	833,893	1,138,607	39,762	52,691	40.7	74.6	$ 1,683	$ 2,695

Building Key	Building Name	Total Building Deep Potential							
		Low Electricity (kWh/yr)	High Electricity (kWh/yr)	Low Gas (th/yr)	High Gas (th/yr)	Low Demand (kW)	High Demand (kW)	Low Cost (x$1000)	High Cost (x$1000)
04C4332D	HEALTH SCI	2,679,048	3,658,003	127,744	169,281	130.7	239.7	$ 9,732	$ 15,586
04C4332E	M DAVIES CC	209,050	285,439	9,968	13,209	10.2	18.7	$ 759	$ 1,216
04C4332F	SEMEL INST	526,301	718,617	25,095	33,255	25.7	47.1	$ 1,912	$ 3,062
04C4334	DENTISTRY	824,070	1,125,194	39,294	52,070	40.2	73.7	$ 2,994	$ 4,794
Campus Total, Deep Lab Projects		29,958,910	40,906,248	1,360,166	1,802,425	1,462	2,680	$ 67,304	$ 107,787
Deep HVAC Projects									
04C404B	X5767CENTURY	193,946	253,607	15,403	22,952	21.2	46.6	$ 278	$ 394
04C404H	UNEX 1010 WW	117,350	153,448	9,320	13,887	12.8	28.2	$ 168	$ 238
04C4051	HAMMER MUSM	235,920	308,491	18,737	27,919	25.8	56.6	$ 338	$ 479
04C4057	XOPPENHEIMER	115,859	151,499	9,202	13,711	12.7	27.8	$ 166	$ 235
04C410R	X924 WSTWOOD	202,493	264,782	16,082	23,964	22.1	48.6	$ 290	$ 411
04C410T	X10880 WILSH	108,531	141,916	8,620	12,844	11.9	26.1	$ 156	$ 220
04C412H	X2020 SM BLV	112,704	147,373	8,951	13,338	12.3	27.1	$ 162	$ 229
04C4200	MURPHY HALL	657,440	859,676	52,215	77,803	71.9	157.8	$ 943	$ 1,335
04C4203	YOUNG LIBRY	913,417	1,194,394	72,545	108,096	99.9	219.3	$ 1,310	$ 1,854
04C4204	PAULEY	610,494	798,289	48,486	72,247	66.8	146.6	$ 875	$ 1,239
04C4206	BROAD CTR	418,650	547,431	33,250	49,544	45.8	100.5	$ 600	$ 850
04C4211	PARKG ST CHS	168,938	220,905	13,417	19,993	18.5	40.6	$ 242	$ 343
04C4213	DODD HALL	233,798	305,717	18,569	27,668	25.6	56.1	$ 335	$ 475
04C4216	ROLFE HALL	218,788	286,090	17,376	25,892	23.9	52.5	$ 314	$ 444
04C4217	LA TENNIS CT	138,205	180,718	10,976	16,356	15.1	33.2	$ 198	$ 281
04C4221	MORGAN CTR	168,417	220,223	13,376	19,931	18.4	40.4	$ 241	$ 342
04C4223	ACOSTA CTR	158,346	207,055	12,576	18,739	17.3	38.0	$ 227	$ 321
04C4225	HAINES HALL	399,654	522,592	31,741	47,296	43.7	95.9	$ 573	$ 811
04C4228A	GEOLOGY	182,236	238,294	14,473	21,566	19.9	43.7	$ 261	$ 370
04C4228B	YOUNG HALL	179,917	235,261	14,289	21,292	19.7	43.2	$ 258	$ 365
04C4228C	MOLECULR SCI	96,697	126,442	7,680	11,443	10.6	23.2	$ 139	$ 196
04C4233	CSB1	127,396	166,585	10,118	15,076	13.9	30.6	$ 183	$ 259
04C4235	WOODEN	453,459	592,948	36,014	53,663	49.6	108.9	$ 650	$ 921
04C4250	MOORE HALL	264,259	345,548	20,988	31,273	28.9	63.4	$ 379	$ 536
04C4256A	ENGR BLDG 4	205,793	269,097	16,344	24,354	22.5	49.4	$ 295	$ 418
04C4260	FACMGMT BLDG	564,907	738,678	44,866	66,852	61.8	135.6	$ 810	$ 1,147
04C4262	KINROSS	224,297	293,294	17,814	26,544	24.5	53.8	$ 322	$ 455
04C4266	ENGR BLDG 5	73,807	96,511	5,862	8,735	8.1	17.7	$ 106	$ 150
04C4270	WILSHIRE CTR	664,816	869,320	52,801	78,676	72.7	159.6	$ 953	$ 1,350
04C4271	BRADLEY HALL	112,044	146,511	8,899	13,260	12.3	26.9	$ 161	$ 227
04C4278	DE NEVE CMNS	241,359	315,603	19,169	28,563	26.4	57.9	$ 346	$ 490
04C4279	STRATHMORE	190,853	249,562	15,158	22,586	20.9	45.8	$ 274	$ 387
04C4294	CAMPBELL	163,754	214,126	13,006	19,379	17.9	39.3	$ 235	$ 332
04C4302C	COURTSIDE/PK	194,026	253,710	15,410	22,961	21.2	46.6	$ 278	$ 394
04C4302D	COVEL COMMON	344,126	449,983	27,331	40,725	37.6	82.6	$ 493	$ 699
04C4310	KERCKHOFF	169,164	221,201	13,435	20,019	18.5	40.6	$ 243	$ 343
04C4315	GONDA CENTER	93,843	122,711	7,453	11,106	10.3	22.5	$ 135	$ 191
04C4317	LAW	822,409	1,075,392	65,317	97,326	89.9	197.4	$ 1,179	$ 1,670
04C4318A	POWELL LIB	498,171	651,414	39,565	58,955	54.5	119.6	$ 714	$ 1,011
04C4319	FRANZ HALL	568,628	743,544	45,161	67,293	62.2	136.5	$ 815	$ 1,154
04C4320	LIFE SCIENCE	134,140	175,404	10,654	15,875	14.7	32.2	$ 192	$ 272
04C4329	REED RESRCH	82,570	107,970	6,558	9,772	9.0	19.8	$ 118	$ 168
04C4331	PUBLIC HLTH	290,954	380,454	23,108	34,432	31.8	69.8	$ 417	$ 591
04C4332B	BRAIN RSCH	53,658	70,164	4,262	6,350	5.9	12.9	$ 77	$ 109
04C4332G	VIVARIUM	96,874	126,674	7,694	11,464	10.6	23.3	$ 139	$ 197
04C4335	SCHOENBERG	365,917	478,478	29,062	43,304	40.0	87.8	$ 525	$ 743
04C4336	FACTOR	269,577	352,501	21,410	31,902	29.5	64.7	$ 386	$ 547
04C4337	DREW-COBB	129,916	169,880	10,318	15,375	14.2	31.2	$ 186	$ 264
04C4343	BOELTER HALL	527,458	689,709	41,891	62,421	57.7	126.6	$ 756	$ 1,071
04C4348	MACDONALDLAB	75,589	98,841	6,003	8,945	8.3	18.1	$ 108	$ 153
04C4359	MATH SCIENCE	535,244	699,891	42,510	63,342	58.5	128.5	$ 767	$ 1,087

Building Key	Building Name	Total Building Deep Potential							
		Low Electricity (kWh/yr)	High Electricity (kWh/yr)	Low Gas (th/yr)	High Gas (th/yr)	Low Demand (kW)	High Demand (kW)	Low Cost (x$1000)	High Cost (x$1000)
04C4360	SAC	338,540	442,679	26,887	40,064	37.0	81.3	$ 485	$ 687
04C4362	HUMANITIES	373,457	488,336	29,660	44,196	40.8	89.7	$ 535	$ 758
04C4363	KNUDSEN HALL	186,845	244,320	14,839	22,112	20.4	44.9	$ 268	$ 379
04C4374	FOWLER MUSM	304,538	398,217	24,187	36,040	33.3	73.1	$ 437	$ 618
04C4375	ROYCE HALL	551,399	721,015	43,793	65,254	60.3	132.4	$ 791	$ 1,119
04C4377	ALOE COURT	114,210	149,342	9,071	13,516	12.5	27.4	$ 164	$ 232
04C4394	PHYS ASTRO	233,974	305,947	18,583	27,689	25.6	56.2	$ 335	$ 475
04C4400A	U ELEM SCH 1	141,238	184,684	11,217	16,714	15.4	33.9	$ 202	$ 287
04C4403	BOYER HALL	91,712	119,923	7,284	10,853	10.0	22.0	$ 131	$ 186
04C4410	UEBERROTH	157,023	205,325	12,471	18,582	17.2	37.7	$ 225	$ 319
04C4415	UNEX	227,077	296,928	18,035	26,873	24.8	54.5	$ 326	$ 461
04C4461	BIOMED SCI	70,356	91,998	5,588	8,326	7.7	16.9	$ 101	$ 143
04C4463	NEUROSCI RCH	140,792	184,101	11,182	16,662	15.4	33.8	$ 202	$ 286
04C4486	CNSI	91,304	119,390	7,251	10,805	10.0	21.9	$ 131	$ 185
04C4501	STRB	147,834	193,309	11,741	17,495	16.2	35.5	$ 212	$ 300
04C4562	SRLF	681,679	891,371	54,140	80,672	74.5	163.7	$ 977	$ 1,384
04C4577A	MELNITZ HALL	184,604	241,390	14,661	21,846	20.2	44.3	$ 265	$ 375
04C4578	MACGOWAN	386,788	505,768	30,719	45,773	42.3	92.9	$ 555	$ 785
04C4579	PUB AFFAIRS	602,140	787,365	47,823	71,259	65.8	144.6	$ 863	$ 1,222
04C4580	BUNCHE HALL	684,492	895,049	54,363	81,004	74.8	164.3	$ 981	$ 1,390
04C4581	WARREN HALL	72,535	94,847	5,761	8,584	7.9	17.4	$ 104	$ 147
04C4582	ACKERMAN	509,413	666,114	40,458	60,285	55.7	122.3	$ 730	$ 1,034
04C4594	REHAB CENTER	171,618	224,409	13,630	20,310	18.8	41.2	$ 246	$ 348
04C515B	GOLD HALL	132,197	172,863	10,499	15,645	14.5	31.7	$ 190	$ 268
04C515C	ENTREP HALL	173,395	226,733	13,771	20,520	19.0	41.6	$ 249	$ 352
04C515D	CORNELL HALL	171,355	224,065	13,609	20,279	18.7	41.1	$ 246	$ 348
04C515E	ROSNFLD LIBR	121,931	159,438	9,684	14,430	13.3	29.3	$ 175	$ 248
04C4325	DORIS STEIN	281,589	368,209	22,364	33,324	30.8	67.6	$ 727	$ 1,029
04C4332D	HEALTH SCI	2,740,257	3,583,190	217,635	324,289	299.6	657.9	$ 7,072	$ 10,014
04C4332F	SEMEL INST	720,446	942,063	57,219	85,259	78.8	173.0	$ 1,859	$ 2,633
04C4333	JULES STEIN	262,468	343,206	20,846	31,061	28.7	63.0	$ 677	$ 959
04C4334	DENTISTRY	359,143	469,619	28,524	42,502	39.3	86.2	$ 927	$ 1,312
Campus Total, Deep HVAC		25,597,156	33,471,121	2,032,961	3,029,231	2,799	6,145	$ 41,704	$ 59,054
Deep Lighting Projects									
04C404B	X5767CENTURY	154,223	178,050	-	-	25.2	29.1	$ 209	$ 244
04C404H	UNEX 1010 WW	76,630	88,469	-	-	12.5	14.4	$ 104	$ 121
04C4051	HAMMER MUSM	150,080	173,266	-	-	24.5	28.3	$ 203	$ 237
04C4057	XOPPENHEIMER	92,129	106,363	-	-	15.0	17.4	$ 125	$ 145
04C410R	X924 WSTWOOD	161,019	185,896	-	-	26.3	30.3	$ 218	$ 254
04C410T	X10880 WILSH	86,302	99,635	-	-	14.1	16.3	$ 117	$ 136
04C412H	X2020 SM BLV	89,620	103,466	-	-	14.6	16.9	$ 121	$ 142
04C4200	MURPHY HALL	418,228	482,843	-	-	68.3	78.8	$ 567	$ 660
04C4203	YOUNG LIBRY	581,067	670,840	-	-	94.8	109.5	$ 787	$ 918
04C4204	PAULEY	388,364	448,365	-	-	63.4	73.2	$ 526	$ 613
04C4206	BROAD CTR	67,367	77,775	-	-	11.0	12.7	$ 91	$ 106
04C4211	PARKG ST CHS	91,201	105,291	-	-	14.9	17.2	$ 124	$ 144
04C4213	DODD HALL	131,510	151,828	-	-	21.5	24.8	$ 178	$ 208
04C4216	ROLFE HALL	118,259	136,530	-	-	19.3	22.3	$ 160	$ 187
04C4217	LA TENNIS CT	109,898	126,877	-	-	17.9	20.7	$ 149	$ 174
04C4221	MORGAN CTR	133,922	154,613	-	-	21.9	25.2	$ 181	$ 211
04C4223	ACOSTA CTR	125,914	145,367	-	-	20.5	23.7	$ 171	$ 199
04C4225	HAINES HALL	219,652	253,587	-	-	35.8	41.4	$ 298	$ 347
04C4226	DRAKE STAD	134,078	154,792	-	-	21.9	25.3	$ 182	$ 212
04C4228A	GEOLOGY	115,929	133,839	-	-	18.9	21.8	$ 157	$ 183
04C4228B	YOUNG HALL	114,453	132,136	-	-	18.7	21.6	$ 155	$ 181
04C4228C	MOLECULR SCI	61,514	71,017	-	-	10.0	11.6	$ 83	$ 97
04C4233	CSB1	101,303	116,954	-	-	16.5	19.1	$ 137	$ 160

Building Key	Building Name	Total Building Deep Potential							
		Low Electricity (kWh/yr)	High Electricity (kWh/yr)	Low Gas (th/yr)	High Gas (th/yr)	Low Demand (kW)	High Demand (kW)	Low Cost (x$1000)	High Cost (x$1000)
04C4235	WOODEN	360,583	416,292	-	-	58.8	67.9	$ 489	$ 569
04C4246	DYKSTRA HALL	248,082	286,410	-	-	40.5	46.7	$ 336	$ 392
04C4247	SPROUL HALL	248,922	287,379	-	-	40.6	46.9	$ 337	$ 393
04C4250	MOORE HALL	143,546	165,724	-	-	23.4	27.0	$ 195	$ 227
04C4256A	ENGR BLDG 4	130,915	151,140	-	-	21.4	24.7	$ 177	$ 207
04C4260	FACMGMT BLDG	359,364	414,884	-	-	58.6	67.7	$ 487	$ 567
04C4262	KINROSS	121,428	140,188	-	-	19.8	22.9	$ 165	$ 192
04C4266	ENGR BLDG 5	58,690	67,758	-	-	9.6	11.1	$ 80	$ 93
04C4270	WILSHIRE CTR	528,650	610,325	-	-	86.3	99.6	$ 716	$ 835
04C4271	BRADLEY HALL	85,503	98,713	-	-	14.0	16.1	$ 116	$ 135
04C4273	DE NEVE B	71,334	82,355	-	-	11.6	13.4	$ 97	$ 113
04C4274	DE NEVE C	64,598	74,579	-	-	10.5	12.2	$ 88	$ 102
04C4275	DE NEVE D	64,609	74,591	-	-	10.5	12.2	$ 88	$ 102
04C4276	DE NEVE E	86,147	99,456	-	-	14.1	16.2	$ 117	$ 136
04C4277	DE NEVE F	65,381	75,482	-	-	10.7	12.3	$ 89	$ 103
04C4278	DE NEVE CMNS	153,540	177,261	-	-	25.1	28.9	$ 208	$ 242
04C4279	STRATHMORE	121,411	140,168	-	-	19.8	22.9	$ 165	$ 192
04C4285	MARGAN APTS	67,068	77,429	-	-	10.9	12.6	$ 91	$ 106
04C4286A	KEYSTONE A	66,489	76,761	-	-	10.9	12.5	$ 90	$ 105
04C4286B	KEYSTONE B	73,035	84,318	-	-	11.9	13.8	$ 99	$ 115
04C4286C	KEYSTONE C	66,489	76,761	-	-	10.9	12.5	$ 90	$ 105
04C4286D	KEYSTONE D	66,489	76,761	-	-	10.9	12.5	$ 90	$ 105
04C4287	VILLAGE TERR	141,292	163,121	-	-	23.1	26.6	$ 191	$ 223
04C4288	FAC APTS-GLY	111,037	128,192	-	-	18.1	20.9	$ 150	$ 175
04C4289	WW CHATEAU	192,221	221,918	-	-	31.4	36.2	$ 260	$ 304
04C4294	CAMPBELL	92,042	106,262	-	-	15.0	17.3	$ 125	$ 145
04C4295	VENICE BARRY	197,539	228,058	-	-	32.2	37.2	$ 268	$ 312
04C4297	FAC APTS-LEV	185,975	214,708	-	-	30.4	35.0	$ 252	$ 294
04C4298	RIEBER HALL	302,502	349,238	-	-	49.4	57.0	$ 410	$ 478
04C4299	HEDRICK HALL	301,604	348,201	-	-	49.2	56.8	$ 409	$ 476
04C4300A	11140 ROSE	70,184	81,027	-	-	11.5	13.2	$ 95	$ 111
04C4302A	CANYON POINT	163,227	188,445	-	-	26.6	30.8	$ 221	$ 258
04C4302B	DELTA TERR	199,238	230,020	-	-	32.5	37.5	$ 270	$ 315
04C4302C	COURTSIDE/PK	123,429	142,498	-	-	20.1	23.3	$ 167	$ 195
04C4302D	COVEL COMMON	273,643	315,920	-	-	44.7	51.6	$ 371	$ 432
04C4310	KERCKHOFF	134,517	155,299	-	-	22.0	25.3	$ 182	$ 212
04C4315	GONDA CENTER	59,698	68,921	-	-	9.7	11.2	$ 81	$ 94
04C4317	LAW	465,471	537,385	-	-	76.0	87.7	$ 631	$ 735
04C4318A	POWELL LIB	284,819	328,822	-	-	46.5	53.7	$ 386	$ 450
04C4319	FRANZ HALL	167,157	192,982	-	-	27.3	31.5	$ 227	$ 264
04C4320	LIFE SCIENCE	85,333	98,517	-	-	13.9	16.1	$ 116	$ 135
04C4329	REED RESRCH	52,527	60,642	-	-	8.6	9.9	$ 71	$ 83
04C4331	PUBLIC HLTH	185,089	213,685	-	-	30.2	34.9	$ 251	$ 292
04C4332G	VIVARIUM	61,626	71,147	-	-	10.1	11.6	$ 84	$ 97
04C4335	SCHOENBERG	117,476	135,625	-	-	19.2	22.1	$ 159	$ 186
04C4336	FACTOR	171,490	197,985	-	-	28.0	32.3	$ 232	$ 271
04C4337	DREW-COBB	103,307	119,268	-	-	16.9	19.5	$ 140	$ 163
04C4343	BOELTER HALL	335,540	387,380	-	-	54.8	63.2	$ 455	$ 530
04C4352	SYCAMORE CT	145,798	168,324	-	-	23.8	27.5	$ 198	$ 230
04C4353	PALM COURT	128,877	148,788	-	-	21.0	24.3	$ 175	$ 204
04C4357	OLIVE COURT	150,668	173,945	-	-	24.6	28.4	$ 204	$ 238
04C4358	JACARANDA CT	149,528	172,630	-	-	24.4	28.2	$ 203	$ 236
04C4359	MATH SCIENCE	308,538	356,206	-	-	50.4	58.1	$ 418	$ 487
04C4360	SAC	210,326	242,821	-	-	34.3	39.6	$ 285	$ 332
04C4361	KAUFMAN	57,820	66,753	-	-	9.4	10.9	$ 78	$ 91
04C4362	HUMANITIES	191,366	220,931	-	-	31.2	36.1	$ 259	$ 302
04C4363	KNUDSEN HALL	118,861	137,224	-	-	19.4	22.4	$ 161	$ 188

Building Key	Building Name	Total Building Deep Potential							
		Low Electricity (kWh/yr)	High Electricity (kWh/yr)	Low Gas (th/yr)	High Gas (th/yr)	Low Demand (kW)	High Demand (kW)	Low Cost (x$1000)	High Cost (x$1000)
04C4374	FOWLER MUSM	126,710	146,287	-	-	20.7	23.9	$ 172	$ 200
04C4375	ROYCE HALL	333,521	385,049	-	-	54.4	62.8	$ 452	$ 527
04C4376	CYPRESS CT	125,411	144,786	-	-	20.5	23.6	$ 170	$ 198
04C4377	ALOE COURT	72,654	83,879	-	-	11.9	13.7	$ 98	$ 115
04C4378	MAGNOLIA CT	139,200	160,706	-	-	22.7	26.2	$ 189	$ 220
04C4394	PHYS ASTRO	148,842	171,837	-	-	24.3	28.0	$ 202	$ 235
04C4403	BOYER HALL	58,342	67,356	-	-	9.5	11.0	$ 79	$ 92
04C4410	UEBERROTH	100,561	116,097	-	-	16.4	18.9	$ 136	$ 159
04C4415	UNEX	170,893	197,295	-	-	27.9	32.2	$ 232	$ 270
04C4463	NEUROSCI RCH	89,564	103,401	-	-	14.6	16.9	$ 121	$ 141
04C4469	GAYLEY TWRS	86,727	100,126	-	-	14.2	16.3	$ 118	$ 137
04C4475	GLENROCK WST	61,960	71,533	-	-	10.1	11.7	$ 84	$ 98
04C4486	CNSI	58,083	67,056	-	-	9.5	10.9	$ 79	$ 92
04C4540	HEDRK SUMIT	304,994	352,115	-	-	49.8	57.5	$ 413	$ 482
04C4541	RIEBER TERRC	281,417	324,895	-	-	45.9	53.0	$ 381	$ 444
04C4542	RIEBER VISTA	272,964	315,136	-	-	44.5	51.4	$ 370	$ 431
04C4562	SRLF	433,648	500,645	-	-	70.8	81.7	$ 588	$ 685
04C4578	MACGOWAN	64,470	74,431	-	-	10.5	12.1	$ 87	$ 102
04C4579	PUB AFFAIRS	305,161	352,308	-	-	49.8	57.5	$ 414	$ 482
04C4580	BUNCHE HALL	354,783	409,596	-	-	57.9	66.8	$ 481	$ 560
04C4582	ACKERMAN	405,077	467,660	-	-	66.1	76.3	$ 549	$ 640
04C4594	REHAB CENTER	109,174	126,041	-	-	17.8	20.6	$ 148	$ 172
04C515B	GOLD HALL	99,699	115,103	-	-	16.3	18.8	$ 135	$ 157
04C515C	ENTREP HALL	128,993	148,922	-	-	21.1	24.3	$ 175	$ 204
04C515D	CORNELL HALL	120,570	139,198	-	-	19.7	22.7	$ 163	$ 190
04C515E	ROSNFLD LIBR	85,960	99,241	-	-	14.0	16.2	$ 116	$ 136
04C4006	MED PLZA 100	96,686	111,624	-	-	15.8	18.2	$ 236	$ 275
04C4325	DORIS STEIN	179,132	206,807	-	-	29.2	33.8	$ 437	$ 509
04C4332D	HEALTH SCI	1,743,205	2,012,524	-	-	284.5	328.4	$ 4,252	$ 4,955
04C4332E	M DAVIES CC	92,876	107,225	-	-	15.2	17.5	$ 227	$ 264
04C4332F	SEMEL INST	458,309	529,116	-	-	74.8	86.4	$ 1,118	$ 1,303
04C4333	JULES STEIN	141,094	162,892	-	-	23.0	26.6	$ 344	$ 401
04C4334	DENTISTRY	228,467	263,765	-	-	37.3	43.0	$ 557	$ 649
Campus Total, Deep Lighting		20,493,845	23,660,079	-	-	3,345	3,861	$ 30,958	$ 36,076

9.4. Campus Specific Projects

Additionally, during discussions with the campus, staff identified projects that have deep efficiency potential but do not fall into savings quantified for the four project categories above. These projects and estimated economics as provided by the campus are shown in Table 9.7 below. These costs and savings are not included in the campus level summary.

Table 9.7: UCLA Campus Specific Projects

TITLE	[1] EST. COST	[1] EST. SAVINGS
Process Cooling Efficiency Improvements	$170,000	$85,000
North Campus Heating Plant	$2,500,000	$500,000
Solar Photovoltaic System for SEAS-VI	$1,440,000	$22,750
Solar Water Heating for Pools	$250,000	$75,000
Solar Photovoltaic Installations at 4 Parking Structures	$26,000,000	$580,000
Campus Control Systems Upgrades	$3,000,000	$300,000

[1]Amounts shown are order-of-magnitude estimates only. Further cost development is required.

10. UC Merced – Deep Efficiency Potential

10.1. Campus Deep Efficiency Potential

The total campus potential is tabulated in the table below for all projects identified in this investigation. The savings, along with project economics and a resulting aggregate simple payback, are shown for the range of savings for each project type, as well as the campuswide potential.

Table 10.1: UC Merced Potential Savings Summary, All Projects

	Total Building Deep Potential								Economics			
	Low Electricity (kWh/yr)	High Electricity (kWh/yr)	Low Gas (th/yr)	High Gas (th/yr)	Low Demand (kW)	High Demand (kW)	Low Cost (x$1000)	High Cost (x$1000)	Low Utility Savings (x$1000)	High Utility Savings (x$1000)	Low SPB (yrs)	High SPB (yrs)
SmartLab	2,516,620	3,402,618	71,079	94,190	189	288	$ 3,043	$ 4,553	$ 465	$ 627	6.5	7.3
Deep HVAC	1,381,795	1,806,850	109,744	163,525	151	332	$ 1,585	$ 2,244	$ 312	$ 424	5.1	5.3
Deep Lighting	922,219	1,064,699	-	-	151	174	$ 1,000	$ 1,165	$ 150	$ 173	6.7	6.7
Total	4,820,634	6,274,167	180,823	257,715	490	793	$ 5,628	$ 7,963	$ 926	$ 1,224	6.1	6.5

Based on campus review and input into the potential deep efficiency projects in the identified buildings, the total potential is further broken down into the Tier 1 (reasonably certain candidate projects) and Tier 2 (questionable candidate projects) categories. The resulting savings and economics are presented in the following two tables, respectively.

Table 10.2: UC Merced Potential Savings Summary, Tier 1

	Total Building Deep Potential								Economics			
	Low	High	Low	High	Low	High	Low	High	Low	High	Low	High
	Electricity (kWh/yr)	Electricity (kWh/yr)	Gas (th/yr)	Gas (th/yr)	Demand (kW)	Demand (kW)	Cost (x$1000)	Cost (x$1000)	Utility Savings (x$1000)	Utility Savings (x$1000)	SPB (yrs)	SPB (yrs)
SmartLab	2,516,620	3,402,618	71,079	94,190	189	288	$ 3,043	$ 4,553	$ 465	$ 627	6.5	7.3
Deep HVAC	1,381,795	1,806,850	109,744	163,525	151	332	$ 1,585	$ 2,244	$ 312	$ 424	5.1	5.3
Deep Lighting	922,219	1,064,699	-	-	151	174	$ 1,000	$ 1,165	$ 150	$ 173	6.7	6.7
Total	4,820,634	6,274,167	180,823	257,715	490	793	$ 5,628	$ 7,963	$ 926	$ 1,224	6.1	6.5

Table 10.3: UC Merced Potential Savings Summary, Tier 2

	Total Building Deep Potential								Economics			
	Low	High	Low	High	Low	High	Low	High	Low	High	Low	High
	Electricity (kWh/yr)	Electricity (kWh/yr)	Gas (th/yr)	Gas (th/yr)	Demand (kW)	Demand (kW)	Cost (x$1000)	Cost (x$1000)	Utility Savings (x$1000)	Utility Savings (x$1000)	SPB (yrs)	SPB (yrs)
SmartLab	-	-	-	-	-	-	$ -	$ -	$ -	$ -	n/a	n/a
Deep HVAC	-	-	-	-	-	-	$ -	$ -	$ -	$ -	n/a	n/a
Deep Lighting	-	-	-	-	-	-	$ -	$ -	$ -	$ -	n/a	n/a
Total	-	-	-	-	-	-	$ -	$ -	$ -	$ -	n/a	n/a

The total impacts on greenhouse gas (GHG) emissions at the campus level have also been tabulated for all range of potential project savings. The metric tons of carbon dioxide equivalent are presented in the table below, including details attributable to the two tiers of projects.

Table 10.4: UC Merced GHG Impact Summary

	Low	High
	GHG Savings (Metric Tons C02e/yr*)	GHG Savings (Metric Tons C02e/yr)*
All Deep Projects	2,405	3,248
Tier 1	2,405	3,248
Tier 2	-	-

*eGrid average factors used, including CH_4 & N_2O impacts:

0.000299916 metric tons CO_2e/kWh

0.005302204 metric tons CO_2e/therm

10.2. Deep Efficiency Project Summary by Building

The table below provides a view of the project applicability for each of the four deep efficiency project categories by building, and the savings and cost ranges for the buildings.

Table 10.5: UC Merced Projects by Building

			Projects by Building				Total Building Deep Potential							
							Low	High	Low	High	Low	High	Low	High
Building Key	Building Name	Basic Gross Area	ESDVR	Deep Lab	Deep HVAC	Deep Lighting	Electricity (kWh/yr)	Electricity (kWh/yr)	Gas (th/yr)	Gas (th/yr)	Demand (kW)	Demand (kW)	Cost (x$1000)	Cost (x$1000)
10C0100	CASTLE 1200	69,169				Tier 1	98,711	113,962	-	-	16.1	18.6	$ 107	$ 125
10C0200	SCI ENG BLDG	186,726	Tier 1	Tier 1	Tier 1	Tier 1	2,520,389	3,393,335	79,289	106,424	192.0	300.0	$ 3,130	$ 4,692
10C0201	LIBRARY INFO	178,468			Tier 1	Tier 1	871,857	1,088,146	42,321	63,061	113.6	191.8	$ 979	$ 1,294
10C0202	CLASS OFFICE	101,644	Tier 1		Tier 1	Tier 1	606,409	776,028	24,104	35,916	74.3	123.7	$ 600	$ 779
10C0212	MARIPOSA	41,606			Tier 1	Tier 1	203,255	253,678	9,866	14,701	26.5	44.7	$ 228	$ 302
10C0213	TUOLUMNE	42,793			Tier 1	Tier 1	209,054	260,915	10,148	15,121	27.2	46.0	$ 235	$ 310
10C9419	FRESNO	63,653			Tier 1	Tier 1	310,959	388,102	15,095	22,492	40.5	68.4	$ 349	$ 461
Campus Total			2	1	6	7	4,820,634	6,274,167	180,823	257,715	490.2	793.2	$ 5,628	$ 7,963

10.3. Deep Efficiency Projects by Type

The table below provides a list of all the buildings for each type of deep efficiency project, including the project savings and cost ranges for each building.

Table 10.6: UC Merced Project by Type

Building Key	Building Name	Total Building Deep Potential							
		Low Electricity (kWh/yr)	High Electricity (kWh/yr)	Low Gas (th/yr)	High Gas (th/yr)	Low Demand (kW)	High Demand (kW)	Low Cost (x$1000)	High Cost (x$1000)
ESDVR Projects									
10C0200	SCI ENG BLDG	860,588	1,146,868	-	-	97.2	129.5	$ 534	$ 586
10C0202	CLASS OFFICE	165,372	220,384	-	-	18.7	24.9	$ 103	$ 113
Campus Total, ESDVR Projects		1,025,960	1,367,252	-	-	116	154	$ 637	$ 699
Deep Lab Projects									
10C0200	SCI ENG BLDG	1,490,661	2,035,365	71,079	94,190	72.7	133.4	$ 2,407	$ 3,854
Campus Total, Deep Lab Projects		1,490,661	2,035,365	71,079	94,190	73	133	$ 2,407	$ 3,854
Deep HVAC Projects									
10C0200	SCI ENG BLDG	103,377	135,177	8,210	12,234	11.3	24.8	$ 119	$ 168
10C0201	LIBRARY INFO	532,872	696,789	42,321	63,061	58.3	127.9	$ 611	$ 865
10C0202	CLASS OFFICE	303,490	396,847	24,104	35,916	33.2	72.9	$ 348	$ 493
10C0212	MARIPOSA	124,228	162,442	9,866	14,701	13.6	29.8	$ 142	$ 202
10C0213	TUOLUMNE	127,772	167,076	10,148	15,121	14.0	30.7	$ 147	$ 208
10C9419	FRESNO	190,056	248,519	15,095	22,492	20.8	45.6	$ 218	$ 309
Campus Total, Deep HVAC		1,381,795	1,806,850	109,744	163,525	151	332	$ 1,585	$ 2,244
Deep Lighting Projects									
10C0100	CASTLE 1200	98,711	113,962	-	-	16.1	18.6	$ 107	$ 125
10C0200	SCI ENG BLDG	65,763	75,923	-	-	10.7	12.4	$ 71	$ 83
10C0201	LIBRARY INFO	338,985	391,357	-	-	55.3	63.9	$ 367	$ 428
10C0202	CLASS OFFICE	137,547	158,798	-	-	22.4	25.9	$ 149	$ 174
10C0212	MARIPOSA	79,027	91,236	-	-	12.9	14.9	$ 86	$ 100
10C0213	TUOLUMNE	81,282	93,839	-	-	13.3	15.3	$ 88	$ 103
10C9419	FRESNO	120,903	139,583	-	-	19.7	22.8	$ 131	$ 153
Campus Total, Deep Lighting		922,219	1,064,699	-	-	151	174	$ 1,000	$ 1,165

11. UC Riverside – Deep Efficiency Potential

11.1. Campus Deep Efficiency Potential

The total campus potential is tabulated in the table below for all projects identified in this investigation. The savings, along with project economics and a resulting aggregate simple payback, are shown for the range of savings for each project type, as well as the campuswide potential.

Table 11.1: UC Riverside Potential Savings Summary, All Projects

	Total Building Deep Potential								Economics			
	Low Electricity (kWh/yr)	High Electricity (kWh/yr)	Low Gas (th/yr)	High Gas (th/yr)	Low Demand (kW)	High Demand (kW)	Low Cost (x$1000)	High Cost (x$1000)	Low Utility Savings (x$1000)	High Utility Savings (x$1000)	Low SPB (yrs)	High SPB (yrs)
SmartLab	20,340,684	27,522,040	603,971	800,353	1,485	2,288	$ 25,211	$ 37,979	$ 1,943	$ 2,620	13.0	14.5
Deep HVAC	5,047,726	6,600,461	400,897	597,360	552	1,212	$ 5,790	$ 8,198	$ 620	$ 850	9.3	9.6
Deep Lighting	4,122,413	4,759,313	-	-	673	777	$ 4,469	$ 5,208	$ 327	$ 377	13.7	13.8
Total	29,510,823	38,881,814	1,004,868	1,397,713	2,710	4,276	$ 35,470	$ 51,385	$ 2,890	$ 3,847	12.3	13.4

Based on campus review and input into the potential deep efficiency projects in the identified buildings, the total potential is further broken down into the Tier 1 (reasonably certain candidate projects) and Tier 2 (questionable candidate projects) categories. The resulting savings and economics are presented in the following two tables, respectively.

Table 11.2: UC Riverside Potential Savings Summary, Tier 1

	Total Building Deep Potential								Economics			
	Low Electricity (kWh/yr)	High Electricity (kWh/yr)	Low Gas (th/yr)	High Gas (th/yr)	Low Demand (kW)	High Demand (kW)	Low Cost (x$1000)	High Cost (x$1000)	Low Utility Savings (x$1000)	High Utility Savings (x$1000)	Low SPB (yrs)	High SPB (yrs)
SmartLab	19,714,444	26,666,964	574,110	760,783	1,454	2,232	$ 24,200	$ 36,360	$ 1,877	$ 2,531	12.9	14.4
Deep HVAC	3,509,729	4,589,360	278,747	415,350	384	843	$ 4,026	$ 5,700	$ 431	$ 591	9.3	9.6
Deep Lighting	4,122,413	4,759,313	-	-	673	777	$ 4,469	$ 5,208	$ 327	$ 377	13.7	13.8
Total	27,346,586	36,015,637	852,858	1,176,133	2,511	3,851	$ 32,695	$ 47,268	$ 2,635	$ 3,499	12.4	13.5

Table 11.3: UC Riverside Potential Savings Summary, Tier 2

	Total Building Deep Potential								Economics			
	Low Electricity (kWh/yr)	High Electricity (kWh/yr)	Low Gas (th/yr)	High Gas (th/yr)	Low Demand (kW)	High Demand (kW)	Low Cost (x$1000)	High Cost (x$1000)	Low Utility Savings (x$1000)	High Utility Savings (x$1000)	Low SPB (yrs)	High SPB (yrs)
SmartLab	626,241	855,076	29,861	39,570	31	56	$ 1,011	$ 1,619	$ 66	$ 89	15.3	18.1
Deep HVAC	1,537,997	2,011,101	122,150	182,010	168	369	$ 1,764	$ 2,498	$ 189	$ 259	9.3	9.6
Deep Lighting	-	-	-	-	-	-	$ -	$ -	$ -	$ -	n/a	n/a
Total	2,164,237	2,866,178	152,011	221,581	199	425	$ 2,775	$ 4,117	$ 255	$ 348	10.9	11.8

The total impacts on greenhouse gas (GHG) emissions at the campus level have also been tabulated for all range of potential project savings. The metric tons of carbon dioxide equivalent are presented in the table below, including details attributable to the two tiers of projects.

Table 11.4: UC Riverside GHG Impact Summary

	Low	High
	GHG Savings (Metric Tons C02e/yr*)	GHG Savings (Metric Tons C02e/yr)*
All Deep Projects	14,179	19,072
Tier 1	12,724	17,038
Tier 2	1,455	2,034

*eGrid average factors used, including CH_4 & N_2O impacts:

0.000299916 metric tons CO_2e/kWh

0.005302204 metric tons CO_2e/therm

11.2. Deep Efficiency Project Summary by Building

The table beginning on the following page provides a view of the project applicability for each of the four deep efficiency project categories by building, and the savings and cost ranges for the buildings.

Table 11.5: UC Riverside Projects by Building

Building Key	Building Name	Basic Gross Area	Projects by Building				Total Building Deep Potential							
							Low Electricity (kWh/yr)	High Electricity (kWh/yr)	Low Gas (th/yr)	High Gas (th/yr)	Low Demand (kW)	High Demand (kW)	Low Cost (x$1000)	High Cost (x$1000)
			ESDVR	Deep Lab	Deep HVAC	Deep Lighting								
05CP5186	BIOLOGIC SCI	53,035	Tier 1	Tier 1			613,819	830,756	18,556	24,589	44.4	68.6	$ 768	$ 1,159
05CP5194	ENGINEERING2	157,987	Tier 1	Tier 1		Tier 1	1,603,806	2,147,265	44,933	59,543	126.6	188.3	$ 1,986	$ 2,956
05CP5261	BOURNS	157,189	Tier 1	Tier 1	Tier 1	Tier 1	2,003,404	2,690,696	64,172	86,614	156.2	245.3	$ 2,480	$ 3,704
05CP5307	HUM & SOC SC	105,966	Tier 1			Tier 1	242,466	290,975	-	-	36.5	43.3	$ 234	$ 270
05CP5316	LIFE SCIENCE	47,099	Tier 1	Tier 2			437,701	591,632	12,123	16,064	33.1	50.3	$ 524	$ 782
05CP5322	RIVERA LIB	225,413			Tier 1	Tier 1	1,092,517	1,364,359	53,454	79,649	142.1	240.6	$ 1,227	$ 1,623
05CP5323	SPIETH	100,927	Tier 1	Tier 1			1,369,743	1,853,841	41,408	54,871	99.0	153.1	$ 1,713	$ 2,587
05CP5334	PE	66,335	Tier 1		Tier 2	Tier 1	325,784	411,464	12,584	18,752	41.5	67.2	$ 334	$ 433
05CP5335	GEOLOGY	96,760	Tier 1	Tier 1	Tier 2	Tier 1	1,049,836	1,401,421	34,135	46,483	86.3	135.4	$ 1,290	$ 1,910
05CP5341	BOYCE	124,321	Tier 1	Tier 1			1,628,367	2,203,869	49,226	65,232	117.7	182.0	$ 2,037	$ 3,075
05CP5342	WEBBER	48,565	Tier 1	Tier 1			615,559	833,112	18,609	24,659	44.5	68.8	$ 770	$ 1,163
05CP5343	ABER INVER	203,939			Tier 1	Tier 1	996,288	1,243,447	48,362	72,062	129.8	219.2	$ 1,118	$ 1,478
05CP5354	WATKINS	62,237	Tier 1		Tier 2	Tier 1	321,735	408,917	11,807	17,593	40.4	65.2	$ 320	$ 412
05CP5372	CHASS INT S	63,194	Tier 1	Tier 2	Tier 2	Tier 1	570,233	750,116	21,634	30,645	54.5	89.7	$ 667	$ 957
05CP5373	PSYCHOLOGY1	63,194	Tier 1	Tier 1			677,972	917,583	20,495	27,159	49.0	75.8	$ 848	$ 1,280
05CP5380	CAMPUS SURGE	72,340			Tier 1	Tier 1	339,770	425,335	17,155	25,561	43.8	75.2	$ 382	$ 507
05CP5403	CHASS INT N	51,405			Tier 2	Tier 1	210,486	261,806	9,752	14,531	27.7	46.0	$ 236	$ 310
05CP5404	COMMONS	119,871			Tier 1	Tier 1	585,597	730,871	28,426	42,356	76.3	128.8	$ 657	$ 869
05CP5411	ARTS	106,659	Tier 1	Tier 1		Tier 1	1,290,925	1,737,196	37,510	49,706	97.9	148.2	$ 1,606	$ 2,407
05CP5414	CHEMICAL SCI	134,709	Tier 1	Tier 1			1,793,114	2,426,842	54,206	71,831	129.6	200.4	$ 2,243	$ 3,386
05CP5416	SCIENCE LAB1	45,472	Tier 1	Tier 1			597,364	808,486	18,058	23,930	43.2	66.8	$ 747	$ 1,128
05CP5417	ENTOMOLOGY	69,417	Tier 1	Tier 1			841,588	1,139,025	25,441	33,714	60.8	94.1	$ 1,053	$ 1,589
05CP5418	SCIENCE LIB	175,719				Tier 1	333,763	385,329	-	-	54.5	62.9	$ 362	$ 422
05CP5473	GLEN MOR D	55,057			Tier 2	Tier 1	236,088	292,699	10,445	15,563	31.4	51.3	$ 264	$ 346
05CP5474	GLEN MOR E	51,898			Tier 2	Tier 1	222,542	275,905	9,846	14,670	29.6	48.3	$ 249	$ 326
05CP5480	HINDERAKER	44,873			Tier 2	Tier 1	192,418	238,558	8,513	12,685	25.6	41.8	$ 215	$ 282
05CP5497	OLMSTED	92,594	Tier 1	Tier 1	Tier 2	Tier 1	1,006,498	1,343,684	32,712	44,538	82.7	129.7	$ 1,237	$ 1,832
05CP5501	BATCHELOR	105,334	Tier 1	Tier 1		Tier 1	1,217,600	1,636,484	35,069	46,472	93.2	140.5	$ 1,513	$ 2,264
05CP5502	LOTHIAN HALL	246,791			Tier 1	Tier 1	1,205,630	1,504,722	58,523	87,203	157.1	265.2	$ 1,353	$ 1,789
05CP5504	PHYSICS	89,541	Tier 1	Tier 1			1,044,628	1,413,824	31,579	41,847	75.5	116.8	$ 1,306	$ 1,973
05CP5508	PIERCE	141,355	Tier 1	Tier 1	Tier 1	Tier 1	1,797,327	2,413,669	57,614	77,782	140.3	220.3	$ 2,225	$ 3,322
05CP5523	SPROUL	78,834	Tier 1	Tier 2	Tier 2	Tier 1	589,134	766,605	23,049	33,009	60.4	99.3	$ 684	$ 965
05CP5588	STAT COMP	41,939	Tier 1			Tier 1	122,469	152,872	-	-	16.8	20.6	$ 103	$ 117
05CP5716	HIGHLANDER	51,817			Tier 2	Tier 1	209,184	260,454	9,830	14,648	27.5	45.8	$ 235	$ 309
05CP5722	UCR EXTEN CT	196,641			Tier 1	Tier 1	349,746	436,510	16,977	25,297	45.6	76.9	$ 393	$ 519
05CP5902	UNIV TOWERS	40,274			Tier 2	Tier 1	172,698	214,108	7,640	11,385	23.0	37.5	$ 193	$ 253
05CP5986	SALINITY LAB	78,250	Tier 1	Tier 1		Tier 1	828,661	1,110,912	23,437	31,058	64.7	96.7	$ 1,027	$ 1,532
05CP5991	STONEHAVEN	158,511			Tier 1	Tier 1	774,362	966,465	37,589	56,010	100.9	170.3	$ 869	$ 1,149
Campus Total			24	20	21	28	29,510,823	38,881,814	1,004,868	1,397,713	2,709.7	4,276.4	$ 35,470	$ 51,385

11.3. Deep Efficiency Projects by Type

The table beginning on the following page provides a list of all the buildings for each type of deep efficiency project, including the project savings and cost ranges for each building.

Table 11.6: UC Riverside Project by Type

Building Key	Building Name	Total Building Deep Potential							
		Low Electricity (kWh/yr)	High Electricity (kWh/yr)	Low Gas (th/yr)	High Gas (th/yr)	Low Demand (kW)	High Demand (kW)	Low Cost (x$1000)	High Cost (x$1000)
ESDVR Projects									
05CP5186	BIOLOGIC SCI	224,666	299,402	-	-	25.4	33.8	$ 139	$ 153
05CP5194	ENGINEERING2	544,027	725,001	-	-	61.5	81.8	$ 338	$ 371
05CP5261	BOURNS	661,151	881,087	-	-	74.7	99.5	$ 410	$ 450
05CP5307	HUM & SOC SC	62,011	82,639	-	-	7.0	9.3	$ 38	$ 42
05CP5316	LIFE SCIENCE	183,467	244,499	-	-	20.7	27.6	$ 114	$ 125
05CP5323	SPIETH	501,344	668,119	-	-	56.6	75.4	$ 311	$ 342
05CP5334	PE	62,225	82,925	-	-	7.0	9.4	$ 39	$ 42
05CP5335	GEOLOGY	321,601	428,584	-	-	36.3	48.4	$ 200	$ 219
05CP5341	BOYCE	596,004	794,268	-	-	67.3	89.7	$ 370	$ 406
05CP5342	WEBBER	225,303	300,251	-	-	25.5	33.9	$ 140	$ 153
05CP5354	WATKINS	82,582	110,054	-	-	9.3	12.4	$ 51	$ 56
05CP5372	CHASS INT S	145,977	194,537	-	-	16.5	22.0	$ 91	$ 99
05CP5373	PSYCHOLOGY1	248,147	330,694	-	-	28.0	37.3	$ 154	$ 169
05CP5411	ARTS	454,148	605,224	-	-	51.3	68.3	$ 282	$ 309
05CP5414	CHEMICAL SCI	656,303	874,627	-	-	74.1	98.7	$ 407	$ 447
05CP5416	SCIENCE LAB1	218,643	291,376	-	-	24.7	32.9	$ 136	$ 149
05CP5417	ENTOMOLOGY	308,032	410,501	-	-	34.8	46.3	$ 191	$ 210
05CP5497	OLMSTED	308,698	411,388	-	-	34.9	46.4	$ 192	$ 210
05CP5501	BATCHELOR	424,601	565,847	-	-	48.0	63.9	$ 263	$ 289
05CP5504	PHYSICS	382,348	509,538	-	-	43.2	57.5	$ 237	$ 260
05CP5508	PIERCE	592,267	789,288	-	-	66.9	89.1	$ 367	$ 403
05CP5523	SPROUL	122,482	163,227	-	-	13.8	18.4	$ 76	$ 83
05CP5588	STAT COMP	64,444	85,882	-	-	7.3	9.7	$ 40	$ 44
05CP5986	SALINITY LAB	283,768	378,166	-	-	32.1	42.7	$ 176	$ 193
Campus Total, ESDVR Projects		7,674,239	10,227,126	-	-	867	1,155	$ 4,761	$ 5,228
Deep Lab Projects									
05CP5186	BIOLOGIC SCI	389,153	531,354	18,556	24,589	19.0	34.8	$ 628	$ 1,006
05CP5194	ENGINEERING2	942,331	1,286,670	44,933	59,543	46.0	84.3	$ 1,521	$ 2,437
05CP5261	BOURNS	1,145,207	1,563,680	54,607	72,362	55.9	102.5	$ 1,849	$ 2,961
05CP5316	LIFE SCIENCE	254,233	347,133	12,123	16,064	12.4	22.7	$ 410	$ 657
05CP5323	SPIETH	868,399	1,185,722	41,408	54,871	42.4	77.7	$ 1,402	$ 2,245
05CP5335	GEOLOGY	557,059	760,615	26,562	35,199	27.2	49.8	$ 899	$ 1,440
05CP5341	BOYCE	1,032,363	1,409,600	49,226	65,232	50.4	92.4	$ 1,667	$ 2,669
05CP5342	WEBBER	390,256	532,861	18,609	24,659	19.0	34.9	$ 630	$ 1,009
05CP5372	CHASS INT S	202,282	276,198	9,645	12,782	9.9	18.1	$ 327	$ 523
05CP5373	PSYCHOLOGY1	429,825	586,889	20,495	27,159	21.0	38.5	$ 694	$ 1,111
05CP5411	ARTS	786,649	1,074,100	37,510	49,706	38.4	70.4	$ 1,270	$ 2,034
05CP5414	CHEMICAL SCI	1,136,811	1,552,215	54,206	71,831	55.5	101.7	$ 1,835	$ 2,939
05CP5416	SCIENCE LAB1	378,721	517,110	18,058	23,930	18.5	33.9	$ 611	$ 979
05CP5417	ENTOMOLOGY	533,556	728,523	25,441	33,714	26.0	47.7	$ 861	$ 1,380
05CP5497	OLMSTED	534,709	730,098	25,496	33,787	26.1	47.8	$ 863	$ 1,383
05CP5501	BATCHELOR	735,469	1,004,218	35,069	46,472	35.9	65.8	$ 1,187	$ 1,902
05CP5504	PHYSICS	662,280	904,285	31,579	41,847	32.3	59.3	$ 1,069	$ 1,712
05CP5508	PIERCE	1,025,890	1,400,763	48,917	64,823	50.1	91.8	$ 1,656	$ 2,653
05CP5523	SPROUL	169,725	231,745	8,093	10,724	8.3	15.2	$ 274	$ 439
05CP5986	SALINITY LAB	491,527	671,136	23,437	31,058	24.0	44.0	$ 794	$ 1,271
Campus Total, Deep Lab Projects		12,666,446	17,294,914	603,971	800,353	618	1,133	$ 20,450	$ 32,751
Deep HVAC Projects									
05CP5261	BOURNS	120,433	157,479	9,565	14,252	13.2	28.9	$ 138	$ 196
05CP5322	RIVERA LIB	673,041	880,076	53,454	79,649	73.6	161.6	$ 772	$ 1,093
05CP5334	PE	158,451	207,192	12,584	18,752	17.3	38.0	$ 182	$ 257
05CP5335	GEOLOGY	95,353	124,685	7,573	11,284	10.4	22.9	$ 109	$ 155
05CP5343	ABER INVER	608,924	796,235	48,362	72,062	66.6	146.2	$ 698	$ 989
05CP5354	WATKINS	148,662	194,393	11,807	17,593	16.3	35.7	$ 171	$ 241

Building Key	Building Name	Total Building Deep Potential							
		Low Electricity (kWh/yr)	High Electricity (kWh/yr)	Low Gas (th/yr)	High Gas (th/yr)	Low Demand (kW)	High Demand (kW)	Low Cost (x$1000)	High Cost (x$1000)
05CP5372	CHASS INT S	150,948	197,382	11,989	17,864	16.5	36.2	$ 173	$ 245
05CP5380	CAMPUS SURGE	215,994	282,436	17,155	25,561	23.6	51.9	$ 248	$ 351
05CP5403	CHASS INT N	122,789	160,560	9,752	14,531	13.4	29.5	$ 141	$ 199
05CP5404	COMMONS	357,912	468,010	28,426	42,356	39.1	85.9	$ 411	$ 581
05CP5473	GLEN MOR D	131,512	171,966	10,445	15,563	14.4	31.6	$ 151	$ 214
05CP5474	GLEN MOR E	123,966	162,100	9,846	14,670	13.6	29.8	$ 142	$ 201
05CP5480	HINDERAKER	107,186	140,157	8,513	12,685	11.7	25.7	$ 123	$ 174
05CP5497	OLMSTED	90,849	118,795	7,215	10,751	9.9	21.8	$ 104	$ 148
05CP5502	LOTHIAN HALL	736,872	963,542	58,523	87,203	80.6	176.9	$ 845	$ 1,197
05CP5508	PIERCE	109,507	143,193	8,697	12,959	12.0	26.3	$ 126	$ 178
05CP5523	SPROUL	188,307	246,232	14,956	22,285	20.6	45.2	$ 216	$ 306
05CP5716	HIGHLANDER	123,773	161,847	9,830	14,648	13.5	29.7	$ 142	$ 201
05CP5722	UCR EXTEN CT	213,762	279,517	16,977	25,297	23.4	51.3	$ 245	$ 347
05CP5902	UNIV TOWERS	96,201	125,793	7,640	11,385	10.5	23.1	$ 110	$ 156
05CP5991	STONEHAVEN	473,284	618,872	37,589	56,010	51.8	113.6	$ 543	$ 769
Campus Total, Deep HVAC		5,047,726	6,600,461	400,897	597,360	552	1,212	$ 5,790	$ 8,198
Deep Lighting Projects									
05CP5194	ENGINEERING2	117,448	135,594	-	-	19.2	22.1	$ 127	$ 148
05CP5261	BOURNS	76,613	88,449	-	-	12.5	14.4	$ 83	$ 97
05CP5307	HUM & SOC SC	180,456	208,336	-	-	29.5	34.0	$ 196	$ 228
05CP5322	RIVERA LIB	419,475	484,283	-	-	68.5	79.0	$ 455	$ 530
05CP5334	PE	105,108	121,347	-	-	17.2	19.8	$ 114	$ 133
05CP5335	GEOLOGY	75,823	87,537	-	-	12.4	14.3	$ 82	$ 96
05CP5343	ABER INVER	387,365	447,211	-	-	63.2	73.0	$ 420	$ 489
05CP5354	WATKINS	90,490	104,471	-	-	14.8	17.0	$ 98	$ 114
05CP5372	CHASS INT S	71,026	81,999	-	-	11.6	13.4	$ 77	$ 90
05CP5380	CAMPUS SURGE	123,776	142,899	-	-	20.2	23.3	$ 134	$ 156
05CP5403	CHASS INT N	87,697	101,246	-	-	14.3	16.5	$ 95	$ 111
05CP5404	COMMONS	227,685	262,861	-	-	37.2	42.9	$ 247	$ 288
05CP5411	ARTS	50,128	57,873	-	-	8.2	9.4	$ 54	$ 63
05CP5418	SCIENCE LIB	333,763	385,329	-	-	54.5	62.9	$ 362	$ 422
05CP5473	GLEN MOR D	104,576	120,733	-	-	17.1	19.7	$ 113	$ 132
05CP5474	GLEN MOR E	98,576	113,805	-	-	16.1	18.6	$ 107	$ 125
05CP5480	HINDERAKER	85,232	98,401	-	-	13.9	16.1	$ 92	$ 108
05CP5497	OLMSTED	72,242	83,403	-	-	11.8	13.6	$ 78	$ 91
05CP5501	BATCHELOR	57,531	66,419	-	-	9.4	10.8	$ 62	$ 73
05CP5502	LOTHIAN HALL	468,758	541,180	-	-	76.5	88.3	$ 508	$ 592
05CP5508	PIERCE	69,663	80,425	-	-	11.4	13.1	$ 76	$ 88
05CP5523	SPROUL	108,620	125,402	-	-	17.7	20.5	$ 118	$ 137
05CP5588	STAT COMP	58,025	66,990	-	-	9.5	10.9	$ 63	$ 73
05CP5716	HIGHLANDER	85,412	98,608	-	-	13.9	16.1	$ 93	$ 108
05CP5722	UCR EXTEN CT	135,984	156,993	-	-	22.2	25.6	$ 147	$ 172
05CP5902	UNIV TOWERS	76,497	88,316	-	-	12.5	14.4	$ 83	$ 97
05CP5986	SALINITY LAB	53,366	61,611	-	-	8.7	10.1	$ 58	$ 67
05CP5991	STONEHAVEN	301,078	347,594	-	-	49.1	56.7	$ 326	$ 380
Campus Total, Deep Lighting		4,122,413	4,759,313	-	-	673	777	$ 4,469	$ 5,208

12. UC San Diego – Deep Efficiency Potential

12.1. Campus Deep Efficiency Potential

The total campus potential is tabulated in the table below for all projects identified in this investigation. The savings, along with project economics and a resulting aggregate simple payback, are shown for the range of savings for each project type, as well as the campuswide potential.

Table 12.1: UC San Diego Potential Savings Summary, All Projects

	Total Building Deep Potential								Economics			
	Low Electricity (kWh/yr)	High Electricity (kWh/yr)	Low Gas (th/yr)	High Gas (th/yr)	Low Demand (kW)	High Demand (kW)	Low Cost (x$1000)	High Cost (x$1000)	Low Utility Savings (x$1000)	High Utility Savings (x$1000)	Low SPB (yrs)	High SPB (yrs)
SmartLab	23,065,958	31,906,804	512,208	707,016	1,881	2,871	$ 25,608	$ 38,863	$ 3,147	$ 4,352	8.1	8.9
Deep HVAC	5,189,783	6,844,988	398,558	598,238	583	1,287	$ 5,952	$ 8,502	$ 918	$ 1,264	6.5	6.7
Deep Lighting	6,434,099	7,585,016	-	-	988	1,157	$ 6,975	$ 8,300	$ 772	$ 910	9.0	9.1
Total	34,689,839	46,336,807	910,766	1,305,254	3,453	5,315	$ 38,535	$ 55,664	$ 4,837	$ 6,526	8.0	8.5

Based on campus review and input into the potential deep efficiency projects in the identified buildings, the total potential is further broken down into the Tier 1 (reasonably certain candidate projects) and Tier 2 (questionable candidate projects) categories. The resulting savings and economics are presented in the following two tables, respectively.

Table 12.2: UC San Diego Potential Savings Summary, Tier 1

	Total Building Deep Potential								Economics			
	Low	High	Low	High	Low	High	Low	High	Low	High	Low	High
	Electricity (kWh/yr)	Electricity (kWh/yr)	Gas (th/yr)	Gas (th/yr)	Demand (kW)	Demand (kW)	Cost (x$1000)	Cost (x$1000)	Utility Savings (x$1000)	Utility Savings (x$1000)	SPB (yrs)	SPB (yrs)
SmartLab	22,008,609	30,463,088	446,716	620,229	1,830	2,776	$ 23,901	$ 36,129	$ 2,972	$ 4,115	8.0	8.8
Deep HVAC	5,080,547	6,702,150	381,207	572,384	571	1,261	$ 5,827	$ 8,325	$ 892	$ 1,228	6.5	6.8
Deep Lighting	5,782,463	6,734,078	-	-	909	1,062	$ 6,269	$ 7,369	$ 694	$ 808	9.0	9.1
Total	32,871,620	43,899,316	827,923	1,192,613	3,310	5,099	$ 35,997	$ 51,822	$ 4,557	$ 6,150	7.9	8.4

Table 12.3: UC San Diego Potential Savings Summary, Tier 2

	Total Building Deep Potential								Economics			
	Low	High	Low	High	Low	High	Low	High	Low	High	Low	High
	Electricity (kWh/yr)	Electricity (kWh/yr)	Gas (th/yr)	Gas (th/yr)	Demand (kW)	Demand (kW)	Cost (x$1000)	Cost (x$1000)	Utility Savings (x$1000)	Utility Savings (x$1000)	SPB (yrs)	SPB (yrs)
SmartLab	1,057,348	1,443,716	65,492	86,787	52	95	$ 1,707	$ 2,734	$ 175	$ 237	9.7	11.5
Deep HVAC	109,235	142,837	17,351	25,854	12	26	$ 125	$ 177	$ 26	$ 36	4.8	4.9
Deep Lighting	651,636	850,938	-	-	79	95	$ 706	$ 931	$ 78	$ 102	9.0	9.1
Total	1,818,219	2,437,491	82,843	112,641	142	216	$ 2,539	$ 3,842	$ 279	$ 376	9.1	10.2

The total impacts on greenhouse gas (GHG) emissions at the campus level have also been tabulated for all range of potential project savings. The metric tons of carbon dioxide equivalent are presented in the table below, including details attributable to the two tiers of projects.

Table 12.4: UC San Diego GHG Impact Summary

	Low	High
	GHG Savings (Metric Tons C02e/yr*)	GHG Savings (Metric Tons C02e/yr)*
All Deep Projects	15,233	20,818
Tier 1	14,249	19,490
Tier 2	985	1,328

*eGrid average factors used, including CH_4 & N_2O impacts:

0.000299916 metric tons CO_2e/kWh

0.005302204 metric tons CO_2e/therm

12.2. Deep Efficiency Project Summary by Building

The table beginning on the following page provides a view of the project applicability for each of the four deep efficiency project categories by building, and the savings and cost ranges for the buildings.

Table 12.5: UC San Diego Projects by Building

Building Key	Building Name	Basic Gross Area	Projects by Building				Total Building Deep Potential							
							Low Electricity (kWh/yr)	High Electricity (kWh/yr)	Low Gas (th/yr)	High Gas (th/yr)	Low Demand (kW)	High Demand (kW)	Low Cost (x$1000)	High Cost (x$1000)
			ESDVR	Deep Lab	Deep HVAC	Deep Lighting								
06C6115	RIMAC	217,864				Tier 1	311,472	375,405	-	-	42.1	52.6	$ 338	$ 411
06C6119	MTF	93,419	Tier 1	Tier 1			1,083,830	1,466,880	32,764	43,418	78.3	121.2	$ 1,356	$ 2,047
06C6129	CMRR	43,654	Tier 1	Tier 1			456,182	714,163	479	4,813	35.5	64.3	$ 576	$ 1,055
06C6131	ENG UNIT 1	244,667	Tier 1	Tier 1		Tier 2	2,853,216	3,841,464	83,192	110,242	215.4	326.7	$ 3,552	$ 5,325
06C6132	ENG UNIT 2	123,007	Tier 1	Tier 1			858,925	1,323,359	26,605	39,521	74.0	125.9	$ 909	$ 1,620
06C6135	CENT MOL GEN	44,123	Tier 1	Tier 1			528,793	715,681	15,986	21,183	38.2	59.1	$ 661	$ 999
06C6137	SUPERCOMPUTR	59,070				Tier 1	112,198	129,533	-	-	18.3	21.1	$ 122	$ 142
06C6143	CMM WEST	78,165	Tier 1				387,382	516,247	-	-	43.8	58.3	$ 240	$ 264
06C6156	CLIN SCI BLD	101,188	Tier 1				465,244	620,010	-	-	52.6	70.0	$ 289	$ 317
06C6163	BLACK BOX	49,211				Tier 1	93,472	107,913	-	-	15.3	17.6	$ 101	$ 118
06C6172	WAR LEC HALL	73,612			Tier 1		116,159	183,769	14,599	23,154	22.4	51.2	$ 133	$ 228
06C6173	LITERATURE	47,364				Tier 2	4,194	14,792	-	-	-	-	$ 5	$ 16
06C6176	CMM EAST	87,603	Tier 1				396,399	528,264	-	-	44.8	59.6	$ 246	$ 270
06C6188	SCI ENG RSCH	96,224	Tier 1	Tier 1			1,029,652	1,393,554	31,127	41,247	74.4	115.1	$ 1,288	$ 1,945
06C6206	HUBBS HALL	70,108	Tier 1	Tier 1			709,103	1,204,549	22,071	38,718	40.4	95.7	$ 837	$ 1,710
06C6210	SIO AQUARIUM	42,302			Tier 1	Tier 1	148,577	199,843	10,031	14,947	13.8	30.5	$ 169	$ 243
06C6218	NIERENBERG	47,528				Tier 2	29,859	34,472	-	-	4.9	5.6	$ 32	$ 38
06C6264	MAYER ANNEX	80,868	Tier 1	Tier 1		Tier 1	861,036	1,154,505	24,382	32,310	67.2	100.4	$ 1,068	$ 1,592
06C6272	ECKART LIB	52,939			Tier 1	Tier 1	258,619	322,777	12,554	18,706	33.7	56.9	$ 290	$ 384
06C6285	RITTER HALL	42,447	Tier 1	Tier 1		Tier 2	418,588	572,207	12,149	16,099	29.0	44.9	$ 521	$ 790
06C6312	STEWART HALL	41,505			Tier 1	Tier 1	202,761	253,062	9,842	14,666	26.4	44.6	$ 228	$ 301
06C6313	BROWN HALL	41,000			Tier 1	Tier 1	200,294	249,983	9,723	14,487	26.1	44.1	$ 225	$ 297
06C6314	BATES HALL	41,267			Tier 1	Tier 1	201,599	251,611	9,786	14,582	26.3	44.3	$ 226	$ 299
06C6320	POWELL FOCHT	110,065	Tier 1	Tier 2		Tier 1	968,445	1,292,328	24,476	32,435	80.7	117.6	$ 1,150	$ 1,687
06C6328	SVERDRUP	63,764	Tier 1	Tier 1			607,064	1,104,870	-	10,348	64.6	120.2	$ 671	$ 1,519
06C6335	CENT UTLTIES	62,976			Tier 1		188,035	245,876	14,934	22,252	20.6	45.1	$ 216	$ 305
06C6336	UREY HALL	177,955	Tier 1			Tier 1	807,477	1,058,139	-	-	96.3	125.3	$ 548	$ 609
06C6352	MAYER HALL	105,369	Tier 1	Tier 1			1,408,730	1,906,607	29,810	39,503	101.8	157.5	$ 1,762	$ 2,661
06C6353	BONNER HALL	120,749	Tier 1				489,876	652,837	-	-	55.3	73.7	$ 304	$ 334
06C6354	IGPP	41,668		Tier 2		Tier 2	247,036	333,268	10,866	14,400	14.2	24.0	$ 389	$ 613
06C6355	PACIFIC HALL	188,848	Tier 1			Tier 1	951,269	1,257,162	-	-	110.4	145.4	$ 618	$ 683
06C6357	GALBRTH HALL	112,674				Tier 1	103,239	143,089	-	-	2.3	8.8	$ 112	$ 157
06C6361	YORK HALL	93,739	Tier 1				419,959	559,662	-	-	47.4	63.2	$ 261	$ 286
06C6365	TOR PINE NOR	54,496				Tier 2	7,988	20,782	-	-	-	-	$ 9	$ 23
06C6367	TOR PIN CTR	279,179			Tier 1	Tier 1	590,331	736,780	28,656	42,699	76.9	129.9	$ 663	$ 876
06C6371	7835 TRADE	183,364				Tier 1	348,284	402,093	-	-	56.8	65.6	$ 378	$ 440
06C6402	STUSVCSFAC	91,462			Tier 2	Tier 2	178,725	223,063	17,351	25,854	23.3	39.3	$ 201	$ 265
06C6405	CENTER HALL	56,819				Tier 2	5,733	18,671	-	-	-	-	$ 6	$ 20
06C6429	RITTER REPL	65,899	Tier 1	Tier 1		Tier 2	879,852	1,187,801	26,141	34,640	65.0	99.5	$ 1,098	$ 1,652
06C6438	SOM RSCH FAC	141,579	Tier 1	Tier 1		Tier 1	1,837,317	2,476,879	54,055	71,631	137.3	209.2	$ 2,290	$ 3,439
06C6461	BAS SCI BLDG	333,043				Tier 1	195,573	225,788	-	-	31.9	36.8	$ 212	$ 247
06C6507	RCRH ARGO	69,973			Tier 1	Tier 1	307,651	383,972	16,593	24,725	40.1	67.7	$ 345	$ 457

Building Key	Building Name	Basic Gross Area	Projects by Building				Total Building Deep Potential							
			ESDVR	Deep Lab	Deep HVAC	Deep Lighting	Low Electricity (kWh/yr)	High Electricity (kWh/yr)	Low Gas (th/yr)	High Gas (th/yr)	Low Demand (kW)	High Demand (kW)	Low Cost (x$1000)	High Cost (x$1000)
06C6548	EBU 3B	149,804				Tier 1	153,415	177,117	-	-	25.0	28.9	$ 166	$ 194
06C6598	MANDEVILLE	115,769			Tier 1		345,665	451,995	21,963	32,725	37.8	83.0	$ 396	$ 561
06C6599	GEISEL LIB	422,239				Tier 1	786,448	907,952	-	-	128.3	148.2	$ 853	$ 994
06C6600	AP M BLDG	183,206	Tier 1	Tier 1		Tier 2	1,133,051	1,559,302	15,919	21,095	76.1	117.7	$ 1,404	$ 2,136
06C6601	BIOLOGY BLDG	82,468	Tier 1			Tier 2	415,753	550,730	-	-	47.9	63.3	$ 267	$ 294
06C6602	MCGILL BLDG	80,794			Tier 1		241,236	315,443	19,159	28,548	26.4	57.9	$ 277	$ 392
06C6603	H SS BLDG	85,331			Tier 1		206,912	285,286	16,924	26,840	26.0	59.3	$ 237	$ 354
06C6661	CALITIT	235,819				Tier 1	76,491	88,309	-	-	12.5	14.4	$ 83	$ 97
06C6666	NAT SCI	174,445	Tier 1	Tier 1		Tier 2	2,413,752	3,260,693	72,036	95,459	177.3	272.2	$ 3,014	$ 4,539
06C6668	PHARM SCI	122,273	Tier 1	Tier 2		Tier 1	623,361	826,996	30,150	39,953	54.1	77.5	$ 738	$ 1,073
06C6697	OTTERSON	85,447				Tier 1	145,422	167,889	-	-	23.7	27.4	$ 158	$ 184
06C6701	PRICE CTR	169,274			Tier 1	Tier 1	765,080	970,227	24,085	35,888	89.7	163.9	$ 861	$ 1,159
06C6750	MANDELL WEIS	41,200			Tier 1	Tier 1	201,271	251,203	9,770	14,558	26.2	44.3	$ 226	$ 299
06C6783	PEPCYNHALL	70,506			Tier 1	Tier 1	277,854	359,126	13,983	22,177	38.9	69.1	$ 312	$ 428
06C6811	SOC SCI BLDG	67,743				Tier 2	86,909	114,706	-	-	5.4	9.9	$ 94	$ 126
06C6862	PRICE EAST	122,000			Tier 1	Tier 1	595,998	743,852	20,252	30,176	77.6	131.1	$ 669	$ 884
06C6999	EARTH	93,090				Tier 1	176,816	204,134	-	-	28.9	33.3	$ 192	$ 223
06C7041	ECGH 1	62,731			Tier 1	Tier 1	306,455	382,480	14,876	22,166	39.9	67.4	$ 344	$ 455
06C7042	ECGH 2	102,357			Tier 1	Tier 1	500,037	624,086	24,273	36,168	65.1	110.0	$ 561	$ 742
06C7043	ECGH 3	94,193			Tier 1	Tier 1	460,154	574,309	22,337	33,283	60.0	101.2	$ 517	$ 683
06C7044	ECGH 4	106,293			Tier 1	Tier 1	519,265	648,084	25,206	37,558	67.7	114.2	$ 583	$ 771
06C7081	3525 John Hopkins (	48,306				Tier 2	13,662	15,773	-	-	2.2	2.6	$ 15	$ 17
06C7157	BLACK	58,209				Tier 1	110,563	127,645	-	-	18.0	20.8	$ 120	$ 140
06C7158	BRENNAN	59,037				Tier 1	112,136	129,460	-	-	18.3	21.1	$ 122	$ 142
06C7159	DOUGLAS	58,154				Tier 1	110,459	127,524	-	-	18.0	20.8	$ 120	$ 140
06C7160	GOLDBERG	58,834				Tier 1	111,750	129,015	-	-	18.2	21.1	$ 121	$ 141
06C7214	BSB ADDITION	43,607			Tier 1	Tier 1	213,030	265,878	10,341	15,408	27.8	46.9	$ 239	$ 316
06C7228	SDSC EXP	82,409				Tier 1	130,051	150,143	-	-	21.2	24.5	$ 141	$ 164
06C6657	MULTIPURPOSE	70,793			Tier 1	Tier 2	317,546	398,970	16,788	25,015	40.4	70.7	$ 358	$ 477
06C6760	17190 BERNAR	61,286			Tier 1	Tier 1	299,396	373,670	14,533	21,655	39.0	65.9	$ 336	$ 444
06C6977	CTF	122,845	Tier 1			Tier 2	569,761	751,099	-	-	66.7	87.5	$ 375	$ 415
Campus Total			26	18	24	55	34,689,839	46,336,807	910,766	1,305,254	3,452.6	5,314.7	$ 38,535	$ 55,664

12.3. Deep Efficiency Projects by Type

The table beginning on the following page provides a list of all the buildings for each type of deep efficiency project, including the project savings and cost ranges for each building.

Table 12.6: UC San Diego Project by Type

Building Key	Building Name	Total Building Deep Potential							
		Low Electricity (kWh/yr)	High Electricity (kWh/yr)	Low Gas (th/yr)	High Gas (th/yr)	Low Demand (kW)	High Demand (kW)	Low Cost (x$1000)	High Cost (x$1000)
ESDVR Projects									
06C6119	MTF	396,696	528,660	-	-	44.8	59.7	$ 246	$ 270
06C6129	CMRR	161,385	215,070	-	-	18.2	24.3	$ 100	$ 110
06C6131	ENG UNIT 1	1,007,250	1,342,319	-	-	113.8	151.5	$ 625	$ 686
06C6132	ENG UNIT 2	480,979	640,980	-	-	54.3	72.4	$ 298	$ 328
06C6135	CENT MOL GEN	193,545	257,930	-	-	21.9	29.1	$ 120	$ 132
06C6143	CMM WEST	387,382	516,247	-	-	43.8	58.3	$ 240	$ 264
06C6156	CLIN SCI BLD	465,244	620,010	-	-	52.6	70.0	$ 289	$ 317
06C6176	CMM EAST	396,399	528,264	-	-	44.8	59.6	$ 246	$ 270
06C6188	SCI ENG RSCH	376,866	502,233	-	-	42.6	56.7	$ 234	$ 257
06C6206	HUBBS HALL	309,935	413,037	-	-	35.0	46.6	$ 192	$ 211
06C6264	MAYER ANNEX	295,203	393,404	-	-	33.3	44.4	$ 183	$ 201
06C6285	RITTER HALL	147,093	196,025	-	-	16.6	22.1	$ 91	$ 100
06C6320	POWELL FOCHT	370,431	493,658	-	-	41.8	55.7	$ 230	$ 252
06C6328	SVERDRUP	311,412	415,005	-	-	35.2	46.9	$ 193	$ 212
06C6336	UREY HALL	706,719	941,813	-	-	79.8	106.3	$ 438	$ 481
06C6352	MAYER HALL	515,614	687,136	-	-	58.3	77.6	$ 320	$ 351
06C6353	BONNER HALL	489,876	652,837	-	-	55.3	73.7	$ 304	$ 334
06C6355	PACIFIC HALL	892,032	1,188,772	-	-	100.8	134.2	$ 553	$ 608
06C6361	YORK HALL	419,959	559,662	-	-	47.4	63.2	$ 261	$ 286
06C6429	RITTER REPL	316,498	421,783	-	-	35.8	47.6	$ 196	$ 216
06C6438	SOM RSCH FAC	654,473	872,188	-	-	73.9	98.5	$ 406	$ 446
06C6600	AP M BLDG	385,480	513,713	-	-	43.5	58.0	$ 239	$ 263
06C6601	BIOLOGY BLDG	397,084	529,177	-	-	44.9	59.7	$ 246	$ 271
06C6666	NAT SCI	872,178	1,162,315	-	-	98.5	131.2	$ 541	$ 594
06C6668	PHARM SCI	228,149	304,044	-	-	25.8	34.3	$ 142	$ 155
06C6977	CTF	523,758	697,989	-	-	59.2	78.8	$ 325	$ 357
Campus Total, ESDVR Projects		11,701,639	15,594,269	-	-	1,322	1,761	$ 7,260	$ 7,972
Deep Lab Projects									
06C6119	MTF	687,134	938,220	32,764	43,418	33.5	61.5	$ 1,109	$ 1,777
06C6129	CMRR	294,797	499,093	479	4,813	17.3	40.0	$ 476	$ 945
06C6131	ENG UNIT 1	1,744,701	2,382,235	83,192	110,242	85.1	156.1	$ 2,817	$ 4,511
06C6132	ENG UNIT 2	377,947	682,380	26,605	39,521	19.6	53.5	$ 610	$ 1,292
06C6135	CENT MOL GEN	335,248	457,752	15,986	21,183	16.4	30.0	$ 541	$ 867
06C6188	SCI ENG RSCH	652,786	891,321	31,127	41,247	31.8	58.4	$ 1,054	$ 1,688
06C6206	HUBBS HALL	399,168	791,512	22,071	38,718	5.4	49.1	$ 644	$ 1,499
06C6264	MAYER ANNEX	511,334	698,181	24,382	32,310	24.9	45.7	$ 826	$ 1,322
06C6285	RITTER HALL	254,787	347,889	12,149	16,099	12.4	22.8	$ 411	$ 659
06C6320	POWELL FOCHT	513,312	700,882	24,476	32,435	25.0	45.9	$ 829	$ 1,327
06C6328	SVERDRUP	295,652	689,865	-	10,348	29.4	73.3	$ 477	$ 1,306
06C6352	MAYER HALL	893,116	1,219,471	29,810	39,503	43.6	79.9	$ 1,442	$ 2,309
06C6354	IGPP	227,888	311,161	10,866	14,400	11.1	20.4	$ 368	$ 589
06C6429	RITTER REPL	548,219	748,545	26,141	34,640	26.7	49.0	$ 885	$ 1,417
06C6438	SOM RSCH FAC	1,133,640	1,547,885	54,055	71,631	55.3	101.4	$ 1,830	$ 2,931
06C6600	AP M BLDG	667,706	911,694	15,919	21,095	32.6	59.7	$ 1,078	$ 1,726
06C6666	NAT SCI	1,510,737	2,062,778	72,036	95,459	73.7	135.2	$ 2,439	$ 3,906
06C6668	PHARM SCI	316,149	431,673	30,150	39,953	15.4	28.3	$ 510	$ 817
Campus Total, Deep Lab Projects		11,364,318	16,312,535	512,208	707,016	559	1,110	$ 18,348	$ 30,890
Deep HVAC Projects									
06C6172	WAR LEC HALL	116,159	183,769	14,599	23,154	22.4	51.2	$ 133	$ 228
06C6210	SIO AQUARIUM	126,306	165,159	10,031	14,947	13.8	30.3	$ 145	$ 205
06C6272	ECKART LIB	158,066	206,689	12,554	18,706	17.3	37.9	$ 181	$ 257
06C6312	STEWART HALL	123,926	162,047	9,842	14,666	13.6	29.8	$ 142	$ 201
06C6313	BROWN HALL	122,418	160,076	9,723	14,487	13.4	29.4	$ 140	$ 199
06C6314	BATES HALL	123,216	161,118	9,786	14,582	13.5	29.6	$ 141	$ 200

Building Key	Building Name	Total Building Deep Potential							
		Low Electricity (kWh/yr)	High Electricity (kWh/yr)	Low Gas (th/yr)	High Gas (th/yr)	Low Demand (kW)	High Demand (kW)	Low Cost (x$1000)	High Cost (x$1000)
06C6335	CENT UTLTIES	188,035	245,876	14,934	22,252	20.6	45.1	$ 216	$ 305
06C6367	TOR PIN CTR	360,806	471,794	28,656	42,699	39.5	86.6	$ 414	$ 586
06C6402	STUSVCSFAC	109,235	142,837	17,351	25,854	11.9	26.2	$ 125	$ 177
06C6507	RCRH ARGO	188,034	245,875	16,593	24,725	20.6	45.1	$ 216	$ 305
06C6598	MANDEVILLE	345,665	451,995	21,963	32,725	37.8	83.0	$ 396	$ 561
06C6602	MCGILL BLDG	241,236	315,443	19,159	28,548	26.4	57.9	$ 277	$ 392
06C6603	H SS BLDG	206,912	285,286	16,924	26,840	26.0	59.3	$ 237	$ 354
06C6701	PRICE CTR	505,421	660,893	24,085	35,888	55.3	121.3	$ 580	$ 821
06C6750	MANDELL WEIS	123,016	160,856	9,770	14,558	13.5	29.5	$ 141	$ 200
06C6783	PEPCYNHALL	170,964	235,722	13,983	22,177	21.5	49.0	$ 196	$ 293
06C6862	PRICE EAST	364,269	476,322	20,252	30,176	39.8	87.5	$ 418	$ 592
06C7041	ECGH 1	187,303	244,920	14,876	22,166	20.5	45.0	$ 215	$ 304
06C7042	ECGH 2	305,619	399,631	24,273	36,168	33.4	73.4	$ 351	$ 496
06C7043	ECGH 3	281,243	367,756	22,337	33,283	30.8	67.5	$ 323	$ 457
06C7044	ECGH 4	317,371	414,998	25,206	37,558	34.7	76.2	$ 364	$ 515
06C7214	BSB ADDITION	130,202	170,254	10,341	15,408	14.2	31.3	$ 149	$ 211
06C6657	MULTIPURPOSE	211,375	276,396	16,788	25,015	23.1	50.7	$ 242	$ 343
06C6760	17190 BERNAR	182,989	239,278	14,533	21,655	20.0	43.9	$ 210	$ 297
Campus Total, Deep HVAC		5,189,783	6,844,988	398,558	598,238	583	1,287	$ 5,952	$ 8,502
Deep Lighting Projects									
06C6115	RIMAC	311,472	375,405	-	-	42.1	52.6	$ 338	$ 411
06C6131	ENG UNIT 1	101,265	116,910	-	-	16.5	19.1	$ 110	$ 128
06C6137	SUPERCOMPUTR	112,198	129,533	-	-	18.3	21.1	$ 122	$ 142
06C6163	BLACK BOX	93,472	107,913	-	-	15.3	17.6	$ 101	$ 118
06C6173	LITERATURE	4,194	14,792	-	-	-	-	$ 5	$ 16
06C6210	SIO AQUARIUM	22,271	34,684	-	-	-	0.2	$ 24	$ 38
06C6218	NIERENBERG	29,859	34,472	-	-	4.9	5.6	$ 32	$ 38
06C6264	MAYER ANNEX	54,500	62,920	-	-	8.9	10.3	$ 59	$ 69
06C6272	ECKART LIB	100,553	116,088	-	-	16.4	18.9	$ 109	$ 127
06C6285	RITTER HALL	16,708	28,293	-	-	-	-	$ 18	$ 31
06C6312	STEWART HALL	78,835	91,015	-	-	12.9	14.9	$ 85	$ 100
06C6313	BROWN HALL	77,876	89,908	-	-	12.7	14.7	$ 84	$ 98
06C6314	BATES HALL	78,383	90,493	-	-	12.8	14.8	$ 85	$ 99
06C6320	POWELL FOCHT	84,702	97,788	-	-	13.8	16.0	$ 92	$ 107
06C6336	UREY HALL	100,759	116,326	-	-	16.4	19.0	$ 109	$ 127
06C6354	IGPP	19,149	22,107	-	-	3.1	3.6	$ 21	$ 24
06C6355	PACIFIC HALL	59,238	68,390	-	-	9.7	11.2	$ 64	$ 75
06C6357	GALBRTH HALL	103,239	143,089	-	-	2.3	8.8	$ 112	$ 157
06C6365	TOR PINE NOR	7,988	20,782	-	-	-	-	$ 9	$ 23
06C6367	TOR PIN CTR	229,525	264,986	-	-	37.5	43.2	$ 249	$ 290
06C6371	7835 TRADE	348,284	402,093	-	-	56.8	65.6	$ 378	$ 440
06C6402	STUSVCSFAC	69,490	80,226	-	-	11.3	13.1	$ 75	$ 88
06C6405	CENTER HALL	5,733	18,671	-	-	-	-	$ 6	$ 20
06C6429	RITTER REPL	15,135	17,473	-	-	2.5	2.9	$ 16	$ 19
06C6438	SOM RSCH FAC	49,205	56,807	-	-	8.0	9.3	$ 53	$ 62
06C6461	BAS SCI BLDG	195,573	225,788	-	-	31.9	36.8	$ 212	$ 247
06C6507	RCRH ARGO	119,617	138,097	-	-	19.5	22.5	$ 130	$ 151
06C6548	EBU 3B	153,415	177,117	-	-	25.0	28.9	$ 166	$ 194
06C6599	GEISEL LIB	786,448	907,952	-	-	128.3	148.2	$ 853	$ 994
06C6600	AP M BLDG	79,865	133,896	-	-	-	-	$ 87	$ 147
06C6601	BIOLOGY BLDG	18,669	21,553	-	-	3.0	3.5	$ 20	$ 24
06C6661	CALITIT	76,491	88,309	-	-	12.5	14.4	$ 83	$ 97
06C6666	NAT SCI	30,836	35,600	-	-	5.0	5.8	$ 33	$ 39
06C6668	PHARM SCI	79,064	91,279	-	-	12.9	14.9	$ 86	$ 100
06C6697	OTTERSON	145,422	167,889	-	-	23.7	27.4	$ 158	$ 184
06C6701	PRICE CTR	259,659	309,334	-	-	34.5	42.6	$ 281	$ 338
06C6750	MANDELL WEIS	78,256	90,346	-	-	12.8	14.7	$ 85	$ 99

Building Key	Building Name	Total Building Deep Potential							
		Low Electricity (kWh/yr)	High Electricity (kWh/yr)	Low Gas (th/yr)	High Gas (th/yr)	Low Demand (kW)	High Demand (kW)	Low Cost (x$1000)	High Cost (x$1000)
06C6783	PEPCYNHALL	106,890	123,404	-	-	17.4	20.1	$ 116	$ 135
06C6811	SOC SCI BLDG	86,909	114,706	-	-	5.4	9.9	$ 94	$ 126
06C6862	PRICE EAST	231,729	267,530	-	-	37.8	43.7	$ 251	$ 293
06C6999	EARTH	176,816	204,134	-	-	28.9	33.3	$ 192	$ 223
06C7041	ECGH 1	119,152	137,561	-	-	19.4	22.4	$ 129	$ 151
06C7042	ECGH 2	194,418	224,455	-	-	31.7	36.6	$ 211	$ 246
06C7043	ECGH 3	178,912	206,553	-	-	29.2	33.7	$ 194	$ 226
06C7044	ECGH 4	201,894	233,087	-	-	32.9	38.0	$ 219	$ 255
06C7081	3525 John Hopkins Cour	13,662	15,773	-	-	2.2	2.6	$ 15	$ 17
06C7157	BLACK	110,563	127,645	-	-	18.0	20.8	$ 120	$ 140
06C7158	BRENNAN	112,136	129,460	-	-	18.3	21.1	$ 122	$ 142
06C7159	DOUGLAS	110,459	127,524	-	-	18.0	20.8	$ 120	$ 140
06C7160	GOLDBERG	111,750	129,015	-	-	18.2	21.1	$ 121	$ 141
06C7214	BSB ADDITION	82,828	95,624	-	-	13.5	15.6	$ 90	$ 105
06C7228	SDSC EXP	130,051	150,143	-	-	21.2	24.5	$ 141	$ 164
06C6657	MULTIPURPOSE	106,171	122,574	-	-	17.3	20.0	$ 115	$ 134
06C6760	17190 BERNAR	116,408	134,392	-	-	19.0	21.9	$ 126	$ 147
06C6977	CTF	46,003	53,110	-	-	7.5	8.7	$ 50	$ 58
Campus Total, Deep Lighting		6,434,099	7,585,016	-	-	988	1,157	$ 6,975	$ 8,300

12.4. Campus Specific Projects

Additionally, during discussions with the campus, staff identified projects that have deep efficiency potential but do not fall into savings quantified for the four project categories above. These include campuswide supply air temperature reset and using ocean water cooling. These project are discussed below, but require additional engineering to determine scope, costs or savings.

12.4.1. Ocean Water Cooling

The campus has been investigating the use of ocean water to provide cooling for the campus, and Makai Ocean Engineering has performed a Feasibility Analysis. Briefly, the project would pump sea water through a heat exchanger, providing in excess of 4000 tons of cooling for the campus. Additional details can be found in the Feasibility Analysis. If the campus can clear environmental hurdles, it is estimated to save over 28 million kWh per year.

12.4.2. SAT Reset Campuswide

The campus has implemented a number of controls and variable air volume conversion projects across the campus, and has an interest in optimizing the supply air reset setpoints to garner additional savings.

13. UC San Francisco – Deep Efficiency Potential

13.1. Campus Deep Efficiency Potential

The total campus potential is tabulated in the table below for all projects identified in this investigation. The savings, along with project economics and a resulting aggregate simple payback, are shown for the range of savings for each project type, as well as the campuswide potential.

Table 13.1: UC San Francisco Potential Savings Summary, All Projects

	Total Building Deep Potential								Economics			
	Low Electricity (kWh/yr)	High Electricity (kWh/yr)	Low Gas (th/yr)	High Gas (th/yr)	Low Demand (kW)	High Demand (kW)	Low Cost (x$1000)	High Cost (x$1000)	Low Utility Savings (x$1000)	High Utility Savings (x$1000)	Low SPB (yrs)	High SPB (yrs)
SmartLab	23,386,226	31,857,740	628,309	855,233	1,606	2,547	$ 42,636	$ 64,546	$ 3,582	$ 4,879	11.9	13.2
Deep HVAC	1,491,068	2,079,517	108,571	183,026	156	406	$ 2,565	$ 3,874	$ 280	$ 414	9.2	9.4
Deep Lighting	1,525,456	1,775,579	-	-	250	291	$ 2,481	$ 2,914	$ 203	$ 236	12.2	12.3
Total	26,402,750	35,712,835	736,880	1,038,259	2,012	3,244	$ 47,682	$ 71,335	$ 4,064	$ 5,529	11.7	12.9

Based on campus review and input into the potential deep efficiency projects in the identified buildings, the total potential is further broken down into the Tier 1 (reasonably certain candidate projects) and Tier 2 (questionable candidate projects) categories. The resulting savings and economics are presented in the following two tables, respectively.

Table 13.2: UC San Francisco Potential Savings Summary, Tier 1

	Total Building Deep Potential								Economics			
	Low	High	Low	High	Low	High	Low	High	Low	High	Low	High
	Electricity (kWh/yr)	Electricity (kWh/yr)	Gas (th/yr)	Gas (th/yr)	Demand (kW)	Demand (kW)	Cost (x$1000)	Cost (x$1000)	Utility Savings (x$1000)	Utility Savings (x$1000)	SPB (yrs)	SPB (yrs)
SmartLab	23,386,226	31,857,740	628,309	855,233	1,606	2,547	$ 42,636	$ 64,546	$ 3,582	$ 4,879	11.9	13.2
Deep HVAC	1,491,068	2,079,517	108,571	183,026	156	406	$ 2,565	$ 3,874	$ 280	$ 414	9.2	9.4
Deep Lighting	1,525,456	1,775,579	-	-	250	291	$ 2,481	$ 2,914	$ 203	$ 236	12.2	12.3
Total	26,402,750	35,712,835	736,880	1,038,259	2,012	3,244	$ 47,682	$ 71,335	$ 4,064	$ 5,529	11.7	12.9

Table 13.3: UC San Francisco Potential Savings Summary, Tier 2

	Total Building Deep Potential								Economics			
	Low	High	Low	High	Low	High	Low	High	Low	High	Low	High
	Electricity (kWh/yr)	Electricity (kWh/yr)	Gas (th/yr)	Gas (th/yr)	Demand (kW)	Demand (kW)	Cost (x$1000)	Cost (x$1000)	Utility Savings (x$1000)	Utility Savings (x$1000)	SPB (yrs)	SPB (yrs)
SmartLab	-	-	-	-	-	-	$ -	$ -	$ -	$ -	n/a	n/a
Deep HVAC	-	-	-	-	-	-	$ -	$ -	$ -	$ -	n/a	n/a
Deep Lighting	-	-	-	-	-	-	$ -	$ -	$ -	$ -	n/a	n/a
Total	-	-	-	-	-	-	$ -	$ -	$ -	$ -	n/a	n/a

The total impacts on greenhouse gas (GHG) emissions at the campus level have also been tabulated for all range of potential project savings. The metric tons of carbon dioxide equivalent are presented in the table below, including details attributable to the two tiers of projects.

Table 13.4: UC San Francisco GHG Impact Summary

	Low	High
	GHG Savings (Metric Tons C02e/yr*)	GHG Savings (Metric Tons C02e/yr)*
All Deep Projects	11,826	16,216
Tier 1	11,826	16,216
Tier 2	-	-

*eGrid average factors used, including CH_4 & N_2O impacts:

0.000299916 metric tons CO_2e/kWh

0.005302204 metric tons CO_2e/therm

13.2. Deep Efficiency Project Summary by Building

The table beginning on the following page provides a view of the project applicability for each of the four deep efficiency project categories by building, and the savings and cost ranges for the buildings.

Table 13.5: UC San Francisco Projects by Building

			Projects by Building				Total Building Deep Potential							
Building Key	Building Name	Basic Gross Area	ESDVR	Deep Lab	Deep HVAC	Deep Lighting	Low Electricity (kWh/yr)	High Electricity (kWh/yr)	Low Gas (th/yr)	High Gas (th/yr)	Low Demand (kW)	High Demand (kW)	Low Cost (x$1000)	High Cost (x$1000)
02C2037	MTZ CANCER R	109,671	Tier 1	Tier 1		Tier 1	1,443,405	1,946,518	42,568	56,409	107.5	164.1	$ 2,699	$ 4,056
02C2212	MILLBERRY	422,974			Tier 1	Tier 1	357,252	469,074	21,880	32,603	44.4	84.8	$ 607	$ 850
02C2252	MED SCIENCES	392,649	Tier 1	Tier 1		Tier 1	3,305,750	4,430,884	93,370	123,729	258.7	386.2	$ 6,147	$ 9,161
02C2290	LPPI	107,237			Tier 1	Tier 1	480,582	603,856	25,430	37,892	61.2	107.1	$ 812	$ 1,084
02C2325	VISION RSCH	40,000	Tier 1				149,588	199,350	-	-	16.9	22.5	$ 139	$ 153
02C2410	NURSING	88,668				Tier 1	141,000	162,784	-	-	23.0	26.6	$ 229	$ 267
02C2412	DENTISTRY	128,403				Tier 1	212,692	245,553	-	-	34.7	40.1	$ 346	$ 403
02C2415	MISSION CTR	290,883	Tier 1	Tier 1	Tier 1		1,002,305	1,471,955	35,875	71,271	77.2	200.6	$ 1,832	$ 2,957
02C3000	PSSRB	90,500	Tier 1	Tier 1			1,386,906	1,877,070	41,927	55,559	100.2	155.0	$ 2,602	$ 3,929
02C3001	ROCK HALL	170,565	Tier 1			Tier 1	848,186	1,119,820	-	-	98.8	129.9	$ 830	$ 918
02C3002	GENENTECH HA	438,361	Tier 1	Tier 1		Tier 1	4,987,221	6,943,543	95,609	149,326	252.3	466.3	$ 8,967	$ 13,972
02C3003	COMMUNITY CE	158,605			Tier 1	Tier 1	774,822	967,038	37,611	56,043	100.9	170.5	$ 1,305	$ 1,725
02C3008	HSIR EAST	206,305	Tier 1	Tier 1			1,852,345	2,507,006	55,997	74,204	133.9	207.1	$ 3,475	$ 5,248
02C3009	HSIR WEST	233,516	Tier 1	Tier 1	Tier 1		2,074,782	2,803,100	68,044	91,586	154.0	245.8	$ 3,875	$ 5,835
02C3034	BYERS HALL	154,434	Tier 1	Tier 1			2,014,867	2,726,967	60,910	80,715	145.6	225.2	$ 3,780	$ 5,708
02C3043	654 MINNESOT	65,525				Tier 1	124,459	143,688	-	-	20.3	23.4	$ 202	$ 236
02C2316	DILLER CANCE	160,540	Tier 1	Tier 1			1,563,451	2,116,010	47,264	62,631	113.0	174.8	$ 2,933	$ 4,429
02C3045	SMITH CARDIO	236,000	Tier 1	Tier 1			2,845,555	3,851,240	86,022	113,992	205.7	318.1	$ 5,338	$ 8,061
02C3047	DOLBY REGEN	68,631	Tier 1	Tier 1		Tier 1	837,582	1,127,379	24,375	32,300	63.4	96.0	$ 1,563	$ 2,343
Campus Total			13	11	5	11	26,402,750	35,712,835	736,880	1,038,259	2,011.7	3,243.9	$ 47,682	$ 71,335

13.3. Deep Efficiency Projects by Type

The table beginning on the following page provides a list of all the buildings for each type of deep efficiency project, including the project savings and cost ranges for each building.

Table 13.6: UC San Francisco Project by Type

Building Key	Building Name	Total Building Deep Potential							
		Low Electricity (kWh/yr)	High Electricity (kWh/yr)	Low Gas (th/yr)	High Gas (th/yr)	Low Demand (kW)	High Demand (kW)	Low Cost (x$1000)	High Cost (x$1000)
ESDVR Projects									
02C2037	MTZ CANCER R	515,389	686,836	-	-	58.2	77.5	$ 480	$ 527
02C2252	MED SCIENCES	1,130,475	1,506,535	-	-	127.7	170.1	$ 1,052	$ 1,155
02C2325	VISION RSCH	149,588	199,350	-	-	16.9	22.5	$ 139	$ 153
02C2415	MISSION CTR	252,074	335,928	-	-	28.5	37.9	$ 235	$ 258
02C3000	PSSRB	507,626	676,491	-	-	57.3	76.4	$ 472	$ 519
02C3001	ROCK HALL	789,130	1,051,640	-	-	89.1	118.7	$ 734	$ 806
02C3002	GENENTECH HA	2,000,232	2,665,623	-	-	226.0	300.9	$ 1,862	$ 2,044
02C3008	HSIR EAST	677,983	903,518	-	-	76.6	102.0	$ 631	$ 693
02C3009	HSIR WEST	719,789	959,232	-	-	81.3	108.3	$ 670	$ 736
02C3034	BYERS HALL	737,468	982,792	-	-	83.3	111.0	$ 686	$ 754
02C2316	DILLER CANCE	572,244	762,604	-	-	64.6	86.1	$ 533	$ 585
02C3045	SMITH CARDIO	1,041,511	1,387,976	-	-	117.7	156.7	$ 969	$ 1,064
02C3047	DOLBY REGEN	295,115	393,287	-	-	33.3	44.4	$ 275	$ 302
Campus Total, ESDVR Projects		9,388,623	12,511,813	-	-	1,061	1,413	$ 8,737	$ 9,594
Deep Lab Projects									
02C2037	MTZ CANCER R	892,726	1,218,939	42,568	56,409	43.6	79.9	$ 2,162	$ 3,462
02C2252	MED SCIENCES	1,958,143	2,673,671	93,370	123,729	95.5	175.2	$ 4,742	$ 7,595
02C2415	MISSION CTR	436,628	596,177	20,820	27,589	21.3	39.1	$ 1,057	$ 1,693
02C3000	PSSRB	879,280	1,200,579	41,927	55,559	42.9	78.7	$ 2,129	$ 3,410
02C3002	GENENTECH HA	2,825,854	4,091,891	95,609	149,326	-	135.0	$ 6,844	$ 11,623
02C3008	HSIR EAST	1,174,362	1,603,488	55,997	74,204	57.3	105.1	$ 2,844	$ 4,555
02C3009	HSIR WEST	1,246,777	1,702,364	59,450	78,780	60.8	111.5	$ 3,019	$ 4,836
02C3034	BYERS HALL	1,277,399	1,744,175	60,910	80,715	62.3	114.3	$ 3,094	$ 4,954
02C2316	DILLER CANCE	991,207	1,353,406	47,264	62,631	48.4	88.7	$ 2,400	$ 3,844
02C3045	SMITH CARDIO	1,804,045	2,463,264	86,022	113,992	88.0	161.4	$ 4,369	$ 6,997
02C3047	DOLBY REGEN	511,181	697,972	24,375	32,300	24.9	45.7	$ 1,238	$ 1,983
Campus Total, Deep Lab Projects		13,997,602	19,345,927	628,309	855,233	545	1,134	$ 33,899	$ 54,952
Deep HVAC Projects									
02C2212	MILLBERRY	275,495	360,240	21,880	32,603	30.1	66.1	$ 474	$ 671
02C2290	LPPI	320,190	418,683	25,430	37,892	35.0	76.9	$ 551	$ 780
02C2415	MISSION CTR	313,603	539,850	15,055	43,682	27.4	123.6	$ 540	$ 1,006
02C3003	COMMUNITY CE	473,565	619,239	37,611	56,043	51.8	113.7	$ 815	$ 1,154
02C3009	HSIR WEST	108,216	141,504	8,595	12,807	11.8	26.0	$ 186	$ 264
Campus Total, Deep HVAC		1,491,068	2,079,517	108,571	183,026	156	406	$ 2,565	$ 3,874
Deep Lighting Projects									
02C2037	MTZ CANCER R	35,290	40,742	-	-	5.8	6.6	$ 57	$ 67
02C2212	MILLBERRY	81,757	108,833	-	-	14.3	18.7	$ 133	$ 179
02C2252	MED SCIENCES	217,132	250,679	-	-	35.4	40.9	$ 353	$ 411
02C2290	LPPI	160,393	185,173	-	-	26.2	30.2	$ 261	$ 304
02C2410	NURSING	141,000	162,784	-	-	23.0	26.6	$ 229	$ 267
02C2412	DENTISTRY	212,692	245,553	-	-	34.7	40.1	$ 346	$ 403
02C3001	ROCK HALL	59,056	68,180	-	-	9.6	11.1	$ 96	$ 112
02C3002	GENENTECH HA	161,134	186,029	-	-	26.3	30.4	$ 262	$ 305
02C3003	COMMUNITY CE	301,257	347,800	-	-	49.2	56.8	$ 490	$ 571
02C3043	654 MINNESOT	124,459	143,688	-	-	20.3	23.4	$ 202	$ 236
02C3047	DOLBY REGEN	31,286	36,120	-	-	5.1	5.9	$ 51	$ 59
Campus Total, Deep Lighting		1,525,456	1,775,579	-	-	250	291	$ 2,481	$ 2,914

13.4. Campus Specific Projects

Additionally, during discussions with the campus, staff identified projects that have deep efficiency potential but do not fall into savings quantified for the four project categories above. These include several central plant type and controls projects. The project are discussed below, but require additional engineering to determine scope, costs or savings.

13.4.1. DDC Conversion

The campus has a significant amount of pneumatic controls in varied states of operability. Significant opportunity exists to convert to direct digital controls (DDC). This could potentially be part of Deep HVAC retrofits on a building by building basis, but a campuswide approach may provide benefits to the campus.

13.4.2. Extend CHW Plant to Library

Approximately 500 tons of additional cooling load could be served by the central chilled water loop on the Parnassus campus, replacing existing DX cooling sources. The campus estimates that the distance to a point at which the tie in could be accomplished is 500 feet from the library, making this a feasible endeavor.

13.4.3. Mission Bay Data Center - Hot/Cold Aisle Containment

The data center at Mission Bay has been built up, and could benefit from a project that improved the cooling efficiency by isolating hot and cold aisles and creating physical barriers to force the cold air to be drawn through the loads to the hot aisle and avoid bypass.

13.4.4. Exhaust Energy Recovery (PSSRB)

ARUP has provided the campus with a feasibility study to install an exhaust heat recovery system at PSSRB. The study estimates the campus could save approximately 128,000 kWh and 82,000 therms per year.

13.4.5. Add Steam Header between Rock & Genentech Halls

Currently Rock Hall and Genentech Hall each have dedicated boilers serving steam loads in their respective buildings, and are very lightly loaded. Each boiler could carry the load of both buildings, and by creating a steam header between the buildings one of the plants could be shut down or periodically alternated between.

14. UC Santa Barbara – Deep Efficiency Potential

14.1. Campus Deep Efficiency Potential

The total campus potential is tabulated in the table below for all projects identified in this investigation. The savings, along with project economics and a resulting aggregate simple payback, are shown for the range of savings for each project type, as well as the campuswide potential.

Table 14.1: UC Santa Barbara Potential Savings Summary, All Projects

	Total Building Deep Potential								Economics			
	Low Electricity (kWh/yr)	High Electricity (kWh/yr)	Low Gas (th/yr)	High Gas (th/yr)	Low Demand (kW)	High Demand (kW)	Low Cost (x$1000)	High Cost (x$1000)	Low Utility Savings (x$1000)	High Utility Savings (x$1000)	Low SPB (yrs)	High SPB (yrs)
SmartLab	12,047,183	16,311,821	347,738	460,805	857	1,334	$ 15,276	$ 23,153	$ 1,337	$ 1,804	11.4	12.8
Deep HVAC	4,920,499	6,564,510	259,936	392,793	561	1,260	$ 5,644	$ 8,154	$ 617	$ 852	9.1	9.6
Deep Lighting	2,655,743	3,126,069	-	-	410	487	$ 2,879	$ 3,421	$ 248	$ 292	11.6	11.7
Total	19,623,426	26,002,400	607,674	853,598	1,829	3,081	$ 23,799	$ 34,727	$ 2,203	$ 2,948	10.8	11.8

Based on campus review and input into the potential deep efficiency projects in the identified buildings, the total potential is further broken down into the Tier 1 (reasonably certain candidate projects) and Tier 2 (questionable candidate projects) categories. The resulting savings and economics are presented in the following two tables, respectively.

Table 14.2: UC Santa Barbara Potential Savings Summary, Tier 1

	Total Building Deep Potential								Economics			
	Low	High	Low	High	Low	High	Low	High	Low	High	Low	High
	Electricity (kWh/yr)	Electricity (kWh/yr)	Gas (th/yr)	Gas (th/yr)	Demand (kW)	Demand (kW)	Cost (x$1000)	Cost (x$1000)	Utility Savings (x$1000)	Utility Savings (x$1000)	SPB (yrs)	SPB (yrs)
SmartLab	12,047,183	16,311,821	347,738	460,805	857	1,334	$ 15,276	$ 23,153	$ 1,337	$ 1,804	11.4	12.8
Deep HVAC	4,920,499	6,564,510	259,936	392,793	561	1,260	$ 5,644	$ 8,154	$ 617	$ 852	9.1	9.6
Deep Lighting	2,655,743	3,126,069	-	-	410	487	$ 2,879	$ 3,421	$ 248	$ 292	11.6	11.7
Total	19,623,426	26,002,400	607,674	853,598	1,829	3,081	$ 23,799	$ 34,727	$ 2,203	$ 2,948	10.8	11.8

Table 14.3: UC Santa Barbara Potential Savings Summary, Tier 2

	Total Building Deep Potential								Economics			
	Low	High	Low	High	Low	High	Low	High	Low	High	Low	High
	Electricity (kWh/yr)	Electricity (kWh/yr)	Gas (th/yr)	Gas (th/yr)	Demand (kW)	Demand (kW)	Cost (x$1000)	Cost (x$1000)	Utility Savings (x$1000)	Utility Savings (x$1000)	SPB (yrs)	SPB (yrs)
SmartLab	-	-	-	-	-	-	$ -	$ -	$ -	$ -	n/a	n/a
Deep HVAC	-	-	-	-	-	-	$ -	$ -	$ -	$ -	n/a	n/a
Deep Lighting	-	-	-	-	-	-	$ -	$ -	$ -	$ -	n/a	n/a
Total	-	-	-	-	-	-	$ -	$ -	$ -	$ -	n/a	n/a

The total impacts on greenhouse gas (GHG) emissions at the campus level have also been tabulated for all range of potential project savings. The metric tons of carbon dioxide equivalent are presented in the table below, including details attributable to the two tiers of projects.

Table 14.4: UC Santa Barbara GHG Impact Summary

	Low	High
	GHG Savings (Metric Tons C02e/yr*)	GHG Savings (Metric Tons C02e/yr)*
All Deep Projects	9,107	12,324
Tier 1	9,107	12,324
Tier 2	-	-

*eGrid average factors used, including CH_4 & N_2O impacts:

0.000299916 metric tons CO_2e/kWh

0.005302204 metric tons CO_2e/therm

14.2. Deep Efficiency Project Summary by Building

The table beginning on the following page provides a view of the project applicability for each of the four deep efficiency project categories by building, and the savings and cost ranges for the buildings.

Table 14.5: UC Santa Barbara Projects by Building

Building Key	Building Name	Basic Gross Area	Projects by Building				Total Building Deep Potential							
			ESDVR	Deep Lab	Deep HVAC	Deep Lighting	Low Electricity (kWh/yr)	High Electricity (kWh/yr)	Low Gas (th/yr)	High Gas (th/yr)	Low Demand (kW)	High Demand (kW)	Low Cost (x$1000)	High Cost (x$1000)
08C8221	SRB	69,143			Tier 1	Tier 1	337,779	421,575	3,279	4,886	44.0	74.3	$ 379	$ 501
08C8225	ENG SCI	84,162	Tier 1	Tier 1			966,134	1,307,587	29,206	38,703	69.8	108.0	$ 1,208	$ 1,825
08C8235	LIFESCI	78,295	Tier 1	Tier 1		Tier 1	877,071	1,177,762	12,551	16,633	67.6	101.6	$ 1,089	$ 1,627
08C8243	ICA	43,742			Tier 1	Tier 1	213,690	266,702	10,373	15,456	27.8	47.0	$ 240	$ 317
08C8266	ELINGS HALL	116,999		Tier 1	Tier 1	Tier 1	982,239	1,321,989	46,976	63,558	61.2	109.2	$ 1,505	$ 2,360
08C8503	ENGR 2	127,751	Tier 1	Tier 1			1,555,172	2,104,806	47,013	62,300	112.4	173.8	$ 1,945	$ 2,937
08C8505	EVENTS CNTR	64,197			Tier 1		191,680	250,643	7,612	11,342	21.0	46.0	$ 220	$ 311
08C8511	MAC	53,197			Tier 1		79,418	103,848	2,523	3,759	8.7	19.1	$ 91	$ 129
08C8515	HSSB	155,089			Tier 1	Tier 1	676,652	852,095	11,033	16,440	85.5	151.4	$ 763	$ 1,022
08C8516	RECCEN	66,130			Tier 1		197,452	258,190	15,682	23,367	21.6	47.4	$ 226	$ 321
08C8520	MAR SCI BLDG	59,141	Tier 1	Tier 1			472,401	639,359	14,281	18,924	34.1	52.8	$ 591	$ 892
08C8521	BREN	82,858	Tier 1				141,122	188,067	-	-	15.9	21.2	$ 88	$ 96
08C8525	DAVIDSON LIB	339,447			Tier 1	Tier 1	369,669	604,572	16,099	23,989	65.9	145.0	$ 406	$ 697
08C8528	SOUTH HALL	131,496			Tier 1		392,622	513,397	15,591	23,232	42.9	94.3	$ 450	$ 638
08C8531	MUSIC	90,428			Tier 1	Tier 1	263,989	325,445	10,722	15,976	35.8	56.7	$ 295	$ 382
08C8533	ROBERTSN GYM	79,276			Tier 1		189,363	247,613	15,039	22,410	20.7	45.5	$ 217	$ 308
08C8534	ARTS	82,271			Tier 1		122,823	160,605	5,853	8,721	13.4	29.5	$ 141	$ 199
08C8544	NOBLE HALL	44,536	Tier 1	Tier 1			287,976	389,753	12,188	16,151	20.8	32.2	$ 360	$ 544
08C8551	PSYCHOLOGY	48,027	Tier 1	Tier 1		Tier 1	553,330	745,349	16,189	21,453	41.6	63.2	$ 689	$ 1,034
08C8552	CHEADLE HALL	68,242			Tier 1	Tier 1	333,378	416,082	8,091	12,057	43.4	73.3	$ 374	$ 495
08C8553	SAN MIGUEL	85,414				Tier 1	162,237	187,302	-	-	26.5	30.6	$ 176	$ 205
08C8556	HAROLD FRANK	98,212	Tier 1	Tier 1	Tier 1	Tier 1	899,996	1,199,102	12,927	17,663	75.2	118.2	$ 1,104	$ 1,629
08C8557	CHEMISTRY	98,632	Tier 1	Tier 1			1,230,798	1,665,790	37,207	49,305	89.0	137.6	$ 1,539	$ 2,324
08C8558	UNIV CENTER	148,936			Tier 1	Tier 1	727,586	908,085	17,659	26,313	94.8	160.1	$ 817	$ 1,080
08C8560	PHELPS HALL	134,419			Tier 1	Tier 1	345,417	455,541	22,313	33,248	36.0	76.6	$ 392	$ 553
08C8561	SAN NICOLAS	84,950				Tier 1	161,355	186,284	-	-	26.3	30.4	$ 175	$ 204
08C8563	ELLISON HALL	113,304			Tier 1	Tier 1	399,044	524,077	13,434	20,018	42.5	90.1	$ 454	$ 639
08C8564	GIRVETZ HALL	50,924			Tier 1		106,435	139,175	6,038	8,997	11.6	25.6	$ 122	$ 173
08C8568	SAASB	77,755			Tier 1		232,162	303,577	5,532	8,242	25.4	55.7	$ 266	$ 377
08C8571	BIOLOGY 2	127,949	Tier 1	Tier 1			1,782,983	2,413,130	53,900	71,426	128.9	199.3	$ 2,230	$ 3,367
08C8572	BROIDA HALL	139,440	Tier 1	Tier 1	Tier 1		867,743	1,172,121	22,964	30,958	64.6	103.5	$ 1,080	$ 1,626
08C8586	SAN RAFAEL W	61,473				Tier 1	116,763	134,802	-	-	19.1	22.0	$ 127	$ 148
08C8587	SAN RAFAEL M	48,012				Tier 1	91,195	105,284	-	-	14.9	17.2	$ 99	$ 115
08C8591	KERR HALL	43,548			Tier 1		130,026	170,024	10,327	15,388	14.2	31.2	$ 149	$ 211
08C8657	PSB NORTH	93,045	Tier 1	Tier 1			1,163,492	1,574,697	35,173	46,609	84.1	130.1	$ 1,455	$ 2,197
08C8860	SANTA CATALI	251,100			Tier 1	Tier 1	1,226,681	1,530,994	48,378	77,559	159.8	269.9	$ 1,377	$ 1,820
08C8945	ELDORADO APT	41,936				Tier 1	63,723	73,568	-	-	10.4	12.0	$ 69	$ 81
08C8997	ENG RSH LAB	56,596	Tier 1	Tier 1			711,831	963,408	21,519	28,516	51.5	79.6	$ 890	$ 1,344
Campus Total			13	13	22	19	19,623,426	26,002,400	607,674	853,598	1,829.0	3,081.1	$ 23,799	$ 34,727

14.3. Deep Efficiency Projects by Type

The table beginning on the following page provides a list of all the buildings for each type of deep efficiency project, including the project savings and cost ranges for each building.

Table 14.6: UC Santa Barbara Project by Type

Building Key	Building Name	Total Building Deep Potential							
		Low Electricity (kWh/yr)	High Electricity (kWh/yr)	Low Gas (th/yr)	High Gas (th/yr)	Low Demand (kW)	High Demand (kW)	Low Cost (x$1000)	High Cost (x$1000)
ESDVR Projects									
08C8225	ENG SCI	353,618	471,251	-	-	39.9	53.2	$ 219	$ 241
08C8235	LIFESCI	303,934	405,039	-	-	34.3	45.7	$ 189	$ 207
08C8503	ENGR 2	569,214	758,566	-	-	64.3	85.6	$ 353	$ 388
08C8520	MAR SCI BLDG	172,905	230,423	-	-	19.5	26.0	$ 107	$ 118
08C8521	BREN	141,122	188,067	-	-	15.9	21.2	$ 88	$ 96
08C8544	NOBLE HALL	105,403	140,466	-	-	11.9	15.9	$ 65	$ 72
08C8551	PSYCHOLOGY	196,013	261,218	-	-	22.1	29.5	$ 122	$ 134
08C8556	HAROLD FRANK	268,299	357,551	-	-	30.3	40.4	$ 166	$ 183
08C8557	CHEMISTRY	450,488	600,346	-	-	50.9	67.8	$ 279	$ 307
08C8571	BIOLOGY 2	652,595	869,686	-	-	73.7	98.2	$ 405	$ 445
08C8572	BROIDA HALL	299,205	398,737	-	-	33.8	45.0	$ 186	$ 204
08C8657	PSB NORTH	425,854	567,517	-	-	48.1	64.1	$ 264	$ 290
08C8997	ENG RSH LAB	260,540	347,210	-	-	29.4	39.2	$ 162	$ 178
Campus Total, ESDVR Projects		4,199,188	5,596,077	-	-	474	632	$ 2,605	$ 2,861
Deep Lab Projects									
08C8225	ENG SCI	612,516	836,336	29,206	38,703	29.9	54.8	$ 989	$ 1,584
08C8235	LIFESCI	526,456	718,829	12,551	16,633	25.7	47.1	$ 850	$ 1,361
08C8266	ELINGS HALL	818,848	1,118,064	39,045	51,740	39.9	73.3	$ 1,322	$ 2,117
08C8503	ENGR 2	985,959	1,346,239	47,013	62,300	48.1	88.2	$ 1,592	$ 2,549
08C8520	MAR SCI BLDG	299,496	408,936	14,281	18,924	14.6	26.8	$ 484	$ 774
08C8544	NOBLE HALL	182,573	249,287	12,188	16,151	8.9	16.3	$ 295	$ 472
08C8551	PSYCHOLOGY	339,523	463,588	16,189	21,453	16.6	30.4	$ 548	$ 878
08C8556	HAROLD FRANK	464,733	634,551	9,695	12,847	22.7	41.6	$ 750	$ 1,202
08C8557	CHEMISTRY	780,309	1,065,444	37,207	49,305	38.1	69.8	$ 1,260	$ 2,018
08C8571	BIOLOGY 2	1,130,388	1,543,445	53,900	71,426	55.1	101.1	$ 1,825	$ 2,923
08C8572	BROIDA HALL	518,265	707,645	19,770	26,198	25.3	46.4	$ 837	$ 1,340
08C8657	PSB NORTH	737,639	1,007,181	35,173	46,609	36.0	66.0	$ 1,191	$ 1,907
08C8997	ENG RSH LAB	451,291	616,199	21,519	28,516	22.0	40.4	$ 729	$ 1,167
Campus Total, Deep Lab Projects		7,847,995	10,715,744	347,738	460,805	383	702	$ 12,671	$ 20,292
Deep HVAC Projects									
08C8221	SRB	206,448	269,954	3,279	4,886	22.6	49.6	$ 237	$ 335
08C8243	ICA	130,605	170,781	10,373	15,456	14.3	31.4	$ 150	$ 212
08C8266	ELINGS HALL	99,863	130,582	7,931	11,818	10.9	24.0	$ 115	$ 162
08C8505	EVENTS CNTR	191,680	250,643	7,612	11,342	21.0	46.0	$ 220	$ 311
08C8511	MAC	79,418	103,848	2,523	3,759	8.7	19.1	$ 91	$ 129
08C8515	HSSB	463,067	605,511	11,033	16,440	50.6	111.2	$ 531	$ 752
08C8516	RECCEN	197,452	258,190	15,682	23,367	21.6	47.4	$ 226	$ 321
08C8525	DAVIDSON LIB	82,813	238,699	16,099	23,989	32.4	98.7	$ 95	$ 296
08C8528	SOUTH HALL	392,622	513,397	15,591	23,232	42.9	94.3	$ 450	$ 638
08C8531	MUSIC	135,001	176,528	10,722	15,976	14.8	32.4	$ 155	$ 219
08C8533	ROBERTSN GYM	189,363	247,613	15,039	22,410	20.7	45.5	$ 217	$ 308
08C8534	ARTS	122,823	160,605	5,853	8,721	13.4	29.5	$ 141	$ 199
08C8552	CHEADLE HALL	203,758	266,436	8,091	12,057	22.3	48.9	$ 234	$ 331
08C8556	HAROLD FRANK	93,007	121,616	3,232	4,815	10.2	22.3	$ 107	$ 151
08C8558	UNIV CENTER	444,695	581,488	17,659	26,313	48.6	106.8	$ 510	$ 722
08C8560	PHELPS HALL	280,945	367,367	22,313	33,248	30.7	67.4	$ 322	$ 456
08C8563	ELLISON HALL	338,305	442,371	13,434	20,018	37.0	81.2	$ 388	$ 549
08C8564	GIRVETZ HALL	106,435	139,175	6,038	8,997	11.6	25.6	$ 122	$ 173
08C8568	SAASB	232,162	303,577	5,532	8,242	25.4	55.7	$ 266	$ 377
08C8572	BROIDA HALL	50,274	65,739	3,194	4,760	5.5	12.1	$ 58	$ 82
08C8591	KERR HALL	130,026	170,024	10,327	15,388	14.2	31.2	$ 149	$ 211
08C8860	SANTA CATALI	749,738	980,365	48,378	77,559	82.0	180.0	$ 860	$ 1,218
Campus Total, Deep HVAC		4,920,499	6,564,510	259,936	392,793	561	1,260	$ 5,644	$ 8,154

Building Key	Building Name	Total Building Deep Potential							
		Low Electricity (kWh/yr)	High Electricity (kWh/yr)	Low Gas (th/yr)	High Gas (th/yr)	Low Demand (kW)	High Demand (kW)	Low Cost (x$1000)	High Cost (x$1000)
Deep Lighting Projects									
08C8221	SRB	131,331	151,621	-	-	21.4	24.7	$ 142	$ 166
08C8235	LIFESCI	46,682	53,894	-	-	7.6	8.8	$ 51	$ 59
08C8243	ICA	83,084	95,920	-	-	13.6	15.7	$ 90	$ 105
08C8266	ELINGS HALL	63,528	73,342	-	-	10.4	12.0	$ 69	$ 80
08C8515	HSSB	213,586	246,584	-	-	34.9	40.2	$ 232	$ 270
08C8525	DAVIDSON LIB	286,856	365,873	-	-	33.5	46.4	$ 311	$ 400
08C8531	MUSIC	128,988	148,916	-	-	21.1	24.3	$ 140	$ 163
08C8551	PSYCHOLOGY	17,794	20,543	-	-	2.9	3.4	$ 19	$ 22
08C8552	CHEADLE HALL	129,620	149,646	-	-	21.2	24.4	$ 141	$ 164
08C8553	SAN MIGUEL	162,237	187,302	-	-	26.5	30.6	$ 176	$ 205
08C8556	HAROLD FRANK	73,957	85,383	-	-	12.1	13.9	$ 80	$ 93
08C8558	UNIV CENTER	282,891	326,597	-	-	46.2	53.3	$ 307	$ 357
08C8560	PHELPS HALL	64,472	88,174	-	-	5.2	9.1	$ 70	$ 96
08C8561	SAN NICOLAS	161,355	186,284	-	-	26.3	30.4	$ 175	$ 204
08C8563	ELLISON HALL	60,740	81,706	-	-	5.5	8.9	$ 66	$ 89
08C8586	SAN RAFAEL W	116,763	134,802	-	-	19.1	22.0	$ 127	$ 148
08C8587	SAN RAFAEL M	91,195	105,284	-	-	14.9	17.2	$ 99	$ 115
08C8860	SANTA CATALI	476,943	550,629	-	-	77.8	89.9	$ 517	$ 603
08C8945	ELDORADO APT	63,723	73,568	-	-	10.4	12.0	$ 69	$ 81
Campus Total, Deep Lighting		2,655,743	3,126,069	-	-	410	487	$ 2,879	$ 3,421

14.4. Campus Specific Projects

Additionally, during discussions with the campus, staff identified projects that have deep efficiency potential but do not fall into savings quantified for the four project categories above. These include campuswide EMS upgrades and a central heating hot water loop upgrade. These project are discussed below, but require additional engineering to determine scope, costs or savings.

14.4.1. DDC Conversion

The campus has a significant amount of pneumatic controls in varied states of operability. Significant opportunity exists to convert to direct digital controls (DDC). This could potentially be part of Deep HVAC retrofits on a building by building basis, but a campuswide approach may provide benefits to the campus.

14.4.2. Central HHW Loop Upgrade

The campus currently operates a central heating hot water loop, and has investigated various improvements including use of heat pumps to create chilled water and use the rejected heat for the heating hot water loop. Past efforts to bring the project forward for implementation in the SEP fell short due to utility fuel switching rules, but the campus is still interested.

15. UC Santa Cruz – Deep Efficiency Potential

15.1. Campus Deep Efficiency Potential

The total campus potential is tabulated in the table below for all projects identified in this investigation. The savings, along with project economics and a resulting aggregate simple payback, are shown for the range of savings for each project type, as well as the campuswide potential.

Table 15.1: UC Santa Cruz Potential Savings Summary, All Projects

	Total Building Deep Potential								Economics			
	Low Electricity (kWh/yr)	High Electricity (kWh/yr)	Low Gas (th/yr)	High Gas (th/yr)	Low Demand (kW)	High Demand (kW)	Low Cost (x$1000)	High Cost (x$1000)	Low Utility Savings (x$1000)	High Utility Savings (x$1000)	Low SPB (yrs)	High SPB (yrs)
SmartLab	9,891,384	13,387,227	299,019	396,245	715	1,106	$ 12,371	$ 18,681	$ 1,461	$ 1,972	8.5	9.5
Deep HVAC	3,647,183	4,802,831	293,355	439,576	393	884	$ 4,183	$ 5,965	$ 653	$ 892	6.4	6.7
Deep Lighting	1,183,362	1,436,074	-	-	222	263	$ 1,283	$ 1,571	$ 153	$ 185	8.4	8.5
Total	14,721,929	19,626,132	592,374	835,821	1,330	2,253	$ 17,837	$ 26,218	$ 2,266	$ 3,049	7.9	8.6

Based on campus review and input into the potential deep efficiency projects in the identified buildings, the total potential is further broken down into the Tier 1 (reasonably certain candidate projects) and Tier 2 (questionable candidate projects) categories. The resulting savings and economics are presented in the following two tables, respectively.

Table 15.2: UC Santa Cruz Potential Savings Summary, Tier 1

	Total Building Deep Potential								Economics			
	Low Electricity (kWh/yr)	High Electricity (kWh/yr)	Low Gas (th/yr)	High Gas (th/yr)	Low Demand (kW)	High Demand (kW)	Low Cost (x$1000)	High Cost (x$1000)	Low Utility Savings (x$1000)	High Utility Savings (x$1000)	Low SPB (yrs)	High SPB (yrs)
SmartLab	9,891,384	13,387,227	299,019	396,245	715	1,106	$ 12,371	$ 18,681	$ 1,461	$ 1,972	8.5	9.5
Deep HVAC	3,147,349	4,149,242	253,658	380,424	338	764	$ 3,610	$ 5,154	$ 563	$ 771	6.4	6.7
Deep Lighting	1,183,362	1,436,074	-	-	222	263	$ 1,283	$ 1,571	$ 153	$ 185	8.4	8.5
Total	14,222,095	18,972,543	552,677	776,669	1,275	2,133	$ 17,264	$ 25,406	$ 2,177	$ 2,928	7.9	8.7

Table 15.3: UC Santa Cruz Potential Savings Summary, Tier 2

	Total Building Deep Potential								Economics			
	Low Electricity (kWh/yr)	High Electricity (kWh/yr)	Low Gas (th/yr)	High Gas (th/yr)	Low Demand (kW)	High Demand (kW)	Low Cost (x$1000)	High Cost (x$1000)	Low Utility Savings (x$1000)	High Utility Savings (x$1000)	Low SPB (yrs)	High SPB (yrs)
SmartLab	-	-	-	-	-	-	$ -	$ -	$ -	$ -	n/a	n/a
Deep HVAC	499,835	653,589	39,698	59,152	55	120	$ 573	$ 812	$ 89	$ 121	6.4	6.7
Deep Lighting	-	-	-	-	-	-	$ -	$ -	$ -	$ -	n/a	n/a
Total	499,835	653,589	39,698	59,152	55	120	$ 573	$ 812	$ 89	$ 121	6.4	6.7

The total impacts on greenhouse gas (GHG) emissions at the campus level have also been tabulated for all range of potential project savings. The metric tons of carbon dioxide equivalent are presented in the table below, including details attributable to the two tiers of projects.

Table 15.4: UC Santa Cruz GHG Impact Summary

	Low	High
	GHG Savings (Metric Tons C02e/yr*)	GHG Savings (Metric Tons C02e/yr)*
All Deep Projects	7,556	10,318
Tier 1	7,196	9,808
Tier 2	360	510

*eGrid average factors used, including CH_4 & N_2O impacts:

0.000299916 metric tons CO_2e/kWh

0.005302204 metric tons CO_2e/therm

15.2. Deep Efficiency Project Summary by Building

The table beginning on the following page provides a view of the project applicability for each of the four deep efficiency project categories by building, and the savings and cost ranges for the buildings.

Table 15.5: UC Santa Cruz Projects by Building

			Projects by Building				Total Building Deep Potential							
Building Key	Building Name	Basic Gross Area	ESDVR	Deep Lab	Deep HVAC	Deep Lighting	Low Electricity (kWh/yr)	High Electricity (kWh/yr)	Low Gas (th/yr)	High Gas (th/yr)	Low Demand (kW)	High Demand (kW)	Low Cost (x$1000)	High Cost (x$1000)
07C7098	INTERDIS SCI	60,356			Tier 1	Tier 1	253,080	319,773	14,313	21,327	31.6	57.0	$ 286	$ 385
07C7116	THIMANN LAB	87,483	Tier 1	Tier 1			1,182,316	1,600,173	35,742	47,363	85.5	132.2	$ 1,479	$ 2,233
07C7134	CL COLL COM	41,387			Tier 1	Tier 1	202,185	252,343	9,814	14,624	26.3	44.5	$ 227	$ 300
07C7145	MCHENRY LIB	272,668			Tier 1	Tier 1	879,697	1,210,149	64,660	96,347	128.4	247.9	$ 1,005	$ 1,482
07C7179	NAT SCI 2	88,753	Tier 1	Tier 1			1,142,872	1,546,789	34,549	45,783	82.6	127.8	$ 1,429	$ 2,158
07C7183	ME HOUSE A	40,174			Tier 2	Tier 1	172,269	213,577	7,621	11,356	22.9	37.4	$ 193	$ 252
07C7194	J BASKIN ENG	166,684	Tier 1	Tier 1	Tier 1	Tier 1	1,968,345	2,644,282	65,186	88,540	156.3	248.6	$ 2,430	$ 3,624
07C7300	BAYTREE BOOK	43,461			Tier 2	Tier 1	186,364	231,051	8,245	12,286	24.8	40.5	$ 209	$ 273
07C7303	PORTER HSE A	48,915			Tier 1	Tier 1	238,961	298,242	11,600	17,284	31.1	52.6	$ 268	$ 355
07C7376	KERR HALL	77,970			Tier 1	Tier 1	380,901	475,395	18,490	27,551	49.6	83.8	$ 428	$ 565
07C7706	HUMANIT BLD1	57,069			Tier 1	Tier 1	267,225	334,601	13,533	20,165	34.4	59.2	$ 300	$ 399
07C7744	SINSHEIMR LB	98,359	Tier 1	Tier 1			1,253,509	1,696,528	37,894	50,215	90.6	140.1	$ 1,568	$ 2,367
07C7775	EARTH MAR SC	149,110	Tier 1	Tier 1			1,741,477	2,356,955	52,645	69,763	125.9	194.7	$ 2,178	$ 3,289
07C7782	SCI &ENG LIB	76,372			Tier 1		228,033	298,178	18,111	26,986	24.9	54.7	$ 262	$ 370
07C7838	UC EX CUPERT	50,000			Tier 2	Tier 1	214,403	265,815	9,485	14,134	28.6	46.6	$ 240	$ 314
07C7846	UNIV TWN CTR	64,421			Tier 1	Tier 1	314,711	392,784	15,277	22,763	41.0	69.2	$ 353	$ 467
07C7919	PHYS SCI BLD	134,293	Tier 1	Tier 1			1,369,637	1,853,698	41,404	54,867	99.0	153.1	$ 1,713	$ 2,587
07C7921	SOC SCI 2	75,619			Tier 2	Tier 1	239,768	304,467	14,346	21,376	29.4	54.5	$ 271	$ 368
07C7933	COL 9 DINE	46,485			Tier 1	Tier 1	142,013	198,349	6,004	11,406	15.3	35.7	$ 157	$ 231
07C7940	ENGINEER BLD	148,290	Tier 1	Tier 1	Tier 1		1,635,561	2,206,403	57,177	77,828	124.0	203.0	$ 2,029	$ 3,047
07C7944	2300 DELAWRE	237,324			Tier 1		708,605	926,580	56,278	83,858	77.5	170.1	$ 813	$ 1,151
Campus Total			7	7	16	13	14,721,929	19,626,132	592,374	835,821	1,329.9	2,253.0	$ 17,837	$ 26,218

15.3. Deep Efficiency Projects by Type

The table beginning on the following page provides a list of all the buildings for each type of deep efficiency project, including the project savings and cost ranges for each building.

Table 15.6: UC Santa Cruz Project by Type

Building Key	Building Name	Total Building Deep Potential							
		Low Electricity (kWh/yr)	High Electricity (kWh/yr)	Low Gas (th/yr)	High Gas (th/yr)	Low Demand (kW)	High Demand (kW)	Low Cost (x$1000)	High Cost (x$1000)
ESDVR Projects									
07C7116	THIMANN LAB	432,743	576,698	-	-	48.9	65.1	$ 268	$ 295
07C7179	NAT SCI 2	418,306	557,459	-	-	47.3	62.9	$ 260	$ 285
07C7194	J BASKIN ENG	630,726	840,541	-	-	71.3	94.9	$ 391	$ 430
07C7744	SINSHEIMR LB	458,801	611,424	-	-	51.8	69.0	$ 285	$ 313
07C7775	EARTH MAR SC	637,404	849,440	-	-	72.0	95.9	$ 395	$ 434
07C7919	PHYS SCI BLD	501,305	668,068	-	-	56.6	75.4	$ 311	$ 342
07C7940	ENGINEER BLD	541,092	721,090	-	-	61.1	81.4	$ 336	$ 369
Campus Total, ESDVR Projects		3,620,377	4,824,720	-	-	409	545	$ 2,246	$ 2,466
Deep Lab Projects									
07C7116	THIMANN LAB	749,572	1,023,475	35,742	47,363	36.6	67.1	$ 1,210	$ 1,938
07C7179	NAT SCI 2	724,566	989,330	34,549	45,783	35.4	64.8	$ 1,170	$ 1,873
07C7194	J BASKIN ENG	1,092,507	1,491,722	52,094	69,032	53.3	97.7	$ 1,764	$ 2,825
07C7744	SINSHEIMR LB	794,708	1,085,104	37,894	50,215	38.8	71.1	$ 1,283	$ 2,055
07C7775	EARTH MAR SC	1,104,073	1,507,515	52,645	69,763	53.9	98.8	$ 1,783	$ 2,855
07C7919	PHYS SCI BLD	868,332	1,185,630	41,404	54,867	42.4	77.7	$ 1,402	$ 2,245
07C7940	ENGINEER BLD	937,249	1,279,730	44,691	59,222	45.7	83.9	$ 1,513	$ 2,423
Campus Total, Deep Lab Projects		6,271,007	8,562,507	299,019	396,245	306	561	$ 10,125	$ 16,215
Deep HVAC Projects									
07C7098	INTERDIS SCI	180,212	235,647	14,313	21,327	19.7	43.3	$ 207	$ 293
07C7134	CL COLL COM	123,574	161,587	9,814	14,624	13.5	29.7	$ 142	$ 201
07C7145	MCHENRY LIB	814,136	1,064,573	64,660	96,347	89.0	195.5	$ 934	$ 1,322
07C7183	ME HOUSE A	95,962	125,480	7,621	11,356	10.5	23.0	$ 110	$ 156
07C7194	J BASKIN ENG	140,250	190,956	13,092	19,507	14.6	36.2	$ 161	$ 237
07C7300	BAYTREE BOOK	103,813	135,747	8,245	12,286	11.4	24.9	$ 119	$ 169
07C7303	PORTER HSE A	146,051	190,978	11,600	17,284	16.0	35.1	$ 168	$ 237
07C7376	KERR HALL	232,804	304,417	18,490	27,551	25.5	55.9	$ 267	$ 378
07C7706	HUMANIT BLD1	170,397	222,813	13,533	20,165	18.6	40.9	$ 195	$ 277
07C7782	SCI &ENG LIB	228,033	298,178	18,111	26,986	24.9	54.7	$ 262	$ 370
07C7838	UC EX CUPERT	119,433	156,171	9,485	14,134	13.1	28.7	$ 137	$ 194
07C7846	UNIV TWN CTR	192,349	251,518	15,277	22,763	21.0	46.2	$ 221	$ 312
07C7921	SOC SCI 2	180,627	236,190	14,346	21,376	19.8	43.4	$ 207	$ 293
07C7933	COL 9 DINE	53,719	96,414	6,004	11,406	0.9	19.0	$ 62	$ 120
07C7940	ENGINEER BLD	157,220	205,582	12,487	18,606	17.2	37.7	$ 180	$ 255
07C7944	2300 DELAWRE	708,605	926,580	56,278	83,858	77.5	170.1	$ 813	$ 1,151
Campus Total, Deep HVAC		3,647,183	4,802,831	293,355	439,576	393	884	$ 4,183	$ 5,965
Deep Lighting Projects									
07C7098	INTERDIS SCI	72,868	84,126	-	-	11.9	13.7	$ 79	$ 92
07C7134	CL COLL COM	78,611	90,756	-	-	12.8	14.8	$ 85	$ 99
07C7145	MCHENRY LIB	65,561	145,577	-	-	39.4	52.5	$ 71	$ 159
07C7183	ME HOUSE A	76,307	88,096	-	-	12.5	14.4	$ 83	$ 96
07C7194	J BASKIN ENG	104,862	121,063	-	-	17.1	19.8	$ 114	$ 132
07C7300	BAYTREE BOOK	82,550	95,304	-	-	13.5	15.6	$ 89	$ 104
07C7303	PORTER HSE A	92,910	107,264	-	-	15.2	17.5	$ 101	$ 117
07C7376	KERR HALL	148,097	170,978	-	-	24.2	27.9	$ 161	$ 187
07C7706	HUMANIT BLD1	96,828	111,787	-	-	15.8	18.2	$ 105	$ 122
07C7838	UC EX CUPERT	94,971	109,643	-	-	15.5	17.9	$ 103	$ 120
07C7846	UNIV TWN CTR	122,362	141,267	-	-	20.0	23.1	$ 133	$ 155
07C7921	SOC SCI 2	59,140	68,277	-	-	9.7	11.1	$ 64	$ 75
07C7933	COL 9 DINE	88,294	101,935	-	-	14.4	16.6	$ 96	$ 112
Campus Total, Deep Lighting		1,183,362	1,436,074	-	-	222	263	$ 1,283	$ 1,571

16. UC Davis Medical Center – Deep Efficiency Potential

16.1. Campus Deep Efficiency Potential

The total campus potential is tabulated in the table below for all projects identified in this investigation. The savings, along with project economics and a resulting aggregate simple payback, are shown for the range of savings for each project type, as well as the campuswide potential.

Table 16.1: UC Davis MC Potential Savings Summary, All Projects

	Total Building Deep Potential								Economics			
	Low Electricity (kWh/yr)	High Electricity (kWh/yr)	Low Gas (th/yr)	High Gas (th/yr)	Low Demand (kW)	High Demand (kW)	Low Cost (x$1000)	High Cost (x$1000)	Low Utility Savings (x$1000)	High Utility Savings (x$1000)	Low SPB (yrs)	High SPB (yrs)
SmartLab	2,594,879	3,511,354	77,550	102,765	189	291	$ 4,840	$ 7,298	$ 538	$ 727	9.0	10.0
Deep HVAC	7,822,666	10,229,003	621,287	925,754	855	1,878	$ 15,637	$ 22,143	$ 1,885	$ 2,541	8.3	8.7
Deep Lighting	6,558,690	7,571,987	-	-	1,070	1,236	$ 13,302	$ 15,501	$ 1,228	$ 1,418	10.8	10.9
Total	16,976,234	21,312,344	698,837	1,028,519	2,114	3,405	$ 33,779	$ 44,941	$ 3,651	$ 4,686	9.3	9.6

Based on campus review and input into the potential deep efficiency projects in the identified buildings, the total potential is further broken down into the Tier 1 (reasonably certain candidate projects) and Tier 2 (questionable candidate projects) categories. The resulting savings and economics are presented in the following two tables, respectively.

Table 16.2: UC Davis MC Potential Savings Summary, Tier 1

	Total Building Deep Potential								Economics			
	Low Electricity (kWh/yr)	High Electricity (kWh/yr)	Low Gas (th/yr)	High Gas (th/yr)	Low Demand (kW)	High Demand (kW)	Low Cost (x$1000)	High Cost (x$1000)	Low Utility Savings (x$1000)	High Utility Savings (x$1000)	Low SPB (yrs)	High SPB (yrs)
SmartLab	2,594,879	3,511,354	77,550	102,765	189	291	$ 4,840	$ 7,298	$ 538	$ 727	9.0	10.0
Deep HVAC	7,244,674	9,473,215	575,382	857,353	792	1,739	$ 14,587	$ 20,656	$ 1,745	$ 2,353	8.4	8.8
Deep Lighting	6,380,507	7,366,275	-	-	1,041	1,202	$ 13,012	$ 15,163	$ 1,195	$ 1,380	10.9	11.0
Total	16,220,060	20,350,844	652,932	960,118	2,022	3,233	$ 32,440	$ 43,117	$ 3,479	$ 4,460	9.3	9.7

Table 16.3: UC Davis MC Potential Savings Summary, Tier 2

	Total Building Deep Potential								Economics			
	Low Electricity (kWh/yr)	High Electricity (kWh/yr)	Low Gas (th/yr)	High Gas (th/yr)	Low Demand (kW)	High Demand (kW)	Low Cost (x$1000)	High Cost (x$1000)	Low Utility Savings (x$1000)	High Utility Savings (x$1000)	Low SPB (yrs)	High SPB (yrs)
SmartLab	-	-	-	-	-	-	$ -	$ -	$ -	$ -	n/a	n/a
Deep HVAC	577,991	755,788	45,905	68,401	63	139	$ 1,050	$ 1,487	$ 139	$ 188	7.5	7.9
Deep Lighting	178,184	205,712	-	-	29	34	$ 290	$ 338	$ 33	$ 39	8.7	8.8
Total	756,175	961,500	45,905	68,401	92	172	$ 1,340	$ 1,824	$ 173	$ 226	7.8	8.1

The total impacts on greenhouse gas (GHG) emissions at the campus level have also been tabulated for all range of potential project savings. The metric tons of carbon dioxide equivalent are presented in the table below, including details attributable to the two tiers of projects.

Table 16.4: UC Davis MC GHG Impact Summary

	Low	High
	GHG Savings (Metric Tons C02e/yr*)	GHG Savings (Metric Tons C02e/yr)*
All Deep Projects	8,797	11,845
Tier 1	8,327	11,194
Tier 2	470	651

*eGrid average factors used, including CH_4 & N_2O impacts:

0.000299916 metric tons CO_2e/kWh

0.005302204 metric tons CO_2e/therm

16.2. Deep Efficiency Project Summary by Building

The table beginning on the following page provides a view of the project applicability for each of the four deep efficiency project categories by building, and the savings and cost ranges for the buildings.

Table 16.5: UC Davis MC Projects by Building

Building Key	Building Name	Basic Gross Area	Projects by Building				Total Building Deep Potential							
			ESDVR	Deep Lab	Deep HVAC	Deep Lighting	Low Electricity (kWh/yr)	High Electricity (kWh/yr)	Low Gas (th/yr)	High Gas (th/yr)	Low Demand (kW)	High Demand (kW)	Low Cost (x$1000)	High Cost (x$1000)
03C8065	UMC MIND CL	75,591			Tier 2	Tier 1	279,910	350,802	14,340	21,368	36.0	62.1	$ 472	$ 628
03C8116	UMC OAK PARK	47,118	Tier 1	Tier 1			650,283	880,108	19,658	26,050	47.0	72.7	$ 1,220	$ 1,842
03C8117	UMC ED BLDG	126,532			Tier 1	Tier 1	618,138	771,485	30,005	44,710	80.5	136.0	$ 1,041	$ 1,376
03C8125	UMC 14A WARE	120,867			Tier 1	Tier 1	590,463	736,944	28,662	42,708	76.9	129.9	$ 994	$ 1,314
03C8148	UMC PLACER	43,658			Tier 2	Tier 1	187,208	232,099	8,282	12,341	24.9	40.7	$ 314	$ 411
03C9416	UMC HOSPITAL	599,897			Tier 1	Tier 1	2,035,043	2,486,578	71,129	105,986	283.9	429.7	$ 5,091	$ 6,512
03C9438	UMC CYPRESS	50,491			Tier 2	Tier 2	196,118	244,884	9,579	14,273	25.5	43.2	$ 330	$ 437
03C9519	UMC ADMN SPT	66,697			Tier 1	Tier 1	325,830	406,662	15,816	23,567	42.5	71.7	$ 549	$ 725
03C9529	UMC CNCR CTR	71,951			Tier 1	Tier 1	349,684	436,603	17,062	25,424	45.5	77.0	$ 589	$ 779
03C9814	UMC GLASSRCK	69,946			Tier 1	Tier 1	341,702	426,471	16,587	24,715	44.5	75.2	$ 575	$ 761
03C9854	UMC RSCH II	45,661	Tier 1	Tier 1		Tier 1	521,268	700,353	14,976	19,846	40.0	60.3	$ 971	$ 1,452
03C9880	UMC REG CURE	109,124	Tier 1	Tier 1	Tier 1	Tier 1	601,095	760,687	27,358	40,269	72.5	121.5	$ 1,031	$ 1,398
03C9884	UMC SHRMAN	50,275			Tier 1	Tier 1	137,373	171,452	6,668	9,936	17.9	30.2	$ 231	$ 306
03C9897	UMC PAT SUPP	75,183			Tier 1	Tier 1	362,763	453,180	17,829	26,566	47.1	79.9	$ 611	$ 809
03C9902	UMC FAC SUPP	72,795	Tier 1		Tier 1	Tier 2	349,599	442,160	17,262	25,722	43.9	76.0	$ 568	$ 754
03C9921	UMC BROADWAY	109,479			Tier 1	Tier 1	534,830	667,510	25,962	38,684	69.7	117.7	$ 901	$ 1,190
03C9927	UMC DAV TWR	533,974			Tier 1	Tier 1	1,811,411	2,213,327	63,313	94,339	252.7	382.5	$ 4,531	$ 5,796
03C9929	UMC CENTRAL	54,010			Tier 2	Tier 1	167,093	202,785	5,123	7,634	23.8	34.8	$ 417	$ 527
03C9986	UMC RSCH III	59,116	Tier 1	Tier 1			846,499	1,145,671	25,590	33,910	61.2	94.6	$ 1,588	$ 2,398
03C9992	UMC LJE ACC	372,280			Tier 1	Tier 1	1,818,673	2,269,847	88,282	131,545	236.9	400.1	$ 3,062	$ 4,048
03C8079	UMC PAVILION	519,473			Tier 1	Tier 1	1,762,219	2,153,220	61,593	91,778	245.8	372.1	$ 4,408	$ 5,639
03C8171	UMC CNCR CTR EXP	48,234			Tier 1	Tier 1	235,634	294,090	11,438	17,043	30.7	51.8	$ 397	$ 524
03C8172	UMC N ADDITION	120,000			Tier 1	Tier 1	1,172,455	1,463,316	56,913	84,804	152.8	257.9	$ 1,974	$ 2,610
03C9401	UMC HLTH SCI EXP	19,483			Tier 2	Tier 1	82,064	101,868	3,696	5,507	10.9	17.9	$ 138	$ 181
03C8103	UMC SPEC TSTING C	26,917			Tier 1	Tier 1	131,496	164,117	6,383	9,511	17.1	28.9	$ 221	$ 293
03C8195	UMC TRANS SCI	68,000			Tier 1	Tier 1	332,195	414,606	16,125	24,028	43.3	73.1	$ 559	$ 739
03C9881	UMC GOV HALL	25,746			Tier 2		61,498	80,416	4,884	7,278	6.7	14.8	$ 106	$ 150
03C8066	UMC MIND LAB	31,920	Tier 1	Tier 1			473,690	641,103	14,320	18,976	34.2	53.0	$ 889	$ 1,342
Campus Total			6	5	24	24	16,976,234	21,312,344	698,837	1,028,519	2,114.5	3,405.0	$ 33,779	$ 44,941

16.3. Deep Efficiency Projects by Type

The table beginning on the following page provides a list of all the buildings for each type of deep efficiency project, including the project savings and cost ranges for each building.

Table 16.6: UC Davis MC Project by Type

Building Key	Building Name	Total Building Deep Potential							
		Low Electricity (kWh/yr)	High Electricity (kWh/yr)	Low Gas (th/yr)	High Gas (th/yr)	Low Demand (kW)	High Demand (kW)	Low Cost (x$1000)	High Cost (x$1000)
ESDVR Projects									
03C8116	UMC OAK PARK	238,012	317,188	-	-	26.9	35.8	$ 222	$ 243
03C9854	UMC RSCH II	181,327	241,647	-	-	20.5	27.3	$ 169	$ 185
03C9880	UMC REG CURE	36,389	48,493	-	-	4.1	5.5	$ 34	$ 37
03C9902	UMC FAC SUPP	29,576	39,415	-	-	3.3	4.4	$ 28	$ 30
03C9986	UMC RSCH III	309,830	412,897	-	-	35.0	46.6	$ 288	$ 317
03C8066	UMC MIND LAB	173,377	231,052	-	-	19.6	26.1	$ 161	$ 177
Campus Total, ESDVR Projects		968,510	1,290,692	-	-	109	146	$ 901	$ 990
Deep Lab Projects									
03C8116	UMC OAK PARK	412,271	562,919	19,658	26,050	20.1	36.9	$ 998	$ 1,599
03C9854	UMC RSCH II	314,085	428,855	14,976	19,846	15.3	28.1	$ 761	$ 1,218
03C9880	UMC REG CURE	63,030	86,062	3,005	3,983	3.1	5.6	$ 153	$ 244
03C9986	UMC RSCH III	536,669	732,774	25,590	33,910	26.2	48.0	$ 1,300	$ 2,081
03C8066	UMC MIND LAB	300,313	410,051	14,320	18,976	14.7	26.9	$ 727	$ 1,165
Campus Total, Deep Lab Projects		1,626,368	2,220,662	77,550	102,765	79	146	$ 3,939	$ 6,308
Deep HVAC Projects									
03C8065	UMC MIND CL	180,560	236,103	14,340	21,368	19.7	43.3	$ 311	$ 440
03C8117	UMC ED BLDG	377,801	494,017	30,005	44,710	41.3	90.7	$ 650	$ 920
03C8125	UMC 14A WARE	360,886	471,899	28,662	42,708	39.5	86.6	$ 621	$ 879
03C8148	UMC PLACER	104,284	136,363	8,282	12,341	11.4	25.0	$ 179	$ 254
03C9416	UMC HOSPITAL	895,590	1,171,084	71,129	105,986	97.9	215.0	$ 2,311	$ 3,273
03C9438	UMC CYPRESS	120,605	157,705	9,579	14,273	13.2	29.0	$ 207	$ 294
03C9519	UMC ADMN SPT	199,145	260,404	15,816	23,567	21.8	47.8	$ 343	$ 485
03C9529	UMC CNCR CTR	214,832	280,917	17,062	25,424	23.5	51.6	$ 370	$ 523
03C9814	UMC GLASSRCK	208,846	273,089	16,587	24,715	22.8	50.1	$ 359	$ 509
03C9880	UMC REG CURE	306,621	400,941	24,352	36,286	33.5	73.6	$ 528	$ 747
03C9884	UMC SHRMAN	83,961	109,788	6,668	9,936	9.2	20.2	$ 144	$ 205
03C9897	UMC PAT SUPP	224,482	293,536	17,829	26,566	24.5	53.9	$ 386	$ 547
03C9902	UMC FAC SUPP	217,352	284,212	17,262	25,722	23.8	52.2	$ 374	$ 530
03C9921	UMC BROADWAY	326,884	427,437	25,962	38,684	35.7	78.5	$ 562	$ 796
03C9927	UMC DAV TWR	797,173	1,042,393	63,313	94,339	87.2	191.4	$ 2,057	$ 2,913
03C9929	UMC CENTRAL	64,506	84,348	5,123	7,634	7.1	15.5	$ 166	$ 236
03C9992	UMC LJE ACC	1,111,559	1,453,486	88,282	131,545	121.5	266.9	$ 1,912	$ 2,708
03C8079	UMC PAVILION	775,525	1,014,085	61,593	91,778	84.8	186.2	$ 2,001	$ 2,834
03C8171	UMC CNCR CTR EXP	144,018	188,319	11,438	17,043	15.7	34.6	$ 248	$ 351
03C8172	UMC N ADDITION	716,595	937,028	56,913	84,804	78.4	172.0	$ 1,233	$ 1,746
03C9401	UMC HLTH SCI EXP	46,538	60,854	3,696	5,507	5.1	11.2	$ 80	$ 113
03C8103	UMC SPEC TSTING CNTR	80,369	105,092	6,383	9,511	8.8	19.3	$ 138	$ 196
03C8195	UMC TRANS SCI	203,035	265,491	16,125	24,028	22.2	48.7	$ 349	$ 495
03C9881	UMC GOV HALL	61,498	80,416	4,884	7,278	6.7	14.8	$ 106	$ 150
Campus Total, Deep HVAC		7,822,666	10,229,003	621,287	925,754	855	1,878	$ 15,637	$ 22,143
Deep Lighting Projects									
03C8065	UMC MIND CL	99,350	114,699	-	-	16.2	18.7	$ 162	$ 188
03C8117	UMC ED BLDG	240,337	277,468	-	-	39.2	45.3	$ 391	$ 455
03C8125	UMC 14A WARE	229,577	265,045	-	-	37.5	43.3	$ 373	$ 435
03C8148	UMC PLACER	82,925	95,736	-	-	13.5	15.6	$ 135	$ 157
03C9416	UMC HOSPITAL	1,139,453	1,315,495	-	-	186.0	214.7	$ 2,779	$ 3,239
03C9438	UMC CYPRESS	75,512	87,179	-	-	12.3	14.2	$ 123	$ 143
03C9519	UMC ADMN SPT	126,685	146,258	-	-	20.7	23.9	$ 206	$ 240
03C9529	UMC CNCR CTR	134,852	155,686	-	-	22.0	25.4	$ 219	$ 256
03C9814	UMC GLASSRCK	132,856	153,382	-	-	21.7	25.0	$ 216	$ 252
03C9854	UMC RSCH II	25,856	29,851	-	-	4.2	4.9	$ 42	$ 49
03C9880	UMC REG CURE	195,056	225,191	-	-	31.8	36.8	$ 317	$ 370
03C9884	UMC SHRMAN	53,412	61,663	-	-	8.7	10.1	$ 87	$ 101
03C9897	UMC PAT SUPP	138,281	159,645	-	-	22.6	26.1	$ 225	$ 262

Building Key	Building Name	Total Building Deep Potential							
		Low Electricity (kWh/yr)	High Electricity (kWh/yr)	Low Gas (th/yr)	High Gas (th/yr)	Low Demand (kW)	High Demand (kW)	Low Cost (x$1000)	High Cost (x$1000)
03C9902	UMC FAC SUPP	102,671	118,534	-	-	16.8	19.3	$ 167	$ 195
03C9921	UMC BROADWAY	207,946	240,073	-	-	33.9	39.2	$ 338	$ 394
03C9927	UMC DAV TWR	1,014,238	1,170,934	-	-	165.5	191.1	$ 2,474	$ 2,883
03C9929	UMC CENTRAL	102,587	118,437	-	-	16.7	19.3	$ 250	$ 292
03C9992	UMC LJE ACC	707,114	816,361	-	-	115.4	133.2	$ 1,150	$ 1,340
03C8079	UMC PAVILION	986,695	1,139,136	-	-	161.0	185.9	$ 2,407	$ 2,805
03C8171	UMC CNCR CTR EXP	91,616	105,771	-	-	15.0	17.3	$ 149	$ 174
03C8172	UMC N ADDITION	455,859	526,288	-	-	74.4	85.9	$ 741	$ 864
03C9401	UMC HLTH SCI EXP	35,526	41,015	-	-	5.8	6.7	$ 58	$ 67
03C8103	UMC SPEC TSTING CNTR	51,127	59,025	-	-	8.3	9.6	$ 83	$ 97
03C8195	UMC TRANS SCI	129,160	149,115	-	-	21.1	24.3	$ 210	$ 245
Campus Total, Deep Lighting		6,558,690	7,571,987	-	-	1,070	1,236	$ 13,302	$ 15,501

16.4. Campus Specific Projects

Additionally, during discussions with the campus, staff identified projects that have deep efficiency potential but do not fall into savings quantified for the four project categories above. These include improvements to the central chilled water loop. These project are discussed below, but require additional engineering to determine scope, costs or savings.

16.4.1. Provide Dedicated Cooling for Telecom/Data Rooms

Currently, there are a number of telecom and data rooms that require cooling continuously, and are driving operation of the chilled water plant at very low loads. If removed and provided dedicated cooling sources (CRAC units or similar), the central CHW plant operation could be improved (or likely shut down) in the low load periods.

16.4.2. Improve Campus CHW Delta T

The campus reports that the central plant experiences one to two degree differential between the supply and return chilled water temperatures. As a way of comparison, current plants are designed to achieve 10º or greater delta Ts, as a general minimum. The low delta T requires additional pumping energy as additional flow CHW flow is required to meet the cooling load. There is likely potential through retrocommissioning or replacement of valves and coils in buildings to improve the chilled water loop performance. However, the project would be difficult to implement giving consideration to the difficulties associated with project implementation in medical centers and the number of buildings and systems that would need to be included to achieve results.

17. UC Irvine Medical Center – Deep Efficiency Potential

17.1. Campus Deep Efficiency Potential

The total campus potential is tabulated in the table below for all projects identified in this investigation. The savings, along with project economics and a resulting aggregate simple payback, are shown for the range of savings for each project type, as well as the campuswide potential.

Table 17.1: UC Irvine MC Potential Savings Summary, All Projects

	Total Building Deep Potential								Economics			
	Low Electricity (kWh/yr)	High Electricity (kWh/yr)	Low Gas (th/yr)	High Gas (th/yr)	Low Demand (kW)	High Demand (kW)	Low Cost (x$1000)	High Cost (x$1000)	Low Utility Savings (x$1000)	High Utility Savings (x$1000)	Low SPB (yrs)	High SPB (yrs)
SmartLab	727,196	984,203	21,983	29,131	53	81	$ 1,364	$ 2,060	$ 148	$ 200	9.2	10.3
Deep HVAC	1,824,468	2,385,695	144,902	215,912	199	438	$ 3,294	$ 4,665	$ 429	$ 578	7.7	8.1
Deep Lighting	1,682,914	1,942,919	-	-	275	317	$ 3,198	$ 3,727	$ 311	$ 359	10.3	10.4
Total	4,234,578	5,312,817	166,885	245,043	527	836	$ 7,856	$ 10,451	$ 888	$ 1,137	8.8	9.2

Based on campus review and input into the potential deep efficiency projects in the identified buildings, the total potential is further broken down into the Tier 1 (reasonably certain candidate projects) and Tier 2 (questionable candidate projects) categories. The resulting savings and economics are presented in the following two tables, respectively.

Table 17.2: UC Irvine MC Potential Savings Summary, Tier 1

	Total Building Deep Potential								Economics			
	Low	High	Low	High	Low	High	Low	High	Low	High	Low	High
	Electricity (kWh/yr)	Electricity (kWh/yr)	Gas (th/yr)	Gas (th/yr)	Demand (kW)	Demand (kW)	Cost (x$1000)	Cost (x$1000)	Utility Savings (x$1000)	Utility Savings (x$1000)	SPB (yrs)	SPB (yrs)
SmartLab	727,196	984,203	21,983	29,131	53	81	$ 1,364	$ 2,060	$ 148	$ 200	9.2	10.3
Deep HVAC	1,454,206	1,901,536	115,495	172,094	159	349	$ 2,736	$ 3,875	$ 342	$ 460	8.0	8.4
Deep Lighting	1,682,914	1,942,919	-	-	275	317	$ 3,198	$ 3,727	$ 311	$ 359	10.3	10.4
Total	3,864,316	4,828,658	137,478	201,226	486	747	$ 7,298	$ 9,661	$ 801	$ 1,020	9.1	9.5

Table 17.3: UC Irvine MC Potential Savings Summary, Tier 2

	Total Building Deep Potential								Economics			
	Low	High	Low	High	Low	High	Low	High	Low	High	Low	High
	Electricity (kWh/yr)	Electricity (kWh/yr)	Gas (th/yr)	Gas (th/yr)	Demand (kW)	Demand (kW)	Cost (x$1000)	Cost (x$1000)	Utility Savings (x$1000)	Utility Savings (x$1000)	SPB (yrs)	SPB (yrs)
SmartLab	-	-	-	-	-	-	$ -	$ -	$ -	$ -	n/a	n/a
Deep HVAC	370,262	484,159	29,407	43,818	40	89	$ 558	$ 790	$ 87	$ 117	6.4	6.7
Deep Lighting	-	-	-	-	-	-	$ -	$ -	$ -	$ -	n/a	n/a
Total	370,262	484,159	29,407	43,818	40	89	$ 558	$ 790	$ 87	$ 117	6.4	6.7

The total impacts on greenhouse gas (GHG) emissions at the campus level have also been tabulated for all range of potential project savings. The metric tons of carbon dioxide equivalent are presented in the table below, including details attributable to the two tiers of projects.

Table 17.4: UC Irvine MC GHG Impact Summary

	Low	High
	GHG Savings (Metric Tons C02e/yr*)	GHG Savings (Metric Tons C02e/yr)*
All Deep Projects	2,155	2,893
Tier 1	1,888	2,515
Tier 2	267	378

*eGrid average factors used, including CH_4 & N_2O impacts:

0.000299916 metric tons CO_2e/kWh

0.005302204 metric tons CO_2e/therm

17.2. Deep Efficiency Project Summary by Building

The table beginning on the following page provides a view of the project applicability for each of the four deep efficiency project categories by building, and the savings and cost ranges for the buildings.

Table 17.5: UC Irvine MC Projects by Building

			Projects by Building				Total Building Deep Potential							
Building Key	Building Name	Basic Gross Area	ESDVR	Deep Lab	Deep HVAC	Deep Lighting	Low Electricity (kWh/yr)	High Electricity (kWh/yr)	Low Gas (th/yr)	High Gas (th/yr)	Low Demand (kW)	High Demand (kW)	Low Cost (x$1000)	High Cost (x$1000)
09C9933	333CITYBLVDW	57,765			Tier 2	Tier 1	245,430	304,475	10,959	16,329	32.6	53.4	$ 275	$ 360
09C9335	GOTSHALK PLZ	43,647			Tier 1	Tier 1	213,226	266,122	10,350	15,423	27.8	46.9	$ 359	$ 475
09C9701	MC BLDG 1	154,041				Tier 1	292,588	337,792	-	-	47.8	55.1	$ 714	$ 832
09C9701A	MC BLDG 1A	101,105			Tier 1	Tier 1	342,981	419,081	11,988	17,863	47.8	72.4	$ 858	$ 1,097
09C9703	MC BLDG 3	81,358			Tier 1	Tier 1	275,992	337,230	9,647	14,374	38.5	58.3	$ 690	$ 883
09C9723	MC BLDG 23	71,359			Tier 1	Tier 1	348,605	435,087	16,922	25,215	45.4	76.7	$ 587	$ 776
09C9709	MC BLDG 54	43,315			Tier 1	Tier 1	211,604	264,098	10,272	15,305	27.6	46.5	$ 356	$ 471
09C9755	MC BLDG 55	57,055	Tier 1	Tier 1			727,196	984,203	21,983	29,131	52.6	81.3	$ 1,364	$ 2,060
09C9763	MC BLDG 63	157,886			Tier 1	Tier 1	771,309	962,655	37,441	55,789	100.5	169.7	$ 1,299	$ 1,717
09C9770	MC BLDG 70	50,444			Tier 2	Tier 1	216,307	268,175	9,570	14,259	28.8	47.0	$ 363	$ 475
09C9956	MC BLDG 56	46,800			Tier 2	Tier 1	200,477	248,567	8,878	13,229	26.7	43.5	$ 337	$ 440
09C9965	MC BLDG 65	79,600			Tier 1	Tier 1	388,864	485,333	18,876	28,127	50.7	85.5	$ 655	$ 866
Campus Total			1	1	10	11	4,234,578	5,312,817	166,885	245,043	526.7	836.4	$ 7,856	$ 10,451

17.3. Deep Efficiency Projects by Type

The table beginning on the following page provides a list of all the buildings for each type of deep efficiency project, including the project savings and cost ranges for each building.

Table 17.6: UC Irvine MC Project by Type

			Total Building Deep Potential							
	Building Key	Building Name	Low Electricity (kWh/yr)	High Electricity (kWh/yr)	Low Gas (th/yr)	High Gas (th/yr)	Low Demand (kW)	High Demand (kW)	Low Cost (x$1000)	High Cost (x$1000)
ESDVR Projects										
	09C9755	MC BLDG 55	266,163	354,704	-	-	30.1	40.0	$ 248	$ 272
	Campus Total, ESDVR Projects		266,163	354,704	-	-	30	40	$ 248	$ 272
Deep Lab Projects										
	09C9755	MC BLDG 55	461,032	629,499	21,983	29,131	22.5	41.2	$ 1,117	$ 1,788
	Campus Total, Deep Lab Projects		461,032	629,499	21,983	29,131	22	41	$ 1,117	$ 1,788
Deep HVAC Projects										
	09C9933	333CITYBLVDW	137,980	180,425	10,959	16,329	15.1	33.1	$ 158	$ 224
	09C9335	GOTSHALK PLZ	130,322	170,410	10,350	15,423	14.2	31.3	$ 224	$ 317
	09C9701A	MC BLDG 1A	150,940	197,371	11,988	17,863	16.5	36.2	$ 390	$ 552
	09C9703	MC BLDG 3	121,460	158,822	9,647	14,374	13.3	29.2	$ 313	$ 444
	09C9723	MC BLDG 23	213,065	278,606	16,922	25,215	23.3	51.2	$ 367	$ 519
	09C9709	MC BLDG 54	129,330	169,114	10,272	15,305	14.1	31.0	$ 223	$ 315
	09C9763	MC BLDG 63	471,418	616,431	37,441	55,789	51.5	113.2	$ 811	$ 1,148
	09C9770	MC BLDG 70	120,493	157,558	9,570	14,259	13.2	28.9	$ 207	$ 294
	09C9956	MC BLDG 56	111,789	146,176	8,878	13,229	12.2	26.8	$ 192	$ 272
	09C9965	MC BLDG 65	237,671	310,781	18,876	28,127	26.0	57.1	$ 409	$ 579
	Campus Total, Deep HVAC		1,824,468	2,385,695	144,902	215,912	199	438	$ 3,294	$ 4,665
Deep Lighting Projects										
	09C9933	333CITYBLVDW	107,450	124,051	-	-	17.5	20.2	$ 116	$ 136
	09C9335	GOTSHALK PLZ	82,904	95,712	-	-	13.5	15.6	$ 135	$ 157
	09C9701	MC BLDG 1	292,588	337,792	-	-	47.8	55.1	$ 714	$ 832
	09C9701A	MC BLDG 1A	192,040	221,710	-	-	31.3	36.2	$ 468	$ 546
	09C9703	MC BLDG 3	154,533	178,407	-	-	25.2	29.1	$ 377	$ 439
	09C9723	MC BLDG 23	135,540	156,481	-	-	22.1	25.5	$ 220	$ 257
	09C9709	MC BLDG 54	82,273	94,984	-	-	13.4	15.5	$ 134	$ 156
	09C9763	MC BLDG 63	299,891	346,223	-	-	48.9	56.5	$ 488	$ 568
	09C9770	MC BLDG 70	95,814	110,617	-	-	15.6	18.1	$ 156	$ 182
	09C9956	MC BLDG 56	88,688	102,390	-	-	14.5	16.7	$ 144	$ 168
	09C9965	MC BLDG 65	151,193	174,552	-	-	24.7	28.5	$ 246	$ 287
	Campus Total, Deep Lighting		1,682,914	1,942,919	-	-	275	317	$ 3,198	$ 3,727

17.4. Campus Specific Projects

Additionally, during discussions with the campus, staff identified projects that have deep efficiency potential but do not fall into savings quantified for the four project categories above. These include primarily chilled water loop projects and are discussed below, but require additional engineering to determine scope, costs or savings. The rough costs and savings below are not included in the campus level summary.

17.4.1. Extend CHW Plant to Bldg 54 & 55

Buildings 54 and 55 cooling loads are currently served by DX units, and could be added to the central CHW loop. Additional capacity in the plant may be required, and there are likely space constraints.

17.4.2. Hartman Loop on CHW

The campus has investigated implementation of a Hartman Loop to better control and optimize the chilled water flow through a proprietary control strategy that takes advantage of variable speed pumps, chillers and cooling towers. The campus estimates the cost at $388,000 and savings are expected to be $82,000/year. However, the project is delayed due to funding and debt capacity considerations.

17.4.3. OR Setback in Bldg 55

The campus has implemented controls to set back the airflow and temperature setpoints in operating rooms when not scheduled, and has a couple more operating rooms that are candidates. They estimate a $355,000 cost and $115,000 in annual savings.

17.4.4. Add Bldgs 1A & 3 to central plant

Buildings 1A and 3 are currently served by DX cooling, and could be added to the central plant in the future. However, the capacity would definitely need to be increased and there are significant space constraints. This measure may be considered, if some of the larger drivers in the master plan yield an opportunity that gives necessary space.

17.4.5. Gotshalk Plaza Envelope, extend CHW & HVAC

The Gotshalk Plaza building is in need of a renovation, and the campus believes the envelope is ripe for opportunity in conjunction with the larger renovation. Additionally, the HVAC could be retrofit (would be part of the Deep HVAC defined project) and cooling added to the campus central plant.

18. UC Los Angeles Medical Center – Deep Efficiency Potential

18.1. Campus Deep Efficiency Potential

The total campus potential is tabulated in the table below for all projects identified in this investigation. The savings, along with project economics and a resulting aggregate simple payback, are shown for the range of savings for each project type, as well as the campuswide potential.

Table 18.1: UCLA MC Potential Savings Summary, All Projects

	Total Building Deep Potential								Economics			
	Low Electricity (kWh/yr)	High Electricity (kWh/yr)	Low Gas (th/yr)	High Gas (th/yr)	Low Demand (kW)	High Demand (kW)	Low Cost (x$1000)	High Cost (x$1000)	Low Utility Savings (x$1000)	High Utility Savings (x$1000)	Low SPB (yrs)	High SPB (yrs)
SmartLab	-	-	-	-	-	-	$ -	$ -	$ -	$ -	n/a	n/a
Deep HVAC	3,264,021	4,268,070	259,233	386,272	357	784	$ 7,221	$ 10,226	$ 448	$ 609	16.1	16.8
Deep Lighting	3,303,998	3,814,455	-	-	539	623	$ 7,220	$ 8,413	$ 330	$ 381	21.9	22.1
Total	6,568,019	8,082,525	259,233	386,272	896	1,406	$ 14,441	$ 18,639	$ 779	$ 990	18.5	18.8

Based on campus review and input into the potential deep efficiency projects in the identified buildings, the total potential is further broken down into the Tier 1 (reasonably certain candidate projects) and Tier 2 (questionable candidate projects) categories. The resulting savings and economics are presented in the following two tables, respectively.

Table 18.2: UCLA MC Potential Savings Summary, Tier 1

	Total Building Deep Potential								Economics			
	Low	High	Low	High	Low	High	Low	High	Low	High	Low	High
	Electricity (kWh/yr)	Electricity (kWh/yr)	Gas (th/yr)	Gas (th/yr)	Demand (kW)	Demand (kW)	Cost (x$1000)	Cost (x$1000)	Utility Savings (x$1000)	Utility Savings (x$1000)	SPB (yrs)	SPB (yrs)
SmartLab	-	-	-	-	-	-	$ -	$ -	$ -	$ -	n/a	n/a
Deep HVAC	2,093,113	2,736,978	166,238	247,704	229	502	$ 4,200	$ 5,947	$ 288	$ 390	14.6	15.2
Deep Lighting	1,400,947	1,617,389	-	-	229	264	$ 2,578	$ 3,004	$ 140	$ 162	18.4	18.6
Total	3,494,060	4,354,367	166,238	247,704	458	766	$ 6,778	$ 8,951	$ 428	$ 552	15.8	16.2

Table 18.3: UCLA MC Potential Savings Summary, Tier 2

	Total Building Deep Potential								Economics			
	Low	High	Low	High	Low	High	Low	High	Low	High	Low	High
	Electricity (kWh/yr)	Electricity (kWh/yr)	Gas (th/yr)	Gas (th/yr)	Demand (kW)	Demand (kW)	Cost (x$1000)	Cost (x$1000)	Utility Savings (x$1000)	Utility Savings (x$1000)	SPB (yrs)	SPB (yrs)
SmartLab	-	-	-	-	-	-	$ -	$ -	$ -	$ -	n/a	n/a
Deep HVAC	1,170,908	1,531,092	92,995	138,568	128	281	$ 3,022	$ 4,279	$ 161	$ 218	18.8	19.6
Deep Lighting	1,903,051	2,197,066	-	-	311	359	$ 4,642	$ 5,409	$ 190	$ 220	24.4	24.6
Total	3,073,959	3,728,158	92,995	138,568	439	640	$ 7,664	$ 9,688	$ 351	$ 438	21.8	22.1

The total impacts on greenhouse gas (GHG) emissions at the campus level have also been tabulated for all range of potential project savings. The metric tons of carbon dioxide equivalent are presented in the table below, including details attributable to the two tiers of projects.

Table 18.4: UCLA MC GHG Impact Summary

	Low	High
	GHG Savings (Metric Tons C02e/yr*)	GHG Savings (Metric Tons C02e/yr)*
All Deep Projects	3,344	4,472
Tier 1	1,929	2,619
Tier 2	1,415	1,853

*eGrid average factors used, including CH_4 & N_2O impacts:

0.000299916 metric tons CO_2e/kWh

0.005302204 metric tons CO_2e/therm

18.2. Deep Efficiency Project Summary by Building

The table below provides a view of the project applicability for each of the four deep efficiency project categories by building, and the savings and cost ranges for the buildings.

Table 18.5: UCLA MC Projects by Building

			Projects by Building				Total Building Deep Potential							
							Low	High	Low	High	Low	High	Low	High
Building Key	Building Name	Basic Gross Area	ESDVR	Deep Lab	Deep HVAC	Deep Lighting	Electricity (kWh/yr)	Electricity (kWh/yr)	Gas (th/yr)	Gas (th/yr)	Demand (kW)	Demand (kW)	Cost (x$1000)	Cost (x$1000)
04C4265	TIVERTON HSE	121,634				Tier 1	80,278	92,680	-	-	13.1	15.1	$ 131	$ 152
04C4341	STANFORD ST	46,465				Tier 1	88,256	101,892	-	-	14.4	16.6	$ 144	$ 167
04C4344	MORTON MED	366,834			Tier 1	Tier 1	1,792,068	2,236,642	86,990	129,620	233.5	394.2	$ 3,017	$ 3,989
04C4345	MED PLZA 300	101,095			Tier 1	Tier 1	468,664	587,289	23,973	35,722	60.2	103.9	$ 791	$ 1,051
04C4462	RR/UCLA MC	1,258,821			Tier 2	Tier 2	2,660,646	3,250,990	92,995	138,568	371.2	561.8	$ 6,655	$ 8,513
04C510D	SMH PAVILION	194,181			Tier 1	Tier 1	658,724	804,882	23,024	34,307	91.9	139.1	$ 1,648	$ 2,108
04C510J	SMH SWW	50,000			Tier 1	Tier 2	150,622	185,322	5,928	8,834	20.6	32.2	$ 378	$ 489
UCLAMCnev	SMH Central Wing	99,000			Tier 1	Tier 2	298,231	366,937	11,738	17,491	40.7	63.8	$ 748	$ 968
UCLAMCnev	SMH North Wing	123,000			Tier 1	Tier 2	370,530	455,892	14,584	21,731	50.6	79.3	$ 930	$ 1,202
Campus Total			0	0	7	9	6,568,019	8,082,525	259,233	386,272	896.1	1,406.1	$ 14,441	$ 18,639

18.3. Deep Efficiency Projects by Type

The table below provides a list of all the buildings for each type of deep efficiency project, including the project savings and cost ranges for each building.

Table 18.6: UCLA MC Project by Type

Building Key	Building Name	Total Building Deep Potential							
		Low Electricity (kWh/yr)	High Electricity (kWh/yr)	Low Gas (th/yr)	High Gas (th/yr)	Low Demand (kW)	High Demand (kW)	Low Cost (x$1000)	High Cost (x$1000)
Deep HVAC Projects									
04C4344	MORTON MED	1,095,298	1,432,223	86,990	129,620	119.8	262.9	$ 1,884	$ 2,668
04C4345	MED PLZA 300	301,851	394,703	23,973	35,722	33.0	72.5	$ 519	$ 735
04C4462	RR/UCLA MC	1,170,908	1,531,092	92,995	138,568	128.0	281.1	$ 3,022	$ 4,279
04C510D	SMH PAVILION	289,894	379,069	23,024	34,307	31.7	69.6	$ 748	$ 1,059
04C510J	SMH SWW	74,645	97,607	5,928	8,834	8.2	17.9	$ 193	$ 273
UCLAMCnev	SMH Central Wing	147,798	193,262	11,738	17,491	16.2	35.5	$ 381	$ 540
UCLAMCnev	SMH North Wing	183,628	240,113	14,584	21,731	20.1	44.1	$ 474	$ 671
Campus Total, Deep HVAC		3,264,021	4,268,070	259,233	386,272	357	784	$ 7,221	$ 10,226
Deep Lighting Projects									
04C4265	TIVERTON HSE	80,278	92,680	-	-	13.1	15.1	$ 131	$ 152
04C4341	STANFORD ST	88,256	101,892	-	-	14.4	16.6	$ 144	$ 167
04C4344	MORTON MED	696,770	804,419	-	-	113.7	131.3	$ 1,133	$ 1,320
04C4345	MED PLZA 300	166,813	192,585	-	-	27.2	31.4	$ 271	$ 316
04C4462	RR/UCLA MC	1,489,738	1,719,898	-	-	243.1	280.7	$ 3,634	$ 4,234
04C510D	SMH PAVILION	368,830	425,813	-	-	60.2	69.5	$ 900	$ 1,048
04C510J	SMH SWW	75,977	87,715	-	-	12.4	14.3	$ 185	$ 216
UCLAMCnev	SMH Central Wing	150,434	173,675	-	-	24.6	28.3	$ 367	$ 428
UCLAMCnev	SMH North Wing	186,902	215,778	-	-	30.5	35.2	$ 456	$ 531
Campus Total, Deep Lighting		3,303,998	3,814,455	-	-	539	623	$ 7,220	$ 8,413

19. UC San Diego Medical Center – Deep Efficiency Potential

19.1. Campus Deep Efficiency Potential

The total campus potential is tabulated in the table below for all projects identified in this investigation. The savings, along with project economics and a resulting aggregate simple payback, are shown for the range of savings for each project type, as well as the campuswide potential.

Table 19.1: UC San Diego MC Potential Savings Summary, All Projects

	Total Building Deep Potential								Economics			
	Low Electricity (kWh/yr)	High Electricity (kWh/yr)	Low Gas (th/yr)	High Gas (th/yr)	Low Demand (kW)	High Demand (kW)	Low Cost (x$1000)	High Cost (x$1000)	Low Utility Savings (x$1000)	High Utility Savings (x$1000)	Low SPB (yrs)	High SPB (yrs)
SmartLab	2,077,860	2,813,252	64,311	85,222	148	230	$ 5,813	$ 8,798	$ 321	$ 433	18.1	20.3
Deep HVAC	1,171,093	1,531,334	93,010	138,590	128	281	$ 2,301	$ 3,258	$ 231	$ 317	9.9	10.3
Deep Lighting	1,812,982	2,103,522	-	-	299	347	$ 4,060	$ 4,756	$ 230	$ 267	17.6	17.8
Total	5,061,935	6,448,108	157,321	223,812	575	858	$ 12,173	$ 16,812	$ 783	$ 1,018	15.6	16.5

Based on campus review and input into the potential deep efficiency projects in the identified buildings, the total potential is further broken down into the Tier 1 (reasonably certain candidate projects) and Tier 2 (questionable candidate projects) categories. The resulting savings and economics are presented in the following two tables, respectively.

Table 19.2: UC San Diego MC Potential Savings Summary, Tier 1

	Total Building Deep Potential								Economics			
	Low	High	Low	High	Low	High	Low	High	Low	High	Low	High
	Electricity (kWh/yr)	Electricity (kWh/yr)	Gas (th/yr)	Gas (th/yr)	Demand (kW)	Demand (kW)	Cost (x$1000)	Cost (x$1000)	Utility Savings (x$1000)	Utility Savings (x$1000)	SPB (yrs)	SPB (yrs)
SmartLab	85,751	117,086	4,089	5,418	4	8	$ 208	$ 333	$ 15	$ 20	14.3	16.9
Deep HVAC	689,663	901,811	54,774	81,616	75	166	$ 1,187	$ 1,680	$ 136	$ 187	8.7	9.0
Deep Lighting	1,812,982	2,103,522	-	-	299	347	$ 4,060	$ 4,756	$ 230	$ 267	17.6	17.8
Total	2,588,396	3,122,419	58,863	87,035	379	520	$ 5,454	$ 6,769	$ 381	$ 474	14.3	14.3

Table 19.3: UC San Diego MC Potential Savings Summary, Tier 2

	Total Building Deep Potential								Economics			
	Low	High	Low	High	Low	High	Low	High	Low	High	Low	High
	Electricity (kWh/yr)	Electricity (kWh/yr)	Gas (th/yr)	Gas (th/yr)	Demand (kW)	Demand (kW)	Cost (x$1000)	Cost (x$1000)	Utility Savings (x$1000)	Utility Savings (x$1000)	SPB (yrs)	SPB (yrs)
SmartLab	1,992,109	2,696,166	60,222	79,803	144	223	$ 5,606	$ 8,465	$ 307	$ 413	18.3	20.5
Deep HVAC	481,430	629,523	38,236	56,974	53	116	$ 1,114	$ 1,577	$ 95	$ 131	11.7	12.1
Deep Lighting	-	-	-	-	-	-	$ -	$ -	$ -	$ -	n/a	n/a
Total	2,473,539	3,325,689	98,458	136,777	197	338	$ 6,720	$ 10,043	$ 402	$ 544	16.7	18.5

The total impacts on greenhouse gas (GHG) emissions at the campus level have also been tabulated for all range of potential project savings. The metric tons of carbon dioxide equivalent are presented in the table below, including details attributable to the two tiers of projects.

Table 19.4: UC San Diego MC GHG Impact Summary

	Low	High
	GHG Savings (Metric Tons C02e/yr*)	GHG Savings (Metric Tons C02e/yr)*
All Deep Projects	2,352	3,121
Tier 1	1,088	1,398
Tier 2	1,264	1,723

*eGrid average factors used, including CH_4 & N_2O impacts:

0.000299916 metric tons CO_2e/kWh

0.005302204 metric tons CO_2e/therm

19.2. Deep Efficiency Project Summary by Building

The table below provides a view of the project applicability for each of the four deep efficiency project categories by building, and the savings and cost ranges for the buildings.

Table 19.5: UC San Diego MCProjects by Building

			Projects by Building				Total Building Deep Potential							
							Low	High	Low	High	Low	High	Low	High
Building Key	Building Name	Basic Gross Area	ESDVR	Deep Lab	Deep HVAC	Deep Lighting	Electricity (kWh/yr)	Electricity (kWh/yr)	Gas (th/yr)	Gas (th/yr)	Demand (kW)	Demand (kW)	Cost (x$1000)	Cost (x$1000)
06C6157	PERLMAN HOSP	57,025			Tier 1	Tier 1	278,580	347,690	13,523	20,150	36.3	61.3	$ 469	$ 620
06C6159	SHILEY EYE	40,470		Tier 1	Tier 1		180,462	240,930	11,611	16,627	14.5	30.4	$ 371	$ 563
06C6162	THORNTON HSP	236,570				Tier 1	381,765	451,188	-	-	65.6	77.0	$ 931	$ 1,111
06C6329	BACHMAN BLDG	60,928			Tier 1		70,889	92,695	5,630	8,389	7.8	17.0	$ 122	$ 173
06C6551	CANCERCENTER	278,090	Tier 2	Tier 2	Tier 2	Tier 1	2,546,474	3,387,033	86,600	119,108	216.6	344.3	$ 7,005	$ 10,311
06C6658	UH AMB CARE	52,860			Tier 1	Tier 1	257,898	321,909	12,535	18,678	33.6	56.7	$ 434	$ 574
06C6974	U HOSPITAL	401,666				Tier 1	762,930	880,801	-	-	124.5	143.7	$ 1,861	$ 2,169
06C6976	UH OUTPT CTR	65,633			Tier 1	Tier 1	314,915	393,573	15,564	23,191	40.8	69.5	$ 531	$ 703
06C6983	UH SOUTH WNG	62,504			Tier 2	Tier 1	268,021	332,290	11,858	17,669	35.7	58.2	$ 450	$ 589
Campus Total			1	2	7	7	5,061,935	6,448,108	157,321	223,812	575.4	858.1	$ 12,173	$ 16,812

19.3. Deep Efficiency Projects by Type

The table below provides a list of all the buildings for each type of deep efficiency project, including the project savings and cost ranges for each building.

Table 19.6: UC San Diego MC Project by Type

Building Key	Building Name	Total Building Deep Potential							
		Low Electricity (kWh/yr)	High Electricity (kWh/yr)	Low Gas (th/yr)	High Gas (th/yr)	Low Demand (kW)	High Demand (kW)	Low Cost (x$1000)	High Cost (x$1000)
ESDVR Projects									
06C6551	CANCERCENTER	729,138	971,691	-	-	82.4	109.7	$ 1,018	$ 1,118
Campus Total, ESDVR Projects		729,138	971,691	-	-	82	110	$ 1,018	$ 1,118
Deep Lab Projects									
06C6159	SHILEY EYE	85,751	117,086	4,089	5,418	4.2	7.7	$ 208	$ 333
06C6551	CANCERCENTER	1,262,971	1,724,475	60,222	79,803	61.6	113.0	$ 4,588	$ 7,348
Campus Total, Deep Lab Projects		1,348,722	1,841,561	64,311	85,222	66	121	$ 4,796	$ 7,680
Deep HVAC Projects									
06C6157	PERLMAN HOSP	170,266	222,642	13,523	20,150	18.6	40.9	$ 293	$ 415
06C6159	SHILEY EYE	94,710	123,844	7,522	11,208	10.4	22.7	$ 163	$ 231
06C6329	BACHMAN BLDG	70,889	92,695	5,630	8,389	7.8	17.0	$ 122	$ 173
06C6551	CANCERCENTER	332,130	434,297	26,378	39,305	36.3	79.7	$ 857	$ 1,214
06C6658	UH AMB CARE	157,830	206,380	12,535	18,678	17.3	37.9	$ 272	$ 385
06C6976	UH OUTPT CTR	195,968	256,250	15,564	23,191	21.4	47.0	$ 337	$ 477
06C6983	UH SOUTH WNG	149,300	195,227	11,858	17,669	16.3	35.8	$ 257	$ 364
Campus Total, Deep HVAC		1,171,093	1,531,334	93,010	138,590	128	281	$ 2,301	$ 3,258
Deep Lighting Projects									
06C6157	PERLMAN HOSP	108,314	125,048	-	-	17.7	20.4	$ 176	$ 205
06C6162	THORNTON HSP	381,765	451,188	-	-	65.6	77.0	$ 931	$ 1,111
06C6551	CANCERCENTER	222,236	256,570	-	-	36.3	41.9	$ 542	$ 632
06C6658	UH AMB CARE	100,068	115,529	-	-	16.3	18.9	$ 163	$ 190
06C6974	U HOSPITAL	762,930	880,801	-	-	124.5	143.7	$ 1,861	$ 2,169
06C6976	UH OUTPT CTR	118,947	137,324	-	-	19.4	22.4	$ 193	$ 225
06C6983	UH SOUTH WNG	118,721	137,063	-	-	19.4	22.4	$ 193	$ 225
Campus Total, Deep Lighting		1,812,982	2,103,522	-	-	299	347	$ 4,060	$ 4,756

20. UC San Francisco Medical Center– Deep Efficiency Potential

20.1. Campus Deep Efficiency Potential

The total campus potential is tabulated in the table below for all projects identified in this investigation. The savings, along with project economics and a resulting aggregate simple payback, are shown for the range of savings for each project type, as well as the campuswide potential.

Table 20.1: UC San Francisco MC Potential Savings Summary, All Projects

	Total Building Deep Potential								Economics			
	Low Electricity (kWh/yr)	High Electricity (kWh/yr)	Low Gas (th/yr)	High Gas (th/yr)	Low Demand (kW)	High Demand (kW)	Low Cost (x$1000)	High Cost (x$1000)	Low Utility Savings (x$1000)	High Utility Savings (x$1000)	Low SPB (yrs)	High SPB (yrs)
SmartLab	-	-	-	-	-	-	$ -	$ -	$ -	$ -	n/a	n/a
Deep HVAC	2,095,090	2,739,563	228,404	340,335	229	503	$ 5,407	$ 7,656	$ 465	$ 643	11.6	11.9
Deep Lighting	1,495,769	1,784,076	-	-	235	282	$ 3,648	$ 4,392	$ 194	$ 232	18.8	18.9
Total	3,590,860	4,523,639	228,404	340,335	464	785	$ 9,055	$ 12,049	$ 660	$ 875	13.7	13.8

Based on campus review and input into the potential deep efficiency projects in the identified buildings, the total potential is further broken down into the Tier 1 (reasonably certain candidate projects) and Tier 2 (questionable candidate projects) categories. The resulting savings and economics are presented in the following two tables, respectively.

Table 20.2: UC San Francisco MC Potential Savings Summary, Tier 1

	Total Building Deep Potential								Economics			
	Low	High	Low	High	Low	High	Low	High	Low	High	Low	High
	Electricity (kWh/yr)	Electricity (kWh/yr)	Gas (th/yr)	Gas (th/yr)	Demand (kW)	Demand (kW)	Cost (x$1000)	Cost (x$1000)	Utility Savings (x$1000)	Utility Savings (x$1000)	SPB (yrs)	SPB (yrs)
SmartLab	-	-	-	-	-	-	$ -	$ -	$ -	$ -	n/a	n/a
Deep HVAC	2,095,090	2,739,563	228,404	340,335	229	503	$ 5,407	$ 7,656	$ 465	$ 643	11.6	11.9
Deep Lighting	1,495,769	1,784,076	-	-	235	282	$ 3,648	$ 4,392	$ 194	$ 232	18.8	18.9
Total	3,590,860	4,523,639	228,404	340,335	464	785	$ 9,055	$ 12,049	$ 660	$ 875	13.7	13.8

Table 20.3: UC San Francisco MC Potential Savings Summary, Tier 2

	Total Building Deep Potential								Economics			
	Low	High	Low	High	Low	High	Low	High	Low	High	Low	High
	Electricity (kWh/yr)	Electricity (kWh/yr)	Gas (th/yr)	Gas (th/yr)	Demand (kW)	Demand (kW)	Cost (x$1000)	Cost (x$1000)	Utility Savings (x$1000)	Utility Savings (x$1000)	SPB (yrs)	SPB (yrs)
SmartLab	-	-	-	-	-	-	$ -	$ -	$ -	$ -	n/a	n/a
Deep HVAC	-	-	-	-	-	-	$ -	$ -	$ -	$ -	n/a	n/a
Deep Lighting	-	-	-	-	-	-	$ -	$ -	$ -	$ -	n/a	n/a
Total	-	-	-	-	-	-	$ -	$ -	$ -	$ -	n/a	n/a

The total impacts on greenhouse gas (GHG) emissions at the campus level have also been tabulated for all range of potential project savings. The metric tons of carbon dioxide equivalent are presented in the table below, including details attributable to the two tiers of projects.

Table 20.4: UC San Francisco MC GHG Impact Summary

	Low	High
	GHG Savings (Metric Tons C02e/yr*)	GHG Savings (Metric Tons C02e/yr)*
All Deep Projects	2,288	3,161
Tier 1	2,288	3,161
Tier 2	-	-

*eGrid average factors used, including CH_4 & N_2O impacts:

0.000299916 metric tons CO_2e/kWh

0.005302204 metric tons CO_2e/therm

20.2. Deep Efficiency Project Summary by Building

The table below provides a view of the project applicability for each of the four deep efficiency project categories by building, and the savings and cost ranges for the buildings.

Table 20.5: UC San Francisco MC Projects by Building

			Projects by Building				Total Building Deep Potential							
							Low	High	Low	High	Low	High	Low	High
Building Key	Building Name	Basic Gross Area	ESDVR	Deep Lab	Deep HVAC	Deep Lighting	Electricity (kWh/yr)	Electricity (kWh/yr)	Gas (th/yr)	Gas (th/yr)	Demand (kW)	Demand (kW)	Cost (x$1000)	Cost (x$1000)
02C2018	MTZ BLDG A	118,800			Tier 1	Tier 1	403,008	492,427	14,086	20,989	56.2	85.1	$ 1,008	$ 1,290
02C2019	MTZ BLDG B	106,400			Tier 1	Tier 1	360,943	441,029	12,616	18,798	50.4	76.2	$ 903	$ 1,155
02C2020	MTZ 2330 POS	50,491			Tier 1	Tier 1	246,660	307,851	4,789	7,136	32.1	54.3	$ 623	$ 824
02C2031	MTZ BLDG J	53,500			Tier 1	Tier 1	258,426	322,811	12,687	18,904	33.6	56.9	$ 653	$ 864
02C2036	MTZ 1701 DIV	118,140			Tier 1		132,819	173,676	10,549	15,718	14.5	31.9	$ 343	$ 485
02C2274	MOFFITT HOSP	378,718			Tier 1	Tier 1	688,245	903,734	56,130	83,637	84.6	147.1	$ 1,727	$ 2,373
02C2275	LONG HOSP	372,469			Tier 1	Tier 1	687,373	844,655	55,204	82,257	94.2	146.7	$ 1,724	$ 2,225
02C2408	UC CLINICS	596,899			Tier 1		374,389	489,555	49,557	73,843	40.9	89.9	$ 966	$ 1,368
02C3004	MTZ CANCER C	89,862			Tier 1	Tier 1	438,996	547,902	12,786	19,052	57.2	96.6	$ 1,109	$ 1,466
Campus Total			0	0	9	7	3,590,860	4,523,639	228,404	340,335	463.7	784.7	$ 9,055	$ 12,049

20.3. Deep Efficiency Projects by Type

The table below provides a list of all the buildings for each type of deep efficiency project, including the project savings and cost ranges for each building.

Table 20.6: UC San Francisco MC Project by Type

Building Key	Building Name	Total Building Deep Potential							
		Low Electricity (kWh/yr)	High Electricity (kWh/yr)	Low Gas (th/yr)	High Gas (th/yr)	Low Demand (kW)	High Demand (kW)	Low Cost (x$1000)	High Cost (x$1000)
Deep HVAC Projects									
02C2018	MTZ BLDG A	177,357	231,914	14,086	20,989	19.4	42.6	$ 458	$ 648
02C2019	MTZ BLDG B	158,845	207,708	12,616	18,798	17.4	38.1	$ 410	$ 580
02C2020	MTZ 2330 POS	150,757	197,131	4,789	7,136	16.5	36.2	$ 389	$ 551
02C2031	MTZ BLDG J	159,741	208,879	12,687	18,904	17.5	38.3	$ 412	$ 584
02C2036	MTZ 1701 DIV	132,819	173,676	10,549	15,718	14.5	31.9	$ 343	$ 485
02C2274	MOFFITT HOSP	339,234	443,587	56,130	83,637	37.1	81.4	$ 875	$ 1,240
02C2275	LONG HOSP	333,637	436,267	55,204	82,257	36.5	80.1	$ 861	$ 1,219
02C2408	UC CLINICS	374,389	489,555	49,557	73,843	40.9	89.9	$ 966	$ 1,368
02C3004	MTZ CANCER C	268,311	350,847	12,786	19,052	29.3	64.4	$ 692	$ 980
Campus Total, Deep HVAC		2,095,090	2,739,563	228,404	340,335	229	503	$ 5,407	$ 7,656
Deep Lighting Projects									
02C2018	MTZ BLDG A	225,650	260,513	-	-	36.8	42.5	$ 550	$ 641
02C2019	MTZ BLDG B	202,098	233,321	-	-	33.0	38.1	$ 493	$ 574
02C2020	MTZ 2330 POS	95,903	110,720	-	-	15.7	18.1	$ 234	$ 273
02C2031	MTZ BLDG J	98,685	113,932	-	-	16.1	18.6	$ 241	$ 281
02C2274	MOFFITT HOSP	349,011	460,147	-	-	47.5	65.6	$ 851	$ 1,133
02C2275	LONG HOSP	353,736	408,388	-	-	57.7	66.6	$ 863	$ 1,005
02C3004	MTZ CANCER C	170,685	197,056	-	-	27.9	32.2	$ 416	$ 485
Campus Total, Deep Lighting		1,495,769	1,784,076	-	-	235	282	$ 3,648	$ 4,392

21. Potential Cogeneration Improvements

As part of the cogeneration efficiency investigation, TRC Energy Services met with energy managers, facility managers, and cogeneration plant operators to assess plant configurations and operation. TRC performed site visits at UC Irvine, UC San Francisco, UC Davis Medical Center, and UC San Diego. TRC conducted a conference call to discuss the operations of UC Los Angeles. UC Santa Cruz has a new cogeneration facility targeted to come online in Fall 2014, so it was not included in this study.

During the meetings, TRC and campus personnel discussed the configuration and operation of the individual cogeneration plants; explored disconnects between campus loads and cogeneration plant capabilities; and investigated potential projects. In many cases the campuses had previously identified projects, which comprise the majority of the projects identified below.

TRC developed calculations of energy, monetary, and carbon savings based on plant configurations, identified operating conditions, historical utility consumption and spend, and CA eGRID emissions factors provided by The Climate Registry. Savings were compared against historical consumption to substantiate reasonability.

Analysis of the campus' cogeneration plant performances revealed that in general all of the plants are well run, having good waste heat utilization and efficient overall plant heat rates (ratio of gas energy input to electric energy output). In all cases it was found to be more cost effective to purchase additional natural gas to generate additional electricity and offset utility purchased electricity.

Carbon accounting unfortunately is less straight forward. The efficiency losses of converting natural gas into electricity via a cogeneration plant in general results in more carbon intensive energy content than the generic CA power grid mix, as illustrated below.

CAMX Electric (at source 10239 BTU/kWh)	0.029292	metric tons CO_{2e} / MMBtu (electricity)
Natural Gas Emission Factor	0.005303	metric tons CO_2 / therm
Natural Gas Emission Factor	0.053025	metric tons CO_2 / MMBtu
Cogen Equivalent Electric Emission Factor[1]	0.121322	metric tons CO_2 / MMBtu (electricity)

[1] *based on observed UCI plant heat rate of 7,809 Btu/kWh or 43.7% efficiency*

Exhibit 21-1 Cogeneration Improvement Opportunities Summary

Efficiency Improvement Opportunities			CO_2 Savings Metric	Cost Savings	Install Cost
Campus	**Project**		**Ton/yr**	**$/yr**	
UCI	Extend CHW & HTW - MPAA, Irvine, Hitachi		934	$97,040	$1,890,000
UCSF	Cogen Recommissioning		292	$47,260	$440,000
UCLA	Cogen Recommissioning		534	$226,175	$440,000
UCD MC	Cogen Recommissioning		337	$210,089	$440,000
UCSD	New SCONOx Reactive Gas Generator		86	$10,912	$750,000
UCSD	Improve SCONOx Condenser Operation		89	$37,644	$350,000
UCSD	Direct Contact Stack Economizer		1,209	$512,101	$2,500,000
UCSD	Variable flow Condenser Water		353	$600,956	$200,000
		Total	3,834	$1,653,323	$7,010,000

Capacity Improvement Opportunities			CO2 Savings Metric	Cost Savings	Install Cost
Campus	**Project**		**Ton/yr**	**$/yr**	
UCI	Expand 12kV to Housing & Gottschalk		(3,606)	$3,453,666	$11,281,000
UCSF	Increases Dump Condenser Capacity		(78)	$28,413	$1,000,000
UCLA	Cogeneration Plant Repower		(3,852)	$3,044,327	$80,000,000
UCLA	Add 2nd Steam Turbine to Cogen		(392)	$844,333	$20,000,000
UCSD	Turbine Upgrade		(2,234)	$1,067,382	$1,000,000
		Total	(10,162)	$8,438,121	$113,281,000

21.1. UC Irvine – Cogen Improvements

The cogeneration plant at UC Irvine comprises a 13.5 MW combustion gas turbine and a 5 MW condensing steam turbine. The plant was designed for the addition of another gas turbine in the future, however, the current loads do not yet support the build out of another gas turbine. The cogeneration plant currently has sufficient electric and thermal capacity to satisfy campus loads under most conditions. On peak cooling days the campus is forced to import approximately 2 MW of electricity due to the operation of centrifugal chillers after the thermal energy storage (TES) is exhausted. The duct burners provide sufficient thermal capacity for campus expansion in the near term.

A monitoring based retrocommissioning project is currently in progress and is expect to be completed at the end of 2014. Opportunities to improve plant performance are focused on connecting additional campus loads to the cogen plant.

21.1.1. Plant Configuration

1	CTG - Titan 130	13.5	MW
	CTG Heat Rate	10,083	Btu/kWh
1	HRSG	56,000	lb/hr
1	Duct Burner	128,000	lb/hr (total)
1	STG	5	MW
	STG	14.6	lb/kWh
	Plant Steam	230-240	psig
	Campus HTHW	360	°F Variable flow
4	Steam Boilers	90,000	lb/hr (total)
7	Centrifugal Chillers	14,000	tons (total)
1	ST Chiller	2,000	tons
	TES	4.5	M Gal
	TES	53,000	ton-hrs
	CHW Temp	39	°F

21.1.2. Campus Loads

Summer Peak Demand	20.9	MW
Winter Minimum Demand	9.9	MW

21.1.3. Sequence of Operations

- Import net zero (inadvertent export)
- Use TES to shape load
- Using cogen electricity, schedule chillers to be turned on as load comes up in the AM to pre cooling

- Bring STG up as needed to trim load
- Balance CTG and STG to meet net zero
- As campus load drops add electric chillers to keep CTG base loaded and charge TES

21.1.4. Project – Expand 12kV Connections to Housing Communities & Gottschalk

The cogeneration plant currently has sufficient electric and thermal capacity to satisfy campus loads under most conditions. On peak cooling days the campus is forced to import approximately 2 MW of electricity due to the operation of centrifugal chillers. The duct burners provide sufficient thermal capacity for campus expansion in the near term.

Ongoing energy retrofits have created spare capacity in the electrical, high temperature, and chilled water systems. The planned addition of 2.7 MW of photovoltaic and 1.4 MW of fuel cell generation will further reduce the load on the cogen plant and lower the overall efficiency of the cogen plant.

Most of the campus is electrically connected to the cogen plant, however, there are opportunities to interconnect addition facilities. The campus has studied interconnecting additional building and has recently expanded the cogen electrical distribution system to the baseball diamonds. The following buildings offer additional opportunity:

- Arroyo Vista Housing
- Vista Del Campo Housing
- Vista Del Campo Norte Housing
- Gottschalk Medical Center and MRI

Electrically interconnecting these facilities maintains the load and efficiency of the cogen plant.

21.1.5. Project - Extend CHW and HTW to the MPAA Building, Irvine Hall, and the Hitachi Building

UCI produces chilled water and high temperature water (HTW) in the central plant using steam from the cogeneration plant. The steam can also be used to drive a steam turbine generator and steam driven chillers. Considering the duct burners, the campus has spare thermal capacity.

The campus HTW system is more efficient than the distributed boilers located in the buildings and will reduce natural gas use, with only a negligible increase of pump energy. The savings associated with this measure were developed by Goss Engineering, Inc. in a study commissioned by UCI.

21.2. UC Los Angeles – Cogen Improvements

The cogeneration plant at UC Los Angeles comprises two 14.4 MW combustion gas turbines and a 14 MW extraction condensing steam turbine. The cogeneration plant currently satisfies 90% of the campus electric load, 90% of the time (importing 10% from LADWP). On peak cooling days the campus is forced to import approximately 10 MW of electricity. All of the steam produced by the cogen plant is used in the plant and on campus. In fact, during periods of high steam demand, the header pressure at the far end of campus (North Campus) can drop 40 psi below setpoint. It is believed that the steam distribution system has a pinch point limiting steam delivery to the North Campus.

The cogen plant runs fully loaded at most times. Opportunities to improve plant performance are focused on increasing generation and steam production to meet the campus demand.

21.2.1. Plant Configuration

2	CTG - LM1600	14.4	MW (ea)	
	CTG Heat Rate	9,624	Btu/kWh	estimated from GE literature
2	HRSG	80,000	lb/hr (total)	2 @ 40,000
2	Duct Burner	220,000	lb/hr (total)	2 @ 110,000
1	STG	14	MW	due to lack of steam only getting 10MW
	STG	20	lb/kWh	conservative estimate by TRC
	Campus Steam	125	psig	
3	Aux Boilers	160,000	lb/hr (ea)	permitted to run 2 of 3
2	ST Chiller	5,300	tons (total)	primary 50,000 lb/hr
4	ABS Chillers	1,500	tons (ea)	always run at least 3
	CHW Temp	42	°F	

21.2.2. Campus Loads

Summer Peak Demand	55	kW
Coincident Steam Demand	190,000	lb/hr

Winter Minimum Demand	35	kW
Coincident Steam Demand	130,000	lb/hr

21.2.3. Sequence of operations

- Run CTG baseload to make as much electricity as possible
- Duct burners operate to balance steam header pressure
- Always run STG
- Always provide low grade steam for ABS chiller

21.2.4. Project – Repower

The cogen plant no longer is capable of fully meeting the campus energy needs, requiring UCLA to import "10% of their electricity 90% of the time". Repowering the plant would enable UCLA to provide electricity to the campus more efficiently, and better address electricity and steam demands due to growing campus needs.

21.2.5. Project - Drive New STG with Auxiliary Boiler and Excess CTG steam

UCLA currently uses waste low pressure steam to power their absorption chillers, which are very inefficient. Additionally, the cogen plant creates low pressure steam that can be captured if a good use could be found for it. This measure would result in the Campus using more steam than they are currently permitted to produce.

UCLA has received positive indication that their permit could be modified to allow them to run the auxiliary boiler along with both CTGs. A third dedicated stack would need to be added to support this configuration, which would then provide enough steam for a 10MW low pressure steam turbine.

21.2.6. Project – Cogen Recommissioning

The cogen plant is 20 years old and several of the systems are not operating at their optimum efficiency. Recommissioning the plant would take a holistic look at the cogeneration plant systems and components to identify new control strategies and components available to reduce the plant's growing parasitic demand.

21.3. UC San Diego – Cogen Improvements

The cogeneration plant at UC San Diego comprises two 13.5 MW combustion gas turbines and a 3 MW condensing steam turbine. On average, the cogeneration plant satisfies about 90% of the campus electric load, 95% of the time (importing 10% from SDG&E). On peak cooling days the campus is forced to import approximately 7 MW of electricity. All of the steam produced by the cogen plant is used in the plant and on campus. The cogen plant runs fully loaded at most times.

The plant is versatile and well run, with many modes of operation. Opportunities to improve plant performance are focused on increasing generation, maximizing heat recovery, and minimizing parasitic losses. The plant is also interested in expanded thermal energy storage (TES) capacity by retrofitting the tank with a eutectic material that has a higher freezing temperature than water. This TES retrofit saves money, but unfortunately in terms of carbon savings it only shifts the time of emission.

21.3.1. Plant Configuration

2	CTG - Titan 130	13.5	MW	
	CTG Heat Rate	10,083	Btuh/kW	
2	HRSG	60,000	lb/hr (ea)	
1	STG	3	MW	
	STG Steam Rate	16.0	lb/kWh	
	Plant Steam	250	psi	
	Campus HTHW	350	°F	
2	Aux Steam Boilers	50,000	lb/hr (total)	
1	Aux Steam Boilers	80,000	lb/hr (total)	
	Steam Boilers (eff)	85%		
3	ST Chiller	9,750	tons (total)	4500, 3000, 2250
	ST Chiller Steam Rate	10	lb/ton	3000 ton has 7 lb/ton - newer STG, higher eff
1	TES	4	Mgal	
	TES	40,000	ton-hrs	able to keep it charged
	Chilled Water	42	°F	try and keep tank at 40F

21.3.2. Campus Loads

Summer Peak Demand	37	MW
Coincident Steam Demand	160k	lb/hr
Coincident CHW Demand	11,500	tons

Winter Minimum Demand	27	MW
Coincident Steam Demand	120k	lb/hr
Coincident CHW Demand	2000	Tons

21.3.3. Sequence of Operations

- Loading order for steam: Heating, ST Chiller, STG
- Plant operates in cascade mode, trimming with STG
- Generally base loading CTG - full out 95% of the time
- Will back off CTG at night during the winter
- High temp HW is self-regulating
- Base load 3,000 ton ABS chiller
- Supplement with TES
- Decide to run electric or ST chiller
- Run elect chiller until SDG&E peak
- Try not to run smaller ST Chillers
- Try not to run boilers

21.3.4. Project – New SCONOx Reactive Gas Generator

The SCONOx emission control on each of the turbines uses a catalyst to reduce CO and NOx. The catalyst is regenerated by injecting hydrogen (H_2) and carrier steam into individual SCONOx chambers. Specifications for the existing H_2 generator were unavailable, but it is understood that natural gas is used both to heat process water and as the raw material for H_2 generation. A new H_2 generator would not require process hot water, thereby saving the associated natural gas. This project should be further explored since very little information about it was readily available for review and the limited scope of this study.

21.3.5. Project – Improve SCONOx Condenser Operation

After the regeneration gas (H_2 and steam) passes though the catalyst bed, it is sent through a condenser, which is used to recover some of the heat used in the regeneration process. The design temperature of the water leaving the condenser is 130°F. A heat exchanger was added to transfer the heat from this water to the low temperature condensate, which has a design temperature of 90°F. The plant has not seen the level of heat recovery by the low temperature condensate they were expecting.

Observed operation shows that the regeneration gas leaving the catalyst chambers is 70°F cooler than design and the low temperature condensate is nearly 15°F hotter than design. The narrowing of these two endpoints has drastically reduced heat recovery. It is also indicative of a plant that is sliding from designed operation. Further study and adjustments to bring the plant back into designed operation has the potential to save energy through additional heat recovery.

It is assumed that all extra steam created due to the additional heat recovery would be used in the steam turbine.

21.3.6. Project – Direct Contact Exhaust Economizer

Turbine exhaust leaves the stack at 350°F. Condensate from the steam turbine generator and steam turbine chillers is discharged at 130°F. Installation of a direct contact heat exchanger will

allow waste heat from the stack to be transfer to the low temperature condensate. Direct contact heat exchangers involve heat transfer between exhaust and condensate in the absence of a separating wall. Heat is transferred between the gas and liquid in the form of drops, films, or sprays.

It is assumed that all extra steam created due to the additional heat recovery would be used in the steam turbine.

21.3.7. Project – Variable Flow Condenser Water

Condenser water flow to the steam turbine generator (STG) and chillers 3, 5, 6 and 7 is regulated by manual isolation valves. The valve position for the STG and each chiller was estimated by facility engineers, and remains constant unless manually adjusted regardless of pressure variations in the condenser water supply or load conditions at the chiller. A study by EnerNOC revealed that chillers 5 and 6 are typically receiving near their design flows, while chiller 3 typically receives approximately 500 gpm of excessive flow on average and chiller 7 receives nearly 2,000 gpm of excessive flow on average. The STG is frequently operated at part load, and thus often requires less than its design condenser flow.

It is recommended that electronically actuated valves be installed on the condenser water supply lines for chillers 3, 5, 6 and 7. The EMS should be programmed to modulate each chiller's valve position to maintain the design flow through the condenser when the chiller is enabled and to close when the chiller is shut down. The STG condenser flow set point should be determined based on its operating conditions, and the EMS should be programmed to modulate its valve to maintain the flow set point through its condenser. All manual isolation valves on the condenser water supply lines to the chillers and STG should be opened to 100%.

Additionally it is recommended that variable speed drives be installed on condenser pumps and the EMS be programed to operate the fewest number of pumps at the lowest speed necessary to satisfy flow requirements.

These recommendations assume that the flow meters have been calibrated.

21.3.8. Project – Turbine Upgrade

The Solar Titian gas turbines installed at the plant are each rated for 13.5 MW output. Advances in turbine design and their control systems have enabled new Solar Titians to have a rated output of 15 MW. In anticipation of these advances, the generators installed at UCSD are each rated for 15.3 MW. UCSD currently has a full service maintenance warranty which would allow them to swap the existing turbines for the larger turbines during a major overhaul / rebuild. The new turbine would fit into the existing enclosure and bolting pattern. The new turbines would have a higher efficiency, though they would also require more fuel to create the additional electrical output.

Since UCSD has a service contract, the only cost of the turbine upgrade from Solar would be the incremental cost between the two turbines. The control system and all of the ancillary equipment and systems would also need to be analyzed to ensure that they can accommodate the additional flows, which could represent additional cost. The service contract would also likely have a slight increase.

21.4. UC San Francisco – Cogen Improvements

The cogeneration plant at the UC San Francisco comprises two 5 MW combustion gas turbines and a 1.5 MW back pressure steam turbine. The gas-turbine heat-recovery steam generators produce 200 psi steam, the majority of which is supplied to the steam turbine. Steam exits the steam turbine at 15 psi to serve campus loads.

Nearly the entire campus (99%) is interconnected electrically and thermally to the cogen plant, yet the plant is often constrained by the demand for 15 psi steam (mostly used for heating). The cogen plant typically operates in thermal-load-following mode, creating as much electricity as possible without exceeding the steam header setpoints. In this mode, the turbines will modulate based on steam demands and during the day will typically import power from PG&E.

The plant is at full build out and is space constrained. Opportunities to improve plant performance are focused on generating additional electricity and rejecting surplus heat. Ideally, the extra 15 psi steam could be used to make additional electricity in a low pressure steam turbine. Unfortunately, we could not identify a steam turbine that could use such low grade heat.

21.4.1. Plant Configuration

2	CTG - Taurus 60	5	MW (ea)	
	CTG Heat Rate	11,425	btu/kWh	Solar design data (68°F inlet temp)
2	HRSG	44,000	lb/hr (total)	22,000 lb/hr (ea)
2	Duct Burner	104,000	lb/hr (total)	getting 52,000 lb/hr, rated for 54,000 lb/hr (ea)
1	STG	1.5	MW	was 3.75MW but de-rated
	STG Steam Rate	45.2	lb/kWh	Observed 25,800 lb/hr and 0.571 MW
	Plant Steam	200	psig	
	Campus Steam	200 & 15	psig	
2	Aux Steam Boilers	104,000	lb/hr (total)	only used during cogen shutdown (TRC est.)
2	Centrifugal Chillers	1,800	tons (total)	1200 & 600 tons
3	ABS Chiller	3,600	tons (total)	3 @ 1200 tons, use 15 psi steam
	Chilled Water Temp	50	°F	

21.4.2. Campus Loads

Summer Peak Demand	11.5	kW	
Coincident Steam Demand	40,000	lb/hr	
Coincident CHW Demand	1800 – 2000	tons	
Winter Minimum Demand			
Coincident CHW Demand	150	tons	(always have demand for CHW)

21.4.3. Sequence of operations

- Plant is baseloaded during the day (thermal load following)
- Campus steam loads are the priority and dictate the amount of steam through STG
- Dump condenser valve opens to keep steam header below 210 psig
- Duct burners fire to keep steam header above 180 psig
- Plant maintains minimum import at night

21.4.4. Project – Increase Dump Condenser Capacity

The dump condenser has a capacity of 4,000 lb/hr. It is primarily used to keep the 15 psig steam header from exceeding its setpoint. Steam exits the steam turbine into the 15 psig header. During the day, the cogen plant operates in thermal load following mode, creating as much electricity as possible without exceeding the steam header setpoints. In this mode, the campus is typically importing power from PG&E.

Most days, the small size of the dump condenser limits the ability of the cogen plant to produce all of the power necessary for the campus. Increasing the size of the dump condenser will allow the cogen plant to produce all of the power necessary for the campus. It should be noted that siting a new dump condenser will be challenging due to space limitations.

21.5. UC Davis Medical Center – Cogen Improvements

The cogeneration plant at the UC Davis Medical Center comprises a 23 MW combustion gas turbine and a 4 MW back pressure steam turbine. The cogeneration plant currently has spare electrical and cooling capacity; it is able to satisfy these campus loads under all conditions. All major buildings on campus are connected electrically, and are thermally interconnected, to the cogen plant. Only very minor loads remain isolated from the cogen plant. Two new medical office buildings (220,000 sf total) will be completed within the next two to three years; both will be connected to the cogen plant.

The gas turbine heat recovery steam generator produces 400 psi steam, the majority of which is supplied to the steam turbine. Steam exits the steam turbine at 13 psi to serve campus loads and the absorption chillers. During the winter when the campus electrical load is low, an auxiliary boiler is needed to maintain the steam header pressure at its setpoint. The cogen plant does not have duct burners.

Limited opportunities to improve plant performance were identified under the narrow scope of this study. Thermal energy storage is an option to increase the versatility of the plant, but ultimately this is only a load shifting strategy. A water side economizer is another option to increase the versatility of the plant, but its effectiveness is limited by the campus' need for heating at all times. It is recommended that the plant perform a retrocommissioning study to improve efficiency and identify capital projects.

21.5.1. Plant Configuration

1	CTG - LM 2500	23	MW	
	CTG Heat Rate	9,273	Btu/kWh	estimated from GE literature
1	HRSG	89,000	lb/hr	
1	STG	4	MW	
	STG Heat Rate	27	lb/kWh	
	Plant Steam	400	psig	
	Campus Steam	100	psig	
	Campus HTHW	220	°F	
4	Steam Boilers	100,000	lb/hr (total)	25,000 lb/hr each
4	Centrifugal Chillers	8,200	tons (total)	4 @ 2050 tons
4	ABS Chiller	5,200	tons (total)	3 @ 1400 tons & 1 @ 1000 tons
	ABS Chiller Steam Rate	18	lb/ton	
	CHW Temp	42	°F	

21.5.2. Campus Loads

Summer Peak Demand	17	MW
Coincident Steam Demand	45,000	lb/hr
Coincident CHW Demand	10,000	tons

Winter Minimum Demand	8	MW
Coincident Steam Demand	30,000	lb/hr
Coincident CHW Demand	1,400	tons

21.5.3. Sequence of operations

- Electric load follows and dump steam as needed
- Plant will satisfy campus HHW demand first
- During the summer will run as many ABS as possible

21.5.4. Project – Cogen Recommissioning

The cogen plant is well operated, but it is believed that there are opportunities to optimize the efficiency of some of the systems. Recommissioning the plant would take a holistic look at the cogeneration plant systems and components to identify new control strategies and components available to reduce the plant's growing parasitic demand.

22. Conclusion

As a result of this study we have identified a significant number of deep energy efficiency projects and cogeneration efficiency improvements. These projects, particularly the deep energy efficiency, represent a substantial opportunity for UC to make progress toward their climate neutrality goals. Taken together, these projects could require investment of approximately $773 million dollars.

Summary results for the deep energy efficiency portion of the study are presented in Exhibits 22-1, 22-2 and 22-3. In the most aggressive case, just under $766 million dollars are needed to fund retrofits which could save the University approximately $68 million dollars per year in utility costs while avoiding over 243,000 metric tons of CO_2e annually. The avoided compliance costs of the GHG reductions are not included in this study, but could represent additional material financial benefit to the University.

Exhibit 22-1 – Systemwide Deep Energy Efficiency Project Potential Savings and Cost

	Total Building Deep Potential							
	Electricity (kWh/yr)		Gas (th/yr)		Demand (kW)		Cost ($000)	
	Low	High	Low	High	Low	High	Low	High
Tier 1	324,887,036	428,105,284	10,827,925	15,353,376	31,130	50,003	$ 467,349	$ 671,004
Tier 2	43,813,534	56,809,555	2,121,355	3,131,494	4,942	8,775	$ 68,271	$ 94,832
Total	368,700,570	484,914,839	12,949,280	18,484,870	36,072	58,778	$ 535,620	$ 765,835

Exhibit 22-2 – Systemwide Deep Energy Efficiency Project Potential Utility Savings

	Economics			
	Utility Savings ($000)		Simple Payback (yrs)	
	Low	High	Low	High
Tier 1	$ 44,532	$ 59,244	10.5	11.3
Tier 2	$ 6,381	$ 8,505	10.7	11.1
Total	$ 50,913	$ 67,750	10.5	11.3

Exhibit 22-3 – Systemwide Deep Energy Efficiency Project GHG Savings

	GHG Savings (Metric Tons C02e/yr*)	
	Low	High
Tier 1	154,851	209,802
Tier 2	24,388	33,642
Total	179,239	243,444

*eGrid average factors used, including CH_4 & N_2O impacts:

0.000299916 metric tons CO_2e/kWh

0.005302204 metric tons CO_2e/therm

To provide some further context for the findings of this study and enable high-level comparison to other pathways the University is considering to meet its carbon and energy goals, we show total project costs as unit costs under various allocation scenarios in Exhibit 22-4. It is important to recognize this table assigns all costs, without accounting for benefits, to the particular unit(s) of energy or GHG for illustrative purposes.

Exhibit 22-4 – Illustrative Unit Costs

	Illustrative Metrics					
	First Year Savings Only			Project Lifetime Savings*		
Project Cost Allocation Scenario	$/kWh	$/therm	$/MT C02e	$/kWh	$/therm	$/MT C02e
All Costs Allocated to Electric Savings	$1.52			$0.079		
All Costs Allocated to Gas Savings		$41.40			$2.16	
All Costs Prorated by Site Energy Content	$0.73	$21.49		$0.038	$1.12	
All Costs Prorated by Source Energy Content	$1.12	$10.95		$0.058	$0.57	
All Costs Allocated to GHG Savings			$3,079			$160.53

* Project lifetime assumes 20 year Effective Useful Life for SmartLab & Deep HVAC, 15 year EUL for Deep Lighting

It's worth noting that although past projects were used to develop the deep project metrics, we intentionally did not attempt to constrain the projects or savings estimates by current incentive eligibility rules set by the California Public Utilities Commission or the utility incentive programs. The project economics do not contain any assumption about incentives, or the campuses ability to fund projects without such incentives, or otherwise secure financing.

Based on a high-level cash flow analysis comparing the 2006-2014 portfolio to the deep energy efficiency portfolio over their respective average effective useful lives, it would take a 33% external equity contribution to the deep energy efficiency portfolio in order to match the 2006-2014 portfolio's internal rate of return, independent of financing approach. The "external equity" could take the form of utility incentives, grants, or other external funding to directly offset the

capital investment required for the deep measures. Clearly, the savings benefit over the longer expected useful life of deep efficiency measures, which works out to approximately 19 years on a weighted average basis, counterbalances the additional upfront capital required to deploy these more expensive measures, making these projects a good investment over the long term.

Finally, campuses have consistently expressed the need and benefit of adequate energy management staffing to ensure not only the successful implementation of efficiency projects, but more importantly, the persistence of their savings and the ability to continually capture new savings. A successful program would go beyond funding the capital needs and the possible related debt service, and address the need to fund ongoing positions, either through energy savings or other dedicated funding sources.

Summary results for the cogeneration efficiency improvements portion of the study are presented in Exhibit 22-5. An investment of approximately $7M could result in nearly $1.7M in annual utility cost savings and GHG reductions. There are also over $110M worth of cogen capacity expansion opportunities reported in Section 21, which would save utility cost, but result in a net increase in GHG unless combined with something like a biogas initiative.

Exhibit 22-5 – Cogeneration Efficiency Improvement Summary

CO_2 Savings Tonnes/year	Utility Cost Savings $/year ($000)	Installation Cost ($000)
3,834	$1,653,323	$7,010,000

At those sites with cogeneration, the deep energy efficiency and the cogeneration improvements could be undertaken in parallel. However, the CO_2e impacts and utility savings resulting from the separate initiatives cannot simply be added together due to the interactive nature of cogen system, the load it serves, and the operational economics at any given point in time.

This planning study provides an initial identification and analysis of potential projects in candidate buildings and cogeneration plants. It also provides a solid reference point for further program design and development. Additional investigation, auditing and engineering is required to confirm the feasibility, scope and investment-grade costs and savings of any specific project. However, taken as a portfolio of projects across the system, and at any given campus, the findings demonstrate that significant deep savings are available if the required investment is made.

Appendices

Appendix A – UC Building 1999 Benchmarks

Appendix B – 2014 Climate Registry Default Emissions Factors

Appendix C – Deep Metrics Scree Plots

Appendix A – UC Building 1999 Benchmarks

Table 1: UC Building 1999 Energy Benchmarks by Campus – Baseline for Targets

	Annual Electricity kWh/gsf/yr Includes prorated part of plant use and site lighting	**Maximum Power W/gsf** Includes prorated part of small peak (pumping) load at plant	**Max. Chilled Water tons/kgsf** Load on plant	**Annual Thermal therms/gsf/yr** Includes prorated part of plant use	**Max. Thermal therms/hr/kgsf** Includes prorated part of plant use
Academic/Administrative Non-complex Space					
Berkeley	11.2	3.1	N/A	0.21	0.12
Davis	13.3	3.3	2.5	0.20	0.12
Irvine	13.0	2.6	1.93	0.16	0.12
Los Angeles	12.3	2.3	1.72	0.17	0.12
Merced	14.3	3.5	2.6	0.20	0.12
Riverside	13.9	3.3	2.5	0.18	0.12
San Diego	12.2	2.2	1.66	0.16	0.12
San Francisco Parnassus	11.1	2.0	1.51	0.21	0.12
San Francisco Mission Bay	11.4	3.1	N/A	0.21	0.12
Santa Barbara	11.5	2.2	1.66	0.19	0.12
Santa Cruz	11.1	3.2	N/A	0.23	0.12
Housing Non-complex					
Berkeley	7.8	2.1	N/A	0.30	0.18
Davis	9.3	2.3	1.75	0.29	0.18
Irvine	9.1	1.79	1.35	0.23	0.18
Los Angeles	8.6	1.60	1.20	0.24	0.18
Merced	10.0	2.4	1.82	0.28	0.18
Riverside	9.7	2.3	1.75	0.26	0.18
San Diego	8.6	1.55	1.17	0.23	0.18
San Francisco Parnassus	7.8	1.40	1.06	0.30	0.18
San Francisco Mission Bay	8.0	2.1	N/A	0.30	0.18
Santa Barbara	8.0	1.55	1.17	0.28	0.18
Santa Cruz	7.8	2.2	N/A	0.32	0.18
Lab/Complex Space					
Berkeley	36	7.6	N/A	1.83	0.43
Davis	38	6.3	4.7	1.83	0.43
Irvine	38	5.6	4.2	1.78	0.43
Los Angeles	37	5.4	4.1	1.79	0.43
Merced	39	6.4	4.8	1.82	0.43
Riverside	38	6.3	4.7	1.80	0.43
San Diego	37	5.3	4.0	1.78	0.43
San Francisco Parnassus	36	5.2	3.9	1.84	0.43
San Francisco Mission Bay	36	7.6	N/A	1.84	0.43
Santa Barbara	36	5.3	4.0	1.81	0.43
Santa Cruz	36	7.6	N/A	1.85	0.43
Building-Specific Adjustments					
Unique situations such as Santa Cruz's district condenser water system and Berkeley's interconnected building chillers and absorption chillers may require custom adjustments.	Annual chilled water use is typically associated with electricity use and is included in this value.	For campuses with district chilled water (e.g. Davis), if a specific building has a chiller instead, multiply value by (1/0.7) or 1.43 to account for the chiller's electric load.	Only applicable if building supplied by district chilled water system.	These values are directly applicable to buildings with boilers in the building or connected to (low-loss) district hot water systems (non-steam). They can be applicable to buildings connected to district steam systems if additional losses characteristic of steam systems is accounted for where appropriate. For example, 50% extra use from trap/exchanger losses within the building plus 50% extra use from trap/leakage losses in distribution systems has been commonly observed.	
	These values may be slightly lower than previously published values (i.e. for UC Merced) because they reflect load on the building meter (480 V) instead of at the campus meter (12 kV). To reflect load on campus meter, increase value by 1.05 (to account for distribution and transformation losses).				

Appendix B – 2014 Climate Registry Default Emissions Factors

Table 12.1 U.S. Default Factors for Calculating CO_2 Emissions from Fossil Fuel and Biomass Combustion

Fuel Type	Heat Content	Carbon Content (Per Unit Energy)	Fraction Oxidized	CO_2 Emission Factor (Per Unit Energy)	CO_2 Emission Factor (Per Unit Mass or Volume)
Coal and Coke	**MMBtu / short ton**	**kg C / MMBtu**		**kg CO_2 / MMBtu**	**kg CO_2 / short ton**
Anthracite	25.09	28.24	1	103.54	2597.82
Bituminous	24.93	25.47	1	93.40	2328.46
Subbituminous	17.25	26.46	1	97.02	1673.60
Lignite	14.21	26.28	1	96.36	1369.28
Coke	24.80	27.83	1	102.04	2530.59
Mixed Electric Utility/Electric Power	19.73	25.74	1	94.38	1862.12
Unspecified Residential/Com*	21.18	25.71	1	94.27	1996.54
Mixed Commercial Sector	21.39	25.98	1	95.26	2037.61
Mixed Industrial Coking	26.28	25.54	1	93.65	2461.12
Mixed Industrial Sector	22.35	25.61	1	93.91	2098.89
Natural Gas	**Btu / scf**	**kg C / MMBtu**		**kg CO_2 / MMBtu**	**kg CO_2 / scf**
US Weighted Average	1028	14.46	1	53.02	0.05
Greater than 1,000 Btu*	>1000	14.47	1	53.06	Varies
975 to 1,000 Btu*	975 – 1,000	14.73	1	54.01	Varies
1,000 to 1,025 Btu*	1,000 – 1,025	14.43	1	52.91	Varies
1,025 to 1,035 Btu*	1025 – 1035	14.45	1	52.98	Varies
1,025 to 1,050 Btu*	1,025 – 1,050	14.47	1	53.06	Varies
1,050 to 1,075 Btu*	1,050 – 1,075	14.58	1	53.46	Varies
1,075 to 1,100 Btu*	1,075 – 1,100	14.65	1	53.72	Varies
Greater than 1,100 Btu*	>1,100	14.92	1	54.71	Varies
(EPA 2010) Full Sample*		14.48	1	53.09	n/a
(EPA 2010) <1.0% CO_2*		14.43	1	52.91	n/a
(EPA 2010) <1.5% CO_2*		14.47	1	53.06	n/a
(EPA 2010) <1.0% CO_2 and <1,050 Btu/scf*	<1,050	14.42	1	52.87	n/a
(EPA 2010) <1.5% CO_2 and <1,050 Btu/scf*	<1,050	14.47	1	53.06	n/a
(EPA 2010) Flare Gas*	>1,100	15.31	1	56.14	n/a

2014 Climate Registry Default Emission Factors
Released: April 11, 2014

Table 14.1 US Emission Factors by eGRID Subregion

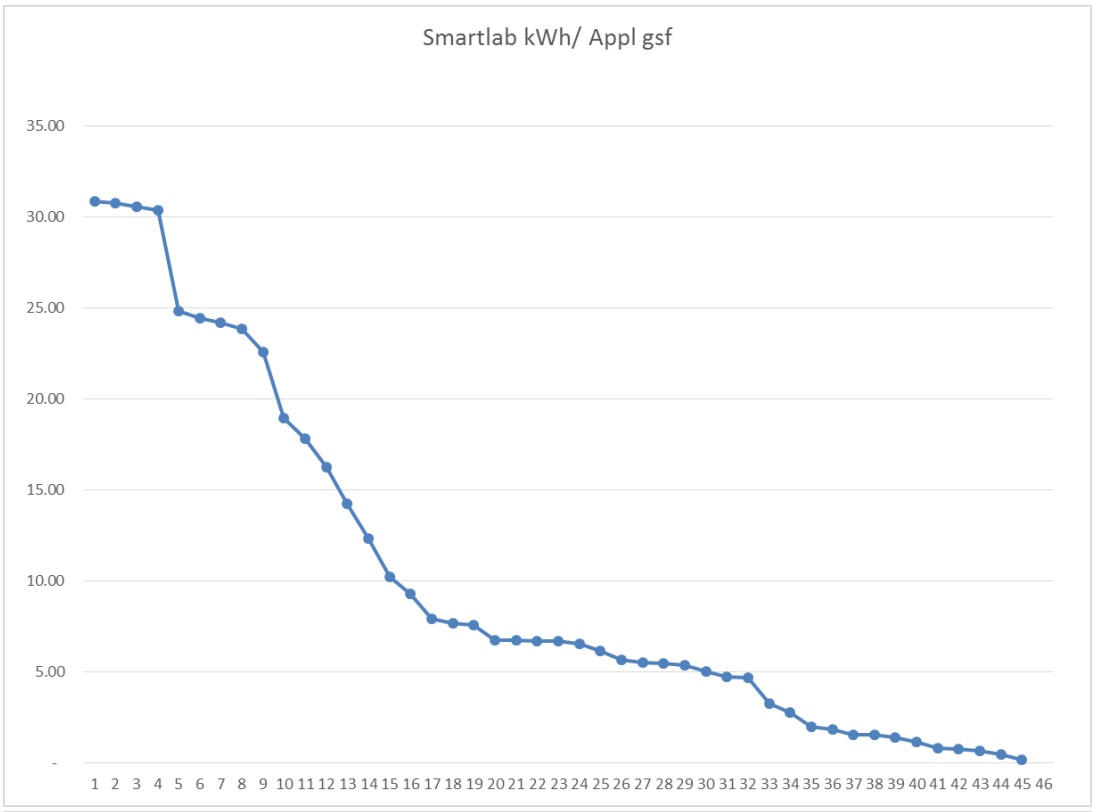
eGRID 2012 Subregion	eGRID 2012 Subregion Name	2009 Emission Rates		
		(lbs CO_2 / MWh)	(lbs CH_4 / GWh)	(lbs N_2O / GWh)
AKGD	ASCC Alaska Grid	1,280.86	27.74	7.69
AKMS	ASCC Miscellaneous	521.26	21.78	4.28
AZNM	WECC Southwest	1,191.35	19.13	15.58
CAMX	WECC California	658.68	28.94	6.17
ERCT	ERCOT All	1,181.73	16.70	13.10
FRCC	FRCC All	1,176.61	39.24	13.53
HIMS	HICC Miscellaneous	1,351.66	72.40	13.80
HIOA	HICC Oahu	1,593.35	101.74	21.98
MROE	MRO East	1,591.65	23.98	27.04
MROW	MRO West	1,628.60	28.80	27.79
NEWE	NPCC New England	728.41	75.68	13.86
NWPP	WECC Northwest	819.21	15.29	12.50
NYCW	NPCC NYC/Westchester	610.67	23.75	2.81
NYLI	NPCC Long Island	1,347.99	96.86	12.37
NYUP	NPCC Upstate NY	497.92	15.94	6.77
RFCE	RFC East	947.42	26.84	14.96
RFCM	RFC Michigan	1,659.46	31.41	27.89
RFCW	RFC West	1,520.59	18.12	25.13
RMPA	WECC Rockies	1,824.51	22.25	27.19
SPNO	SPP North	1,815.76	21.01	28.89
SPSO	SPP South	1,599.02	23.25	21.79
SRMV	SERC Mississippi Valley	1,002.41	19.45	10.65
SRMW	SERC Midwest	1,749.75	19.57	28.98
SRSO	SERC South	1,325.68	22.27	20.78
SRTV	SERC Tennessee Valley	1,357.71	17.28	22.09
SRVC	SERC Virginia/Carolina	1,035.87	21.51	17.45
US Territories (not an eGRID Region)*	n/a	1,891.57	75.91	17.13

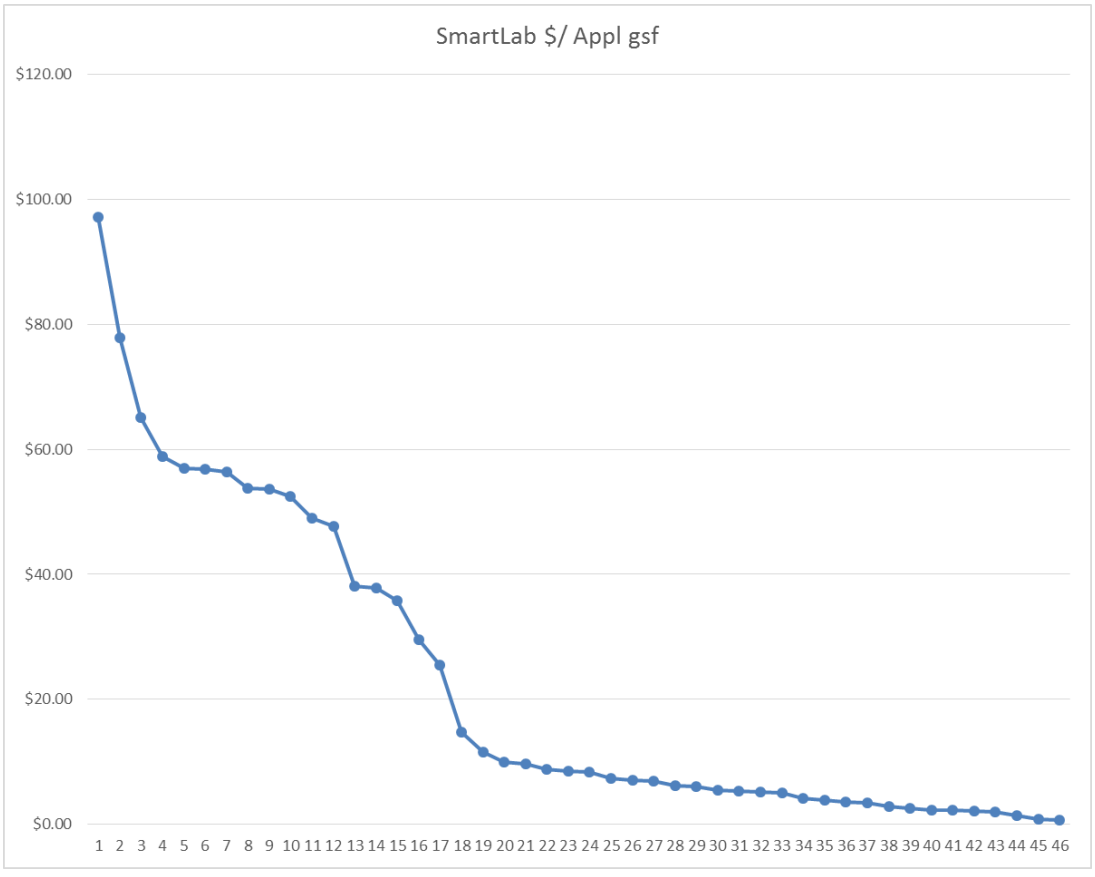
Source: U.S. EPA eGRID2012 Version 1.0 (2009 data: eGRID subregion annual CO_2 total output emission rate). Except * from Department of Energy Guidance on Voluntary Reporting of Greenhouse Gases, Form EIA-1605 (2007), Appendix F, Electricity Emission Factors, Table F-1. Factors do not include emissions from transmission and distribution losses.

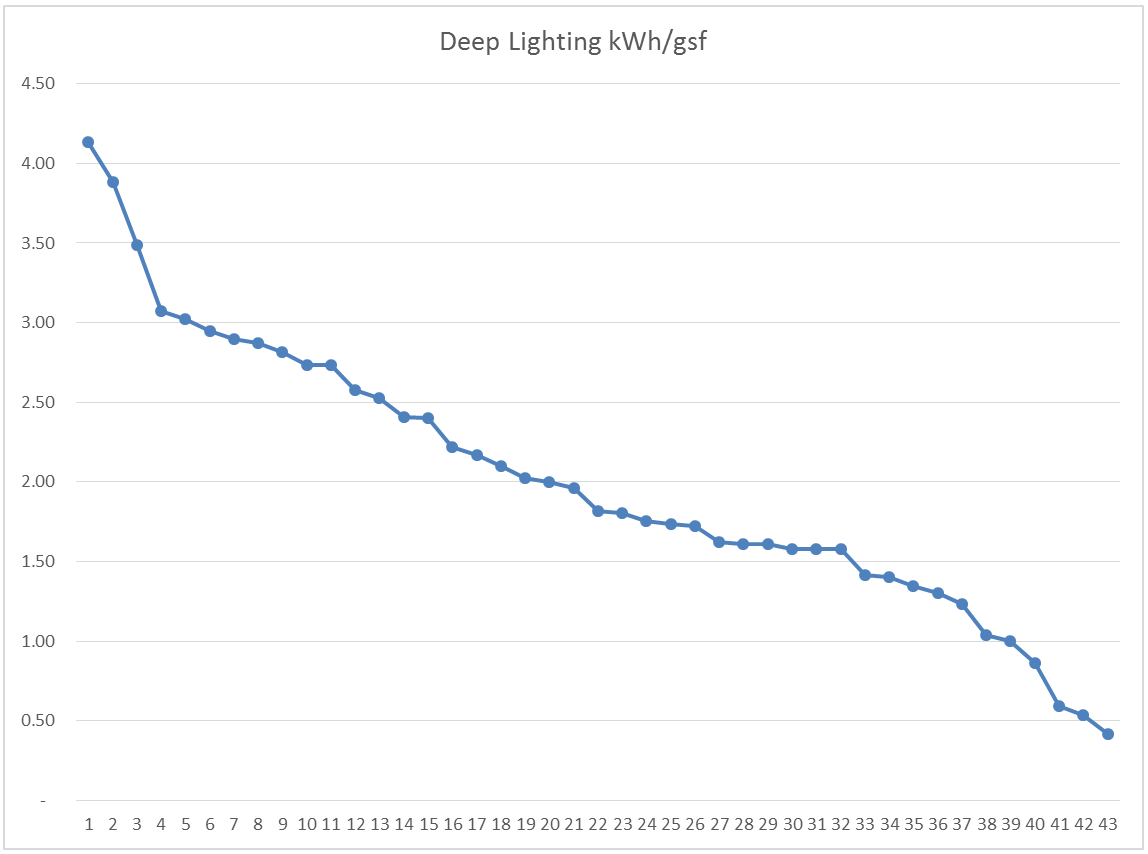
2014 Climate Registry Default Emission Factors
Released: April 11, 2014

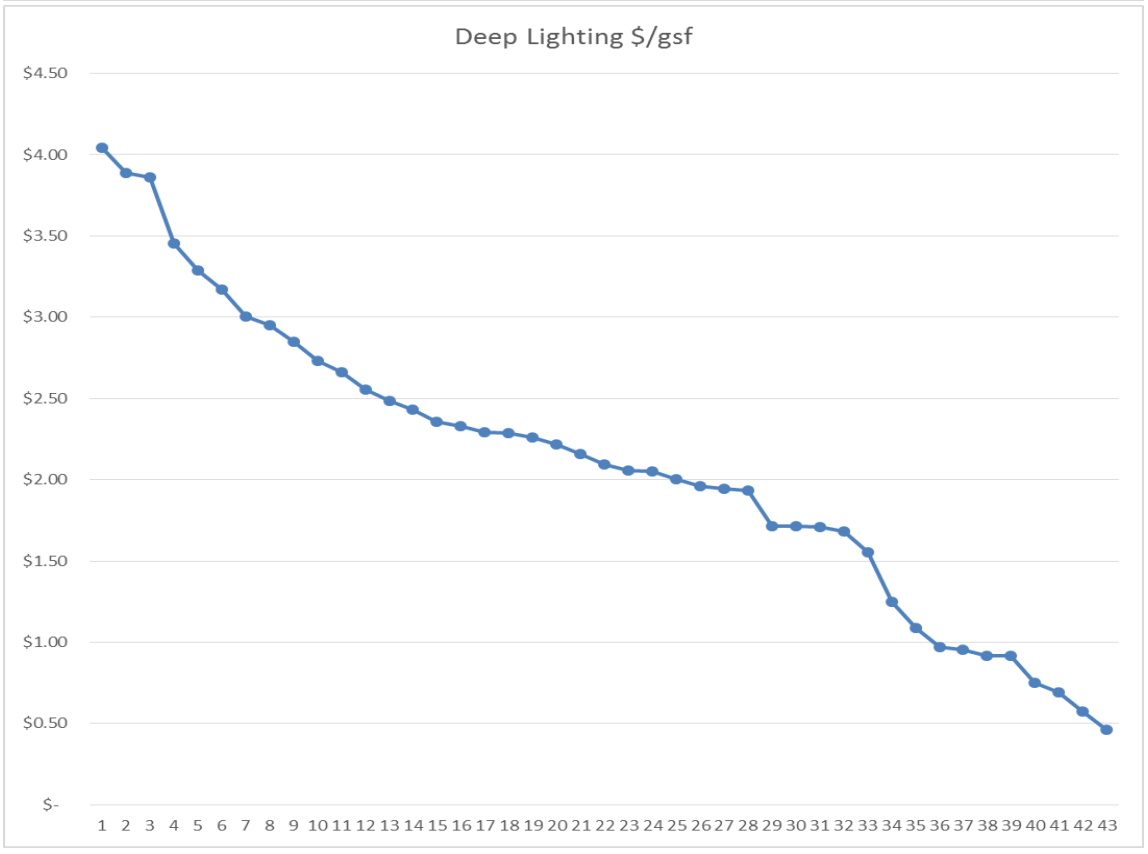
Appendix C – Deep Metrics Scree Plots

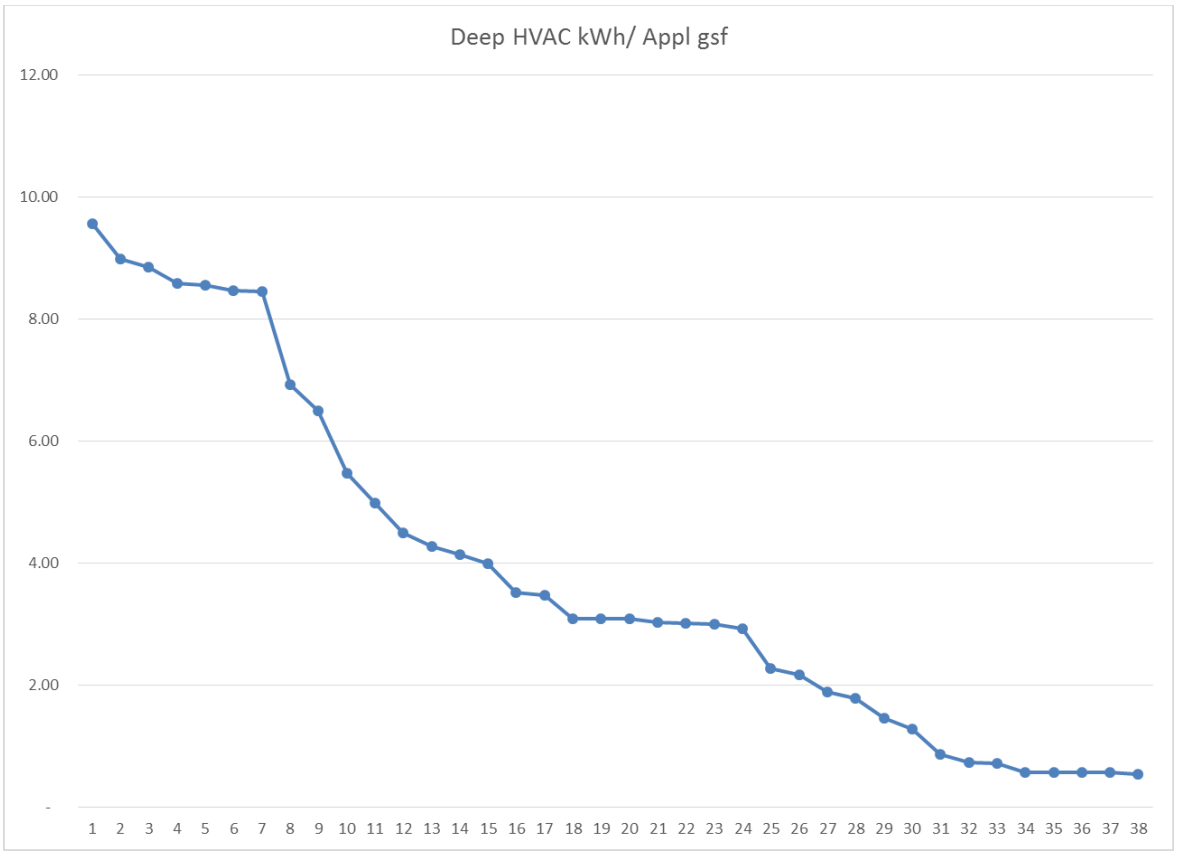
Scree plots, like those that follow, provide a graphical representation of data that allows natural grouping within samples to be observed. In our case, we used these plots to identify high and low cut-off points in our sample building sets to remove deep project metric outliers. These graphs are created by simply plotting each building's respective metric of interest (i.e., kWh/applicable gsf and projects cost/applicable gsf) in descending order by building.

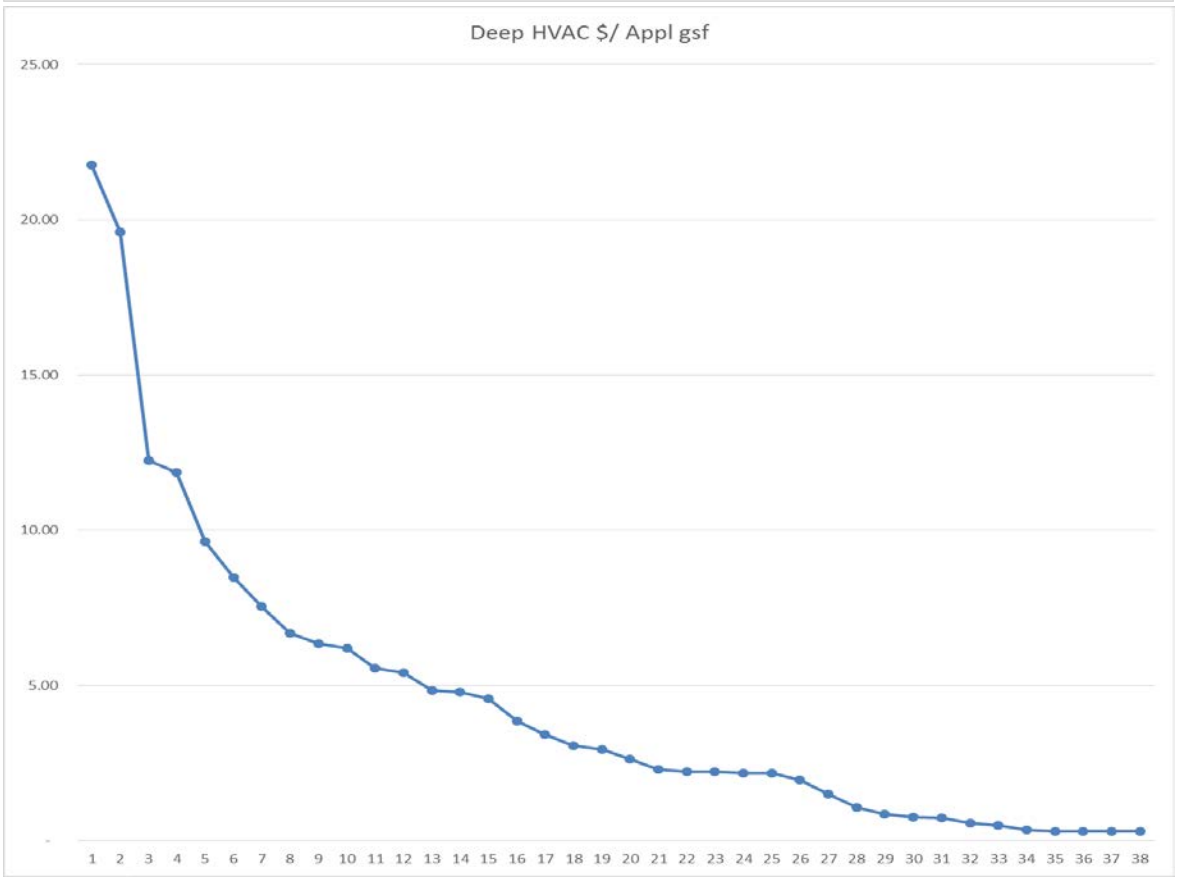

Smartlab kWh/ Appl gsf
35.00
30.00
25.00
20.00
15.00
10.00
5.00
-
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46


SmartLab $/ Appl gsf
$120.00
$100.00
$80.00
$60.00
$40.00
$20.00
$0.00
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46


Deep Lighting kWh/gsf
4.50
4.00
3.50
3.00
2.50
2.00
1.50
1.00
0.50
-
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43


Deep Lighting $/gsf
$4.50
$4.00
$3.50
$3.00
$2.50
$2.00
$1.50
$1.00
$0.50
$-
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43


Deep HVAC kWh/ Appl gsf
12.00
10.00
8.00
6.00
4.00
2.00
-
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38


Deep HVAC $/ Appl gsf
25.00
20.00
15.00
10.00
5.00
-
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38