CLOUD
ARCHITECTURE

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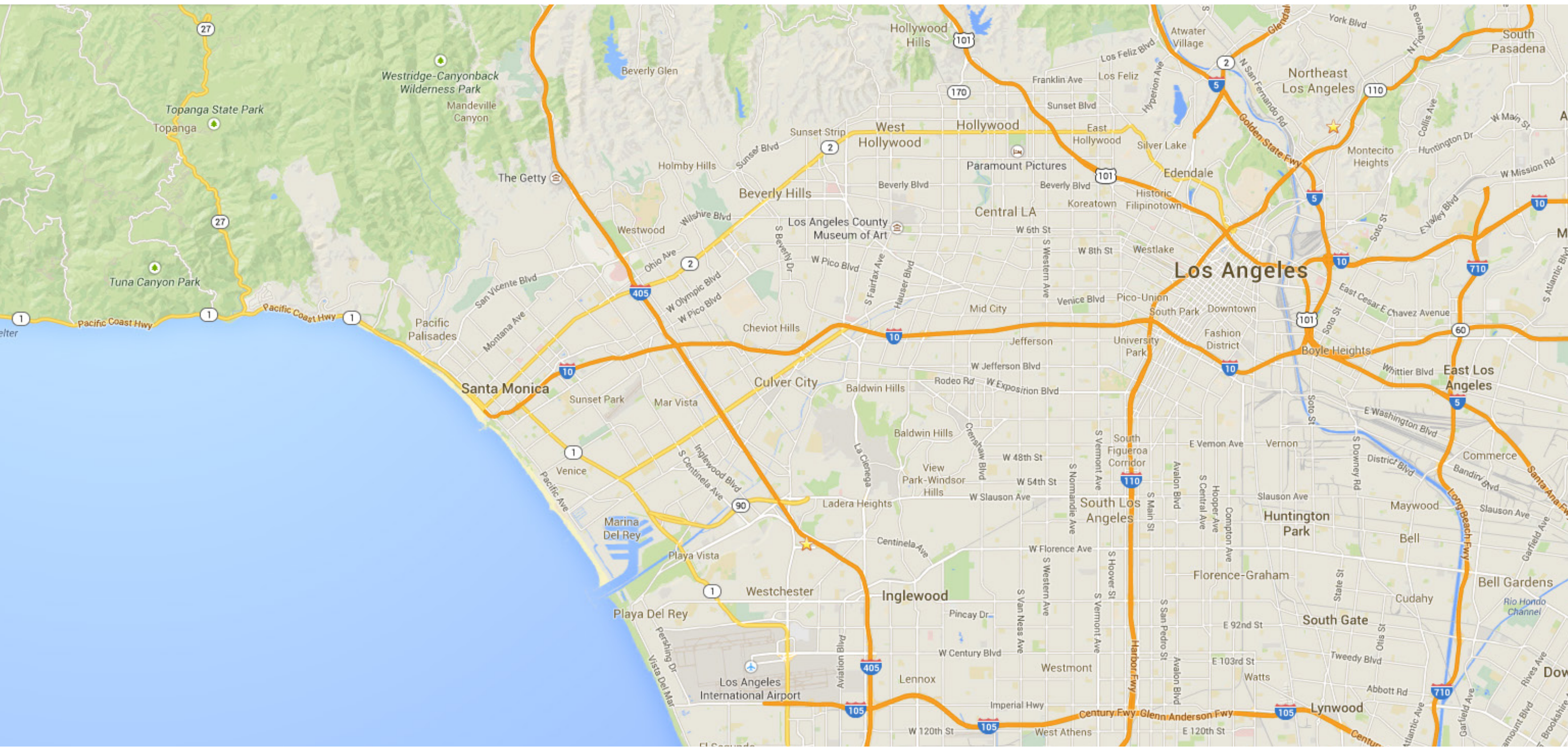
CATHAY KYLIN INTERNATIONAL INVESTMENT HOLDING GROUP CO., LTD



Cathay Kylin
Preliminary Deliverable

September 1, 2014

INTRODUCTION

OVERVIEW

The following deliverable was created by consultant team Cloud Arch Studio for the client Cathay Kylin, represented by James He, Jessica Hung, and Johnny Lu. Its primary goal is to provide recommendations for the design and marketing of energy-efficiency and building technology systems in two of the client's current developments:

1. 109-unit apartment complex on 6055 Center Drive, Los Angeles CA
2. 18 single family homes on Glenalbyn Drive, Los Angeles CA

We have expanded the deliverable to include more parts as part of our own holistic process. These are provided for the client to review, but Cloud Arch Studio retains authorship of its own study and designs. The recommendations provided are free for the client to take as part of its own continued development, though we are in the best position to develop our own recommendations and designs through further commission as lead consultant to design and engineering.

The deliverable is composed of four distinct sections:

1. **MULTIFAMILY SUSTAINABILITY STUDY** is authored by Rob Best, Collin Lee, and Derek Ouyang and approaches the question of sustainability in multifamily residential from an academic perspective. It is intended to be its own separate development of ideas which exists outside of the relationship with the client, but it is presented within this package.
2. **6055 CENTER DRIVE SUSTAINABILITY RECOMMENDATIONS** is authored by Dimitris Farmakis, Rob Best, and Derek Ouyang and consists of a direct application of the ideas from the sustainability study to the client's multifamily site with recommendations on how the client should proceed with the design process. It is preliminary in nature and Cloud Arch Studio would be interested in proceeding with design development if the client is interested in a separate commission.
3. **6055 CENTER DRIVE ARCHITECTURAL CONCEPT** is a design by Klemen Kusar, Tina Vilfan, and Derek Ouyang integrating Cloud Arch Studio's own sustainability recommendations and unique architectural concepts. It is provided as a reference of another possible approach to the building architecture. Additional design sheets will be provided in a separate PDF.
4. **GLENALBYN DRIVE ARCHITECTURAL CONCEPT** is a design by Karolina Ostrowska, Sinan Mihelcic, and Derek Ouyang for the client's single-family development. Additional design sheets will be provided in a separate PDF.

TEAM

- Derek Ouyang, age 22, graduated from Stanford University in 2013 with dual Bachelor's in Civil Engineering and Architectural Design, and will return in the fall for a Master's in Structural Engineering. He participated in the AEC Global Teamwork Project in 2011 and co-created the Global Urban Design Course in 2012. He was project manager of Stanford's first-ever entry to the U.S. DOE's 2013 Solar Decathlon and has been featured as an up-and-coming architect in the Los Angeles Times, in Home Energy magazine's "30 under 30", and at TEDxStanford.

- Sinan Mihelcic, age 31, graduated from Ljubljana University in Architectural Design. He participated in the AEC Global Teamwork Project in 2011 and co-created the Global Urban Design Course in 2012, both exploring digital collaboration tools in urban planning and architectural design. He established Skupina Štajn in 2008, an emerging young architectural studio in Kamnik, Slovenia. He is a technical assistant in architectural and urban planning studios at the Faculty of Architecture in Ljubljana, as well as a mentor to the AEC class at Stanford.

- Klemen Kušar, age 28, graduated from Ljubljana University in 2012 in Architectural design and in 2013 in Economics. In 2010 he was exchange student at Aalborg University and attended a summer workshop for the renewal of favela Dona Marta in Rio de Janeiro. He participated in the Global Urban Design Course in 2012. In 2008 and 2010 he was awarded 1st and 2nd place in the Isover Multi-Comfort House Design, and in 2012 was awarded the University of Ljubljana Prešeren Prize for his master's thesis about public participation in the process of gentrification of urban sprawl. He is author of several articles regarding this matter.

- Karolina Ostrowska, age 27, graduated from Warsaw University of Technology in Architectural Design and from the University of Warsaw with Bachelor's in Mathematics. She will return in the fall for a PhD in Architecture. She participated in the AEC Global Teamwork Project at Stanford in 2012. In 2013, in collaboration with representatives of the University of Warsaw, she developed a concept of revitalization of a pre-war Polish astronomical and meteorological observatory in Chornohora, Ukraine. She is an ArchiCAD trainer and member of BIM Team, a BIM technologies training center authorized by Graphisoft.

- Tina Vilfan, age 29, is writing her thesis on revitalisation of old town cores through temporary usage of space at the Ljubljana Faculty of Architecture. She has been working as an architect at Techline projekt d.o.o. for 5 years and has constructed, managed and built projects. For the past year she has been living in Copenhagen, Denmark where she worked at We Architecture and collaborated on several open architectural competitions. From 2009-2012 she has been a member of Board of European Students of Technology, where she participated and organized international courses. During the faculty she attended 10 workshops focusing from sustainability, urbanism, landscape to revitalisation. She joined the team with participation in the Global Urban Design Course in 2012.

- Dimitris Farmakis, age 28, graduated from Stanford University in 2012 with an M.S. degree in Civil & Environmental Engineering (previous degrees in Business and Operations Research). He participated with the Stanford team and reached the 1st place in the 24th Annual ASC Construction Management competition. At Stanford he was the head Teaching Assistant (TA) for the Building Information Modeling (BIM) courses and also he founded the CEE 224 - Sustainable Development Studio class. After Stanford he founded his startup in Greece offering BIM consulting services and participated as a speaker in two conferences in Greece on Design and Green Buildings. He occasionally teaches remotely at Stanford's BIM courses as a visiting instructor, and works with a Silicon Valley startup on construction scheduling.

- Rob Best, age 26, is a Ph.D candidate in Sustainable Design and Construction program of the Civil and Environmental Engineering department at Stanford University. His research focuses on network planning, integration, and optimization of urban infrastructure systems. He has a B.S. in Engineering from Harvey Mudd College and an M.S. in Civil and Environmental Engineering from Stanford. He was the Design and Construction Manager for the Stanford Solar Decathlon Team, a student-driven project to build a net-zero energy home. Rob is also the Projects and Education Director for Engineers for a Sustainable World, a U.S. based non-profit that advances project-based learning and knowledge-sharing on sustainability and engineering nationwide. In 2010-2011, as a Thomas J. Watson Fellow, Rob researched the socioeconomic and political conditions that foster eco-city development worldwide. He also has experience as a consultant modeling the energy consumption of buildings and urban developments and evaluating the long-term impacts of pollution and hazardous industries.

- Collin Lee, age 24, is a Ph.D. student in Computer Science at Stanford. He received his B.S. from Santa Clara University with a double major in Electrical Engineering and Computer Science and Engineering and M.S. in Electrical Engineering at Stanford. His current research focuses on large-scale distributed systems, and he has a passion for driving the integration of technology to enrich our lives. As the Controls Lead for the Stanford Solar Decathlon Team, Collin headed the interdisciplinary team that designed and implemented the Start. Home's controls and monitoring systems. Collin brings his wide range of experiences from embedded devices to user interface design, emphasizing systems engineering and close collaboration between hardware, software, and design.

CLOUD ARCHITECTURE

MULTIFAMILY SUSTAINABILITY STUDY

INTRODUCTION

The following report is authored by Rob Best, Collin Lee, Derek Ouyang. In this report we will attempt to address the problem of sustainability in multifamily residential buildings in the current political, economical, and technological climate of California, which to our knowledge has not been academically undertaken. While focused on California, many of the insights generated in this report can be applied to other regions with similar characteristics. This report is a work in progress, and we invite interested scholars and practitioners to contribute to its continued development.

While there has been a growth of R&D in energy efficient systems and building controls in the single-family residential industry, most notably represented by the recent forays of both Google and Apple into the home control market, these innovations do not necessarily transfer over to the multifamily building typology, and neither have these newer competitors shown momentum in this direction. At the same time, in the design process of multifamily residential developments, there is still rarely an integrated approach to sustainable and energy-efficient design, largely a result of the fragmented approach to developing real estate, designing architecture, and engineering systems. Thus we are in a critical position in the industry, particularly in California, where the policies are demanding serious energy efficiency measures for future buildings, the economics is finally proving profitable, the technologies are just breaching into exciting new possibilities for sustainable design. But the solutions are not there; neither are the processes.

MARKET POTENTIAL

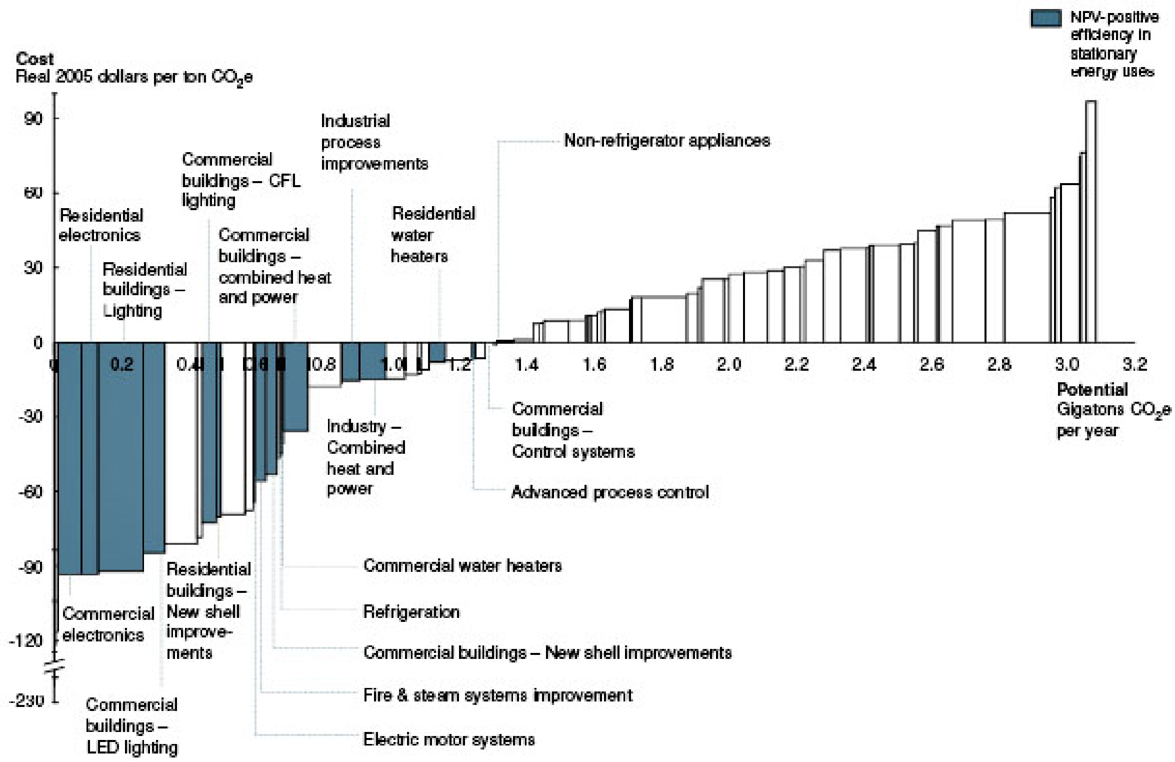
We will first describe the market climate in California, how it is being shaped by very recent political, economic, and technological forces, and the viability of incorporating sustainable and energy-efficient design into multi-family residential projects.

Over the past 20 years, the market demand for certified sustainable space has increased dramatically globally, across the U.S., and within California. In the U.S., this was originally driven by the United States Green Building Council's (USGBC) Leadership in Energy and Environmental Design (LEED) rating system. More recently, state and local codes have driven green building development; California has been the undisputed nationwide leader in this arena.

California adopted the first statewide standard on sustainable buildings in 2008. Known officially as the California Energy Code and colloquially as Title 24, this regulation requires all new buildings to meet energy and water efficiency guidelines through either a prescriptive set of requirements or compliance with performance requirements. These standards apply both to commercial and non-commercial buildings. Historically, California has updated these standards every 2-3 years, requiring ever greater reductions in end-use consumption for compliance.

In addition to Title 24, the state has announced the intent for all new residential buildings to meet on-site net-zero energy standards by 2020. This new regulation will require developers of residential properties to integrate or renewable power generation as part of their architectural and engineering design. Combined with statewide regulations targeting a 33% Renewable Electric Portfolio Standard by 2020, this means that even older properties failing to incorporate renewable power generation and energy efficiency may fail to maintain a competitive edge as the market shifts toward a highly efficient building stock with integrated renewable energy production. Therefore, it makes sense for owners of new buildings today to take steps to stay ahead of the curve and integrate efficient and renewable technologies to stay competitive in a shifting market.

The shift to increased energy efficiency is not only driven by regulatory measures. Studies by the McKinsey Company show that many common energy efficiency measures are obtainable in todays' market with a favorable return on investment (ROI) and a payback period of less than 5 years. The chart below demonstrates this.



For new construction, efficiency measures and sustainable technologies can also typically be incorporated at little to no additional capital cost, meaning that any savings incurred is a direct saving to the building owner and operator. In the case of multifamily residential buildings, these savings are often passed directly to the tenants, creating an added market appeal to the building. However, the owner can also reap the benefits of incorporating energy efficient measures into a building by structuring rental agreements as full-service contracts; this approach has been effectively implemented in Hong Kong, Dubai, and other cities where climatic considerations drive increased efficiency.

Further revenue can be generated throughout the building lifetime from renewable power generation. Current policies in California allow residential rooftop photovoltaic installations to be grid connected and exchange energy with the CAISO grid through the local utility provider at the time of use electricity tariff; credits from selling energy back to the grid can be used within 12 months of generation. While these savings usually reduce tenants or owners' electrical bills, as with efficiency, contract structures can allow the savings to be accrued by the building owner while the cost of electrical service is still paid by tenants. SunRun and Solar City are two examples of California-based companies that operate on this model.

Green buildings also make sense from a marketing point of view. Numerous studies have documented that certified green buildings command 4% lower vacancy rates and $2.42 per square foot higher prices in the commercial market (CBRE). This results in higher rates of occupancy and more revenue generated for the owner. While the residential market has historically lagged in corresponding recognition of the value of green buildings, there are signs that this may be changing; in the U.S. recent market trends show that prices can be as much as 25% higher for green certified apartment buildings (USGBC). As regulations continue driving all buildings toward a higher standard of efficiency and sustainability, the trend toward higher revenues and higher occupancy rates will only continue. Early adopters of green technology will find themselves at the peak of the market and will stand to profit most from the ground swell of civic and private sustainable development.

The market for home automation and control technology in residential construction has also been on the rise. Most of the home automation systems found in residential developments today fall into two rough categories: proprietary monolithic systems, and DIY-style retrofit systems. Historically when approaching new construction, whole systems from one or two vendors are used for every aspect. Companies like Control4 and Lutron provided integrated sets of products that are built into the wall. For larger projects for multi-resident or multi-use facilities, complete commercial products from Johnson Controls, Honeywell, and GE often offer more advanced automation and efficiency features but are lackluster in the user experience domain. For retrofit applications, those homeowners who are particularly adventurous may opt for wireless "ZigBee" based products or other DIY retrofit solutions. The problem with the monolithic systems is that they are generally slower to be updated, mostly because they are prohibitively difficult to physically upgrade. On the other hand, the DIY retrofit style products are easy to upgrade but generally lack the polish of what we come to expect in our consumer electronics. This, however, is all changing. With the introduction of the Nest, we saw the first mainstream push to provide consumer-quality home automation products that are designed for retrofit. This design-for-retrofit aspect is important as it approaches the idea of design for ease of upgrade. With this, we are now seeing a wave of technology moving into a pluggable model of home automation technology. The two main players that have recently announced their position in the ecosystem are Nest with its “Works-With-Nest” and Apple with their announcement of HomeKit. While the technical approach differs between the two, the ultimate goal is the same: to provide a platform where manufacturers of home appliances can participate in the ecosystem and in turn provide an integrated user experience.

MARKET VISION

The life cycle of a building is understood differently depending on the stakeholder. The building itself we hope to last 100 years. But for an individual building owner their ownership usually lasts about 25 years, and for the average occupant the stay in an apartment lease is about 6-7 years. That means that if there are 100 units in a building, each unit will be occupied by about four different families within the client’s ownership of the building. The key question in terms of market vision then becomes: will the fourth set of occupants be getting same value out of the unit as the first set of occupants if the technologies in the unit were innovative 18 years before? And will the next owner of the building buy at a good price if the building’s infrastructure is outdated by 25 years?

A key value proposition to the owner should be to allow the building to retain its value for each succession of new occupants and new owners, meaning there must be flexibility for changes to the building which are still unknown. We believe the key to sustainability and marketability in multi-family residential projects is a level of flexibility that is currently not available. This requires an integrated approach to design and engineering that holistically considers the following areas:

1. **Flexibility in building systems**. The structure and in-wall elements will probably last for the life cycle of the building, but building-wide equipment like central HVAC, tanks, and finishes should be easy to maintain or replace on the order of at least once during the ownership of the building.
2. **Flexibility in occupant devices**. The devices by which the occupant interacts with the building may change at least once in their lease, and certainly may change between occupants to get technology up to date for the market. So these elements (thermostat, appliances, decentralized HVAC, etc.) should be extremely easy to maintain/replace, just like furniture.
3. **Flexibility in management service**. For an unprecedented level of energy-efficient controls and optimization, in fact it’s not just about technology but a critical rethinking of building management. Building owners should consider expanding on the traditional responsibilities of maintenance and management to be more hands-off where technology can take command, but significantly more active in regards to occupant/building service and encouraging energy-efficient behaviors and practices (swapping out old appliances, investing in solar, etc.).

TECHNOLOGY PRINCIPLES

In this section we will cover a series of technological principles which we consider to be fundamental to successful sustainable multifamily developments.

FUTURE-PROOFING

Future-proofing is an approach to building design where individual components are cost-effective to maintain and/or replace relative to their expected life cycle. It requires a level of strategic preparation for technologies that do not yet exist. In that sense, buying a shirt a size slightly too big is a good policy.

In terms of multifamily residential, the process of future-proofing begins with a holistic understanding of the rate of maintenance or replacement for any key elements which cannot be easily replaced by an occupant, such as built-in appliances, lighting systems, centralized building systems, windows, etc. The amount of labor required to fix or replace these elements must then be estimated, including a qualitative description indicating the logistical challenges (e.g. window replacement requires exterior access, large-scale appliance moving may damage floors and baseboards, replacing in-wall wires may require both drywall and painting patchups). Most of these logistical challenges are not considered as part of the design of a building, and so a critical goal of the future-proofing principle is to consider not just the constructability and operability of each element in the building, but also its de-constructability and maintenance.

The effect may be added upfront cost in exchange for reduced operation and maintenance costs over time, but through careful study it may be possible to future-proof a building with no added building cost, and just thoughtful design choices.

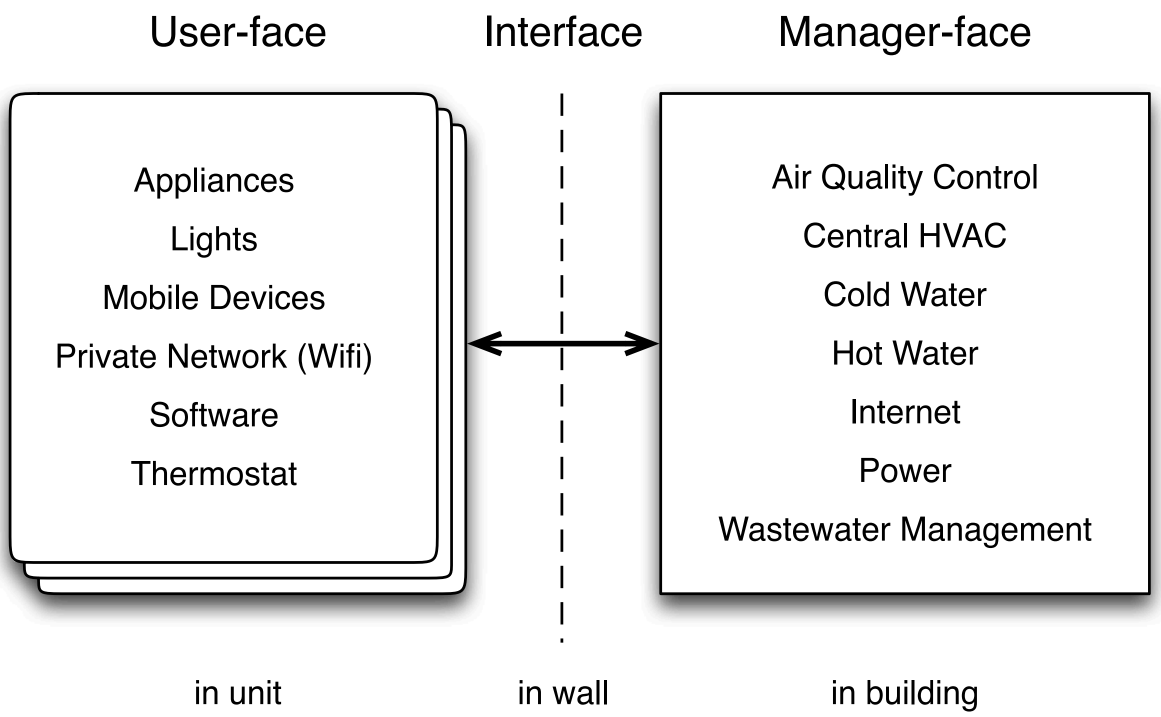
Future-proofing can be thought of as allowing flexibility in building systems or flexibility in occupant devices. In reality these are two sides of the same coin.

As the pace of consumer technology development quickens, consumers themselves are demanding the latest and greatest products at an equally increasing rate. The product life cycles of consumer tech are quickening and consumers like to keep up. Wireless carriers in the United States that previously preferred locking customers into the same device for a two year period are now making extra money selling to customers the “privilege” to upgrade earlier and more often. Upgrades and updates in the consumer tech product happen fast and frequently and consumers have come to expect this from their products. But what happens when you integrate consumer tech with upgrade cycles measured in tens of months into products that traditionally are replaced or upgraded in tens of years?

Let’s take a new car with a top of the line in-dash navigation and media system. Consumers might expect that car to last many years, but after only a year or so, what used to be a top of the line navigation system feels dated and old, even as the rest of the car is perfectly satisfactory. The problem is that there is a mismatch in the lifespan of the car itself and the additional consumer technology within. The solution, then, is to allow customers to upgrade the technology in the car without having to replace the car itself. Today, car manufactures are partnering with technology companies to bring cars to the market that decouple the in-dash technology from the rest of the car. Smartphones with a standardized interface with the car have replaced the built-in systems allow customers to upgrade their in-dash technology as easily and often as they upgrade their phone.

With the predicted adoption of an increasing amount of “smart home” tech, we find the same challenge now making its way to the residential building industry. The typical lifespan of a residential building may be anywhere from 50-100 years; this is an eternity compared to the 2-to-5 year lifespan one might imagine “smart home” tech would have. Without the ability to easily upgrade its technology, buildings with “current hi-tech smart home devices” may begin to feel outdated in less than one tenth of the building’s viable lifespan. It is thus critical that we think thoughtfully about how to design a building that will allow or even facilitate the modular addition or upgrade of technology without requiring a traditional “remodel.”

We separate our design components into three categories; those elements that we would like to allow the resident to change at will, those elements that we would like to allow the building manager to change without greatly interrupting the resident, and those elements that can’t be changed without a traditional remodel. We consider all aspects that might have or are user-facing elements that a resident should be able to change at will. These might be thermostats, lights, appliances, software, or mobile devices. These elements are generally found in the resident's unit. Infrastructure or utility level components and equipment such as centralized HVAC, hot and cold water, internet, or waste management are examples of elements that should be upgradable by the building manager without affecting the user-facing elements previously described. These elements are typically found in some centralized location in the building but outside the units themselves. Lastly, but most importantly, the interface between the resident-supplied "tech" and building-supplied utilities (generally elements built in-wall) must allow the user-facing and manager-facing elements to be upgraded independently. These in-wall elements can't be upgraded easily and thus must be carefully chosen to allow for the flexibility of either end.



In short we can apply 2 key principles when designing the total building systems:

1. Minimal amount of elements should exist in-wall in a fashion that can't be upgraded without a remodel.
2. The interface should be chosen such that there is a minimal dependency between the resident-provided elements and the building-provided utilities except when long-standing standards are used.

C[MEP]

MEP traditionally stands for mechanical, engineering, & plumbing systems within a building. We propose a new terminology, C[MEP], which refers to a holistic control strategy, combining sensors and automatic or manual controls, that can monitor and regulate the MEP systems of a high-tech building to reduce energy consumption and provide greater value to both owner and occupants. Installing sensors in large buildings is becoming increasingly more common, but often is not tied to concrete objectives or even the human resources required to make use of that data. Therefore C[MEP] is named as such to emphasize the goal of controls to regulate building systems, not to provide convenience. C[MEP] is also interconnected with a building management methodology which is discussed in the next section.

The first question in the control environment is, what data is useful from a building owner's perspective? We propose four tiers of importance, in the sense that a limited budget for C[MEP] should be weighted towards solutions in the higher tiers.

1. **Pricing**: For the building owner it is economically valuable to be able to distinguish individual occupant energy use from the overall building use. Therefore, the first tier of monitoring/ metering focuses on what building owners would want to be able to charge for individually by occupant. Some examples are listed below:
- Plug loads
- HVAC loads
- Water use
- Hot water use
2. **Comfort**: This tier is most commonly associated with control systems, namely monitoring of parameters related to comfort conditions that would want to be fine-tuned in control, either by the occupant or by the building owner:
- Temperature and humidity in zones or individual units
- Light levels in zones or individual units
3. **Maintenance**: From a more long-term perspective, monitoring is also valuable to be able to identify when systems should be cleaned, fixed, or replaced for better performance. Some examples include:
- Filters in HVAC system
- Panel performance
4. **Health**: Finally, there may be things worth monitoring to promote awareness, health, or appreciation of quality of environment. This may not relate to any direct profits for the building owner but certainly can be a key marketable factor for occupants.
- Air quality
- Noise

Many companies have commercial products in these areas, but no single system holistically monitors or controls all parameters. Even if a combination of products could handle all control goals on both the user-facing and manager-facing ends, products from different manufacturers are difficult to combine because they are not designed to communicate with competitors, e.g. Lutron and Control 4 or Google Nest and Johnson. Then there is also the issue described earlier of the short life cycle of technologies, which is true of nearly every device within the C[MEP] framework. The in-wall interface is thus the most critical component of any C[MEP] system and is worthy of serious R&D.

The next step is designing MEP systems which are appropriate for the site but also allow for the level of monitoring and control that has been decided. This includes a centralized or decentralized HVAC system, hot water system, and any renewable strategies.

Finally the C[MEP] system must be placed in the hands of a building management that can effectively process the data and guide the control.

BUILDING MANAGEMENT

Just putting the technology and controls in place is inadequate without a building management that can make concrete decisions using that technology. Just as the in-wall interface is the bridge between user-facing and manager-facing technologies, the building manager is a bridge between the building systems and the occupants who benefit from them. Unfortunately, very few building management positions meet the holistic responsibilities that should be expected of them due to the limited business models and risk-averse approach of these companies. This is an even greater issue in the face of new technologies which demand more and more discerning human decision-making and interaction between occupants and owners.

Here are some examples of responsibilities the “Building Manager 2.0” could have:

1. Financial advice for individual occupants on how to best allocate their "investments" into occupant-level and building-level efficiency based on their own use-cases
2. High-level understanding of the C[MEP] system and the ability to act upon critical data like poor HVAC filter quality
3. Allocation of worker responsibilities to not just traditional cleaning but cleaning of solar panels, closing/opening communal windows, etc. A hi-tech building will have specific maintenance and training requirements that did not exist before that technology. These labor roles will take on more responsibility and should be paid better as a result.
4. Record-keeping of the status of all building systems and occupant systems so as to know when something needs to be replaced
5. Strategic scheduling of renovations around occupancy
6. Communication with all occupants in more contemporary means like social media and SMS, dissemination of critical information in real-time
7. Hosting of building-wide events/activities, because fostering community can lower energy consumption through collective buy-in and competition.

SERVICE PRICING

With more granular, distributed electrical metering comes the ability to charge tenants fairly and reliably for the electricity they use. Traditionally, efficiency measures in multifamily residential buildings benefit only the tenants. Efficiency upgrades to building systems are incurred by the owner but reductions in cost are seen by the tenant. This is traditionally known as the problem of "split incentives." However, by metering not just electrical consumption but consumption of end-use services—lighting, cooling, heating, plug loads, etc.—building owners can now structure lease agreements as models of service rather than commodities. This flips the model, incentivizing the owner to provide a level of service (lighting and comfort) at the lowest possible energy consumption. Since the tenant pays for the service rather than the kilowatt-hours of electricity, their price is not reduced as efficiency measures are adopted. Several examples of this service pricing scheme are present in high-rise residential buildings in Hong Kong, and a pilot study for a building in Shanghai is being undertaken with UTC as the service provider.

This model can also be extended to the solar panels on the building. Treatment of renewable energy as a service for a building owner is already a common model in the U.S. through Power Purchase Agreements (PPAs). For a multifamily residential building, a PPA is typically a bilateral agreement between the building owner and the power provider. However, we see the opportunity to use unit-by-unit metering to apportion renewable energy credits to tenants. Using either a flat fee for every unit or a prorated fee based on energy consumption, every tenant could choose to share in the ongoing maintenance of the solar installation and benefit from the "free" electricity. This would spread risk and reward of the installation as well as build social buy-in for renewables within the building. For the owner, this provides an upfront payback for the system, eliminating the longer payback times of the solar installation.

CONCLUSION

This report is in progress and will continue to be developed by the authors. We invite any scholars and practitioners interested in the future of sustainability in multifamily residential developments to contribute to shared research and ideas.

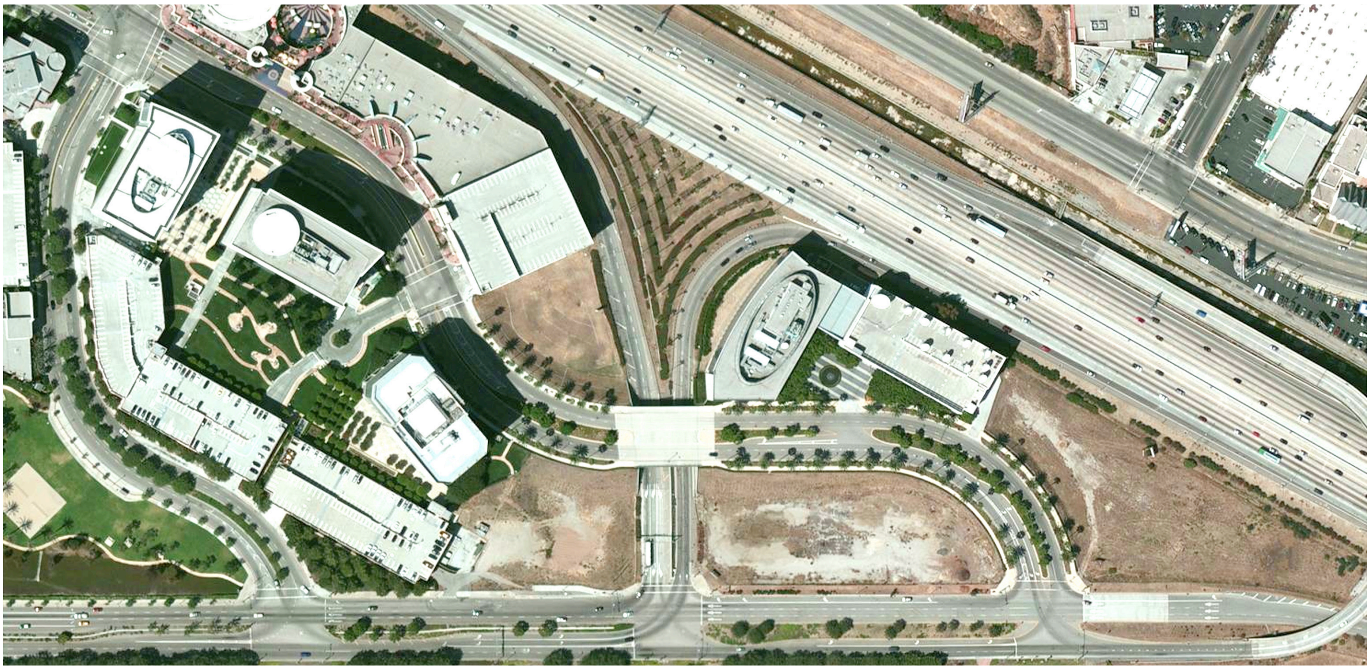
CLOUD ARCHITECTURE

6055 CENTER DRIVE SUSTAINABILITY RECOMMENDATIONS

INTRODUCTION

The following recommendations are provided by Cloud Arch to the client for consideration as part of the 6055 Center Drive project. They are based off of the principles covered in the Multifamily Sustainability Study, primarily approaches to flexibility. Our value as consultants is that we can finetune the building using an integrated design approach to maintain that flexibility over the entire life cycle.

For this first deliverable we will explain how we approach an initial study of the site and what we believe to be the most important principles the client should consider. But at this point, with architectural approach still in development and budget priorities unclear, we cannot reach any final conclusions on systems and technologies, so we will provide our best recommendations as they relate to the baseline design and our own offered design. At this point it is up to the client to decide what direction should be taken. In further (commissioned) development we can work with the client to finalize exactly what systems and technologies are appropriate for the building.



We begin with some climatic considerations referenced from the Pacific Energy Center's Guide to California Climate Zones. The 6055 Center Drive site is located in Climate Zone 6, which is described below by the PEC.

California Climate Zone 6

Reference City:	Los Angeles (LAX)
Latitude:	33.93 N
Longitude:	118.4 W
Elevation:	110 ft

Basic Climate Conditions

	(F)
Summer Temperature Range	15
Record High Temperature (1963)	110
Record Low Temperature (1949)	27

Design Day Data

Winter	99%	41		
	97.5%	43		
Summer	*Mare Island*			
	1%:	83	MCWB	68
	2.5%:	80	MCWB	66

Climatic Design Priorities

Winter: Insulate
Reduce Infiltration
Passive Solar

Summer: Shade
Allow natural ventilation
Distribute Thermal Mass

Title 24 Requirements

Package	*C*	*D*
Ceiling Insulation	R38	R30
Wood Frame Walls	R21	R13
Glazing U-Value	0.42	0.67
Maximum Total Area	14%	20%

Climate

Climate Zone 6 includes the beaches at the foot of the southern California hills, as well as several miles of inland area where hills are low or nonexistent. The Pacific Ocean is relatively warm in these longitudes and keeps the climate very mild. Most of the rain falls during the warm, mild winters.

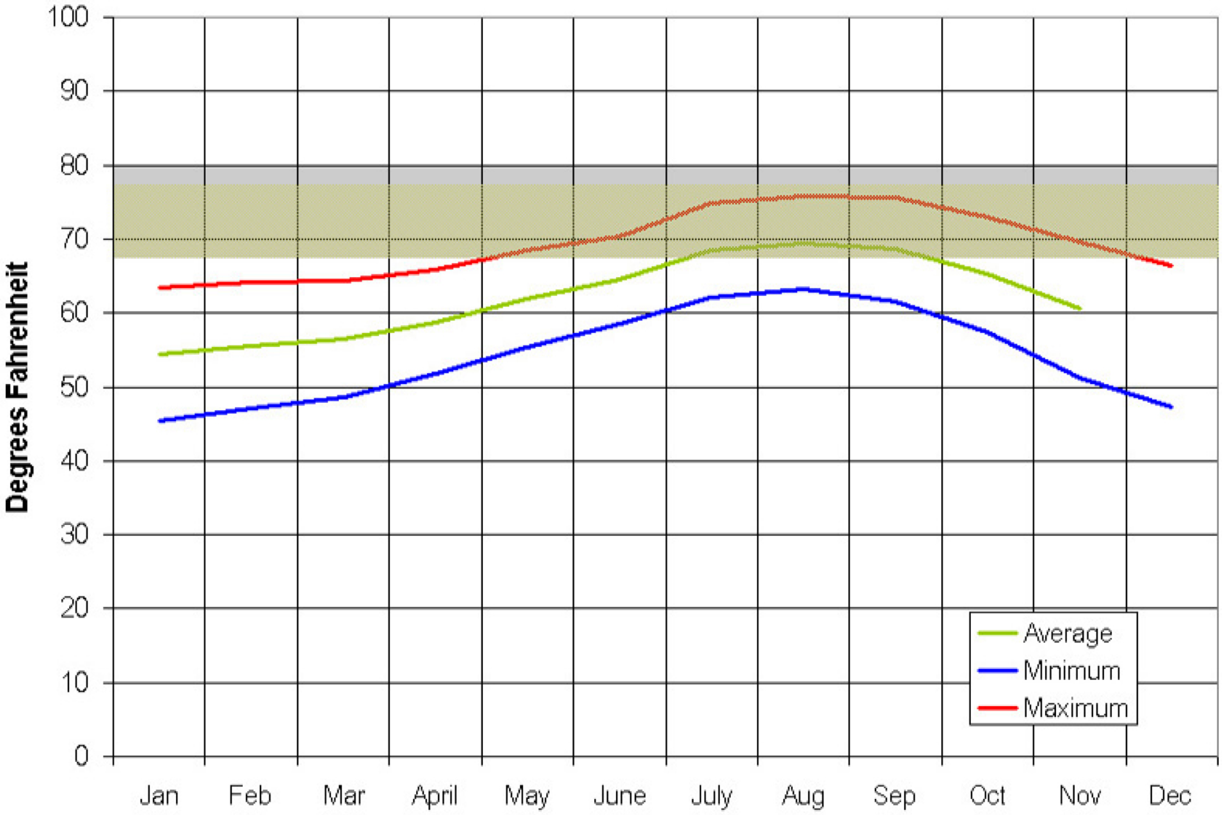
	Santa Barbara	*LAX*	*Long Beach*	*Torrance*
HDD	1902	1458	1430	742
CDD	470	727	1201	568

HDD = Heating Degree Days (base 65F)
CDD = Cooling Degree Days

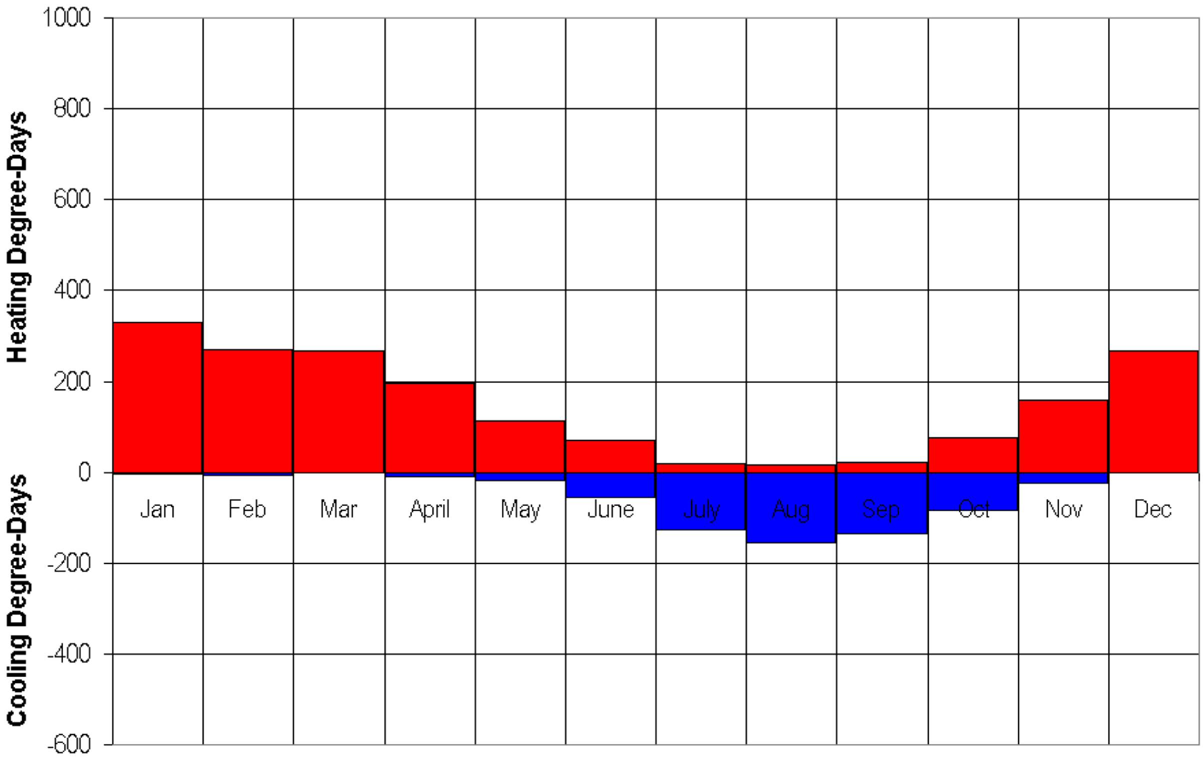
Summers are pleasantly cooled by winds from the ocean. Although these offshore winds bring high humidity, comfort is maintained because of the low temperatures. Occasionally the wind reverses and brings hot, dry desert air.

There is a sharp increase in temperature and decrease in humidity as one leaves the coast. Sunshine is plentiful all year, so solar heating, especially for hot water, is very advantageous. Climate Zone 6 is a very comfortable place to live and therefore requires the least energy of any region in California to achieve thermal comfort levels.

Temperature
(Typical Comfort Zone: 68-80°F)

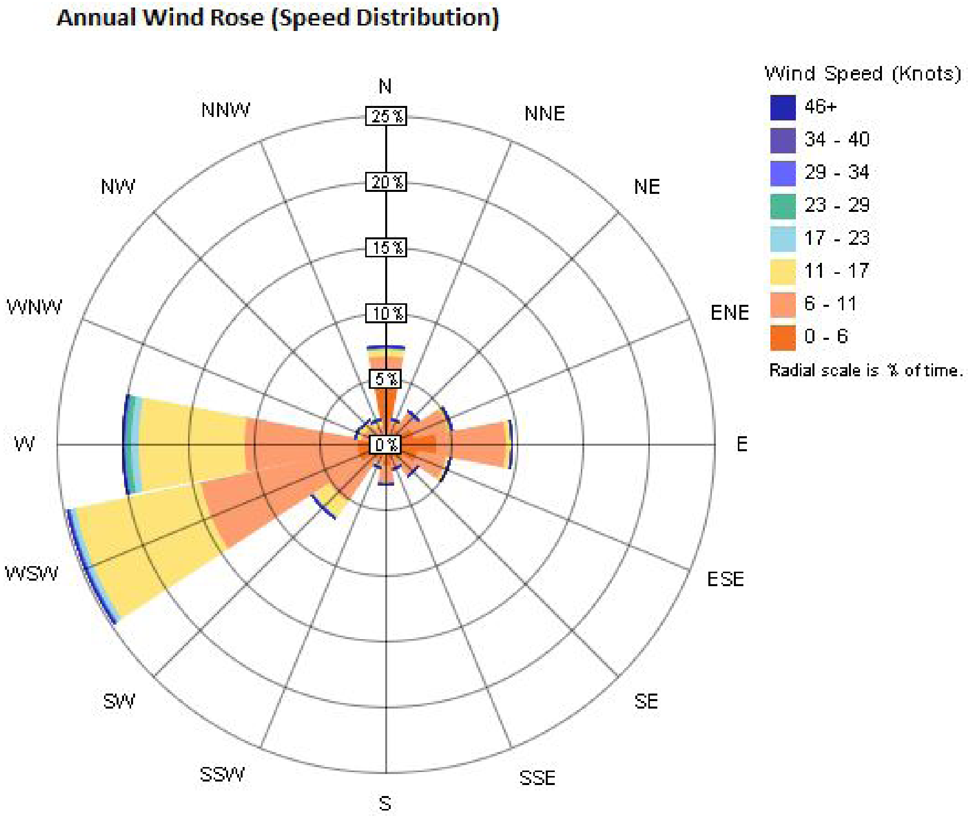


Degree Day
(Base 65°)



While there are more heating degree days than cooling degree days as calculated by weather data, subsequent energy analysis will show that the expected building energy gains through solar radiation and internal occupancy, lighting, and equipment gains largely cover the heating requirements throughout the year. Instead it is cooling against the summer heat which will be the most critical design challenge, typically met through a combination of passive shading, thermal mass, and natural ventilation strategies, as well as active air conditioning.

The chart below shows the annual wind rose, confirming that the wind speed is well within range for natural ventilation strategies. The wind direction is best utilized by creating a building mass or masses with single-loaded narrow widths in the E-W direction, giving occupants the option to open windows on either sides of their units for natural airflow.



Around 25% of the year (for 3 months), winds blow from the WSW direction and 14% (around 1.7 months) of the year they blow from the West. For the most time of the year, wind speed is around 6 – 17knots and very high speed winds blow very rarely.

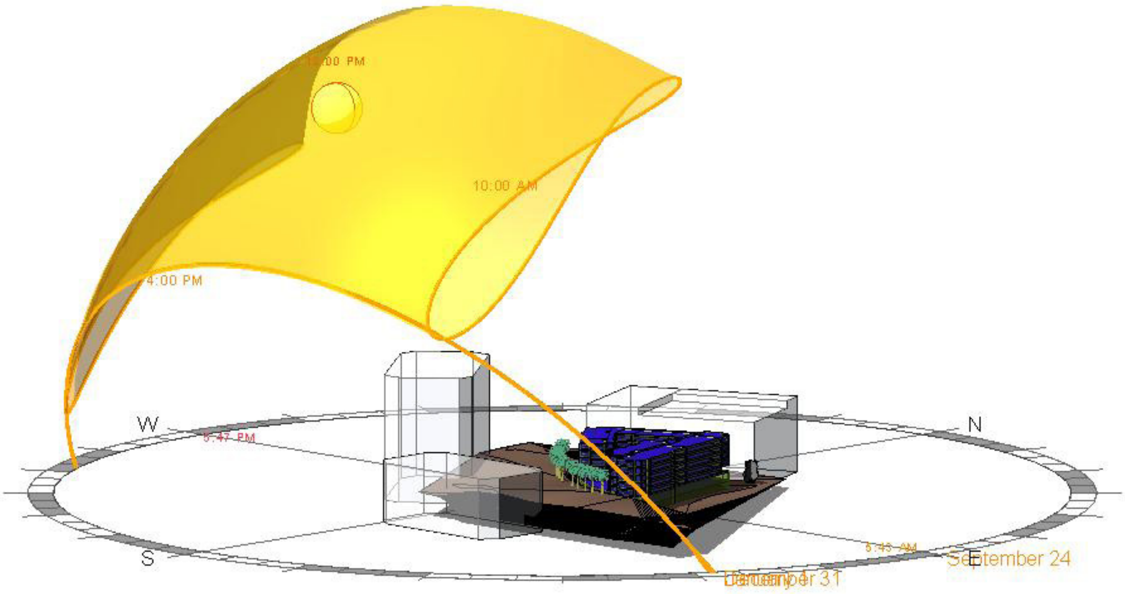
In conclusion, the key environmental advantages on the site are reliable natural ventilation from the W and WSW, high solar insolation year-round, and mild temperatures close to the Pacific coast. These factors suggest that the building can be designed for maximized energy production with a solar array and minimized energy consumption through passive design.

SOLAR RECOMMENDATION

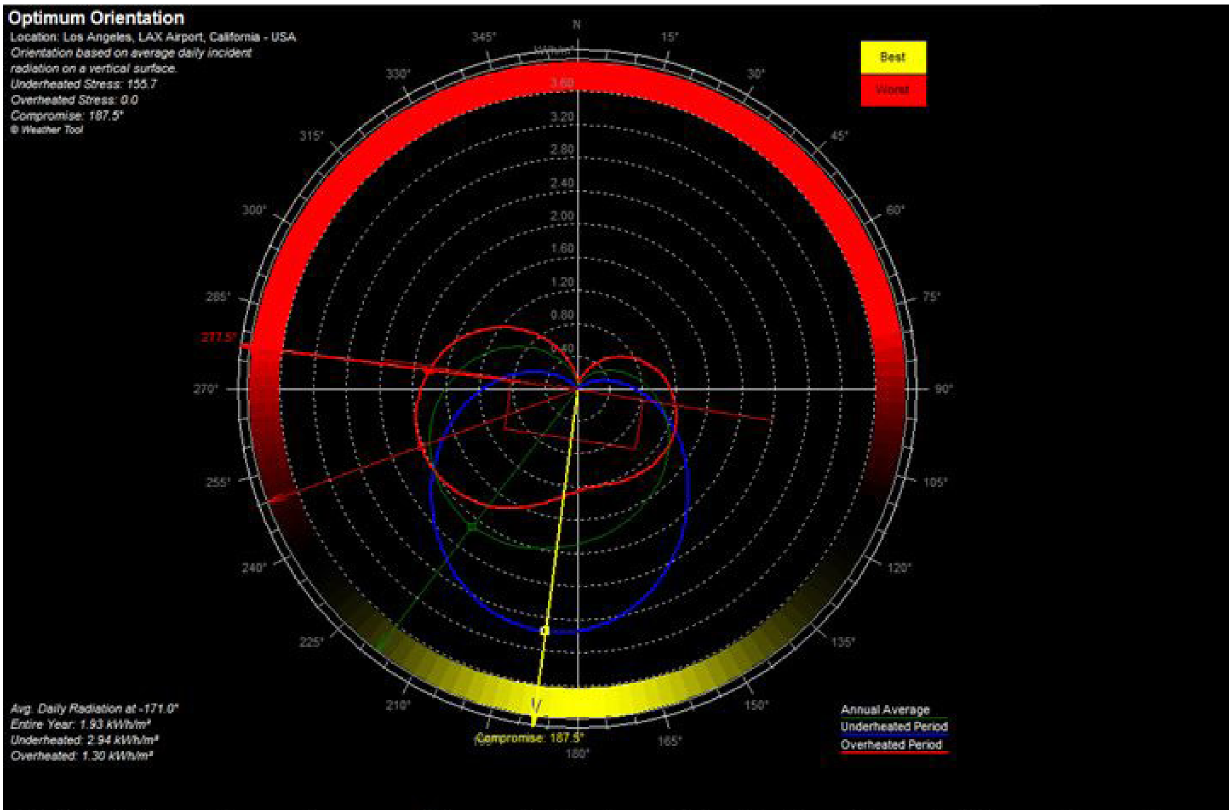
Based on the insights from the Multifamily Sustainability Study, we recommend that the client invest in a sizable photovoltaic panel array for the building.

The solar insolation in Los Angeles in summer is 6.14 kWh/m2/day (Source: http://www.bigfrogmountain.com/SunHoursPerDay.html). The site latitude is 34.5 degrees, but the optimal solar angle is 30 degrees because of balancing the angle of the sun throughout each season and the amount of insolation. Insolation is highest in the summer, when the sun is at its most northern aspect, but to maximize production in shoulder seasons and winter and get the greatest annual energy production, simple analysis shows that the optimal angle of tilt is 30 degrees. Given that pricing for solar feed-in to the grid is fixed in the LADWP service area for residential installation, no advantage is gained from maximizing seasonal solar peak production.

Below is a graphic of the year-round sun path over the site, with maximum solar radiation peaking in the early afternoon. The baseline design features a large roof surface area with PV potential, but some factors must first be carefully considered, including building orientation and shading potential of adjacent buildings.



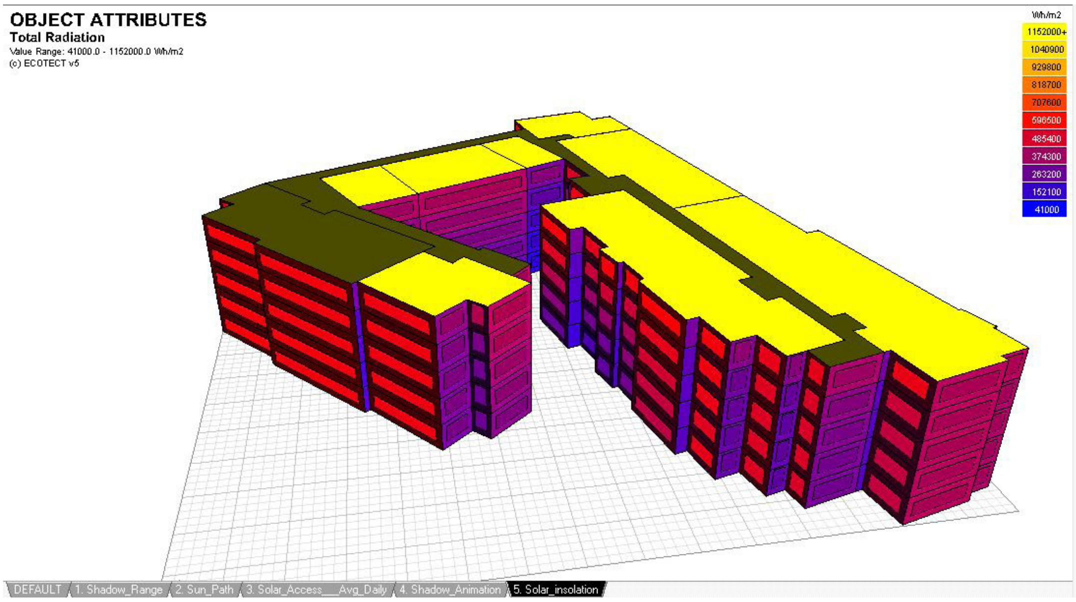
The following chart from ECOTECT analysis software shows the optimum orientation of a rectangular building at the given geo-coordinates, taking into account the solar path. However, note that the optimal is not always practical when confined to a specific site shape, like the client's triangular plot. The baseline design's orientation is poor for both passive solar strategies and optimal PV placement. However, shading devices at glazing locations can mitigate the effects of solar gains during cooling days, and the flat roof allows for solar panels to be installed with orientation independent of the building's orientation.



Good orientation can increase the energy efficiency and reduce the cost of running. The optimum orientation provides maximum winter solar collection (i.e. letting winter sun in) with maximum summer protection (i.e. keep unwanted summer sun out).

There is also a significant shading effect from the tall building SW of the property, which can greatly reduce the efficacy of panels on the W side of the baseline design's roof. To determine whether it is economically viable to install panels in these areas with shading potential, we will need to conduct a thorough tradeoff analysis between the cost of construction and operation of those panels and their expected performance under suboptimal conditions.

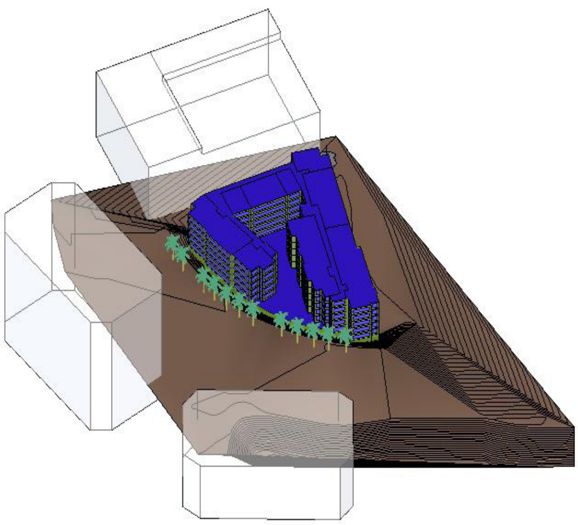
There is also potential shading from new construction south of the site, but based on renders we have seen these buildings appear to be roughly five to six stories tall, which would not have any shading effect on the baseline design. The following is a figure showing radiation on the baseline design's envelope and demonstrates the next steps that would be taken to design a solar array.



At this early stage of architectural design we cannot provide a definitive recommendation for solar panel type, but one good option is the Panasonic HIT panel. Typical payback after rebates is 9-12 years.

ENERGY ANALYSIS

The following energy analysis was conducted using Autodesk software and provides an overview of the environmental site conditions, as well as the expected performance of the baseline design provided by the client. In Section 3 of the deliverable, we will compare this baseline design with an alternative architectural concept.



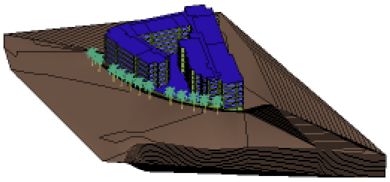
AUTODESK.

LA High Rise - Final Zones (Baseline)

LA High Rise - Final Zones Ins cool roof, low E

Analyzed at 7/12/2014 8:31:19 PM

Energy Analysis Result



Building Performance Factors

Location:	Howard Hughes Pkwy, Los Angeles, CA 90045
Weather Station:	59381
Outdoor Temperature:	Max: 95°F/Min: 40°F
Floor Area:	227,516 sf
Exterior Wall Area:	58,670 sf
Average Lighting Power:	0.70 W / ft²
People:	680 people
Exterior Window Ratio:	0.39
Electrical Cost:	$0.12 / kWh
Fuel Cost:	$0.80 / Therm

Energy Use Intensity

Electricity EUI:	13 kWh / sf / yr
Fuel EUI:	22 kBtu / sf / yr
Total EUI:	66 kBtu / sf / yr

Life Cycle Energy Use/Cost

Life Cycle Electricity Use:	86,970,720 kWh
Life Cycle Fuel Use:	1,506,308 Therms
Life Cycle Energy Cost:	$5,204,340

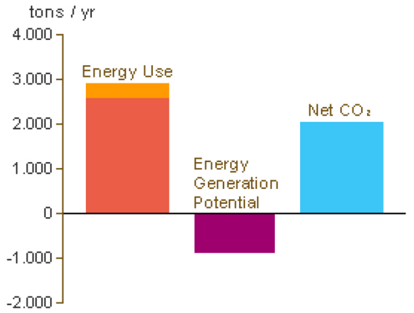
*30-year life and 6.1% discount rate for costs

Renewable Energy Potential

Roof Mounted PV System (Low efficiency):	323,549 kWh / yr
Roof Mounted PV System (Medium efficiency):	647,099 kWh / yr
Roof Mounted PV System (High efficiency):	970,648 kWh / yr
Single 15' Wind Turbine Potential:	1,708 kWh / yr

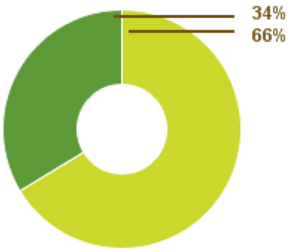
*PV efficiencies are assumed to be 5%, 10% and 15% for low, medium and high efficiency systems

Annual Carbon Emissions



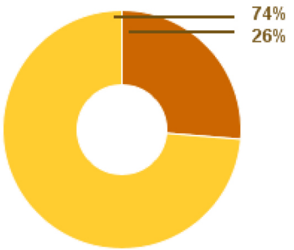
	(tons / yr)
Electricity Consumption	2,607
Fuel Consumption	291
Roof PV Potential (High Efficiency)	-872
Single 15' Wind Turbine Potential	-1
Net CO_2	2,025

Annual Energy Use/Cost



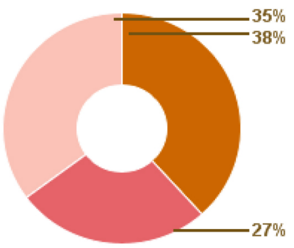
Electricity	66%	$341,795	2,899,024	kWh
Fuel	34%	$40,315	50,210	Therms
		$382,110		

Energy Use: Fuel

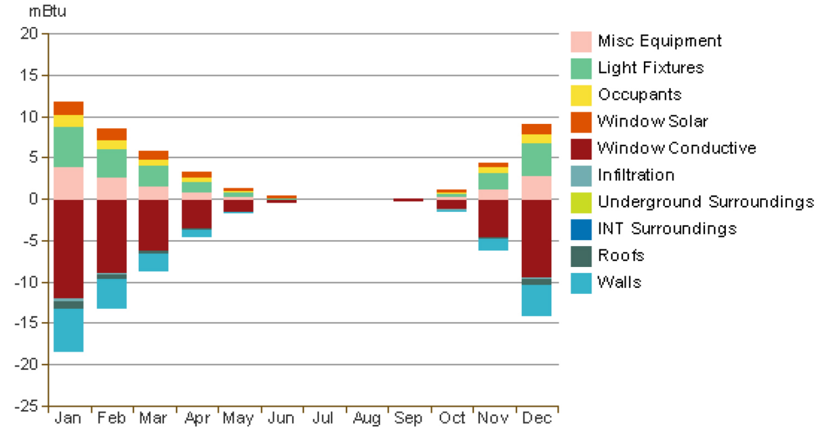


			(Therms)
HVAC	26%	$10,596	13,197
Domestic Hot Water	74%	$29,718	37,012
		$40,314	50,209

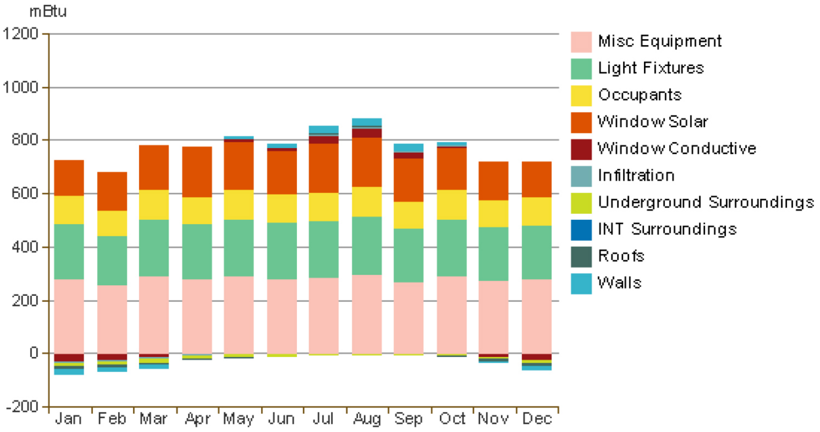
Energy Use: Electricity



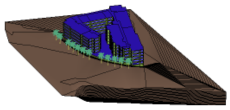
			(kWh)
HVAC	38%	$129,769	1,100,670
Lighting	27%	$89,889	762,418
Misc Equipment	35%	$119,294	1,011,831
		$338,952	2,874,919



Monthly Cooling Load



At the conceptual design phase, we focus our attention on the heating and cooling loads calculated in the energy analysis, as the choices of building massing, shading, and orientation of windows can have a significant passive heating or cooling effect (as well as compound benefits for natural daylighting and natural ventilation). The major results are copied below:

Design Option		Total EUI (Kbtu/ sf/ yr)	Net CO2 (tons/ yr)	Peak Heating Loads – (mBtu) [1]	% of change [2]	Peak Cooling Loads – (mBtu) [3]	% of change [4]	Exterior Wall Area (sf) [5]	Floor Area (sf) [6]	Exterior Window Ratio [7]
Baseline		66	2,025	6	N/A	880	N/A	58,666	227,536	0.39

HVAC SYSTEM

The principal advantages of central air conditioning systems are better control of comfort conditions, higher energy efficiency and greater load-management potential. The main drawback is that these systems are more expensive to install and are usually more sophisticated to operate and maintain.

The principle advantages of decentralized air conditioning systems is lower initial costs, simplified installation, no ductwork or pipes, independent zone control, and less floor space requirements for mechanical room, ducts and pipes. A great benefit of decentralized systems is that they can be individually metered at the unit. Disadvantages are short equipment life (10 years), higher noise, higher energy consumption (kW/ton) and are not fit where precise environmental conditions need to be maintained.

In general, central systems provide better quality of indoor parameters and energy efficiency. However, central systems are costly to build but the operating costs tend to be low on large systems. The decentralized systems are suitable for small or medium sized buildings free of multiple thermal zones and demanding 100 TR or less of air-conditioning. For intermittent use buildings there is a growing trend to select a combination of central plant and packaged or split units to meet the overall functional requirement of the buildings.

At this early phase of design, to allow for the greatest flexbility in the design, we recommend equipping the building with at least one centralized duct per unit into the main space, including the ground floor communal zones, and also providing a decentralized heat pump system in the private quarters of each unit, but this decision will require further design development.

CENTRALIZED SYSTEMS	**DECENTRALIZED SYSTEMS**
APPLICATIONS	
The central systems are used when large buildings, hotels, theaters, airports, shopping malls etc are to be air conditioned completely. The largest capacity of chiller available in market is 2000 tons; multiple chillers are installed to cater for higher loads or to create redundancy in operation. Often a “hybrid system” which is a combination of a central plant and decentralized packaged units/split units is preferred. For example, a hotel may use packaged unitary air conditioners (or fan coil units served with air-water central system) for the individual guest rooms, roof top units for meeting rooms/restaurants, and a Central plant system for the lobby, corridors and other common spaces.	Decentralized systems are more appropriate for low to mid-rise buildings. Also in a building where a large number of spaces may be unoccupied at any given time, such as a dormitory or a motel, decentralized systems may be preferred since these can be totally shut off in the unused spaces, thus providing potential energy savings. Decentralized unit capacities range from 0.5 ton to 130 tons (for roof top package units). If decentralized systems are chosen for large buildings, multiple package units may be installed to serve an entire building. This may be an advantage, since each system can be well matched to the interior space that it serves. Decentralized systems can be also be applied for augmenting the cooling needs in the central HVAC systems necessitated due to expansion or addition of more equipment.

CENTRALIZED SYSTEMS	**DECENTRALIZED SYSTEMS**
ZONING	
Central air conditioning systems may serve multiple thermal zones* and can have as many points of control as the number of zones. [*A thermal zone is referred to a space or group of spaces within a building with heating and cooling requirements that are sufficiently similar so that desired conditions (e.g. temperature) can be maintained throughout using a single sensor (e.g. thermostat or temperature sensor). Each thermal zone must be 'separately controlled' if conditions conducive to comfort are to be provided by an HVAC system]	Decentralized (DX) systems are only suitable for single thermal zone application. The reasoning is as follows: DX systems do not provide modulating control. The capacity control in DX system with fully hermetic sealed compressor is generally accomplished by cycling the compressor ON and OFF in response to the signals from a thermostat. What this means is that the DX system will only have one point of control – typically a thermostat. Thus two rooms with thermostat controllers set at say 22°F and 28°F shall conflict with each other or in other words the two rooms cannot achieve the set conditions unless the rooms are served with independent units. Multiple units are required for multiple zones.
INDIVIDUALIZED CONTROL	
In a central system, the individual control option is not always available. If individual control is desired, the system shall be designed as variable air volume system (VAV). A variable air volume (VAV) system primarily alters the air delivery rates while keeping the fixed off-coil temperatures. Constant air volume (CAV) systems alter the temperature while keeping the constant air delivery. CAV systems serving multiple zones rely on reheat coils to control the delivered cooling. This incurs lot of energy wastage due to simultaneous cooling and heating.	Decentralized systems offer room-by-room control, which provides greater occupant comfort through totally individualized control options -- if one room needs heating while an adjacent one needs cooling, two decentralized systems can respond without conflict. Heating and cooling capability can be provided at all times, independent of other spaces in the building.

CENTRALIZED SYSTEMS	**DECENTRALIZED SYSTEMS**
EFFICIENCIES	
Central HVAC systems deliver improved efficiency and lower first cost by sharing load capacity across an entire building. A central chilled water system using high efficiency water cooled chillers typically provide greater energy efficiency, but efficiency and stability of operation is compromised when only a small proportion of space is using air conditioning. Chiller efficiency is typically defined in terms of kW/ton and/or its coefficient of performance (COP). The COP is the ratio of output BTU's divided by the input BTU's. If the nominal rating of the chiller is 1 ton of refrigeration capacity, equivalent to 12,000 Btu/hr output, and the input energy is equivalent to 1 kW, or 3,413 Btu/hr, the resulting COP is 12,000/3,413 or 3.52.	Decentralized systems have high kW per ton compared to chiller systems. But in buildings where a large number of spaces may be unoccupied at any given time, the units may be totally shut off in the unused spaces thus providing potential energy savings. Federal law mandates a minimum efficiency of 10 SEER* for both split and packaged equipment of less than 65,000 Btu/h capacities. The American Society of Heating, Refrigeration and Air Conditioning Engineers (ASHRAE) recommend 10 EER* for equipment between 65,000 and 135,000 Btuh. ASHRAE standard 90.1 recommends other efficiencies for larger equipment. It is often cost effective to pay for more efficient equipment. For example, upgrading from a 10 SEER to a 12 will reduce cooling costs by about 15 percent. Upgrading from a 10 to a 15 reduces cooling costs by about 30 percent.
SYSTEM FLEXIBILITY	
Chilled water systems are the engineered systems that are generally supplied as the custom built units. These can be fabricated to suit the designer application and the air delivery rate can be sized irrespective of the refrigeration capacity. The cooling coils in a central plant can be custom designed to handle higher latent loads and thus provide better control over moisture. The cooling coils can be selected for high rows deep (6 or 8 row deep coil provide enhanced surface area) for effective condensate removal.	Decentralized systems usually provide fixed air delivery rate of 400 cubic feet per minute (cfm) per ton of refrigeration. Decentralized systems cannot be networked conveniently. The refrigerant piping plays a key role in connection of various components in terms of size, length and pressure drop. Split units installation is restricted by distance criteria between the condensing unit and the evaporator, which is usually 30 to 40 feet for smaller units and around 100 to 120 feet for larger units. The size of the cooling coil and condenser coils is standard generally factory fixed and is typically 3 or 4 row deep.
LIFE EXPECTANCY	
Central systems have longer life. The economic life for reciprocating compressor chillers is normally 15 years, while screw and centrifugal chillers have an expected economic life of 25 years.	Decentralized systems generally have a much shorter useful life (8-10 years).

CENTRALIZED SYSTEMS	**DECENTRALIZED SYSTEMS**
ECONOMY OF SCALE	
Central air conditioning systems offer opportunities of economies of scale. Larger capacity refrigeration equipment is usually more efficient than smaller capacity equipment and require lower capital expenditure over 100TR.	Decentralized systems do not benefit from economies of scale. Capital costs and the operating costs generally tend to be higher for larger setups requiring 100TR or more.
MAINTENANCE	
Grouping and isolating key operating components in mechanical room allows maintenance to occur with limited disruption to building functions.	Decentralized systems maintenance tends to be simple but such maintenance may have to occur directly in occupied spaces.
PLENUM SPACE	
Central systems require plenty of plenum space above false ceiling to accommodate the air distribution system. This results in increase to floor to floor height and consequent building costs. False ceiling to hide the air distribution system may add more costs. Adequate load bearing beams and columns must be available for lifting and shifting of such equipment.	Decentralized systems can be arranged without false ceiling or plenum space. By saving the false ceiling void the resulting building slab to slab height can be lowered by almost 20%. Costs are lower due to less assembly of component ducting etc. However interference to the façade is high.
LOAD DIVERSITY	
Central systems can be designed zone wise with significant diversity (70-80%) in overall plant load capacity.	The decentralized systems being small are designed for full peak load. No diversity is taken on design.
INSTALLATION COSTS	
The installation cost of a central plant is much higher because • Main air conditioning equipment is heavy and voluminous requiring strong foundations, heavy lifting and proper material handling facility at site. • Some equipment requires extra care during installation to ensure minimum vibrations and smooth operation. • Larger quantities of ducting, piping, insulation and false ceiling are required.	Decentralized system provides simple and faster installation. These are easy to install and less time consuming since standard size units are readily available. Replacements can be carried out very fast.

CENTRALIZED SYSTEMS	DECENTRALIZED SYSTEMS
MAINTENANCE COSTS	
The breakdown, repair, replacement and maintenance cost of central plants can be expensive and time consuming. However, the frequency of such breakdown is quite low. These systems require routine inspection and planned checks. Daily operation also adds to the running cost, as trained operators are required. Maintenance costs are difficult to predict since they can vary widely depending on the type of system, the owner's perception of what is needed, the proximity of skilled labor and the labor rates in the area. A recent survey of office buildings indicated a median cost of $0.24 per sq. ft per year.	The decentralized system repair cost per breakdown is normally low. With the emergence of reliable hermetic and scroll compressors, their maintenance expenditure has shown remarkable improvements and is less time consuming and simple. Roof mounted packaged units typically have maintenance costs of 11% or higher than a central plant system serving the same building.

References from this section:

- Gauthier Nathan, "Building Systems – HVAC and Lighting" presentation, ENVR 119, October 19, 2009
- Bhatia A., "Centralized vs Decentralized Air Conditioning Systems", http://www.cedengineering.com/

CLOUD ARCHITECTURE

6055 CENTER DRIVE ARCHITECTURAL CONCEPT

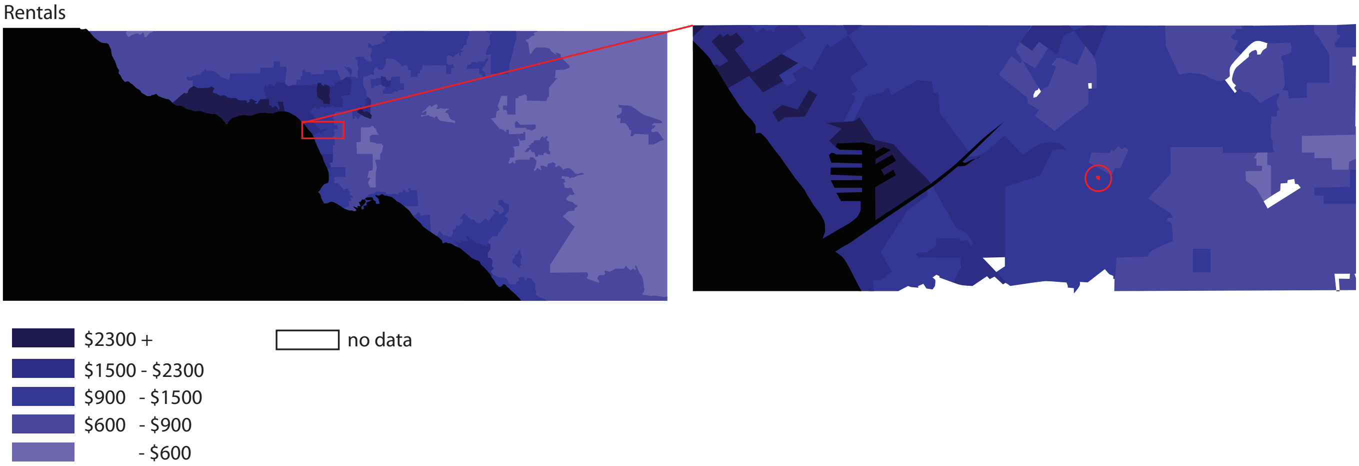
INTRODUCTION

The following concept was created by Cloud Arch Studio as its own personal approach to 109 apartment units on the given site. The design takes into account the principles of the Multifamily Sustainability Study as well as the specific sustainability recommendations for the site, which we believe are best integrated as part of the conceptual design phase.

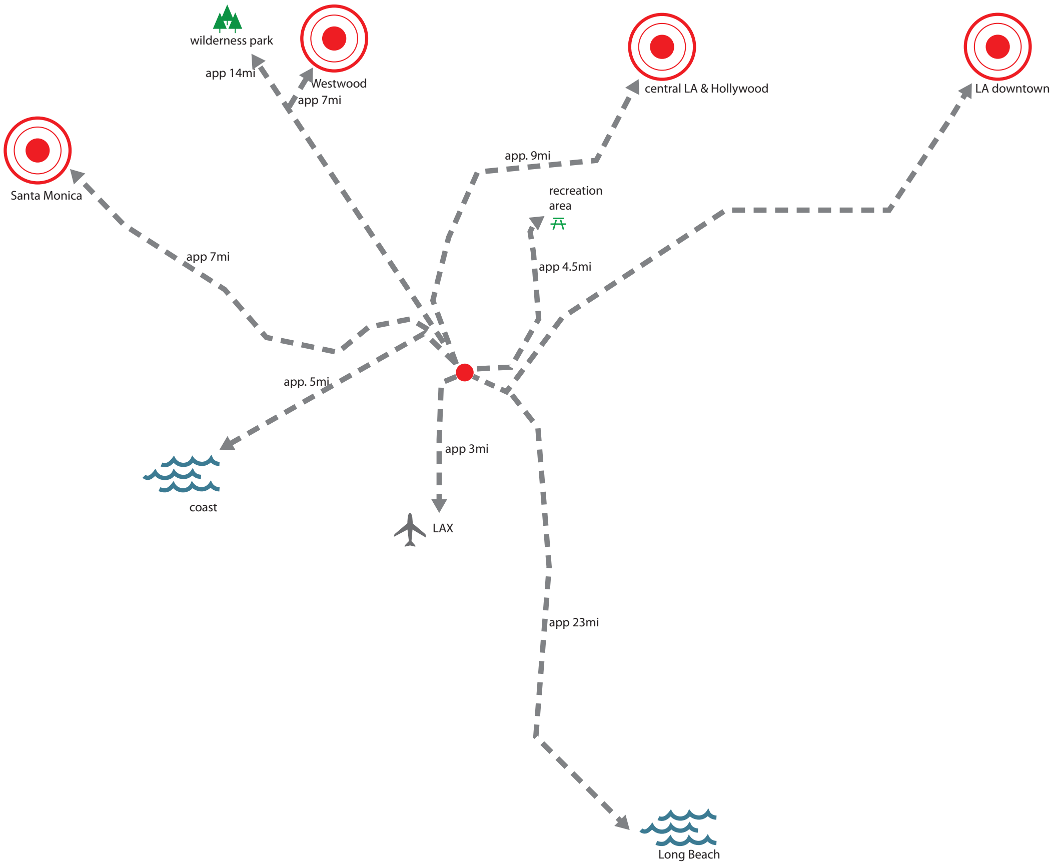
SITE ANALYSIS

The client described the target market as young singles and couples looking for high professional and leisure opportunities. Initial economic analysis via the heat map shown below confirms that the site falls within a region of lower rental price ($900-1500 per month) than other competitively attractive areas of Los Angeles, such as Santa Monica and West LA, while still providing strong transport connections along the 405 freeway to locations such as Venice Beach, Long Beach, LAX, Westwood, Santa Monica, downtown, and more. From a marketing perspective this suggests that the client is in a position to seriously market to young rental seekers in Los Angeles with this high value property.

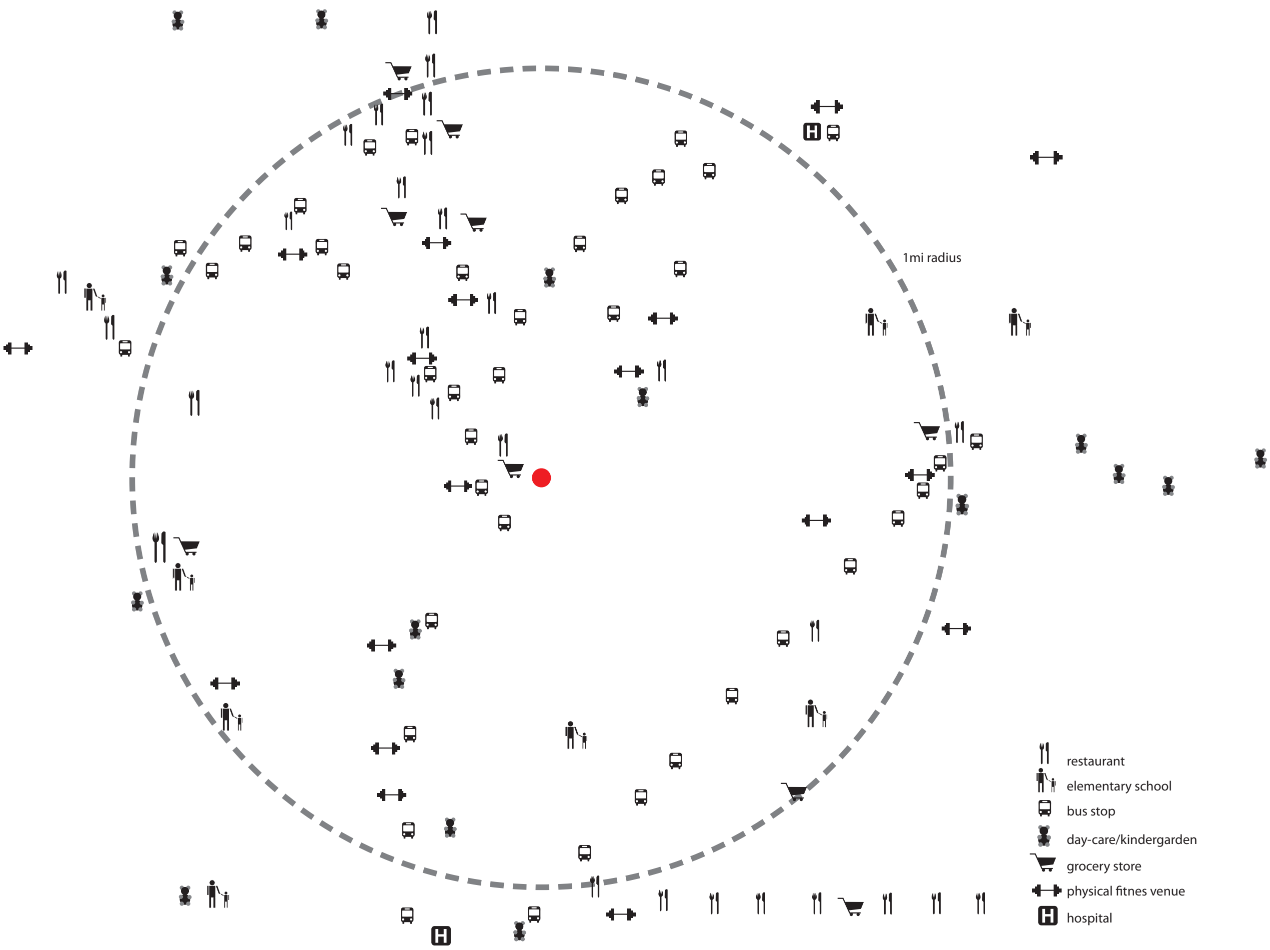
Rentals



http://www.trulia.com/home_prices/California/Los_Angeles-heat_map/



From a closer inspection of the Westchester locale, we find that the region also provides many marketable benefits for occupants. We compiled a list of key services that may be valuable to young couples or families within a mile (short car commute) of the site, including dining & entertainment (primarily from the adjacent Howard Hughes Promenade Center), shopping (a variety of local department stores and malls), daycares, and schools.



Google **food** near **Center Dr**

A. Rubio's Fresh Mexican Grill
6081 Center Dr #216, Los Angeles, CA
(310) 417-5080
3.6 9 reviews $

B. Wild Thai Restaurant
6081 Center Dr #209, Los Angeles, CA
(310) 215-0209
3.5 12 reviews $$

C. Johnny Rockets
6081 Center Dr #109, Los Angeles, CA
(310) 670-7555
3.2 9 reviews $

D. Kabuki Japanese Restaurant
6081 Center Dr #203, Los Angeles, CA
(310) 641-5524
3.4 32 reviews $$

E. The Hummus Factory
6081 Center Dr #218, Los Angeles, CA
(310) 410-9999
4 reviews $

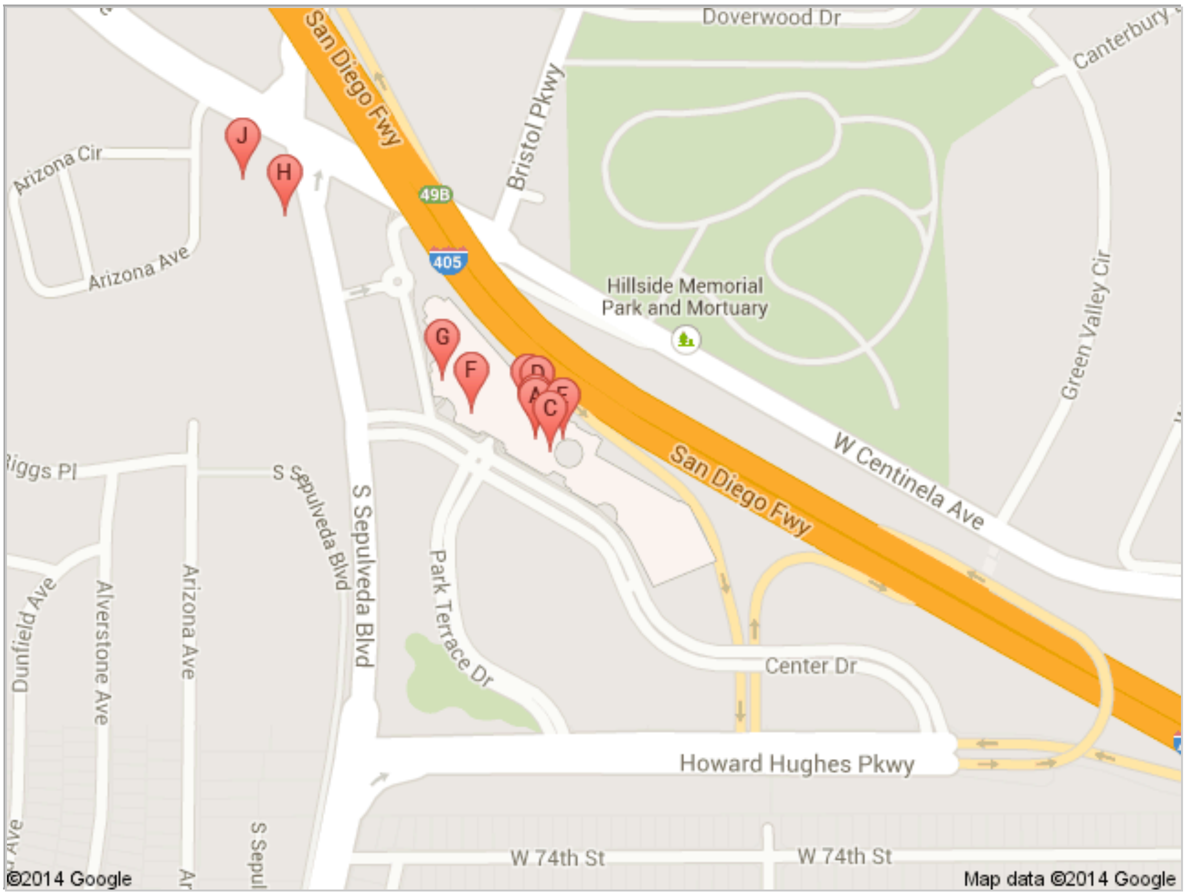
F. Islands Restaurant
6081 Center Dr #104, Los Angeles, CA
(310) 670-8580
3.9 9 reviews $

G. Souplantation
6081 Center Dr #102, Los Angeles, CA
(310) 665-1144
3.8 10 reviews $

H. Dinah's Family Restaurant
6521 S Sepulveda Blvd, Los Angeles, CA
(310) 645-0456
3.4 60 reviews $$

I. SUBWAY® Restaurants
6081 Center Dr #206, Los Angeles, CA
(310) 568-2777
2 reviews $

J. Viva Fresh Mexican Grill
6515 S Sepulveda Blvd, Los Angeles, CA
(310) 338-9153
4.1 20 reviews $



Google **bus station** near **Center Dr la**

A. Centinela / Green Valley
United States

B. Howard Hughes Pkwy/Park Terrace Dr
United States

C. Howard Hughes Center
United States

D. Park Terrace / Howard Hughes
United States

E. Howard Hughes Center
United States

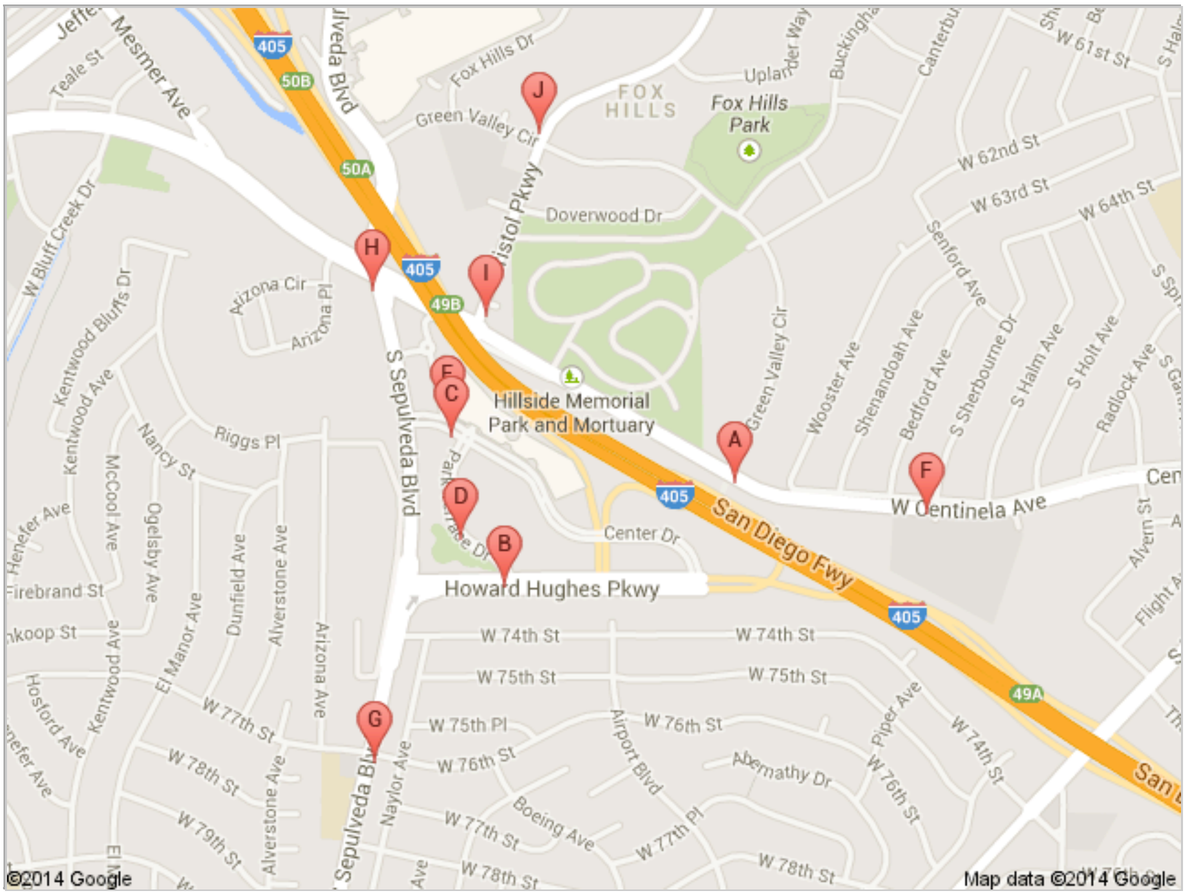
F. Centinela / Sherbourne
United States

G. Sepulveda Blvd/76th St
United States

H. Sepulveda Blvd/Centinela Ave
United States

I. Bristol / Centinela
United States

J. Bristol Pkwy/Green Valley Cir
United States



daycare near **Center Dr**

A. Westchester Lutheran School
7831 S Sepulveda Blvd, Los Angeles, CA
(310) 670-5422
1 review

B. Montessori Academy of Culver City
5881 Green Valley Cir, Culver City, CA
(310) 215-3388
2 reviews

C. Children of Our Savior Preschool
6705 W 77th St, Los Angeles, CA
(310) 215-3166
2 reviews

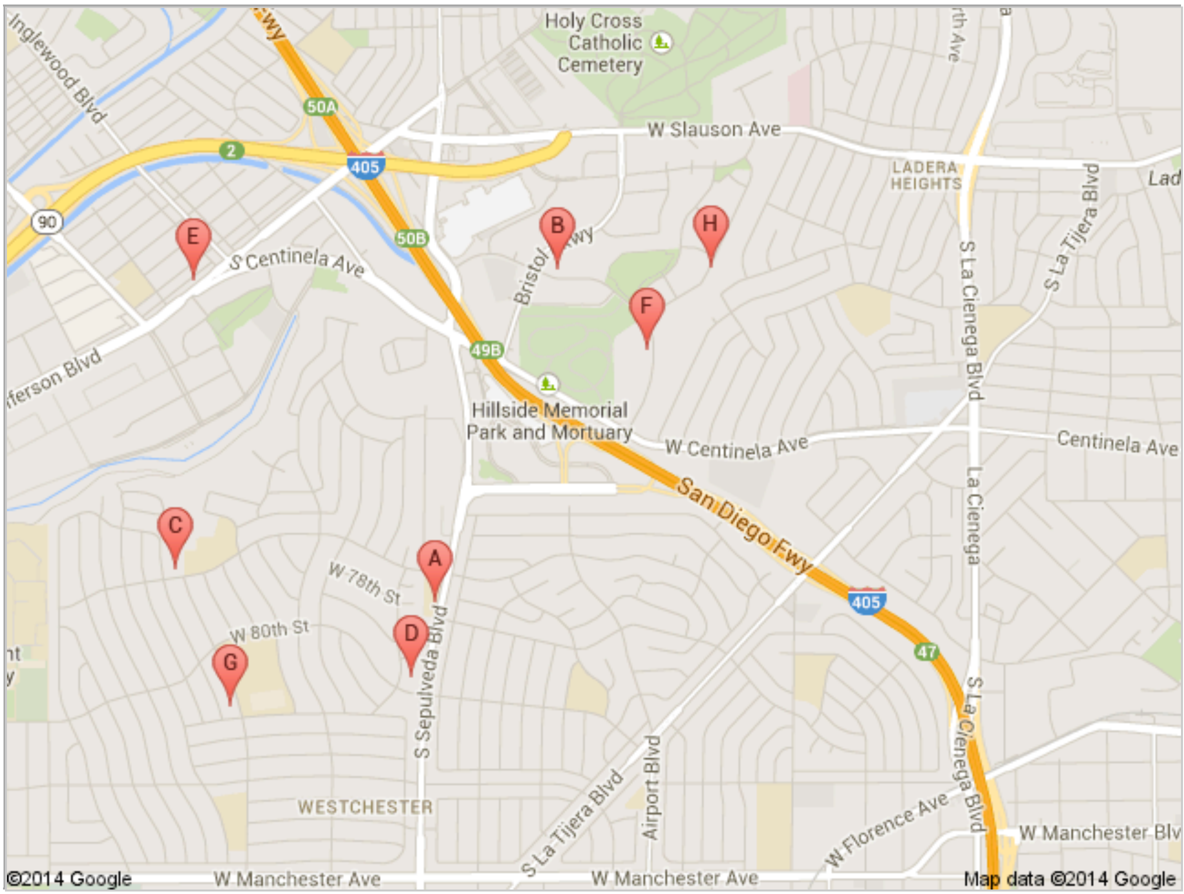
D. Covenant Presbyterian Church Preschool
6323 W 80th St, Los Angeles, CA
(310) 670-5758

E. Gan West Preschool
12053 Jefferson Blvd, Culver City, CA
(310) 391-9800
3 reviews

F. Pacifica Montessori School Inc
6443 Green Valley Cir, Culver City, CA
(310) 417-3087
3 reviews

G. Escuela Plus Elementary
8065 Emerson Ave, Los Angeles, CA
(323) 309-5018
1 review

H. Ozone Family **Daycare**
6120 Canterbury Dr #100, Culver City, CA
(310) 924-7533



elementary school near **Park Terrace Dr**

A. Cowan Avenue **Elementary School**
7615 Cowan Ave, Los Angeles, CA
(310) 645-1973
2 reviews

B. Westport Heights **Elementary School**
6011 W 79th St, Los Angeles, CA
(310) 645-5611
2 reviews

C. Playa Del Rey **Elementary**
12221 Juniette St, Culver City, CA
(310) 827-3560
2 reviews

D. Kentwood **Elementary School**
8401 Emerson Ave, Los Angeles, CA
(310) 670-8977

E. Frank D. Parent K-8 **School**
5354 W 64th St, Inglewood, CA
(310) 680-5430
4.0 ★★★★☆ 7 reviews

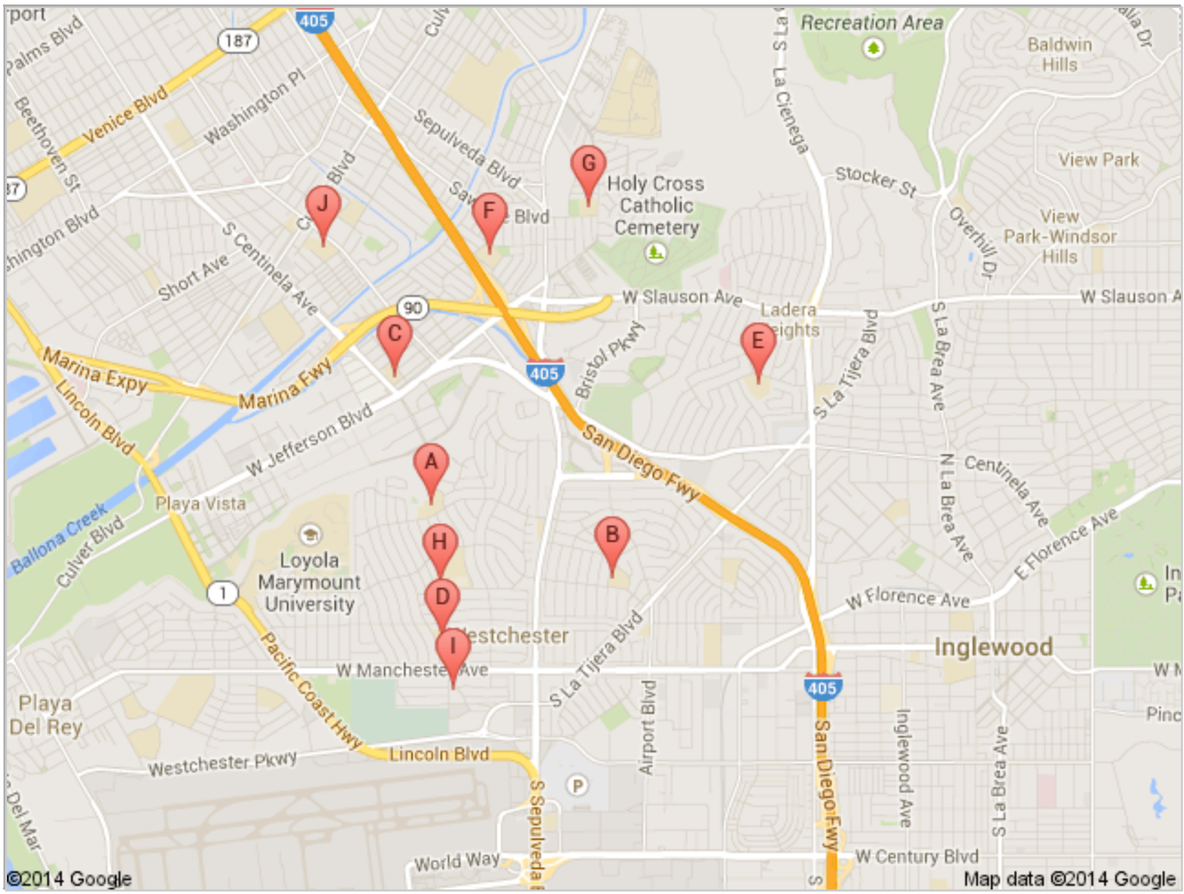
F. El Marino **Elementary School**
11450 Port Rd, Culver City, CA
(310) 842-4241
4.4 ★★★★★ 8 reviews

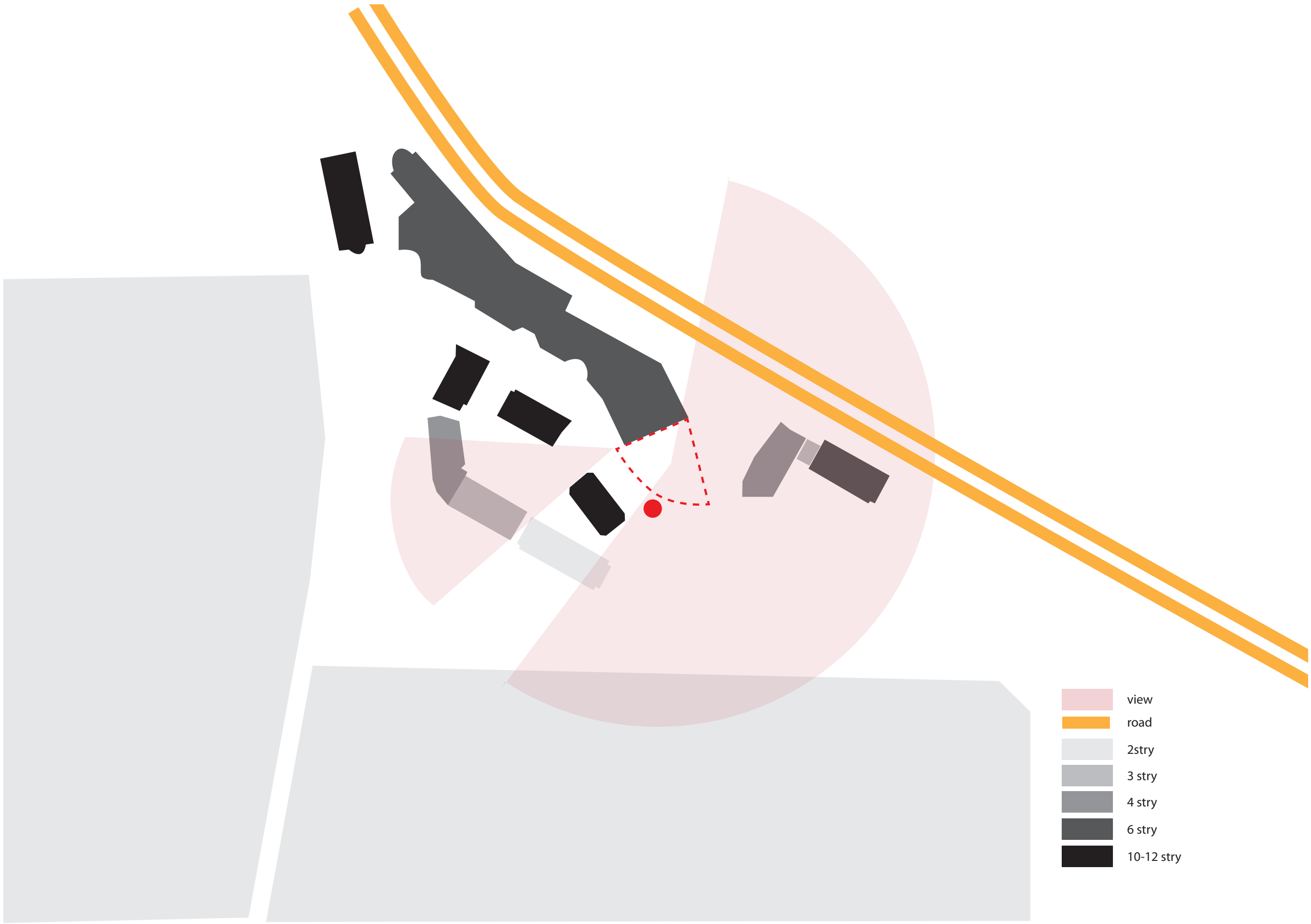
G. El Rincon **Elementary School**
11177 Overland Ave, Culver City, CA
(310) 842-4340
4.6 ★★★★★ 5 reviews

H. Escuela Plus **Elementary**
8065 Emerson Ave, Los Angeles, CA
(323) 309-5018
1 review

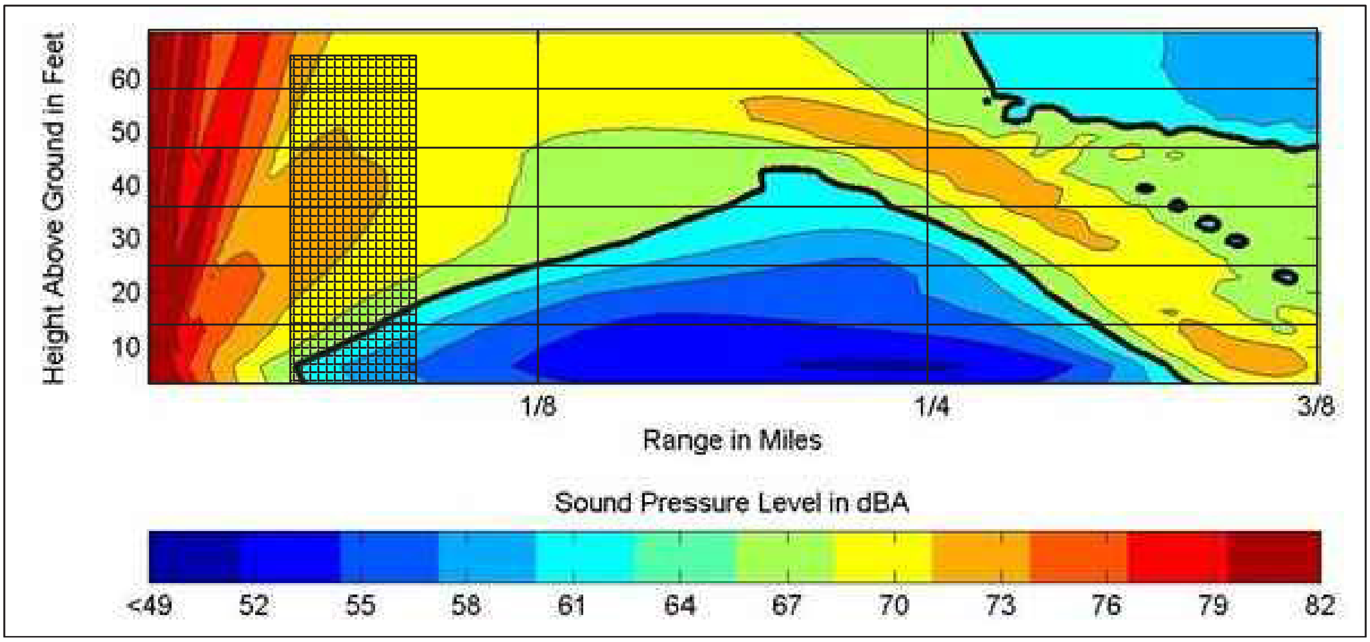
I. Visitation **School**
8740 Emerson Ave, Los Angeles, CA
(310) 645-6620

J. Braddock Drive **Elementary School**
4711 Inglewood Blvd, Los Angeles, CA
(310) 391-6707
3 reviews





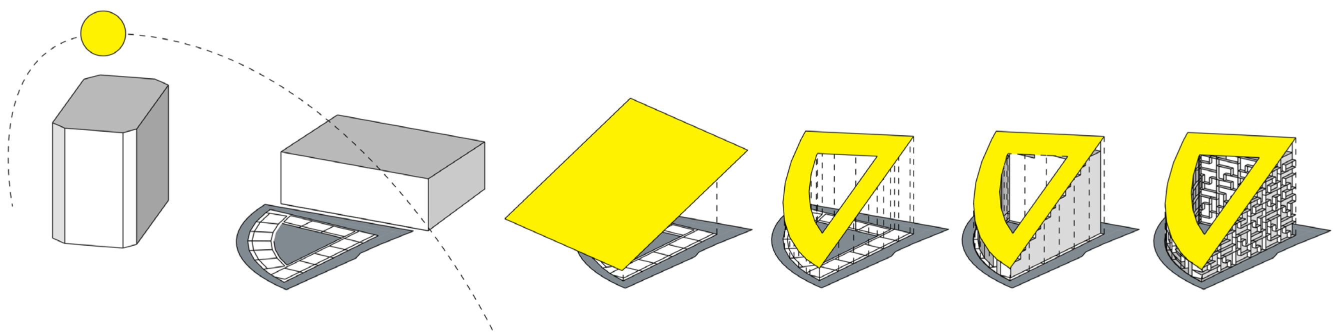
At an even closer scale to the immediate site context, we see some potential challenges, namely views and noise. As seen in the figure above, a significant section of views is blocked by the tall building directly southwest of the site (we also saw earlier that this presents problems of shading for possible photovoltaic systems). Below we see the a building mass positioned on a diagram of sound pressure in dBA as a function of height and distance from a ground source, such as the 405 freeway. Units above ground floor face serious noise disturbances in the 70-75 dBA range and will require some form of noise mitigation if openings are to be had towards the east.

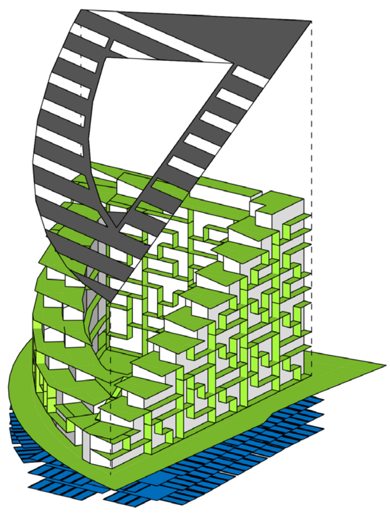


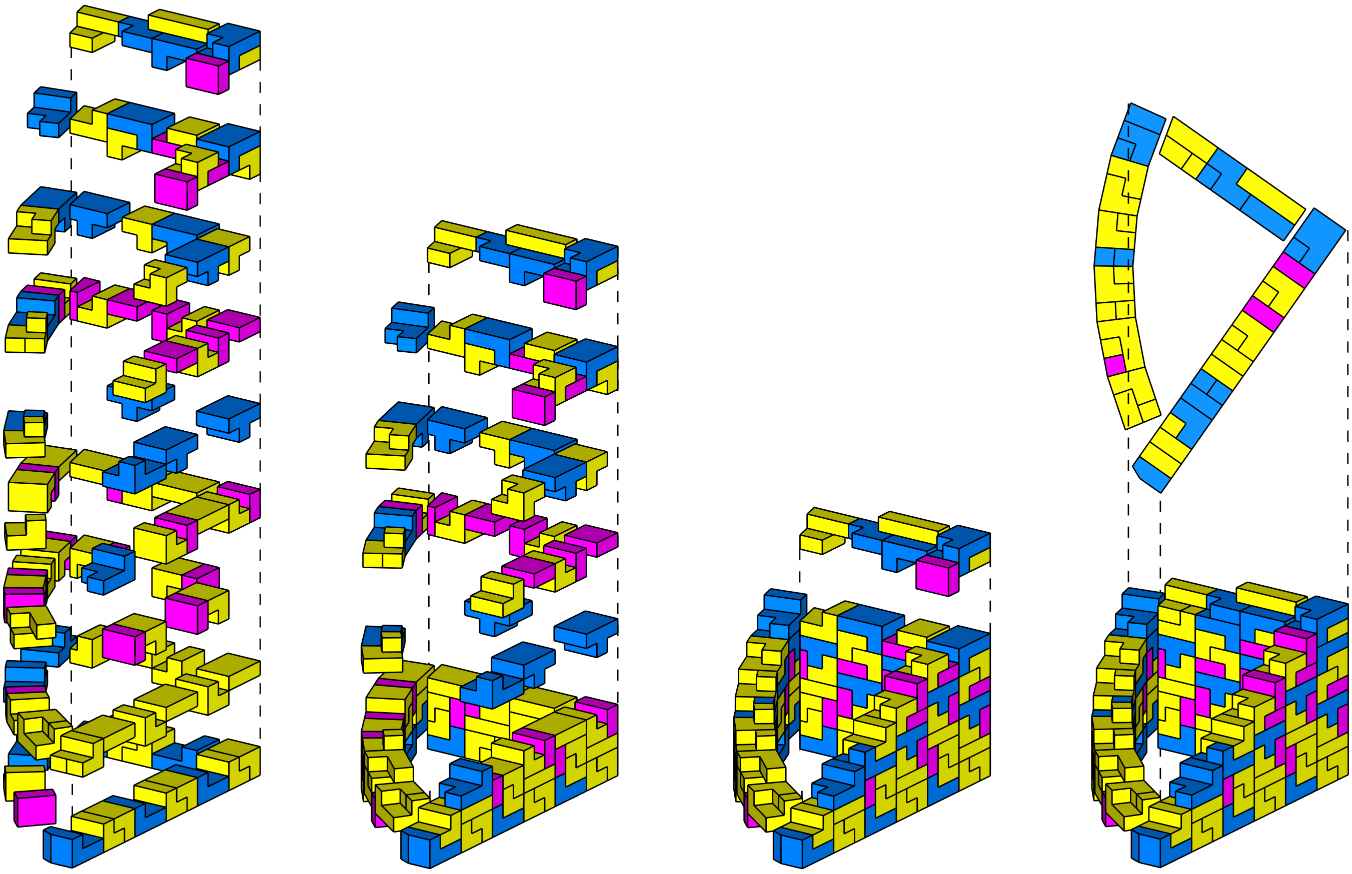
CONCEPTUAL DESIGN

The following diagram shows the series of formal moves taken to create the massing of the building.

1. A floor plan is first generated on the site, maximizing footprint within the setback boundaries, maintaining a single-loaded depth of 26ft around a triangular courtyard, and aligning to a 12ft structural grid. This allows for 45 “units” on a single floor plate, which can be combined in 2/3/4 unit duplex configurations to create studios (624 sqft), 1-BR units (936 sqft), and 2-BR units (1248 sqft). Exterior circulation is placed on the interior of the courtyard on the W and E to direct balcony views outward, while the corridor is placed towards the adjacent garage on the N side to direct the quality views southward.
2. Directly above this floor plan, a solar plane is established facing directly south at a 30 degree angle, which was determined to be optimal for solar incidence. The goal is for the roofscape to match this plane as closely as possible to maximize solar production.
3. The floor plan is projected onto the solar plane to create the “roof icing” which achieves this maximum solar production from the usable building roof space. The structural grid is maintained to support this skin.
4. A pattern of tetris-like units is generated from ground floor to the underside of the roof skin. The units are tetris-shaped such that corridors can be reduced to just every other level, lowering construction costs.
5. Balconies and corridors are attached exterior to the massing to reduce heating/cooling requirements and add additional shading to each facade.
6. The icing is divided up to allow premium roof terraces views outward, a balance of PV and unit value. Landscaping is placed in these areas to manage rainwater runoff.



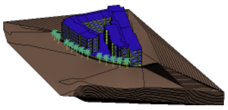
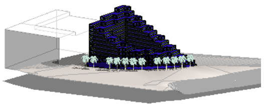
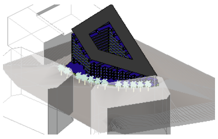
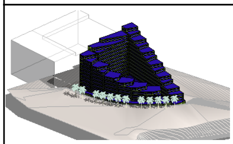
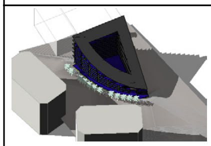
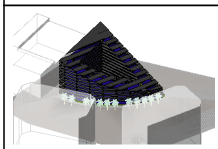
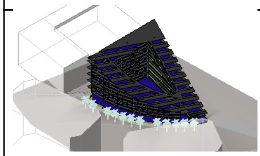


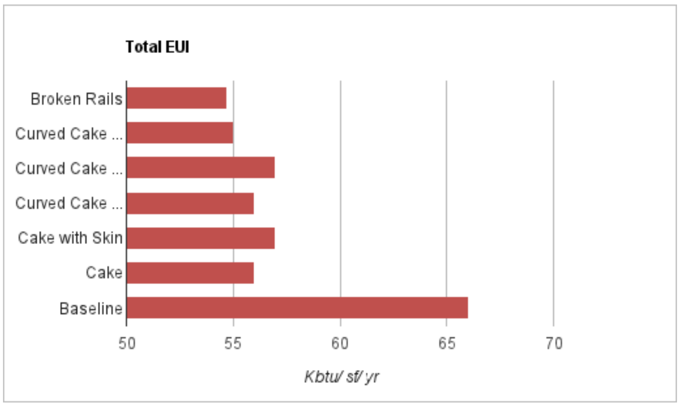


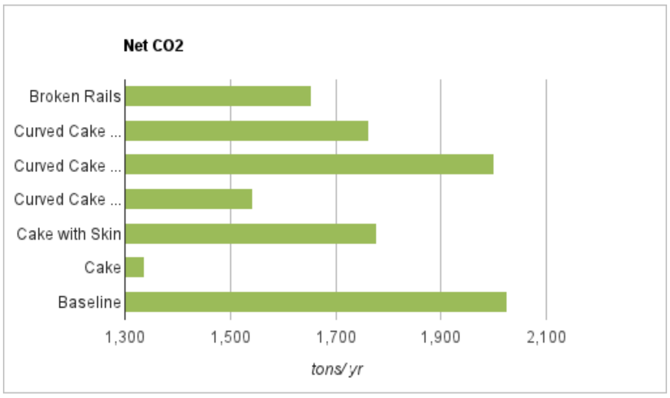
ENERGY ANALYSIS

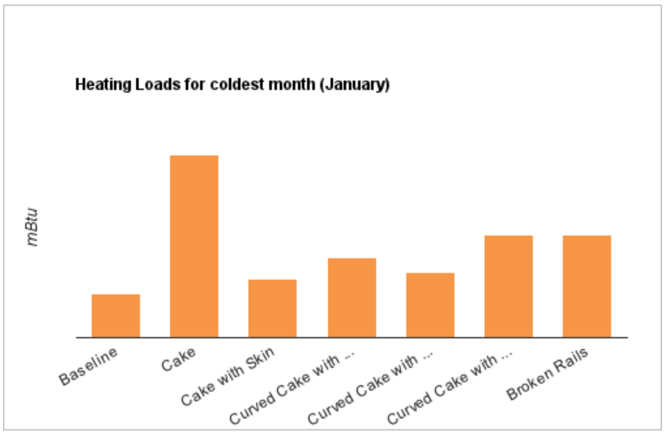
This architectural concept was developed over a series of iterations which were each compared to the baseline design in terms of energy performance. Because of limited time we were not able to conduct cost estimates for each iteration, but we documented the total exterior wall surface area, total floor area, and window/wall ratio as simple metrics for percentage cost increase/ decrease. In further developments we can go through a thorough cost estimate for both the baseline and our final concept, Broken Rails.

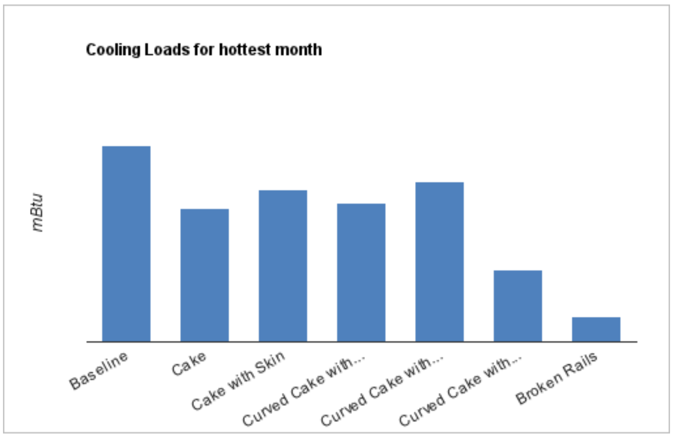
LA Highrise – Design Options Performance Comparison

Design Option		Total EUI (Kbtu/ sf/ yr)	Net CO2 (tons/ yr)	Peak Heating Loads – (mBtu) [1]	% of change [2]	Peak Cooling Loads – (mBtu) [3]	% of change [4]	Exterior Wall Area (sf) [5]	Floor Area (sf) [6]	Exterior Window Ratio [7]
Baseline		66	2,025	6	N/A	880	N/A	58,666	227,536	0.39
Cake		56	1,338	25	316.67%	760	−13.64	79,200	210,339	0.4
Cake with Skin		57	1,779	8	33.33%	795	-9.66%	79,200	210,339	0.4
Curved Cake with Shading		56	1,543	11	83.33%	770	−12.50	105,268	231,650	0.22
Curved Cake with Skin		57	2,000	9	50.00%	810	-7.95%	105,268	231,650	0.22
Curved Cake with Folded Skin		55	1,762	14	133.33%	640	−27.27	100,527	212,450	0.25
Broken Rails		54.7	1,655	14	133.33%	550	−37.50	97,836	201,200	0.23









Over each iteration of the design, we were able to reduce the total energy use intensity, which primarily meant reducing the cooling loads in the cooling climate. As shown below, a direct comparison of the baseline design to our Broken Rails design yields an annual cumulative cooling load reduction of almost 50%.

Annual Cumulative Heating & Cooling Loads								
	Baseline design				Broken Rails design			
Month	Heating Loads (mBtu)	Annual Cumulative	Cooling Loads (mBtu)	Annual Cumulative	Heating Loads (mBtu)	Annual Cumulative	Cooling Loads (mBtu)	Annual Cumulative
January	6	6	640	640	14	14	345	345
February	5	11	610	1250	13	27	320	665
March	2.5	13.5	750	2000	7.5	34.5	390	1055
April	1.3	14.8	770	2770	3	37.5	425	1480
May	0.2	15	800	3570	0.3	37.8	460	1940
June	0	15	785	4355	0.1	37.9	460	2400
July	0	15	845	5200	0	37.9	520	2920
August	0	15	880	6080	0	37.9	550	3470
September	0.3	15.3	785	6865	0	37.9	485	3955
October	0.3	15.6	788	7653	0.4	38.3	465	4420
November	1.5	17.1	705	8358	1.5	39.8	400	4820
December	5.5	22.6	655	9013	10.5	50.3	365	5185

Annual Cumulative Cooling Load reduction:	−42.47%

The full Autodesk energy analysis is shown on the following pages.

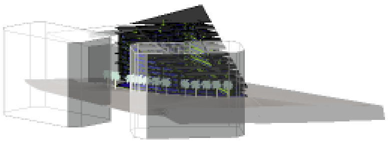
AUTODESK.

LA High Rise - Design Options skin

LA High Rise - Brails Updated glaze (1)

Analyzed at 8/29/2014 3:21:47 PM

Energy Analysis Result



Building Performance Factors

Location:	Los Angeles, CA
Weather Station:	59381
Outdoor Temperature:	Max: 95°F/Min: 40°F
Floor Area:	201,201 sf
Exterior Wall Area:	97,836 sf
Average Lighting Power:	0.70 W / ft²
People:	467 people
Exterior Window Ratio:	0.23
Electrical Cost:	$0.12 / kWh
Fuel Cost:	$0.80 / Therm

Energy Use Intensity

Electricity EUI:	11 kWh / sf / yr
Fuel EUI:	18 kBtu / sf / yr
Total EUI:	55 kBtu / sf / yr

Life Cycle Energy Use/Cost

Life Cycle Electricity Use:	65,515,110 kWh
Life Cycle Fuel Use:	1,066,825 Therms
Life Cycle Energy Cost:	$3,895,689

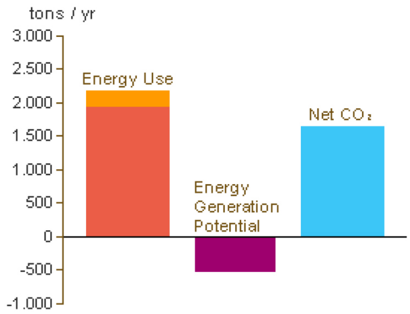
*30-year life and 6.1% discount rate for costs

Renewable Energy Potential

Roof Mounted PV System (Low efficiency):	190,817 kWh / yr
Roof Mounted PV System (Medium efficiency):	381,635 kWh / yr
Roof Mounted PV System (High efficiency):	572,452 kWh / yr
Single 15' Wind Turbine Potential:	1,708 kWh / yr

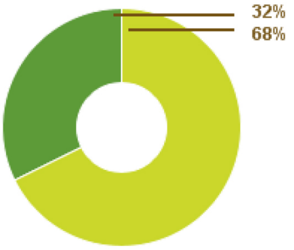
*PV efficiencies are assumed to be 5%, 10% and 15% for low, medium and high efficiency systems

Annual Carbon Emissions



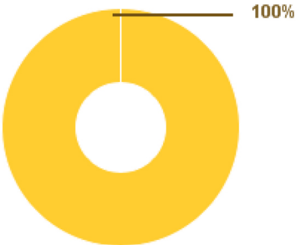
	(tons / yr)
Electricity Consumption	1,964
Fuel Consumption	206
Roof PV Potential (High Efficiency)	-514
Single 15' Wind Turbine Potential	-1
Net CO_2	1,655

Annual Energy Use/Cost



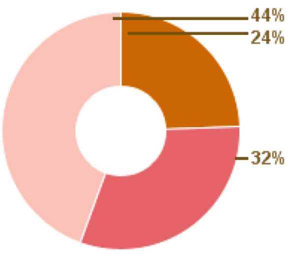
Electricity	68%	$257,474	2,183,837	kWh
Fuel	32%	$28,553	35,560	Therms
		$286,027		

Energy Use: Fuel

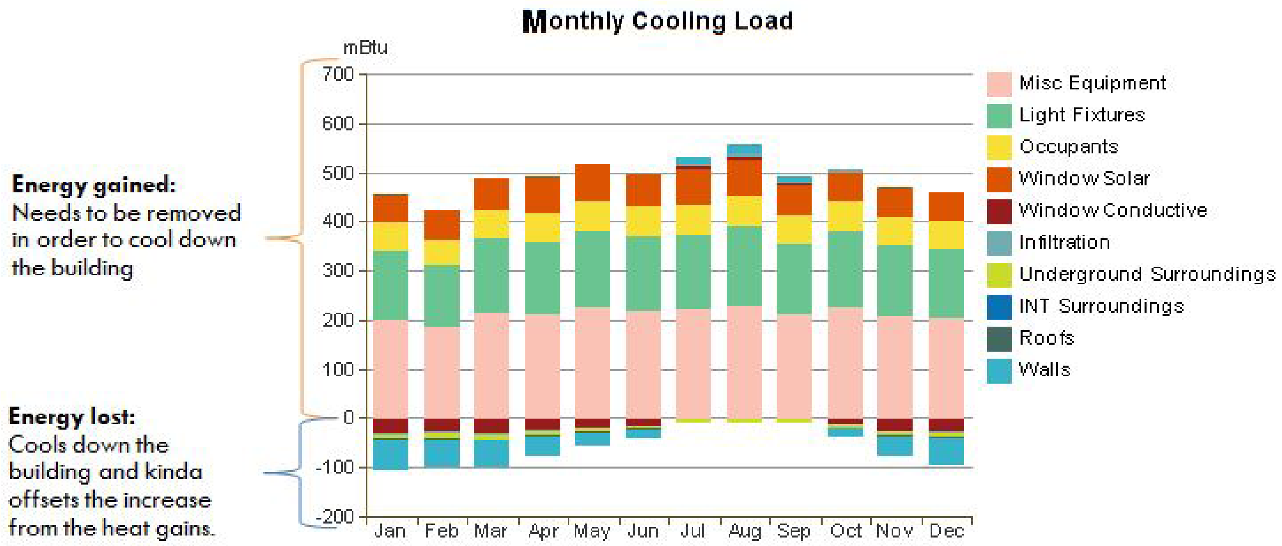


			(Therms)
HVAC	0%	$0	0
Domestic Hot Water	100%	$28,552	35,560
		$28,552	35,560

Energy Use: Electricity

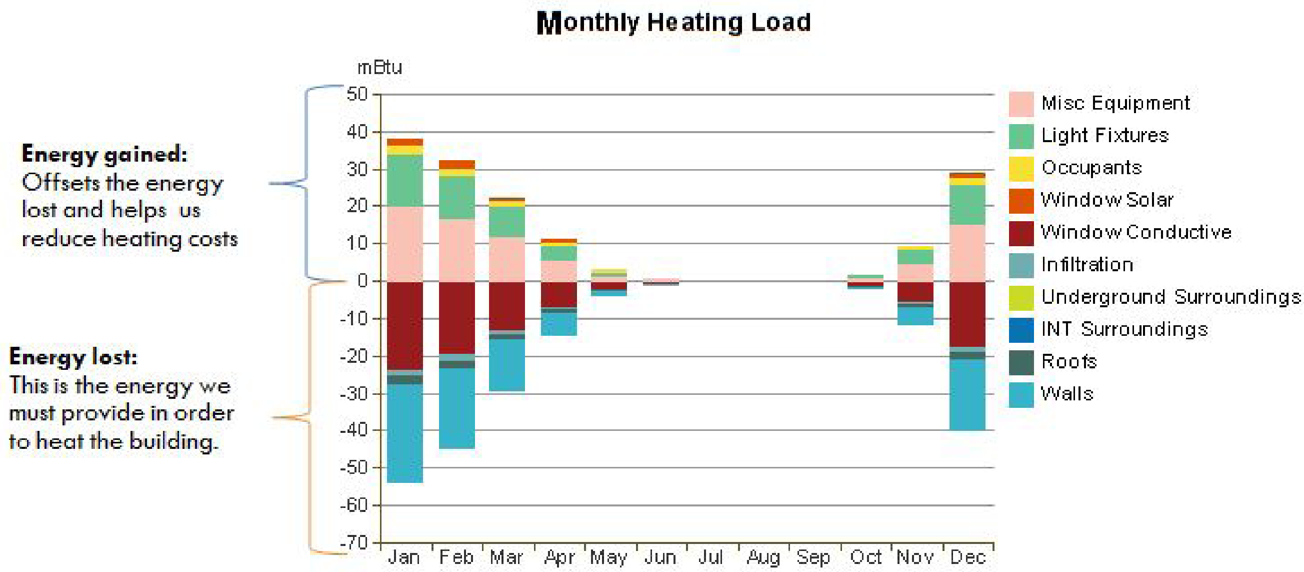


			(kWh)
HVAC	24%	$62,305	528,463
Lighting	32%	$79,446	673,842
Misc Equipment	44%	$113,449	962,248
		$255,200	2,164,553



For the hot period (June until September) our design's cooling requirements range from 460mBtu (June) to around 540mBtu (August).

From these data we can conclude that cooling loads dominate as the Y-axis scale is 900mBtu compared to only the 130mBtu of the Heating loads.
Moreover, our main heat gains come from internal loads (misc equipment, lighting fixtures and occupants) and some from window solar gains.



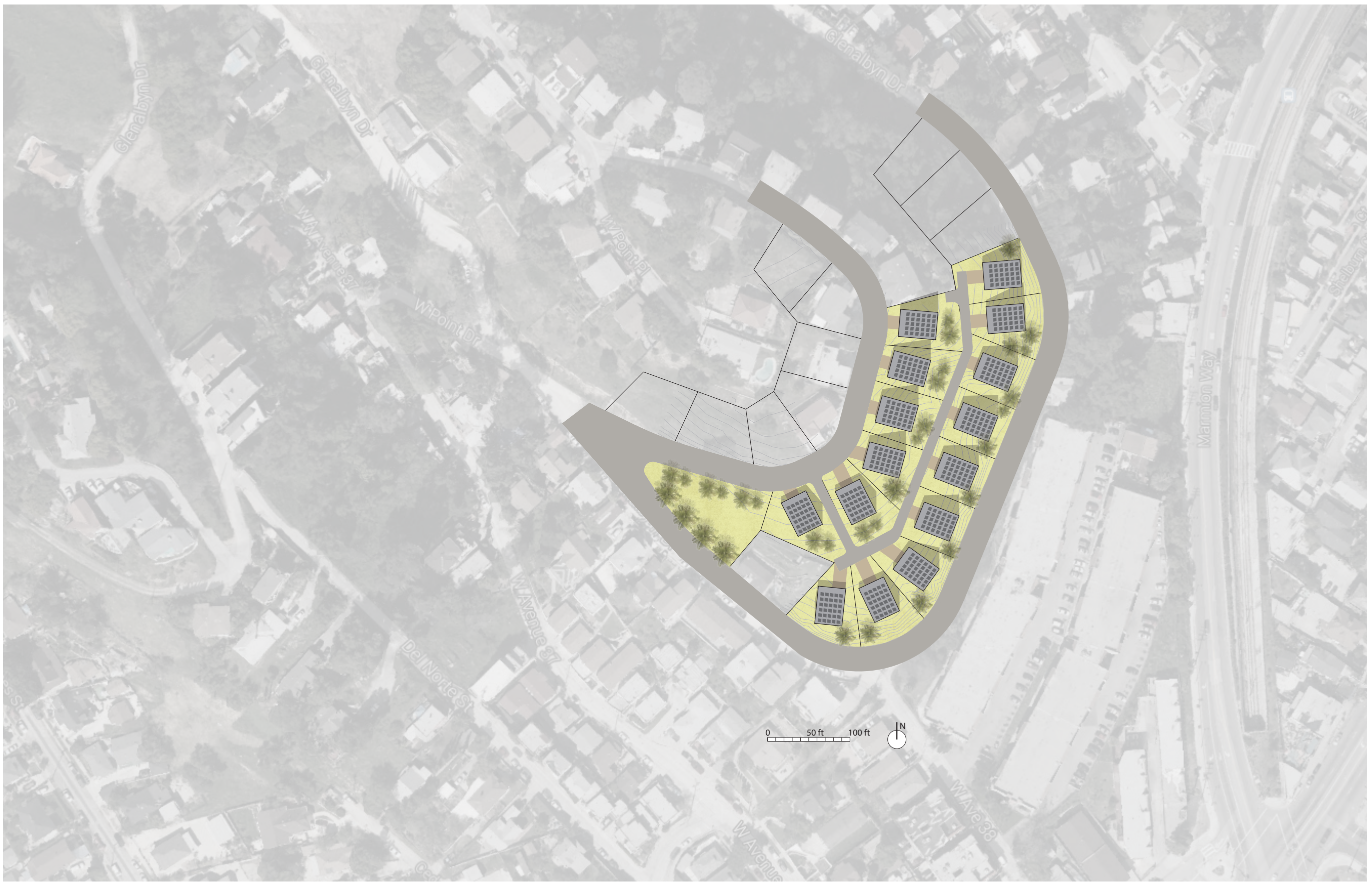
For heating, in January our design will need 53 - 38 = 15 mBtu.
Our ice cake has good heat gains that do a good job covering a big chunk of our heating requirements.
For half the year our building has very low heating requirements (i.e. May, June, October) or does not need any heating (i.e.June till September).

CLOUD
ARCHITECTURE

GLENALBYN DRIVE ARCHITECTURAL CONCEPT

INTRODUCTION

The following concept was created by Cloud Arch Studio as its own personal approach to 18 single-family units on the given site. While the team did not have enough time to undergo a sustainability study of single-family developments as comprehensive as the Multifamily Sustainability Study, many of their concepts were taken from the Start.Home, which was Stanford University's entry to the U.S. Department of Energy's 2013 Solar Decathlon (of which Ouyang, Best, and Lee were project leads). The Start.Home's approach to energy efficiency and sustainability, particularly with the Core concept, are applicable to the challenges of the Glenalbyn Drive site.

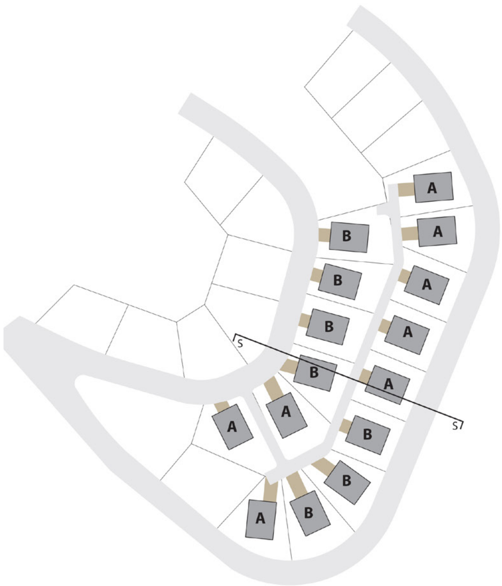


SITE ANALYSIS

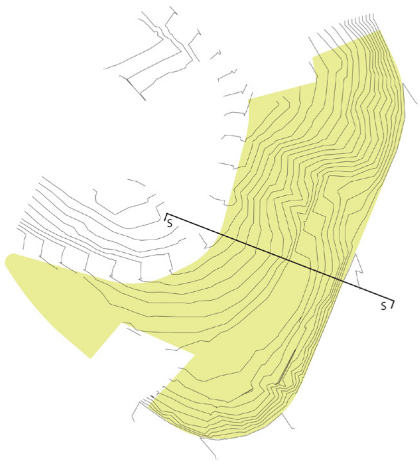
The client described the target market as young families looking to own property, perhaps after a few years of renting an apartment in a building like the previous project. Therefore the same energy efficiency and sustainability goals apply with the possibility of greater upfront investment by the homeowner. The site itself has the prominent characteristic of steep, rocky terrain, making excavation and grading a near impossibility. Solutions depend on a lightweight structure and a small but sturdy footprint.

CONCEPTUAL DESIGN

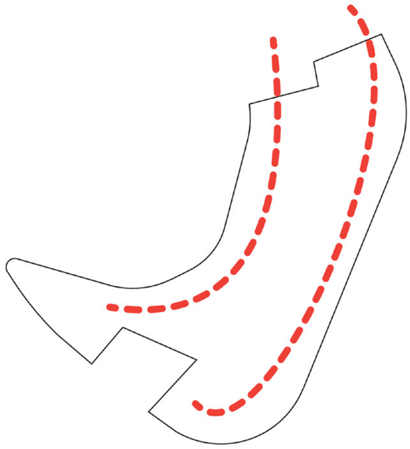
The massing form of the homes is derived from a practical solution to the steep terrain. As shown in the figure below, the long strip of properties caters well to two rows of houses which, depending on the steepness of the site, can be accessed either from the roof or from mid-floor via automobile.



TYPOLOGY OF THE HOUSES
A rooftop parking
B midfloor parking

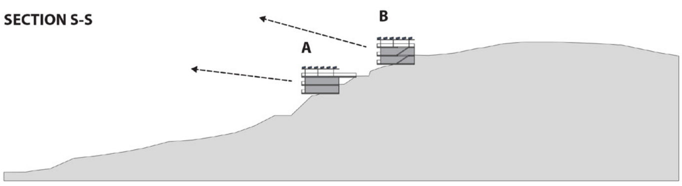


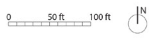
TERRAIN



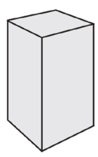
IDEA

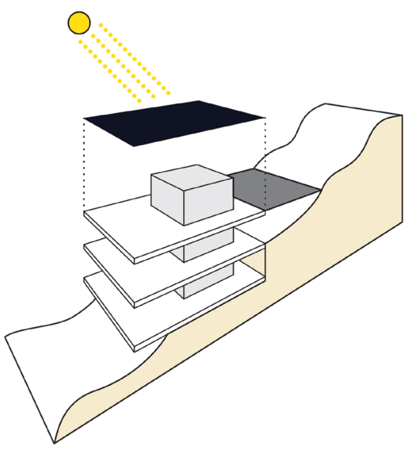
SECTION S-S



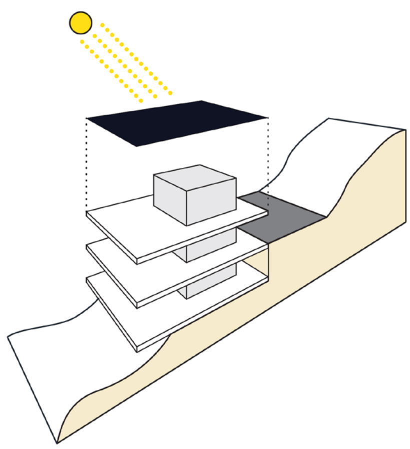


core



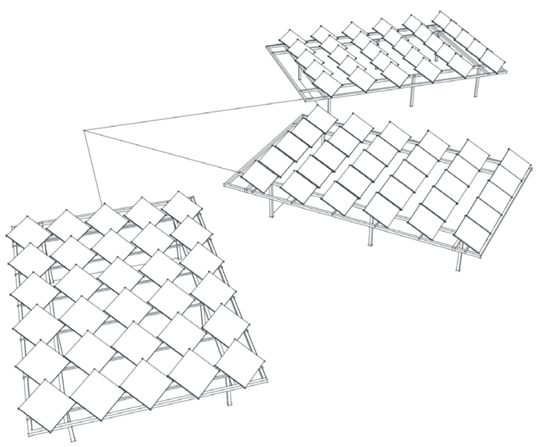


A type

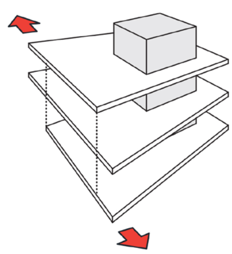


B type

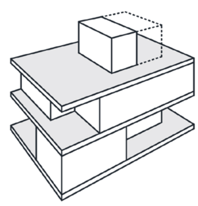
Orientation of photovoltaic (south)



possibility of custom made structure



flexibility of a floor plan



The Core measures 12ft wide by 15ft long by four stories high and can be constructed using structural insulated panels (SIPs) or precast concrete panels. On the roof terrace the Core features an outdoor shed with garden sink, solar inverter, heat recovery ventilator, and electric vehicle charging station. The first floor features a full kitchen wall, half bathroom, and mechanical closet with a heat pump water heater and breaker panel. The ground floor of the Core features two full-sized bathrooms with standing shower and vanity sinks, a laundry closet, and a wine bar for the master bedroom. The basement floor of the Core holds the rain and gray water tank. Prefabricated off-site and shipped to the site with nearly all pipes, ducts, appliances, and equipment ready to go, the Core significantly reduces construction costs and provides a structural and mechanical foundation to a variety of lightweight, energy-efficient homes.