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Electrical Report
2014 Charles Pankow Foundation
Annual AE Student Competition

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EXECUTIVE SUMMARY

The Charles Pankow Foundation Design Competition challenges students to address the design and integration of the electrical and lighting systems for a high performance 30 story high-rise located in San Francisco, California. Our lighting and electrical design process for 350 Mission Street was driven by the design goal of achieving a near net-zero building while keeping in mind the functionality of the spaces. One underlying theme that influenced many of the design choices we made was the user's experience.

Our vision:

"A net-zero energy building is a building that consumes no non-renewable energy that is produced off-site."

To meet our first design goal of achieving near net-zero building design we implemented two driving strategies: on-site energy production and energy use reduction. In order to produce energy on site, we have designed a photovoltaic array for the roof of our building, integrating this design with the mechanical and structural aspects of the overall roof design. We have also included a combined heat and power system consisting of a group of 10 micro-turbines to provide energy to the building and to act as emergency power. The production of harmful greenhouse gas emissions from these micro-turbines has been mitigated through our partnership with the California Center for Algae Biotechnology, which will utilize the carbon emissions in the production of biofuel. These two building systems combined will produce over 1.11 million kWhr every year – about one third of our annual building energy use of 3.33 million kWhr.

Our second strategy, energy use reduction, prompted design criteria which led our building to perform close to our near net-zero goal. We aimed to minimize the lighting power density, hoping to end with a total building LPD of at least 25% less than the allowable amounts provided by ASHRAE 90.1 2010. Our finial design has a power density which is 38.3% lower than what ASHRAE allows. We have also included photosensors to diminish over-lighting of spaces when daylight is available, and vacancy sensors to reduce the amount of energy used in unoccupied spaces. By adopting these two strategies, we managed to reduce the amount of nonrenewable, offsite energy consumed by 350 Mission to less than 28% of the code-allowable baseline.

While near net-zero was a main concern when creating our design, we also wanted to create an inviting and interesting space for the patrons. We achieved this through a lighting design in the lobby and a typical office floor which uses creative and aesthetic application of geometry to provide sufficient light levels based on task as well as help to produce an unconscious understanding of the space. The design of the lighting systems depended on, and had to integrate with the mechanical and structural systems. The mechanical systems in the plenum dictated lower ceiling heights in several spaces, eliminating pendant options in those areas. By choosing recessed fixtures, we needed to further integrate with mechanical and structural systems in the plenum to avoid any clashes, i.e. recess depth of a fixture colliding with or becoming too close to a duct or structural steel member.

Further, to encourage community acceptance and excitement surrounding our building, while also meeting the code, we designed our building to a LEED Platinum level. This demonstrates our commitment to a sustainable building, benefitting not only the owner and tenants, but the environment and the community as a whole.

INTRODUCTION

The 350 Mission Building will be one of the most highly visible and recognizable buildings in San Francisco when it opens. Our objective is to create an energy efficient icon with near net-zero design and performance that is focused on enhancing the user's experience.

350 Mission Street is located at a very prominent intersection where Mission meets Fremont Street. Directly across the intersection is the exit of the Transbay Terminal (**Figure A**) which will produce a high volume of pedestrian traffic around our building. In addition to our goal of near net-zero design and performance, we aimed to design a visually striking and impressive lobby.

Figure A: Bird's eye perspective - site

Figure B: Exterior rendering

The building is a 30-story mixed use office building with a 4-story underground parking garage. The lobby contains opportunities for a restaurant, café, and retail, and it will be used to display local art on a large LED video display wall. It also functions as a means of transition to the 24 office floors above. These are designed to host a single tenant on each floor, but with the flexibility to combine floors for occupants with larger office floor plan needs. A rendering of our iconic design solution can be seen to the left (**Figure B**).

LIGHTING DESIGN CONCEPT

The driving concept behind our lighting design was to utilize geometry in order to make subconsciously understanding the space easier and improve productivity while providing enough illumination to accomplish area-specific tasks. Our design is centered on the user and the experience of our building. In spaces of transition we made use of a lighting design that included directional straight lines and rectilinear forms. To contrast this, in spaces of congregation or meeting, we made use of circular forms. These design choices were inspired by the actions of groups of people.

Figure C: Transition

Figure D: Congregation

When walking, running, driving, flying (any type of movement or transition) people generally move in straight lines. The main purpose of transition spaces is to get from point A to point B and the fastest way to do that is with a straight line. The line invokes a natural sense of motion, inspired by the image seen in **Figure C**, and appears throughout our design in places of transition.

When groups of people need to organize themselves in a way that facilitates talking, working together, etc. they usually form in a circle. This conjures images of desks pointed inward (**Figure D**) or a crowd of people gathered around a campfire. The circle creates a sense of social congregation with other people, and is used throughout our design in places where we thought a point of congregation should be created.

LOBBY

The first impression of our building for many can be seen in the rendering below (**Figure E**). This view is from the intersection of Mission St. and Fremont St., where pedestrians will exit the Transbay Terminal. The desire for this intersection, with the addition of the future terminal and our building, is to make it a major hub for the San Francisco business district. Our lobby design will contribute to the heightened importance for this intersection, while simultaneously creating an impactful impression of our building.

Figure E: Exterior rendering from intersection

The lobby of this space is one large bi-level open atrium space including a reception desk, elevator to the upper floor, retail opportunity, a small café, and an open staircase with adjacent public seating. There is also a restaurant, whose entrance can be found off the upper lobby. The location of all of these components can be seen in **Figure F**.

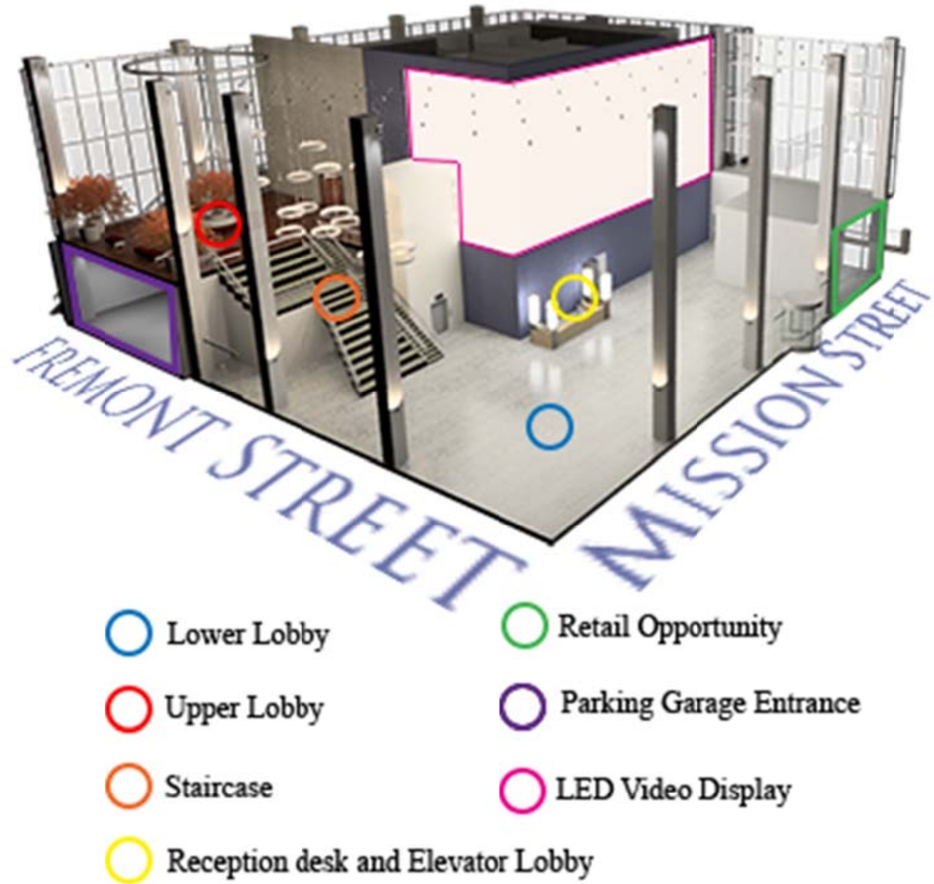


Figure F: Lobby layout space locations

The large core walls in the lobby will feature an LED video display screen which will provide dynamic visual interest to the space, as well as invite curious passers-by on the street to enter. This can be used to display local art, advertise events, or create a mood in the lobby based on the graphics chosen. The display of art on this video screen fulfills the competition requirement to include public artwork into our lobby space.

The staircase has a dual functionality: it provides mobile access to the second floor (lobby and restaurant), as well as offers seating and congregation space. Using RGB color changing circular pendants of varying heights, we have created a dynamic destination which invites users to make use of the seating on the staircase. Color changing opportunities, like those seen in **Figure G** and **Figure H** below, allow the owner to customize the lobby to a specific event, i.e. pink for breast cancer awareness event or green for a Saint Patrick's Day. This staircase will be used as casual seating by patrons of the future café, for which we have allocated space directly underneath portions of the upper lobby.

		Floor Illuminance (Footcandles)	Vertical Illuminance on LED screen (Footcandles)	Avg:Min	LPD W/ft^2
Lower Lobby	Target	10	>5	1.5	0.9
	Designed	12.4	3.37	1.8	0.48
Staircase	Target	10	-	1.5	-
	Designed	11.8	-	1.6	-
Upper Lobby	Target	10	-	1.5	0.9
	Designed	9.22	-	1.68	0.51

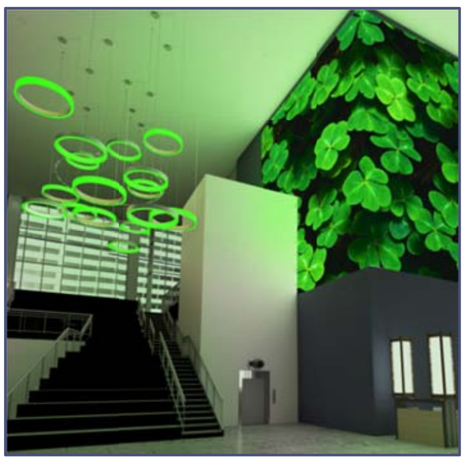


Figure G: Green Lobby option

Figure H: Pink Lobby option

Figure I: Upper Lobby

The second destination for many in our building is the upper lobby, which provides a congregation space for the general public, as well as public space near the restaurant. A rendering of this area can be seen in **Figure I**. The recessed 24' diameter circle of light provides adequate illumination to the floor and couches, as well as creates a visual target leading people's eyes up the stairs to that location.

One design challenge in developing a 53' tall lobby space is creating a comfortable sense of scale for the occupants we have made 2 key lighting choices to accomplish this: uplights on each column and paper lanterns at the reception desk. The RGB color-changing column uplights allow the structure to be a part the dynamic variable color scheme. Placed at 9', they break the monolithic columns into something more scale appropriate (**Figure J**). The rectangular paper lanterns tie our reception desk into our lighting concept of straight lines in areas of transition. The elevator lobby also employs linear forms to promote movement in the transitory space (**Figure K**).

Figure J: RGB Column Uplights

Figure K: Reception desk

OFFICE

The majority of 350 Mission Street is comprised of office floors. We have designed a typical office floor using level 5 as a template for the remainder of the floors above it. Refer to the luminaire schedule (Appendix C, p. E-2) and the office lighting layout (Drawing E102) for more information on the complete lighting design of the office areas (**Figure L**).

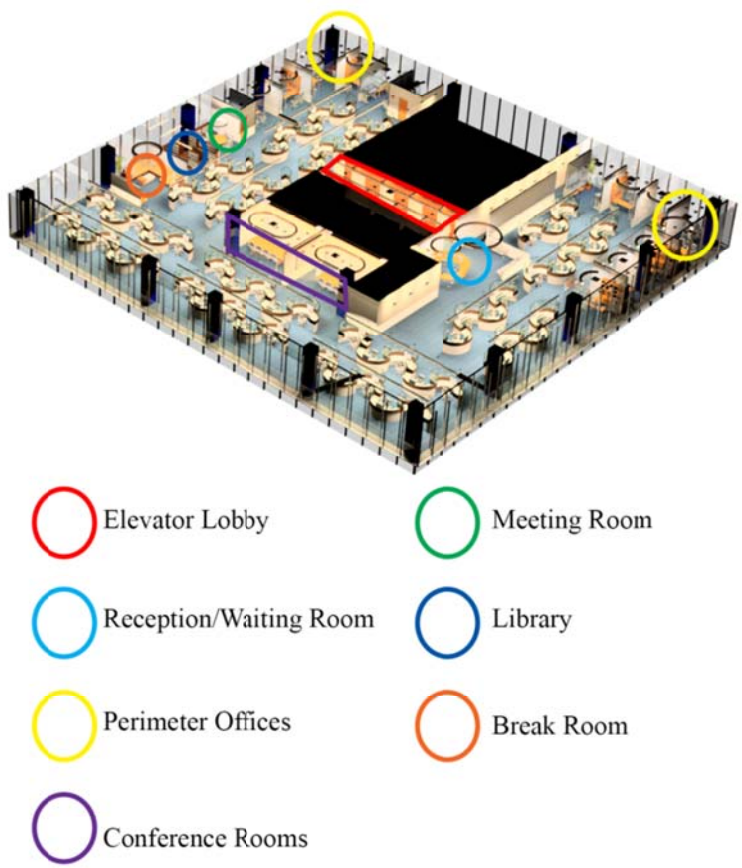


Figure L: Office layout space locations

ELEVATOR LOBBY AND RECEPTION

Continuing with the user's experience in mind, the first spaces visited by everyone on the lobby and office floors are the elevator lobbies. To help create a feeling of consistency and transition, we have added surface mounted linear strips to the elevator lobbies on every floor. These point people in the direction of the reception area, as seen in **Figure M**.

Figure M: Elevator Lobby

In the reception area we have created a point of congregation and a subconscious cue to stop walking by ending the rectilinear strips and including a recessed curvilinear form. (**Figure N**). Behind the reception desk is an accent wall of the same wood cladding found in the elevator lobby. To develop a hierarchy between these two walls, we have chosen to use semi-recessed fixtures to wash the accent wall in the reception area.

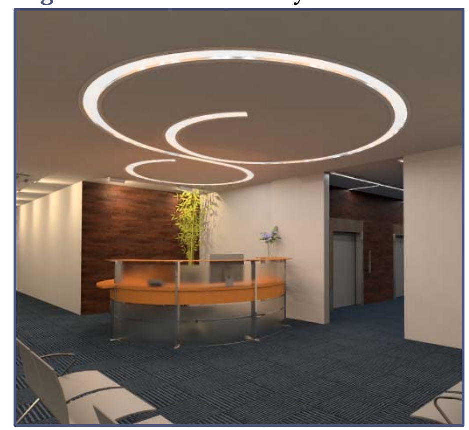


Figure N: Reception area

		Avg. Floor Illuminance (Footcandles)	Avg. Desk Illuminance (Footcandles)	Avg:Min	LPD W/ft^2
Elevator Lobby	Target	5	-	1.5	0.64
	Designed	3.47	-	1.08	0.44
Reception	Target	10	50	2	0.9
	Designed	7.8	48.5	2.68	1.17

OPEN OFFICE

The majority of the typical floor plan is occupied by an open office layout. We have created a layout which fosters productivity through the availability of daylight and the use direct/indirect pendant fixtures. The desks have been designed to improve productivity by using glass partitions to make use of the plentiful daylight in the office, while still providing discrete work spaces and separation from surrounding noise and distraction (**Figure O**).

Figure O: Desks

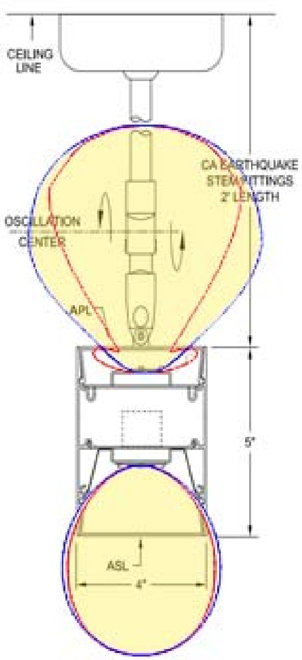


Figure P: Type A distribution

The light fixture we chose to implement throughout the open office is a linear LED pendant fixture. The distribution, which can be seen in **Figure P**, shows that both direct and indirect illumination is being provided; the indirect portion reduces shadows on the work plane and illuminates the ceiling while the direct portion pushes light down onto the desks where it's needed.

In order for our design to comply with the competition's near immediate occupancy requirement after a design level earthquake, we've used the California earthquake stem and fittings. These will allow our pendant fixtures to oscillate and sway without falling or being damaged during seismic activity.

		Avg. Floor Illuminance (Footcandles)	Avg. Desk Illuminance (Footcandles)	Avg:Min	LPD W/ft^2
Open Office	Target	10	30	2	0.92
	Designed	15.3	29.2	2.9	0.51

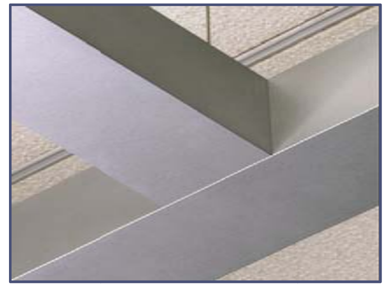


Figure Q: Connections

The fixture series we have chosen will be comprised of 4' long fixtures over each desk, with stainless steel connections between each. The connections will be similar to those seen in **Figure Q**. They are separated by bay and many of the bays are controlled separately in response to available daylight, as can be seen in the figures on page 7.

Figure R: Open Offices - Day

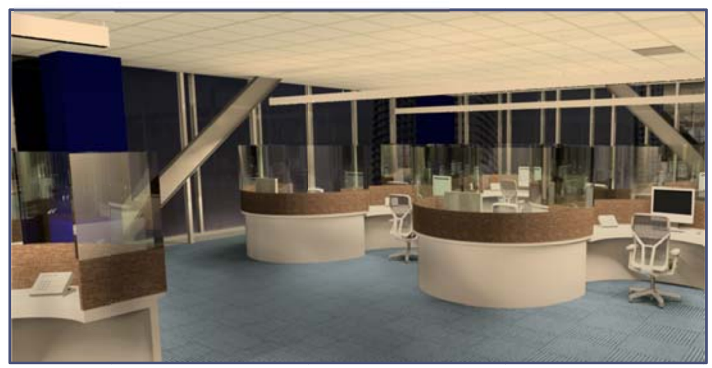


Figure S: Open Offices – Night

To the left are two renderings of the open office. **Figure R** shows the daylight that can be used to illuminate the desks by day, and **Figure S** shows the effect created by the artificial lights at night.

LIGHTING CONTROLS SYSTEM

In order to maximize the amount of energy saved throughout the building, we designed a daylight harvesting system throughout the open office. Our office space was split into seven dimmable zones, and analyzed using DAYSIM. We placed closed loop photosensors mounted in the light fixtures above the critical point of each dimmable zone (**Figure T**). Ultimately, we calculated that this configuration would allow the lights to be dimmed to an average dimming level of 24% throughout the occupied hours during the year, saving over 60% of the lighting energy load.

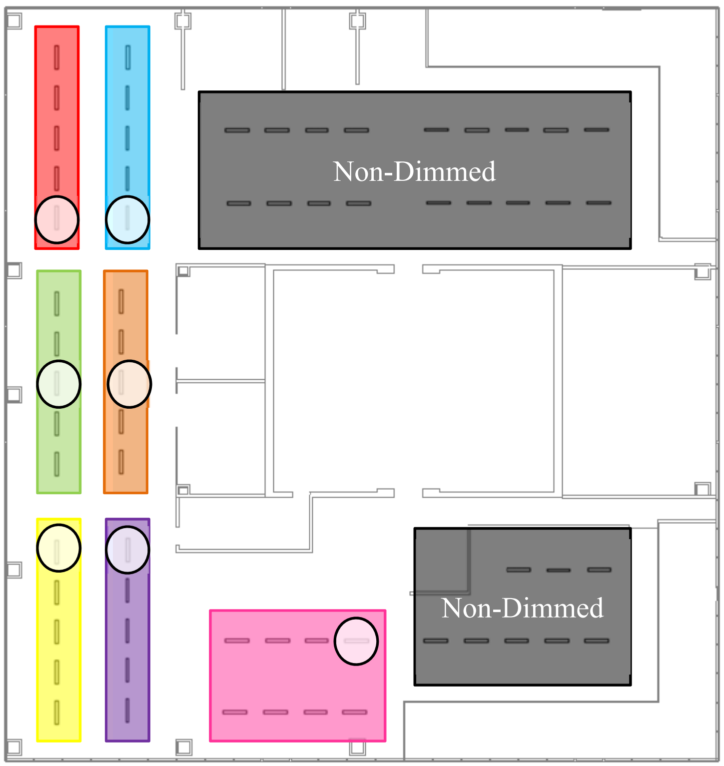


Figure T: Dimming zone and photosensor diagram

In addition to daylight harvesting, our lighting system utilizes light-level tuning. Each lighting fixture in the office will be controlled by the Lutron Quantum system that we specified. The building manager can use this system to methodically reduce the lighting load by a small percentage every week, and request feedback from the occupants. When the occupants express that the light level is too low, the building manager can increase the dimming level by one or two increments. This fine-tuning allows the lights to be dimmed to their maximum level while still maintaining occupant comfort.

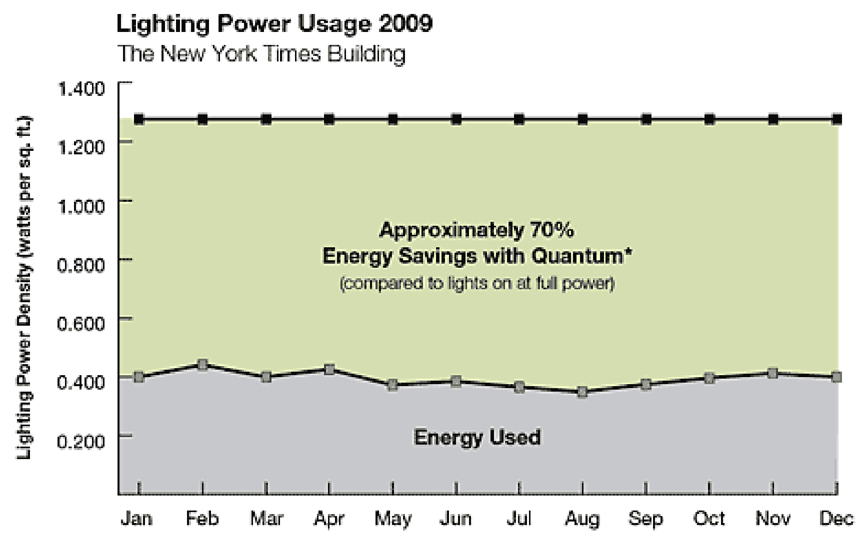


Figure U: case study: New York Times Building saves 70% with light-level tuning strategy, in addition to daylight harvesting

Through numerous case studies like the one in **Figure U**, Lutron's Quantum system has been shown to use light level tuning to reduce lighting loads by more than 20% (in some cases up to 50%). For more details about our daylight harvesting calculations or light-level tuning system, refer to *Appendix H on Page E-8* in the supporting documents section of this report.

PERIMETER OFFICES

The portions of the floor plan dedicated to enclosed private offices are located along the perimeter of the north and east corners. The ceiling heights in these offices (as well as the reception and conference rooms) were dictated by the return air ducts for our mechanical design. These ceilings needed to house return air ducts which, in order to traverse the spans of the office, had to be integrated in between and underneath the structural beams More information on the air return system can be *found on Drawing M-104 in the Mechanical Report*, and descriptions of the clash detection process and solution can be *found on Page 13 of the Integration Report*. This posed an integration challenge for the lighting design because the ceilings were too low to hang pendant fixtures from. We used recessed fixtures in all of the lowered ceilings, paying close attention to any clashes between recessing depths of fixtures and the mechanical and structural systems in the ceiling. Below is an illustration (**Figrue V**) from Navisworks, our clash detection software, showing the close proximity of the systems in our plenum, and illustrating the need for such meticulous and comprehensive clash detection.

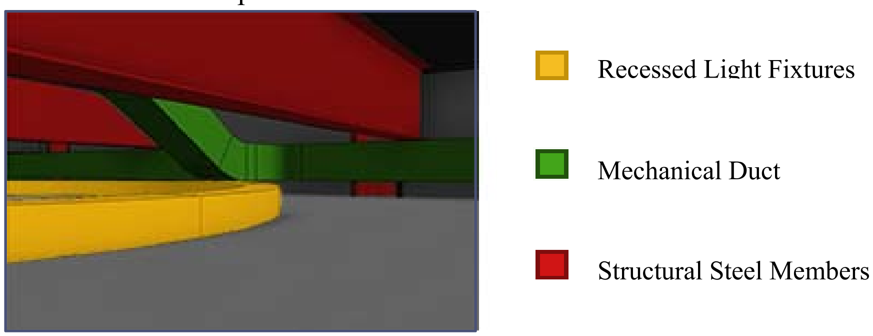


Figure V: Plenum clash avoidance illustration

Our lighting design solution for the perimeter offices can be seen in **Figure W** and **Figure X**. These rooms are separated from the open office by partitions and doors made of glass in order to let the sunlight penetrate into the open office beyond (**Figure W**). Circular recessed fixtures, matching the ones found in the reception, can be seen through these glass walls. This lighting scheme deviates from the open office's rectilinear strips and invites people into the perimeter offices for private meetings. There are round aperture downlights over the desk and work area, as well as desk lamps, to provide additional illumination on the task surface. Similarly to the open office lighting, the light levels in these offices will be tuned to reduce any unneeded or extra illumination.

Figure W: Perimeter Offices – Day

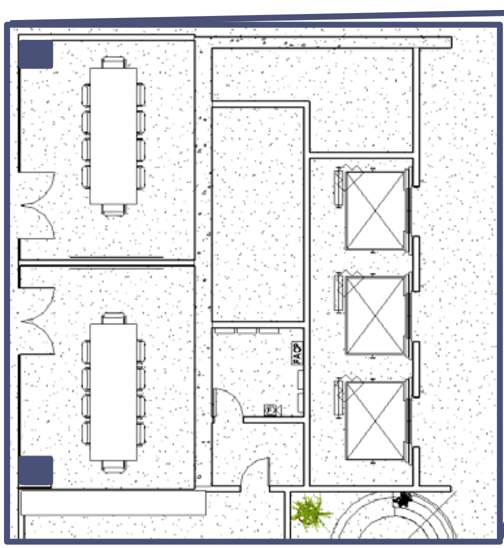
Figure X: Perimeter Offices – Night

		Avg. Floor Illuminance (Footcandles)	Avg. Desk Illuminance (Footcandles)	Avg:Min	LPD W/ft^2
Perimeter Offices	Target	10	30	1.5	1.1
	Designed	10.6	29.3	1.6	0.88

Conference Rooms

Conference rooms often serve many different functions for an office. Each of these uses involves tasks which require varying light levels from dim to very bright. We have created a design which, when paired with Lutron's Maestro controls system, can be programmed to accommodate all of these functions.

The two conference rooms on each floor are located directly southwest of the core. To meet our structural goals, we have included two interior columns to reduce the spans across the open office. The location of these columns led to the placement of our two conference rooms (**Figure Y**). The partitions between the conference rooms and the western facing open offices are clear glass, similar to the perimeter offices, to let daylight into these spaces. There are shading devices included to mitigate any unwanted daylight during presentations.



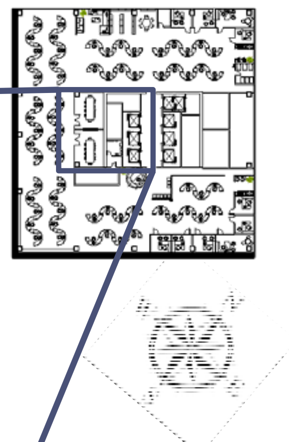


Figure Y: Conference room location

Figure Z: Conference Room- High

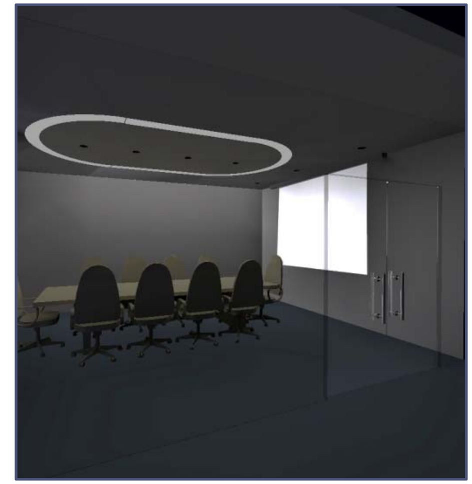


Figure AA: Conference Room – A/V presentations

Above you can see two different scenes, one for general meetings (**Figure Z**) and one for audio visual presentations (**Figure AA**). *Refer to Appendix F on page E-6* for renderings, light levels, and controls of all 4 scenes.

The recessed ring of light draws the eye into the space, and encourages people to enter and sit around the table, increasing productivity and employee performance while providing an aesthetically pleasing work environment.

		Floor Illuminance (Footcandles)	Table Illuminance (Footcandles)	Avg:Min	Vertical Illuminance on screen (Footcandles)	LPD W/ft^2
Conference Room (meeting)	Target	10	30	1.5	-	1.23
	Designed	11	24	1.3	-	1.57
Conference Room (presentation)	Target	3	5	2	3	1.23
	Designed	7	6	1.3	3	1.57

ANCILLARY SPACES

Our typical office plan includes 3 ancillary spaces on the northern perimeter of the floor plan. These spaces are a break room, a library and a small meeting room. Since these are often used, they aren't separated from the open office using walls, and the partitions between each of these spaces is a 6' tall wall, which provides separation but still allows light to travel throughout the spaces.

The break room did not require as high of light levels as the other two ancillary spaces, so recessed direct light in the shape of a circle provides a comfortable space to sit and relax while on break (**Figure AB**).

The library, located between the other two spaces, requires 15fc on the vertical surfaces. We chose to use pendant, direct/indirect fixtures to provide light on the bookshelves as well as the ceiling (**Figure AC**).

The meeting room, used for small gatherings that don't require a conference room, makes use of a pendant circular ring of light, which provides the necessary amount of light on the task surface, but also gives the meeting room a sense of destination (**Figure AD**). Fostering this type of inter-personal gathering will increase productivity, and the aesthetically pleasing luminaire adds to the visual appeal of the office space.

Figure AB: Break Room

Figure AC: Library

For more information on the light levels produced by our design solution for the three spaces found here, *please refer to Appendix E on page E5*. The lighting power density calculated for these spaces, and others throughout the office can be *found in Appendix G on page E-7*.

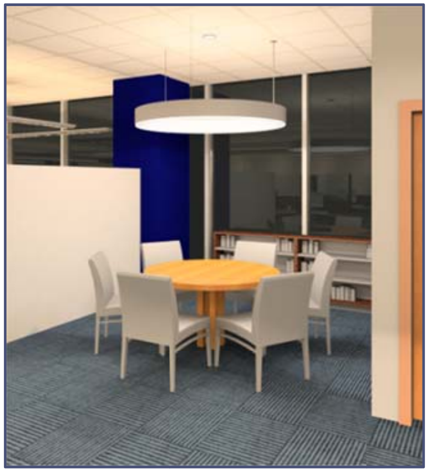


Figure AD: Meeting Room

There are other ancillary spaces throughout the office. The restrooms and kitchenette areas are self-contained pods that have been pre-fabricated off-sire to expedite construction. These will include integrated lighting and will be connected to the main energy through the raised access floor plan.

		Floor Illuminance (Footcandles)	Desk Illuminance (Footcandles)	Vertical Illuminance on Bookshelves (Footcandles)	Avg:Min	LPD W/ft^2
Break Room	Target	10	-	-	2	1.23
	Designed	18.3	-	-	2.82	0.67
Library	Target	-	-	15	-	1.71
	Designed	-	-	11.6	-	0.87
Meeting Room	Target	10	30	-	1.5	1.23
	Designed	9.74	19.66	-	1.16	0.85

ELECTRICAL

TYPICAL OFFICE LOADS

The electrical load on our typical office floors is dominated by plug-loads. Each desk in the open office plan is equipped with a dedicated receptacle for a computer, as well as an inlaid duplex receptacle for convenience items. Plug-loads account for over 65% of the connected load in a typical office, at 63.3 connected kVA. The high flexibility of receptacle locations provided by the raised access floor system mitigates the demand load on the office to 36.65 kVA, however our team has taken extra measures to reduce the actual load on the system.

Our team has specified office desks that are modified to contain Wattstopper Isolé IDP-3050 plug-load occupancy sensors (**Figure AE** and **Figure AF**). These sensors will be programmed with six controlled outlets, and two uncontrolled outlets. If the passive infrared sensor detects no movement for more than ten minutes, the power supply to the controlled loads will switch off. Wattstoper's Isolé IDP-3050 has been used to reduce plug-load demand by 20-40% in multiple case studies of similar use in an office environment.

Figure AE: Wattstopper Isole IDP-3050

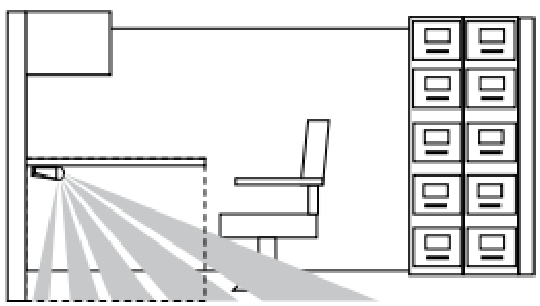


Figure AF: side view diagram

Our design team has also made accommodations for tenants using the space for a technology-based office. A small office on the Northeast wall of the office can be converted into a server-room, housing up to six self-cooling, 8 kW server racks (**Figure AG**).

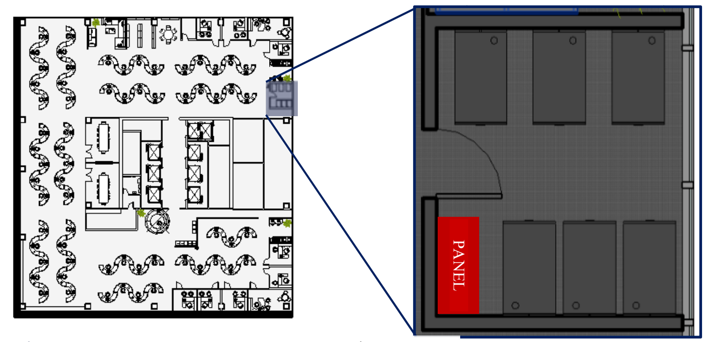


Figure AG: Server Room Location

Wiring (four #10 AWG wires contained in a 1" feeder) will be run to each of these rooms, allowing any tenant to install a server-room panel and operate the server room should they choose. This allows for maximum flexibility. Because server-rooms require such a great deal of energy (48 kW connected load – accounting for over 40% of the total office floor connected load), our energy consumption analysis runs under the assumption that two out of the twenty five office floors require full use of a server room. The other 23 rooms have been fitted with standard office furniture and equipment.

SECURITY/DATA INFRASTRUCTURE

In order to maintain secure office space for our tenants, each office floor is fitted with a magnetic card-swipe reader on each of the entrance doors from the elevator bank. To effectively function in an office, everyone needs to be connected. There are data outlets and Ethernet ports at every desk throughout the open office, as well as in the perimeter offices, the meeting room and the confrerence rooms to provide those spaces with phone and internet connection. See *Drawing E-104* for more details on both of these systems

DISTRIBUTION SYSTEM

The total connected load on the building is 2409 kVA. The utility power is brought on-site, into the main electrical room (**Figure AH**) at 12000Δ/6930 then stepped down to 480Y/277 by the transformer. The transformer feeds into the main switchgear, which allocates power out to nineteen distribution panels. *See Appendix P on page E-17 and Drawing E-106 for details.*

Our main concern in designing the power distribution system was occupancy immediately following a natural disaster. It was this concern that led us to specify a group of distribution panels rather than a riser bus-duct. A bus-duct would have a single point of failure – in the event that it is damaged by an earthquake, all of the floors serviced by the bus would be unoccupied until the bus was fixed. Conversely, a system that relies on a network of distribution panels has many points of failure – if one panel becomes damaged, all of the floors serviced by the other panels will still be able to be occupied. Additionally, our team specified draw-out type distribution panels for ease of maintenance.

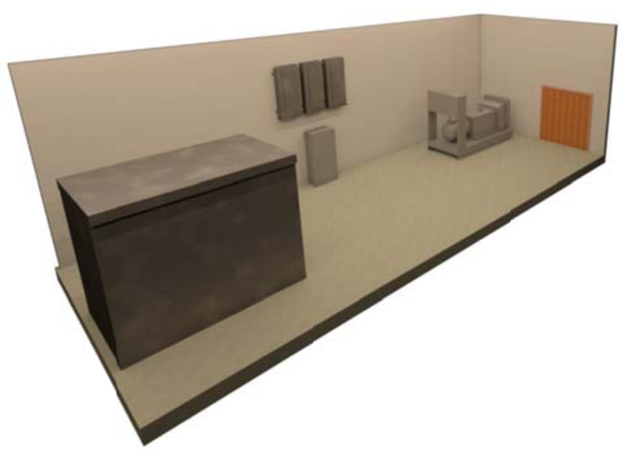


Figure AH: Main Electrical Room Layout

PHOTOVOLTAIC ARRAY

To help achieve our near-net-zero energy use goal, our team designed a photovoltaic array on the roof of 350 Mission. Our system utilizes a combination of pole mounted, and roof mounted panels, all (except four) oriented southwest, and tilted 10 from the horizontal (**Figure AI**). Due to the building orientation and site conditions, this configuration yielded a higher energy output than a south facing configuration. See *Appendix L on page E-13* for details.

Despite the moderate shading conditions, our team determined (using Autodesk's Ecotect Analysis software) that the described photovoltaic array would generate over 149,800 kWhr annually – over 4.5% of our total building energy use. In addition to its contribution to our energy goals, the photovoltaic array would be a rewarding financial investment for the owner, paying for itself in less than 6 years. See the Life-Cycle Cost section on *Page 14 of our Integration Report* for more details.

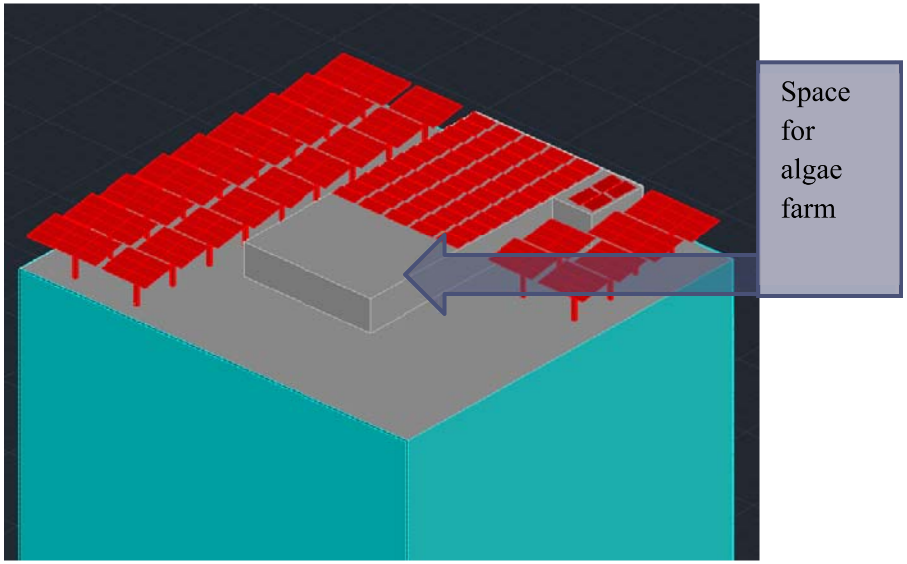


Figure AI: Photovoltaic Diagram

COMBINED HEAT-AND-POWER

In addition to the photovoltaic system, our team has designed a combined-heat-and-power system to generate energy on-site. This system has a combined efficiency of over 80% - well more than the typical source-to-end-use-efficiency of electricity (around 33%). Thus, this system will help to reduce our total carbon footprint.

Our system utilizes ten Capstone 65kW microturbines in the rooftop mechanical room, which produce a maximum power output of 650kW. By analyzing the amount of heating required for the building, and the amount of time that the microturbine system would be operating (*see page 4-5 of the Mechanical Report for details*), our team determined that the combined heat-and-power system would produce 1,014,000 kWhr of electricity annually – over 27% of the total building load of 3.33 million kWhr.

Shown on the right in **Figure AJ**, a set of three distribution panels also located in the rooftop mechanical room distribute power from the microturbines to the office loads on the top 15 floors of the building. This configuration reduces the amount of transmission loss, while still servicing enough office floors to make full use of the energy produced. See *Drawing E-106 Riser Diagram* for more details.

To reduce our carbon footprint even further, our team has partnered with the California Center for Algae Biotechnology. The carbon dioxide emissions from the micro-turbines will feed an algae farm which will ultimately be used to generate biofuel. We estimate an energy production of 1,014,000 kWhr annually for the microturbines. According to our model, the algae bioreactors will reduce $C0_2$ emissions by 1,369,638 lbs per year, reducing the carbon footprint of our combined heat-and-power system by 60%.

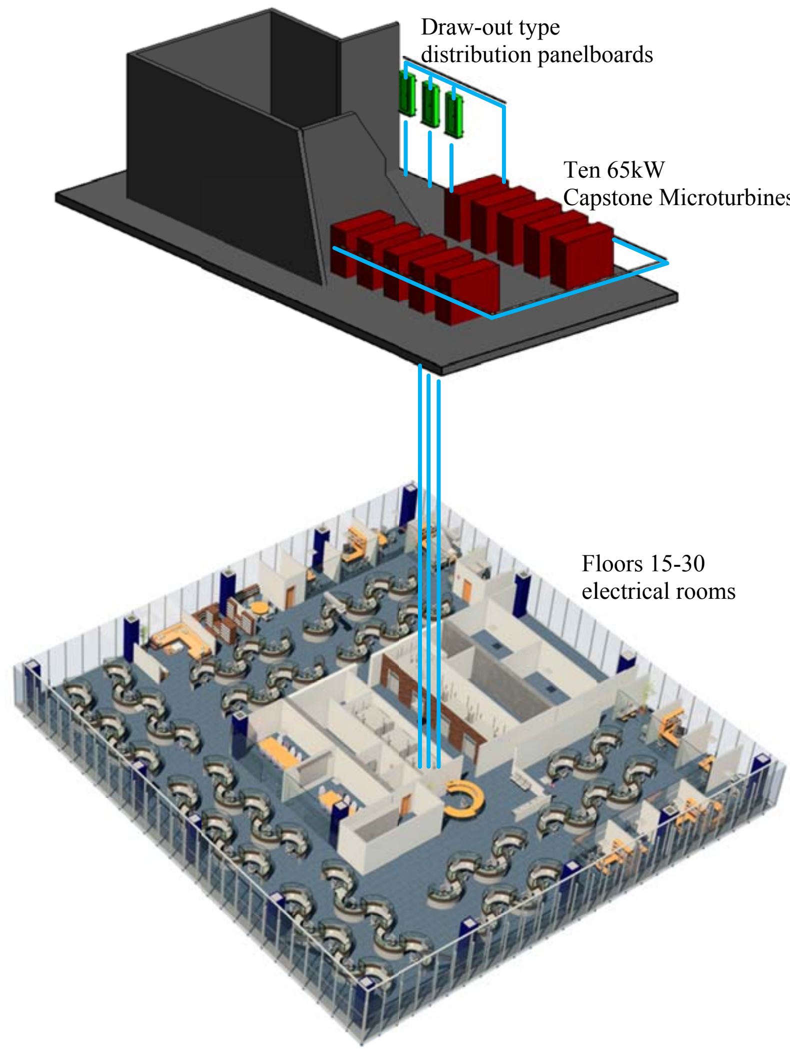


Figure AJ: Rooftop microturbines and electricity flow diagram

FIRE ALARM INFRASTRUCTURE

In addition to designing a power distribution system for 350 Mission, our electrical team also designed a fire alarm infrastructure to comply with NEC 2011, and NFPA 72 standards.

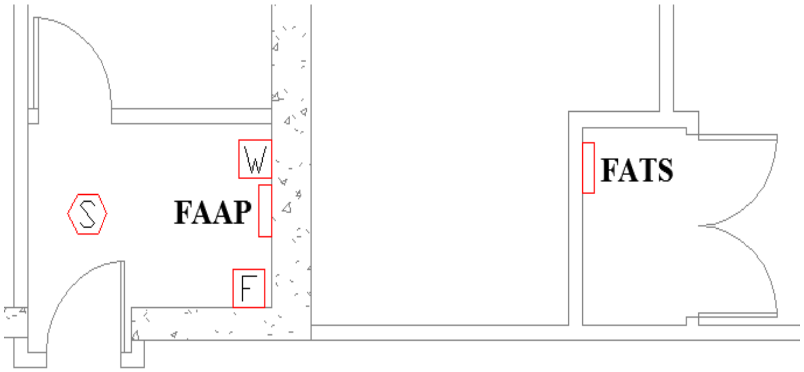


Figure AK: Stairway vestibule and secondary electrical room

The fire alarm infrastructure is controlled by a main fire alarm control panel (FACP) located in the Lobby level telecom room. Each office floor contains a fire alarm terminal cabinet (FATC) located in a secondary electrical closet, as well as a fire alarm annunciator panel, smoke detector, manual pull station, and warden station in each of the stairwell vestibules (**Figure AK**).

In order to ensure that our speaker/strobe devices had enough coverage (**Figure AL**), we split our open office space into 55' x 55' (or smaller) areas, and designed a system such that each area contained at least one initiating device, as per NFPA 72 (See *Appendix O on Page E-16* for diagram). Our specified speaker/strobe devices shall emit 150 cd, in order to maintain visibility. See *Drawings E-104 and E-106* for more details about our fire alarm infrastructure

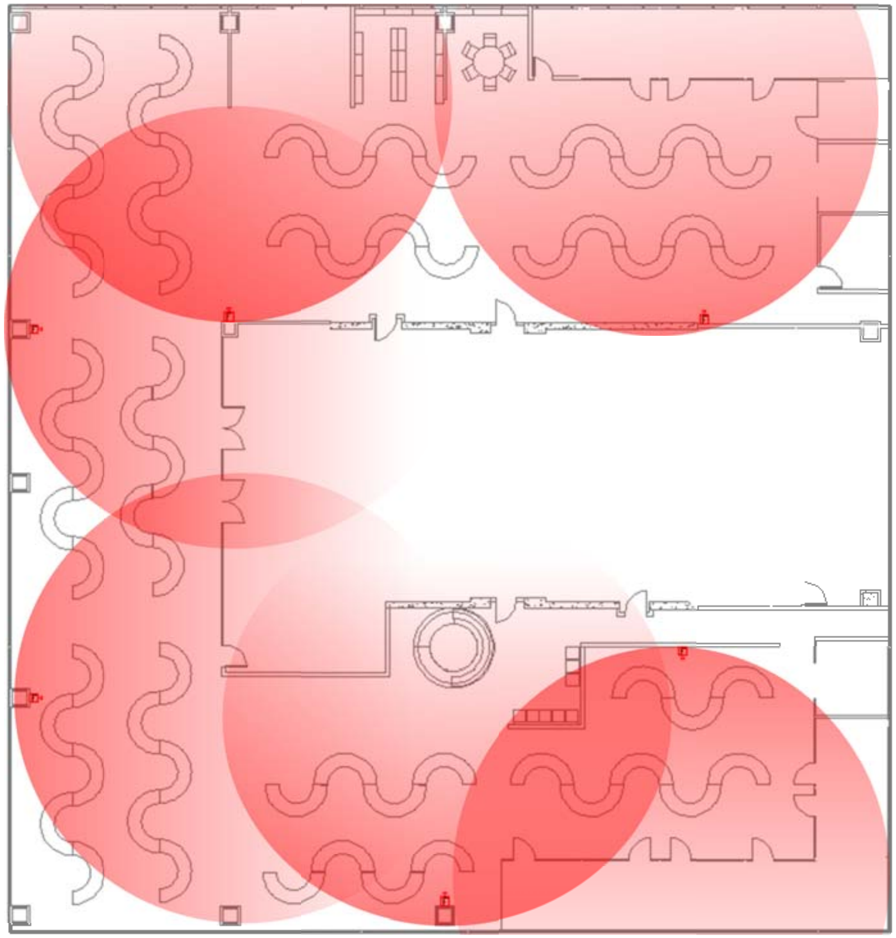


Figure AL: Open office fire alarm speaker/strobe coverage diagram

LEED

LEED certification was not a required design goal for this project; however, because the energy efficiency requirements of our project were so rigorous, our team decided to determine which LEED certification our 350 Mission Street design is eligible to receive. The electrical portion of our design yields 10 LEED points which can be seen listed below. Combining these with the points earned for construction methods, mechanical design and structural design, our team was able to achieve LEED Platinum with 89 points (**Figure AM**). A breakdown of the total points achieved for each category is shown in *Appendix B on page E1* of the supporting documents.

Figure AM: LEED Platinum

Sustainable Sites

SS Credit 7.2	Heat Island Effect-Roof:	1 Point
SS Credit 8	Light Pollution Reduction:	1 Point

Energy and Atmosphere

EA Credit 2	Onsite Renewable Energy:	2 points
EA Credit 5	Measurement and Verification:	3 points

Indoor Environmental Quality

IEQ Credit 6.1	Controllability of Systems – Lighting:	1 point
IEQ Credit 8.1	Daylight and Views – Daylight:	1 point
IEQ Credit 8.2	Daylight and Views – Views:	1 point

Conclusion

Our team set out to create a near net-zero icon for the San Francisco building industry while maintaining a high level of lighting design and performance. By taking measures to reduce our energy use and maximize our energy production, we have achieved that goal.

In order to reduce our energy load, we set a design goal to use up to 75% of the allowable power density in each space. We accomplished this goal, with a final LPD which is 62% of what code allows, saving 191,360 kWhrs annually. In addition, our lighting controls system and plug-load controls system are able to conserve a further 192,454 kWhr every year. Lastly we were able to reduce our energy load by tuning the light levels to the occupant's needs, thereby eliminating unneeded power consumption. By developing these energy reduction methods, we have brought the annual building energy use down to 3.33 million kWhr/yr.

Utilizing a photovoltaic system, a combined-heat-and-power microturbine system, we were able to produce 1.11 million kWhrs annually, or 34% of our projected energy consumption. Ultimately, our building utilizes only 28% of the baseline, code-allowable energy use from nonrenewable, off-site sources – close to the net-zero mark. By developing these systems, and collaborating with the California Center for Algae Biotechnology, we hope to set a precedent for sustainability in San Francisco.