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Charge. Point

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CHARGE.POINT

TABLE OF CONTENTS

CONTENTION

The goal of this thesis is to reduce dependence on fossil fuels, lower the carbon emission footprint, and ignite a paradigm shift towards clean energy usage. Architecture can play a role in increasing the accessibility of sustainable modes of transit by changing the way energy is produced and distributed throughout the city.

Accepting both the reliance and privatization of the automobile as givens, this idea caters to a transitional stage of travel, shifting from internal combustion engine vehicles to electric powered vehicles. Current technological limitations are stunting the momentum of a sustainable transit phenomenon, i.e. EV battery charge time and storage capacity, proximity of EVSE charging points to desired destinations and the capacity of the city grid to supply and distribute adequate amounts of energy. However by embracing these limitations as design objectives one can begin to develop ubiquitous charging points that not only provide reassurance against range anxiety but also brand an idea of clean energy.

The typology will be self-sustaining in terms of energy through manipulation of its facade/exterior treatment. The nodes will create a positive urban experience, and common language through, signage, lighting, coloration, and surface treatment, that showcase a cultural commitment to the new technology. As 80%-90% of charging takes place at home, these charging stations will focus on the other 10%-20% of charging that might occur in downtown lots, parking garages, on-street parking or highway stops.[1] The nodes will feed energy to modes of public and private transit as well as acting as one of several pods within the city setting the stage for a self-organizing and adaptive networked phenomenon. Charge points will be connected to a media network interface enabling the user to efficiently find the closest vacant parking space.

“A fundamental prerequisite for the major transport revolution we anticipate will be provision of sufficient electric energy.”[2] Challenging the conventional centralized single-sourced production and distribution of energy will allow for an interesting dynamic between production and consumer. As oppose to transporting energy from a power plant, energy will be locally produced directly from the architectural façade and into the vehicle creating a direct intersection between energies of the cities and the physical energy being consumed. The nodes will act as energy umbilici and when charging is not taking place, energy will be distributed back into the grid.

In expanding and branding this typology of infrastructure as accessible, consistent and simple to use, EV’s will emerge as a viable option for drivers.

[1] *WXY Architecture + Urban Design, “Siting and Design Guidelines for Electric Vehicle Supply Equipment.” NYSERDA and Development Authority, November, 2012, 1.*

[2] *Gilbert, Richard, and Anthony Perl. Transport Revolutions: Moving People and Freight Without Oil. United Kingdom: Earthscan, 2008.*

CURRENT U.S. ENERGY CONSUMPTION

total= 99.578 Quadrillion BTU

Energy Source

	Source	Share	Total
non-renewable	fossil fuel oil	37%	92%
	natural gas	25%	
	coal	21%	
	nuclear	9%	
renewable	biomass	4%	8%
	hydro-power	2.8%	
	wind energy	0.72%	
	geothermal	0.4%	
		.01%	

http://geology.com/articles/renewable-energy-trends/

Photo Credit : ShutterShock


3500 BC
2000 BC
1700 AD
1780 AD
1790 AD
1865 AD
1900 AD
2013 AD
Petroleum
Percent Consumption by Sector 2013
70% Transportation
24% Industrial
5% Residential/Commercial
1% Electricity
Petroleum
Percent of US Transportation Sector
93% Petroleum
7% Other Sources
U.S. Energy Information Administration
“Today, oil meets 36 percent of US energy demand, with 70 percent directed to fuels used in **transportation** – gasoline, diesel and jet fuel. Another 24 percent is used in industry and manufacturing, 5 percent is used in the commercial and residential sectors, and less than 1 percent is used to generate electricity. Petroleum is the main mover of our nation’s commerce and its use for transportation has made our world more intimate. It is the transportation fuel, as almost all of our nation’s transportation is dependent upon its concentrated liquid form.”
U.S. Energy Information Administration
2010 Jeff Lynch Photography

+CHALLANGES & OPPORTUNITIES

CHALLANGES & OPPORTUNITIES

To begin accommodating for the limitations of the EV, it is necessary to change the way energy is produced and distributed throughout the city. Charging lots must replace traditional parking lots, charging units must begin to dot the streetscape, garages must be equipped with proper EVSE equipment and electric energy must be locally produced, generating renewable energy (sun and wind), when available, and feeding unused resources back into the grid.

+ EV BATTERY PERFORMANCE AND COSTS

Currently the most significant challenge with the electric vehicle is its battery performance and cost. In the 85kWh Tesla Model S EV, the battery life lasts about 301 miles per 85kwh battery (at 55mph) and it takes about 9.5 hours to fully charge using a 240 volt outlet (4.5 hrs using a high power wall connector 240 volt).[1] Other electric vehicles have much lower ranges "with a usable range of about 100 kilometer's (km) the 24 kWh battery-powered Nissan LEAF achieves about a fifth of the range of a comparable ICE vehicle."[2]

+ QUANTITY OF ELECTRIC ENERGY FED INTO THE GRID

"How much more electricity would have to be generated if all cars and other personal vehicles were to become EVs? .... Estimates range from about 15% [Belgium] to about 45% [California] of respective total electricity consumption... A reasonable rule of thumb could be that, other things being equal, converting the personal vehicle fleet to electric drives in a higher-income jurisdiction would increase the amount of electricity that has to be generated by 15-40%."[3] The hub might begin to produce its own energy using renewable resources when available.

+ LACK OF FUELING STATIONS WITH REGARDS TO DESIRED DESTINATION

Placement of these energy nodes is very important with regards to desirable destination; other modes of transit, work, shopping center, highway stop etc. By increasing the number of supercharging stations and EVSE units we can begin to reduce range anxiety. "The Tesla Model S can charge for free at any Supercharger once enabled, unlike gas stations that require you to pay for each fill-up…Superchargers provide half a charge in about 20 minutes and are strategically placed to allow owners to drive from station to station with minimal stops." Tesla motors has begun dispersing their charging stations around North America and Europe deliberately locating them in proximity with amenities such as diners, shopping centers, cafes, public tranit stops and stations etc,. There are currently only 37 stations in North America and 6 stations in Europe. By 2015 they hope to extend supercharger coverage to 98% of both the US population and Canada.[5]

[1] *Tesla. "Supercharger, The Fastest Charging Station on the Planet" 2013. http://www.teslamotors.com/supercharger*

[2] *Clean Energy Ministerial, "Electric Vehicles Initiative, International Energy Agency. Global EV Outlook: Understanding the Electric Vehicle Landscape to 2020." April 2013 http://www.iea.org/topics/transport*

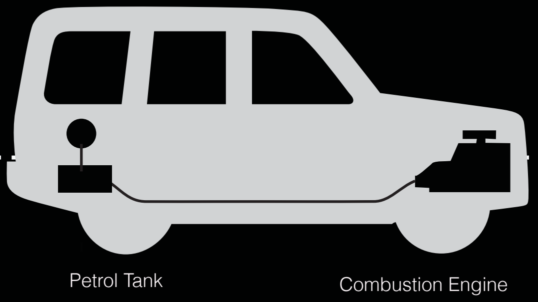
[3] *Gilbert, Richard, and Anthony Perl. Transport Revolutions: Moving People and Freight Without Oil. United Kingdom: Earthscan, 2008.*

[4] *"Supercharger, The Fastest Charging Station on the Planet"*

[5] *"Supercharger, The Fastest Charging Station on the Planet"*

ELECTRICITY AS THE IDEAL TRANSPORT FUEL

ICEs [internal combustion engines] Combustion of a fuel, normally a fossil fuel and the use of internal combustion to generate motion.



10k Miles Driven — $3.80 (cost of fuel national average on 8.12.13) 22 mpg (average sedan) — $1,727

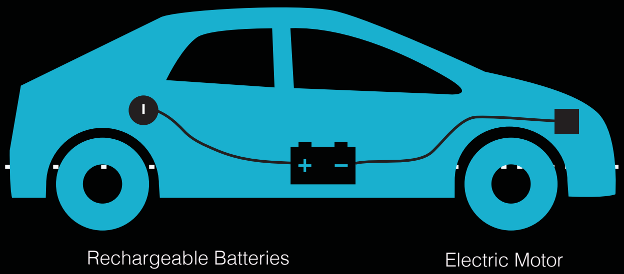
INTERNAL COMBUSTION ENGINES

"The [electric vehicle] powertrain is more efficient at using energy than a combustion engine. Only about 20-25% of the energy stored in gas actually turns the wheels. An EV is about three times more efficient."

Tesla. "Supercharger, The Fastest Charging Station on the Planet" 2013. http://www.teslamotors.com/supercharger

ELECTRIC VEHICLES

EVs [electric vehicles] uses chemical energy stored in batteries that are rechargeable. Instead of internal combustion engines they use electric motors.

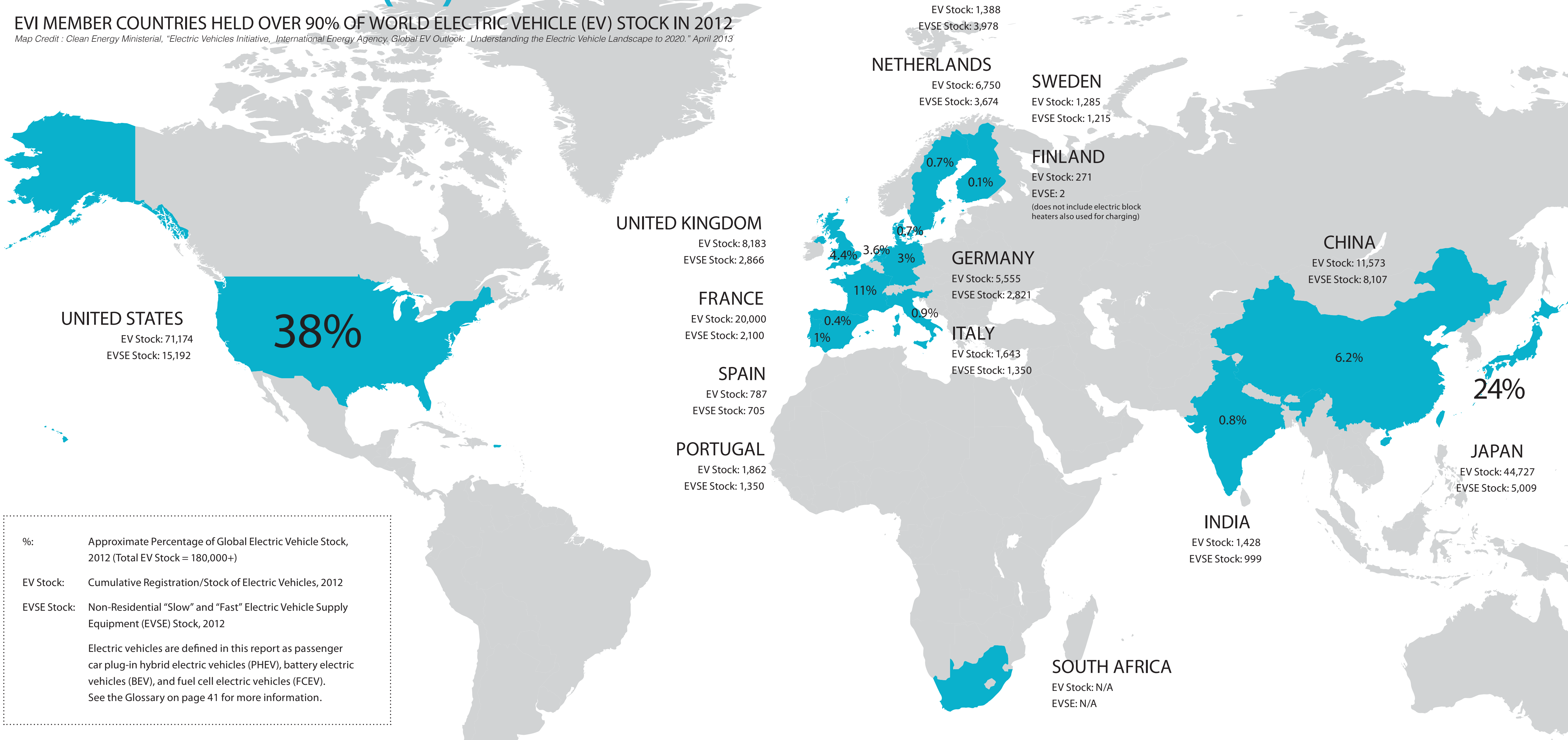


10k Miles Driven — $0.11 kilowatt hours (National Average) — $311

ELECTRIC VEHICLE (EV) STOCK IN 2012

EVI MEMBER COUNTRIES HELD OVER 90% OF WORLD ELECTRIC VEHICLE (EV) STOCK IN 2012

Map Credit : Clean Energy Ministerial, "Electric Vehicles Initiative, International Energy Agency. Global EV Outlook: Understanding the Electric Vehicle Landscape to 2020." April 2013

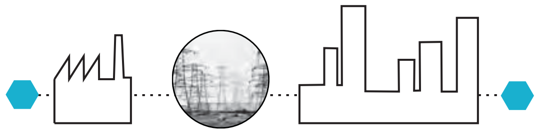


%:	Approximate Percentage of Global Electric Vehicle Stock, 2012 (Total EV Stock = 180,000+)
EV Stock:	Cumulative Registration/Stock of Electric Vehicles, 2012
EVSE Stock:	Non-Residential "Slow" and "Fast" Electric Vehicle Supply Equipment (EVSE) Stock, 2012

Electric vehicles are defined in this report as passenger car plug-in hybrid electric vehicles (PHEV), battery electric vehicles (BEV), and fuel cell electric vehicles (FCEV). See the Glossary on page 41 for more information.

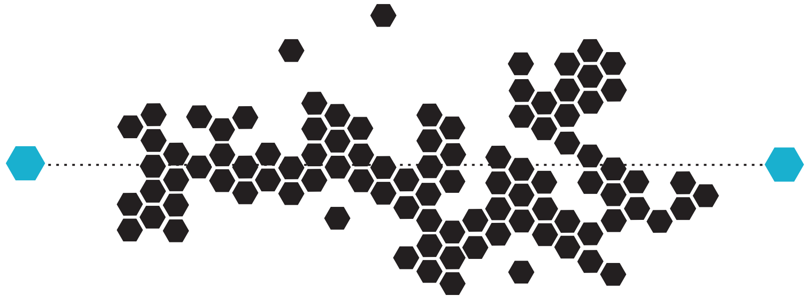
"A fundamental prerequisite for the major transport revolution we anticipate - moving from ICEs to electric motors - will be provision of sufficient electric energy." [1]

[1] *Gilbert, Richard, and Anthony Perl. Transport Revolutions: Moving People and Freight Without Oil. United Kingdom: Earthscan, 2008.*



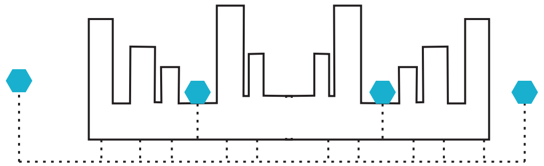
Energy is currently fueled from single source power plants that feed into the city through the power grid. For example, New York's main energy source is from Nuclear (33% nuclear, 31% natural gas, 21% hydro electric, 10% coal and 5% other.) source: New York State Energy Information Association, 2009.

[1] *New York State Energy Information Association, "New York States Energy Sources." 2009*



ENERGY IS SINGLE SOURCED, MILES AWAY FROM ITS ULTIMATE DESTINATION. A LARGE PERCENTAGE OF THE ENERGY IS LOST IN TRANSITION.

What is Architectures role in setting the stage for sustainable fuel awareness?



While one of the greatest limitations with the electric vehicle technology is its inefficiency in charge time and battery storage capacity, architecture might begin to think about a public infrastructure that acts as an energy collection deposit feeding the transportation sector through renewable resources, produced for the city, by the city. The hub will become a positive icon, promoting stainability, and hopefully fuel a post-carbon mobility revolution.

SHIFT TOWARDS DECENTRALIZED ENERGY PRODUCTION, AND DISTRIBUTION WITHIN THE URBAN CENTER SOURCING RENEWABLE ENERGY WHEN AVAILABLE.

+HISTORY & COMPARISON

HISTORY & COMPARISON





All Photos Credited to eff Brouws

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Photo Credit to Z Denko

Photo Credit to Z Denko

Photo Credit to Z Denko

FILLING STATION

Before the 20th century obtaining gasoline was a messy and dangerous process. Motorists had to travel to their town oil refinery, fill five gallon buckets with oil and manualy funnel the product into their vehicle. It wasn't until 1905 that tanks were drawn from underground tanks using a push/pull lever. By 1910 tanks dispensed oil directly into the vehicle and quantity was measurable.

General stores began placing self service split pumps at the curb, directly outside of their store, allowing vehicles to pull up and fill their tanks in the center of town. Originally these stations offered a variety of gasoline brands however in 1911 the Standard Oil trust broke apart and competitive branding and company loyalty became an important driver in the evolution of filling station typologies.

Oil companies began offering free services as incentive to buy their product. The Standard Oil Company dressed their workers up in matching uniforms and provided free tire, and auto cleaning services. Some offered automobile repair services and oil changes, others hired famous architects including Mies van der Rohe and Frank Lloyd Wright to design their stations.[1]

Oil Companies turned these general stores into "decorated sheds," similar to Venturi's explanation of building as a commercial backdrop used to brand their company.[2]

While it was once an abundant waste product, oil was soon in high demand, valuable and very expensive. After the oil crisis in the 1970's, competitive gas pricing became much more important in attracting costumers as oppose to offering free auto services.

[1] *Vieyra, Daniel. "Fill'er Up" An Architectural History of America's Gas Stations. New York: Macmillan Publishing.*

[2] *Vieyra, Daniel. "Fill'er Up"*

18 0
Few places sold fuel, vehicle owners would have to fill a bucket in the outskirts of town.

1 0
The curbside station usually resided on the curb in front of general town stores, hardware, bicycle or grocery shops. They allowed for more convenient fueling however disrupted the flow of traffic.

Industrial Revolution: Before 1900 there were less than 6,000 automobiles in the United States. During the Industrial Revolution machines replaced man labor. Steam, electric and gas powered cars competed until Henry Ford, mass production and the internal combustion engine stole the market. New Energy Sources ignite a transportation revolution. Oil and steam were used to power factories and coal was used to make iron. By 1910 there were over 130,000 automobiles in the United States, 35,000 trucks and 150,000 motorcycles.

1 10
The earliest drive-in gas stations were small sheds with minimal decoration or advertisements and did not have canopies. These split-pump stations offered different gas brands until the Standard Oil Trust broke up in 1911. This caused fierce competition and brand loyalties. They added services including windshield wiping, oil checks, as well as pits and lifts for car maintenance. A Lubritorium was a building, eventually enclosed, that allowed for services in all weather and were equipped with pits and lifts. The Lubritorium doubled the size of the station.

1 20
The domestic station was influenced by the English Picturesque Movement. Its form was associated with vernacular aesthetic to blend into residential areas. They represented comfortable and friendly services and often aquired loyal customers.

By 1925 most gas stations had car washing floors, grease pits, canopies with multiple bays and rest rooms.

Stations as decorated shed.; Oil companies used stations as backdrop for commercial branding. They built architect-designed stations with specific forms, colors, signage and material to represent their corporate identity.

Car ownership increased and oil companies invested in neighborhood gas stations with vernacular aesthetic to blend into residential areas. They represented comfortable and friendly service with a positive association.

1 30
Prefabricated Gas stations using metal and glass were mass produced and erected very quickly . Roof lines became flat and forms took an oblong box shape. Terra cotta was a popular facade material used.

During the 1930s there was a fear of long distance travel. Companies wanted to be a familiar site that reinforced safe traveling, standardized company signs used. They began catering to the traveler, giving free maps and selling soft drinks, tobacco and snacks.

Fantastic stations were very popular through the 20s and 30s. They were very unique designs formally based on gaining the attention of the adventurous traveler. Their forms took the shapes of air planes, lighthouses, shells, Castles etc, while other mimicked foreign design.

Respectable stations were sparked by the city beautiful movement and gained prestige through formal association. Their forms mimicked courthouse, institutions etc.

1 0
The functional station was influenced by the International Style of architecture and the German Bauhaus. It was an simple oblong box favored by modernists lacking ornamentation and nostalgia to historical forms.

Frank Lloyd Wrights idea that the gas station would transform a city. "The roadside service station may be an embryo the future city service distribution center. Each station may grow into a well-designed, convenient neighborhood distribution center naturally develping as a meeting place, restaurant, restroom...." (Wright, 1943).

Walter Dorwin Teague designed the most recognizable gas station in America, originally for Texaco. It was designed to be replicated out of any material as long as it was finished with white porcelain enamel and could be built in any state. Simple bands of color and the company name stretch along the edge of the canopy and building.

1 0
The need to break away from the modernized box led to more animated and dramatic structures. Large sloped "V" roofs served as both canopy and roof.

In Palo Alto, California, Welton Becket and Associates designed a frefab glass box station prototype.

Mies van der Rohe designed a prototype that considered the stations need to break away from the modernized box that led to more animated and dramatic structures. Large sloped "V" roofs served as both canopy and roof they contained drive -ins and station-restaurants.

A shift away from the international style and towards a search for functional, yet still domestic form. The forms were more humanized. The Domestic Station gained popularity again and had masonry walls, slanted roofs, mansard roofs and/or overhanging eves. "Throughout history, the domestic station's popularity has stemmed from its almost universal acceptability. Because they are deemed neither tasteless nor intimidating" (Vieyra, 1979.)

1 0
An asthetic celebration of industrial form allowed parts that were once hidden to become exposed and celebrated.

Eliot Noyes designed a prototype for mobile that was replicated 19,000 times. The plans were flexible enough to be duplicated in any setting.

1 70
Architectonic appeal celebrating poetics of structure and materiality was most important to the design of filling stations during the 1970s..

Facts from this timeline are credited to : Vieyra, Daniel. "Fill'er Up" An Architectural History of America's Gas Stations. 1979 New York: Macmillan Publishing.

In 1973 Lawrence Booth designed a prototypical kit of parts that had the possibility of different assemblies depending on contet and height requirements. The design expressed its structural form through its open space frame roof structure. "The buiding creates a poetic celbration of its materials and method of construction" (Vieyra, 1979).

Merit Petroleum had the Architects Collaborative design several stations in a brutalistic style using concrete channels that were inverted.

Oil Depletition: Oil Crisis of 1973 sparked a clean energy revolution. Internal combustion cars had 50 mpg (in the 50s and 60s Thunder birds and Mustangs that had 12-15 mpg). Advances in battery and clean energy sources have ignited a revolution in electric vehicle technology including advances in battery storage and quanity of clean energy production and distribution.

1 80
A second oil crisis drove oil prices, already limited supply.

1 0
Sustainable gas stations are becoming more popular after the energy crisis. Designs consider ventilation, heating and cooling, natural vegitation, photovoltaic panals and sustainable systems to offset automobile pollution.

Thomas Herzog's filling station, located just off the autobaun in Germany, uses solar panels to produce energy for the building, interior natural ventilation, and shrubs for shading.

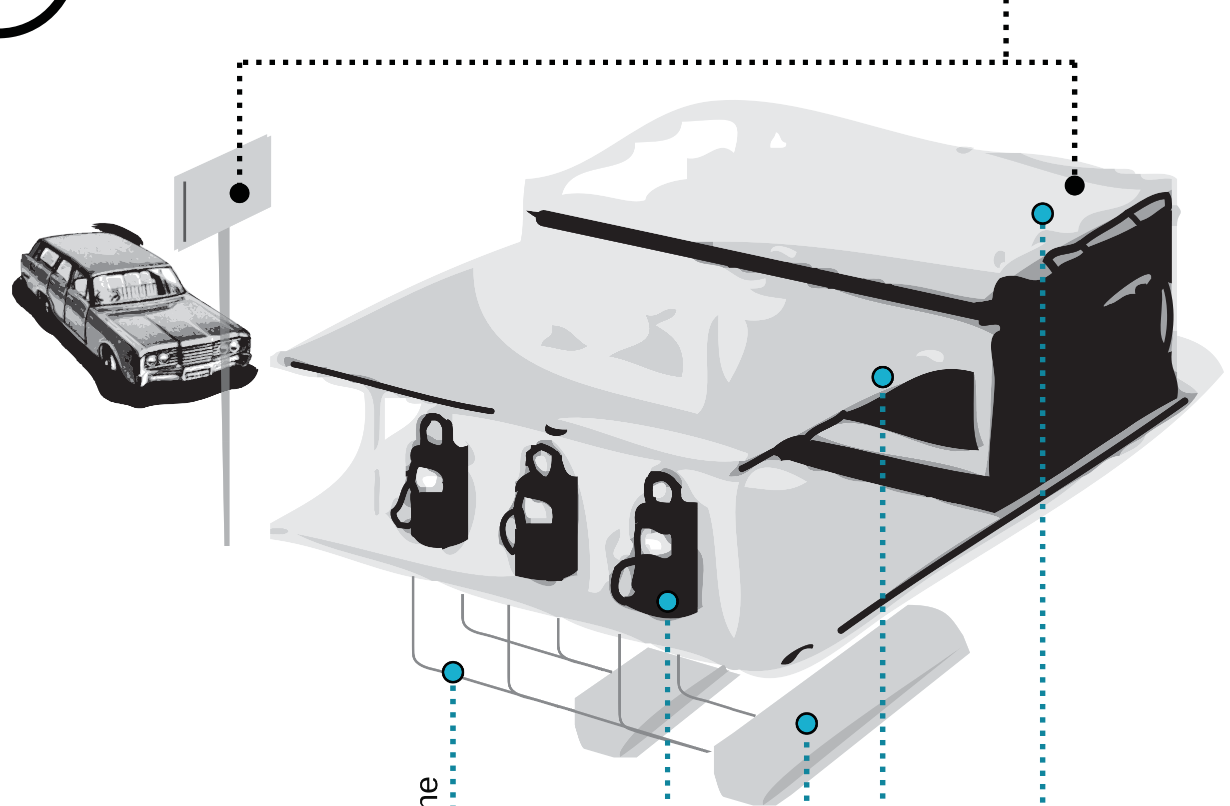
2000
With the growing number of EVs there has been a demand for accessible charging stations around the world.

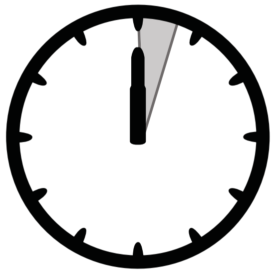
2010
There are 5,678 charging stations and 16,256 public charging points in the United States as of March, 2013.

THE GAS STATION

e Fuel Time 3 minutes

uick on enience



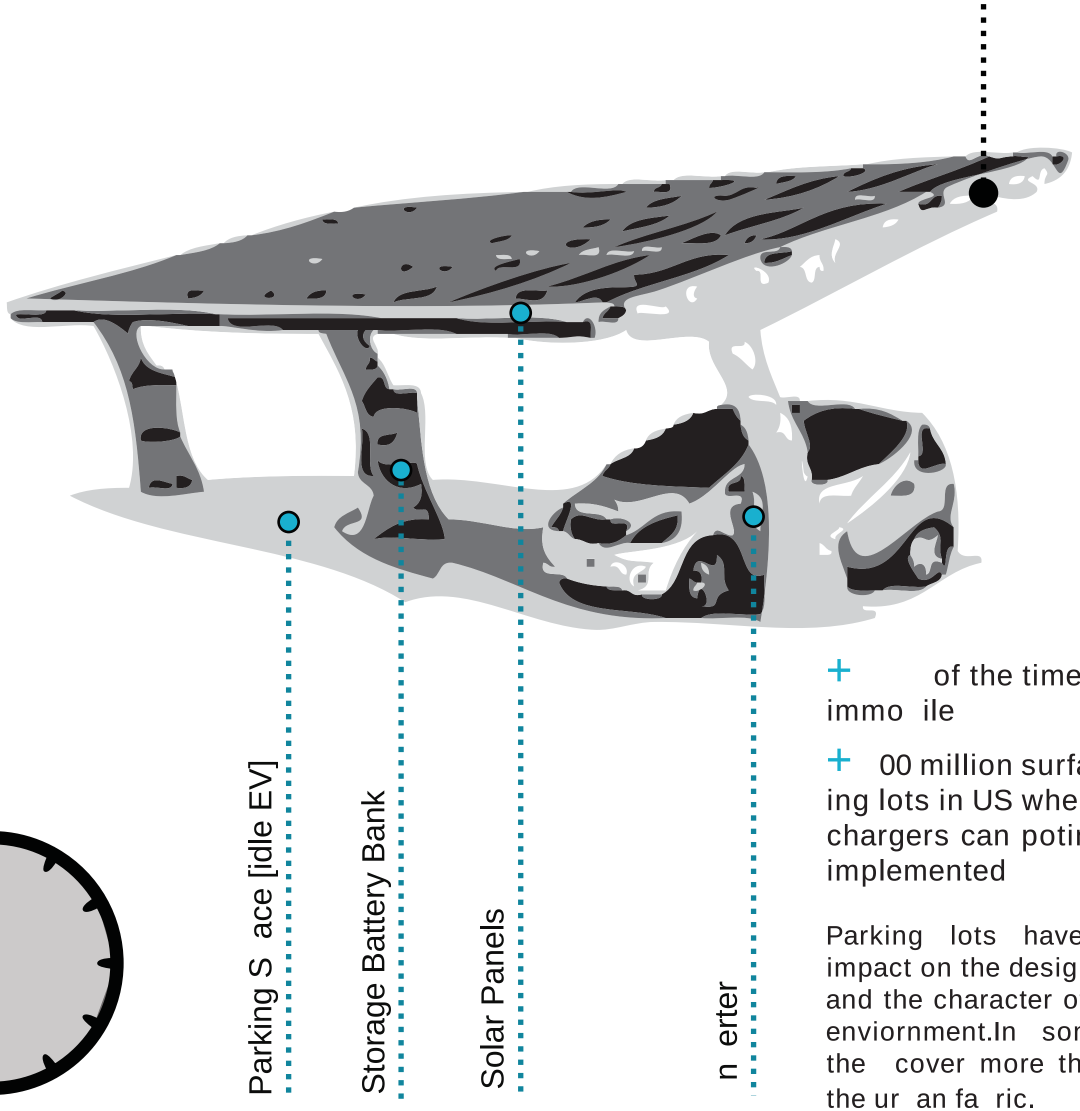


Fuel Time

THE CHARGING STATION

e Fuel Time 30 mins

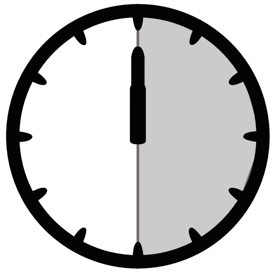
Park and harge



\+ of the time cars are immo ile

\+ 00 million surface parking lots in US where super chargers can potintiall e implemented

Parking lots have a vast impact on the design of cities and the character of the uilt enviornment.In some cities the cover more than 1 3 of the ur an fa ric.



Fuel Time

+SITING & DESIGN

geny

riti ue
f *Siting and Design Guidelines for Electric Vehicle Supply Equipment "*
By rchitects and SE

The Le els of harge
harge times & Sufficient onte ts

The Surface Lot

n Street Parking

Fleet Parking

Parking Garage

The Ser ice Station

SITING & DESIGN

Which t pes of agencies are taking advantage of charging services I contacted the Director of Marketing and Public Relations of the countries largest electric vehicle charging provider, CarCharging. Suzanne Tamargo discussed the company's primary incentive in expanding the public EV charging infrastructure and make electric vehicles a viable option for motorist buyers in cities around the country. The company has recently acquired 3 EV charging companies and has consolidated operations with the Blink Charging Network. Their slogan is *'EV fueling where you live, work and play.'*

When asked what market CarCharging provided the most services to, she described business as being steady across the board, catering to the needs of **retail, shopping malls, hospitals, hotels, parking garages, multifamil , condo and residential.** The company works closely with several very loyal retailers including IKEA and Walgreens, whose aim is to spread charging stations to stores worldwide.

As far as an owner's direct benefits, charging stations will increase property traffic as well as additional time spent on the property. There are nothing but rewards for the companies utilizing these services as CarCharging pays for full installation, maintenance, electricity consumed and equipment (however profit from usage is gained by the Carsharing through user payment.)

As CarCharging continues to buy and consolidate charging companies the next step will be to create a ubiquitous image across their network. According to Tamargo, all energy consumed from the units is taken from the grid and the company does not have a business model for renewable generation of energy.

CARCHARGING™

AGENCY

VEHICLE COMPANIES

Tesla, Volvo and BMW are three examples of car companies that have extended their businesses into the electric vehicle market and have become recently interested in this idea of a charging network. All three companies have produced models for charging stations, each with aesthetic quality mimicking the language of their brand.

Tesla has produced over 200 solar powered Superchargers making state-by-state travel feasible with stations about 80 miles apart. The solar powered charging stations take advantage of DC charging, taking about 22 minutes to fully charge.[1] **"A properl e uipped Model S can charge for free at an Supercharger** once enabled, unlike gas stations that require you to pay for each fill-up. Simply pull up and plug in, take a quick bathroom or food break, and get back on the road."[2]

Most of Tesla Supercharger stations reside in the California, Vancouver, Dallas, and Portland regions however within 6 months the company plans to extend their network to many of the larger cities in the US and in Canada. The company incentive for dispersing these stations across the country is to increase vehicle sales and thus only a Tesla vehicle can currently charge at the Supercharger stations (although owner, Elon Musk mentioned that he eventually wishes to partner with other EV companies to increase vehicle compatibility and usage.)

[1] *Tesla. "Supercharger, The Fastest Charging Station on the Planet" 2013. http://www.teslamotors.com/supercharger*

[2] *Cobb, Jeff. "Tesla Promises 'Free' Supercharger Access 'Forever' For All Its Future Cars." May 30, 2013. http://www.hybridcars.com/*

RETAIL COMMERCIAL

IKEA and Walgreens are two commercial companies that have recently taken advantage of CarChargings electric vehicle charging services. Installation, maintenance, equipment, and energy is free as CarCharging is essentially profiting from motorist usage. IKEA and Walgreen's ,however, benefit from increase in property traffic as well as additional time spent on the property. As of June, 2013 IKEA has purchased more than 55 Blink charging stations and has implemented them in more than half of their stores, country-wide.[1]

The company is well known for its sustainability efforts. **Increasing access to EV charging stations advances our goal of helping coworkers and customers as well as mem ers of the communities in which we operate live more sustaina le lives.**[2] The company is well known for its sustainability efforts and joining the EV network was important to them. Other green efforts include using recycled waste materials in their products, using energy efficient lighting and HVAC as well as recycled construction materials in their stores and corporate offices.

[1] *Roth, Joseph. "IKEA to Grow Presence of Electric Vehicle Charging Stations with Units at 8 More locations Extending Reach Beyond the Western U.S." June 27, 2013. www.IKEA.com*

[2] *Roth, Joseph. "IKEA to Grow Presence of Electric Vehicle Charging Stations with Units at 8 More locations Extending Reach Beyond the Western U.S."*

THE CITY

Portland State Universit and the Cit of Portland Partners up to provide a network of charging stations in what they are calling '**America s Green est Cit** .' "After all, this is a city with a downtown free-rail zone for public transportation, solar-powered parking meters, 315 miles of in-city bikeways and 10,000 acres of parkland."[1] They implemented an 'Electric Avenue' on the Portland State University campus, centralized between the light rail train stations and Portland's Sixth Avenue Transit Mall. It contains seven charging stations from seven different charging companies to test and gain public awareness of how this technology fits into the urban context.

"It is a perfect place to understand the **fit and flow of electric vehicles in the larger mo ilit conte t of the cit** ... we do this because the rapid population growth, mass urbanization, and energy security issues make sustainable urban mobility a top-of-the-agenda item for every metropolitan region on the planet in the decades ahead."[2] As far as energy goes, there are no renewable energy sources supplying the chargers and supply is taken out of the grid.

THE UNIVERSITY

The biggest challange the "Electric Avenue" is facing is clear and consistent way finding and signage, there seems an over abundance of signs that are not cohesive and clear.[3]

[1] *Portland State University. "Electric Avenue." 2013. http://www.pdx.edu/electric avenue/*

[2] *Portland State University. "Electric Avenue."*

[3] *"Electric Avenue."*

Volvo Pure Tension Pavilion
Photo Credit : Jessica Reeves

BMW Point.One S
Photo Credit : BMW

Tesla Supercharger Station
Photo Credit : Tesla Motors

IKEA Charging Stations
Photo Credit : Jessica Reeves

Walgreens Charging Stations
Photo Credit : Green Tech Lead

The City of Portland Charging Station
Photo Credit : Hans van der Meer

Electric Avenue Portland
Photo Credit : OTREC

In November of 2012, NYSERDA teamed up with the Transportation & Climate Initiative and WXY Architecture + Urban Design to prepare a report called "*Siting and Design Guidelines for Electric Vehicle Supply Equipment*." The document is a set of guidelines that lays out the basics of EVSE implementation and is written for developers, local governments, business owners, homeowners etc. The report hopes to establish a common language that begins to register with the public's eye helping to diminish range anxiety, represent a community commitment to this idea of sustainable transport and essentially generate ubiquitous charging.

As filling the gas tank of an ICE vehicle occurs specifically at a local gas station, one benefit of the electric vehicle (EV) is that it can, potentially, be charged 'anywhere, anytime,"; at home, on commercial sites, downtown surface parking lots, parking garages, street parking and DC fast charging service stations. Siting and Design Guidelines for Electric Vehicle Supply Equipment describes factors of installation, access and operation associated with these different contexts.

Where 80% of charging occurs at home however the report caters to the other 20% of charging occurring else ware.[1] Statistics represent a steady growth in the number of EV's driven each year, the necessary public infrastructure needs to be developed in order to sustain them. "Expanding the infrastructure network will help make EV's a viable option for all drivers, even those without garages. The benefits come from extended infrastructure networks that are consistent, accessible and easy to use from place to place." [2]

Public charging stations are nodes of intersection between the driver and the grid. The charging points will have to be transformable as technology is developing at a rapid pace, batteries will soon charge more quickly and store greater amounts of energy. Charging stations, according to the report, are catagorized by 3 different groups according to their maximum voltage, and charge time. Level 1 charging takes 8-20 hrs for full charge with a maximum of 120V (suitable for overnight parking and are particulary found at the home), Level 2 charging points are usually free standing units that take about 4-8hrs with a maximum of 240V and are suitable for indoor and outdoor locations where cars are parked for a few hours at a time. Level 3 are also freestanding units and take about 30 minutes to charge 80% of the EV battery with a maximum of 480V. [3]

The report neglects the opportunity to promote renewable energy sources and make users more aware of their energy consumption by only stating their negative cost implication "...design choices such as canopies, alternative power sources will add expense." [4] In my opinion there is a gap in the discussion regarding self-sustaining energy, on-site energy production. Both Level 2 and 3 put a burden on the city electrical grid and utility upgrades and possible branch circuits might be necessary. There is a missed opportunity in the literature to link the consumption with the production and boost user awareness.

It is interesting how the levels of parking correspond with functions of time, this will be important in considering types of lots based on grid connections, efficiency and amount of time cars will be parked in types of lots. As Level 1 takes longer to charge it proves suitable to for overnight parking, level 2 is suitable for several hour parking and level 3 is most closely associated to gas station typology. As technology improves charges might take only minutes and will potentially become suitable for convenient drive-through service.

A network interface is important in connecting the driver to a vacant charging point, either through a cellular device or on-vehicle systems. It is important to create a language that carries from every aspect of interface, whether it be urban (signage), parking spot (paint designating space, lighting) EVSE interface (mounting approach, coloration and form of unit, number of connectors, etc) and technology interface (app on a smart phone or in-vehicle system.)

Branding plays an interesting role in promoting ease of use and accessibility, "the user experience at the EVSE site presents branding opportunities for the EVSE host's, installer's or partners' purposes" [5] (the perspective of the report clearly targets the buyer or developer where my thesis will target the community, user and the environment.) It goes on to discuss the importance of clarity and consistency, "common visual identity will reduce confusion and increase public awareness of EVSE." [6] Currently there are dozens of signs, symbols and colors used for EVSE guidance, posing an issue with communication. It is important to create a known symbol and common language that will be replicated on every sign and while signs will be needed in different contexts with different associated needs, consistency is key. The report suggests using an electric vehicle symbol as the largest and most pronounced aspect of the sign above the words 'electric vehicle charging station,' and somehow an indication that only ICE's and hybrids may not use these spaces.[7] Also included should be a time limit to parking, whether the space is level 1,2 or 3 and how many hours the space is available for, as well as possible payment methods. One interesting branding technique discussed, included designating priority spots for EV's that sit directly outside the entrance to buildings.

[1] *WXY Architecture + Urban Design, "Siting and Design Guidelines for Electric Vehicle Supply Equipment." NYSERDA and Development Authority, November, 2012, 1.*

[2] *WXY Architecture + Urban Design"Siting and Design Guidelines for Electric Vehicle Supply Equipment."*

[3] *WXY Architecture + Urban Design"Siting and Design Guidelines for Electric Vehicle Supply Equipment."*

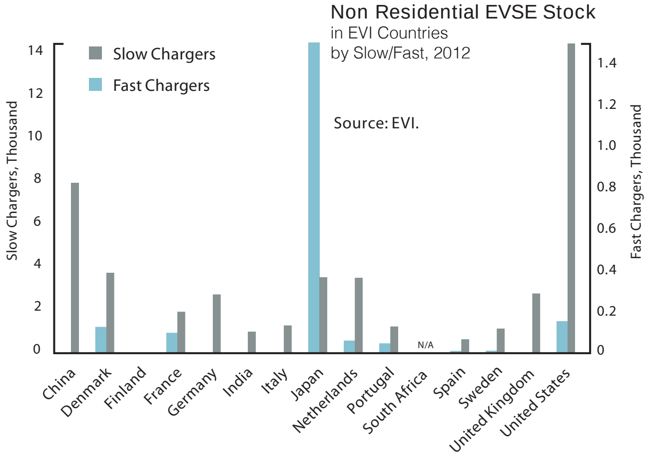
[4] *WXY Architecture + Urban Design"Siting and Design Guidelines for Electric Vehicle Supply Equipment."*

[5] *WXY Architecture + Urban Design "Siting and Design Guidelines for Electric Vehicle Supply Equipment."*

[6] *WXY Architecture + Urban Design"Siting and Design Guidelines for Electric Vehicle Supply Equipment."*

[7] *WXY Architecture + Urban Design"Siting and Design Guidelines for Electric Vehicle Supply Equipment."*

LEVELS OF CHARGE

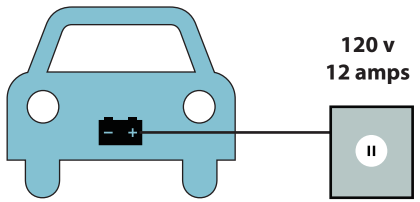


Slow charging is much more common than fast charging as it is less expensive and puts less of a burden on the grid. It uses an external charger to provide alternating current (AC) to an EV's battery. To fully charge a battery slow charging can take anywhere from 4-20 hours.

SLOW CHARGING

FAST CHARGING

Fast charging is not as commmon as it is much more costly. It uses an external charger to provide direct current (DC) to an EV's battery. To fully charge a battery, fast charging can take anywhere from 0.5 to 2 hours.

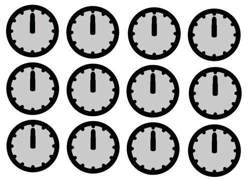


120 v
12 amps

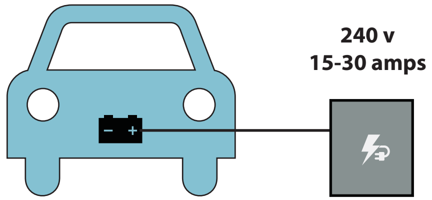
LEVEL 1

+Uses an Alternating Current (AC)
+ Sufficient for home charging or overnight pu ic charging
+ Standard 1772
+Least effecient

8-20+
Hours of Charge Time



SLOW CHARGING

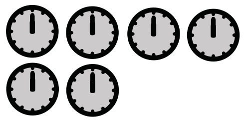


240 v
15-30 amps

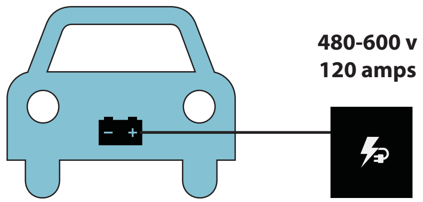
LEVEL 2

+Uses an Alternating Current (AC)
+Sufficient for outdoor locations
+ Several hour parking
+Site will need utilit upgrades
+ Standard 1772
+Burden on e isting electrical s stem

4-8
Hours of Charge Time



SLOW CHARGING



480-600 v
120 amps

LEVEL 3

+Direct Current (DC)
+ Sufficient for pu lic fueling
+ Drive in 30 mins
+Site will need utilit upgrades
+ Has high electrical curent, DC charging
+ Uses a Standard 1772 com o
+Burden on e isting electrical s stem

0.5
Hours of Charge Time

FAST CHARGING

Level 1 and 2 Charging

The report predicts that retailers will be among the first to implement EVSE spaces into their lots for a few different reasons, maybe to satisfy their costumers and employees, 'green' branding or to target a particular customer. Installation for the purposes of branding a 'green' identity might cause a retailer to place EVSE equipment in prime parking spaces. "Priority locations communicate to customers the value that the EVSE host places on a sustainable business while incentivizing EV drivers to patronage their store." [1] Commercial parking is typically in the form of surface lots, charging stations might be placed mid-lot where it can be shared between spaces. This is usually the preference of big box retailers or shopping centers with large parking lots and no adjacent building parking. Another option for surface parking might be to create a carport which allow EV spaces to be clearly distinguishable from regular parking. The added visibility allows for signage and green branding as well as shading and renewable energy source opportunities. Connections to the power grid might not be plausible and the carport solar canopies add potential for a closed loop system battery storage system.

Precedent Examples

Sierra Nevada Brewery Chico, California 2009. GE EV Carport Plainview, Connecticut 2010. Plug and Play Los Angeles, California 2012

[1] *WXY Architecture + Urban Design, "Siting and Design Guidelines for Electric Vehicle Supply Equipment." NYSERDA and Development Authority, November, 2012, 1.*

ON STREET PARKING

Level 1 and 2 Charging

EVSE charging stations are suitable for on-street parking in partiality busy urban centers and main streets. Zoning, space and obstacles, (planters, bike racks, fire hydrants etc.) might prove problematic in these heavily trafficked areas. Overcoming these hurdles creates a great opportunity to provide accessible and highly visible charging points in busy areas. “Municipalities or districts seeking a green identity may choose to locate EVSE spaces in prominent locations, and incorporate identity campaigns into accompanying signage.”[1] Precedents include “Electric Avenue” on the PSU campus (Portland State University) and the London city-center, both successfully implemented strips of charging stations in dense urban areas. Power might be drawn from a nearby business who might sponsor the EVSE station, or city-owned lines.[2]

Precedent Examples

Electric Avenue Portland, Oregon 2011

[1] *WXY Architecture + Urban Design, “Siting and Design Guidelines for Electric Vehicle Supply Equipment.” NYSERDA and Development Authority, November, 2012, 1.*

[2] *“Siting and Design Guidelines for Electric Vehicle Supply Equipment.”*

Level 1, 2 or 3 Charging

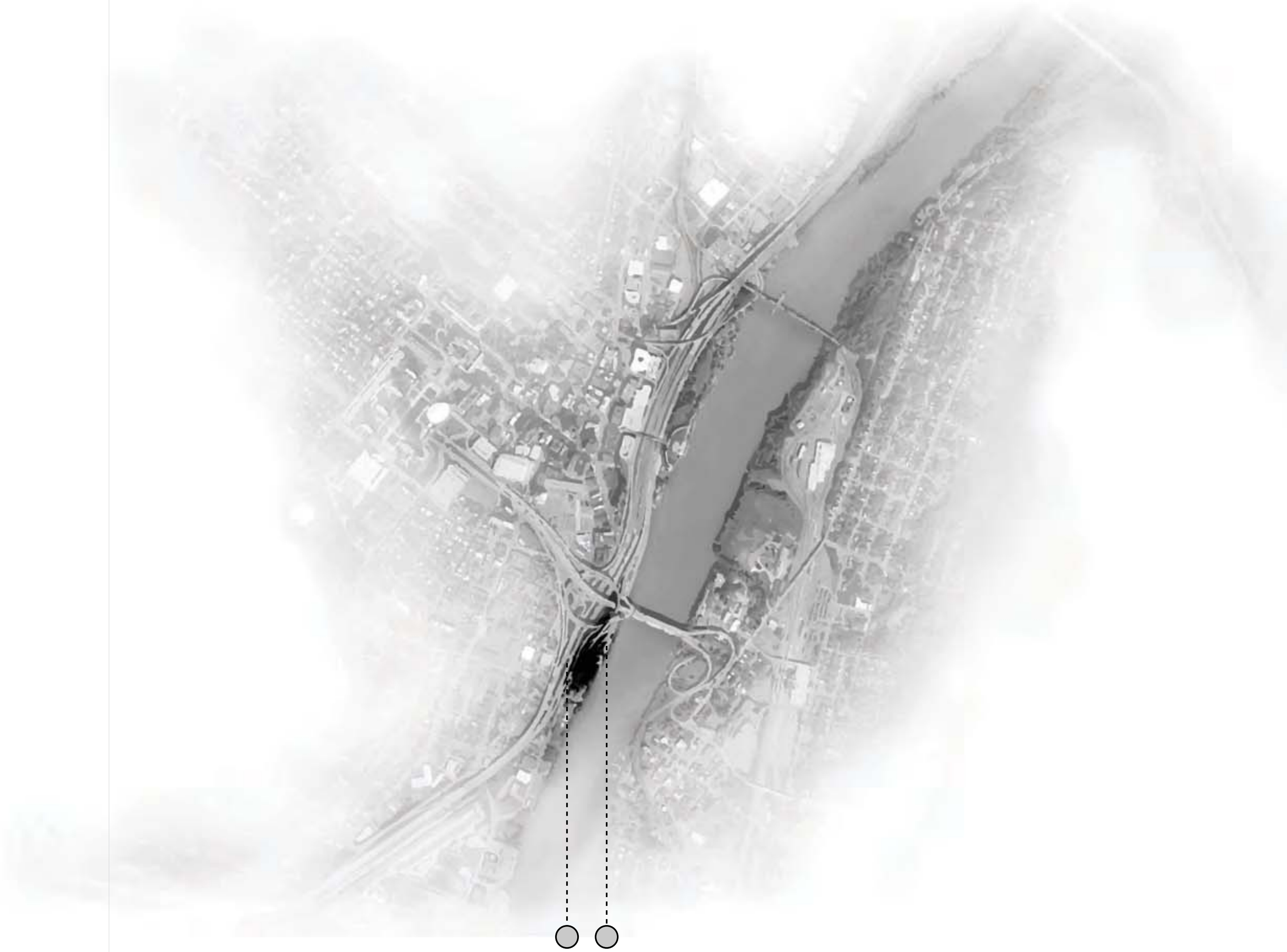
Commercial trucking is an important and growing sector of EV charging. Large corporations that have invested in EV trucking include Duane Reade, Frito Lay and FedEx.[1] Green loading zones should be equipped with DC Level 3 charging for quick turn-around and depending on fleet trucking usage, the charging zones might be "further from building entrances so as not to impede delivery traffic or other industrial operations." [2]

Precedent Examples

Duane Reade, New York 2011. Frito Lay, New York 2010. Fedex, Tennessee 2008.

[1] *WXY Architecture + Urban Design, "Siting and Design Guidelines for Electric Vehicle Supply Equipment." NYSERDA and Development Authority, November, 2012, 1.*

[2] *"Siting and Design Guidelines for Electric Vehicle Supply Equipment."*



PARKING GARAGE

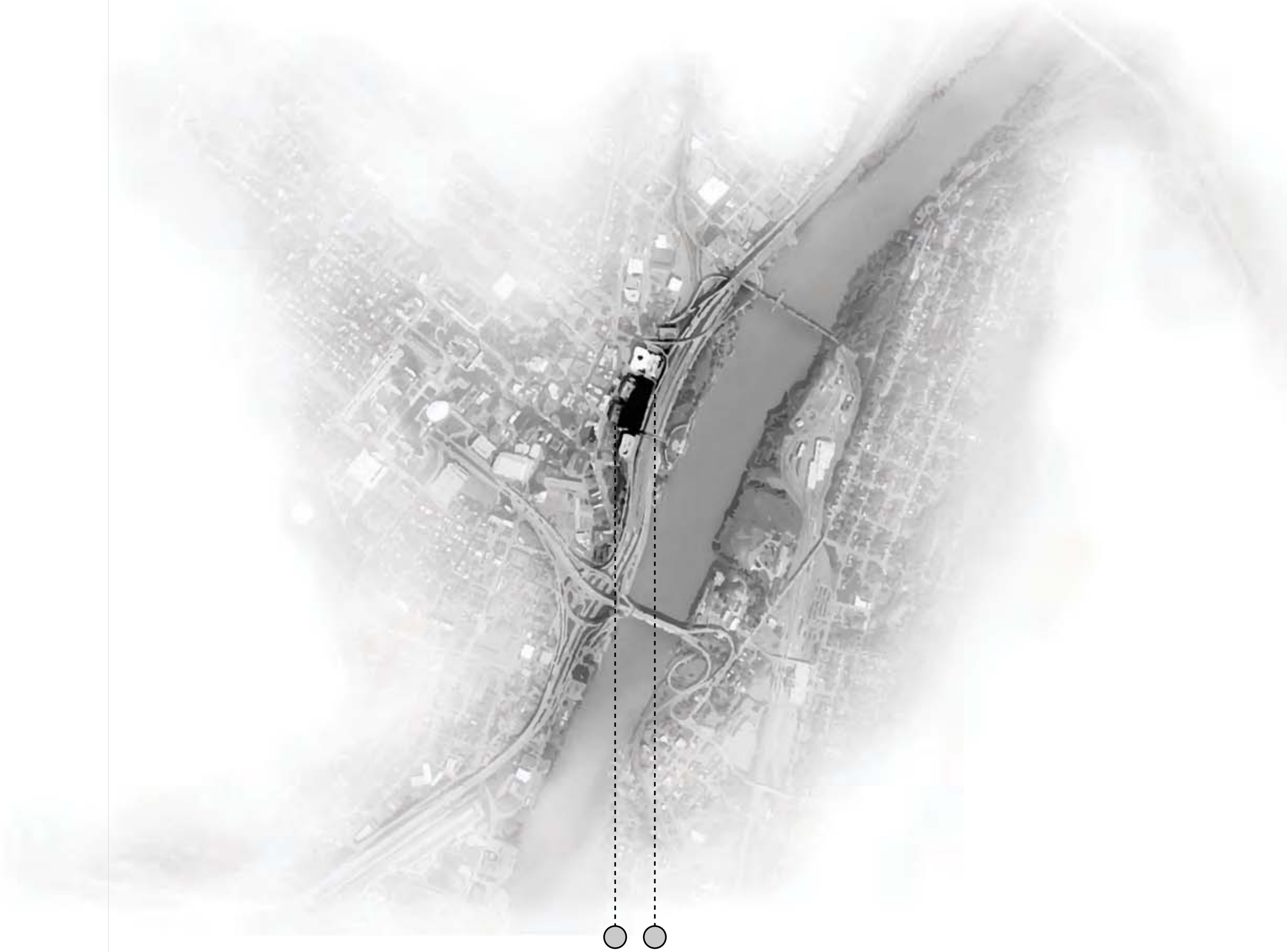
Level 1 or 2 Charging

Parking Garages have similar advantages as carports in that the added visibility allows for signage and green branding as well as shading and renewable energy source opportunities.[1] Connections to the power grid might not be plausible however solar canopies add potential for a closed loop system battery storage system. The garage as added potential for solar application as well as helix wind turbines similar to the Greenway Parking Garage in downtown Chicago.

Precedent Examples

Greenway Self-Park Chicago, Illinois 2010. KKA Electric Charging Station Soleil, Sweden 2013

[1] *WXY Architecture + Urban Design, "Siting and Design Guidelines for Electric Vehicle Supply Equipment." NYSERDA and Development Authority, November,*



Level 3 Charging

Service Station: Level 3 Charging. As technology improves charging times, the typology of a drive through service station will likely be a suitable option for drivers. Currently it takes about 30 minutes to reach an 80% charge with DC Level 3 charging.[1] Service stations are usually situated along interstate highway systems, allowing for customers to quickly and conveniently charge while in transit, roadside highway signage is essential as charging stations resemble gas station designs.[2] "Customer amenities are crucial, as drivers will need a safe place to wait..." [3] the service should be re-programmed with activates that users might engage in while waiting, wifi lounges, food or coffee shops, etc.

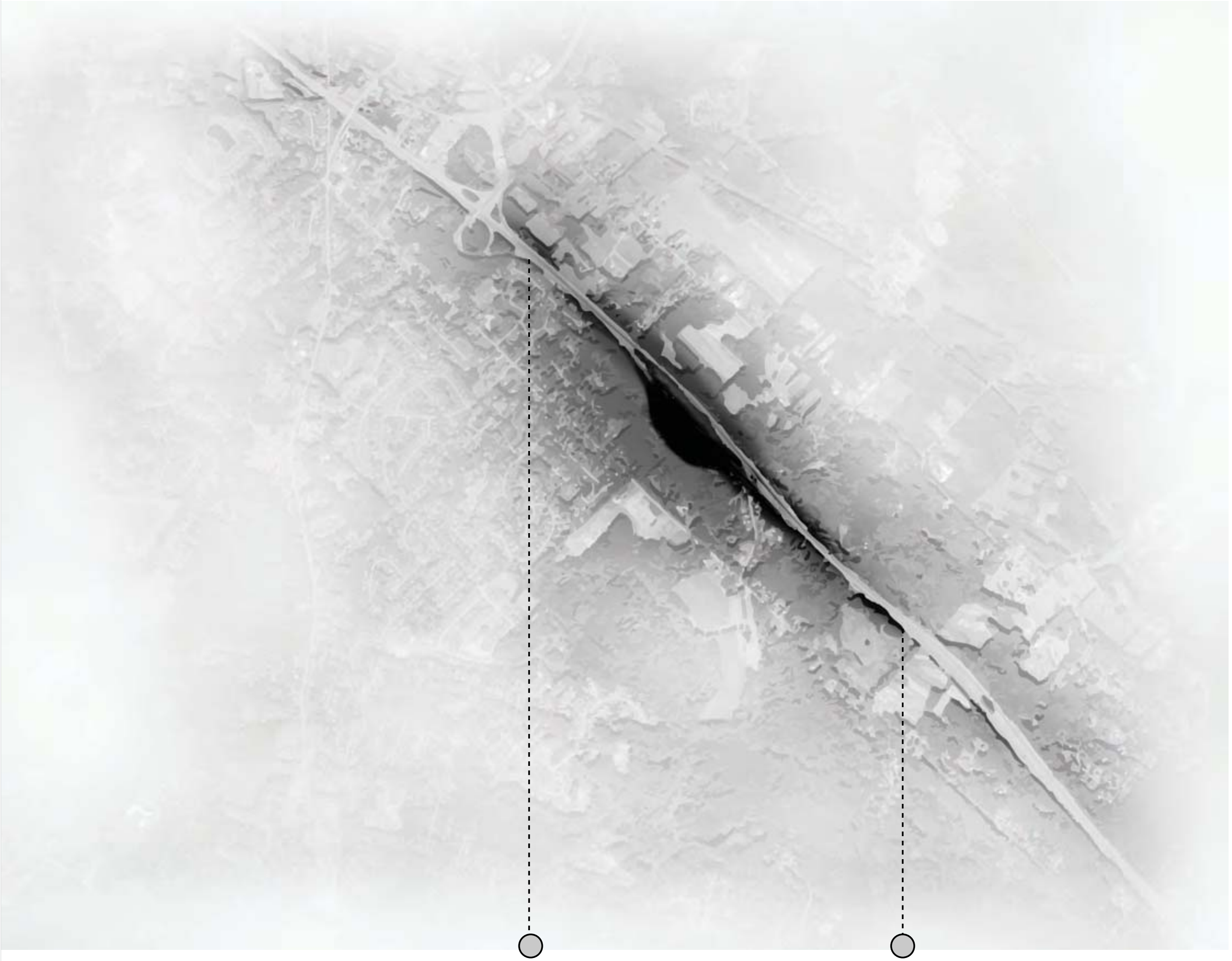
Precedent Examples

Telsa Supercharger Station Los Angeles, California 2009. Geotectura's Green Gasoline Station Haifa, Israel 2010

[1] *WXY Architecture + Urban Design, "Siting and Design Guidelines for Electric Vehicle Supply Equipment." NYSERDA and Development Authority, November, 2012, 1.*

[2] *"Siting and Design Guidelines for Electric Vehicle Supply Equipment."*

[3] *"Siting and Design Guidelines for Electric Vehicle Supply Equipment."*



+PRECEDENTS

PRECEDENTS

+ PRECEDENTS

Teague Texaco Service Station Texas **1938**
Noyes Mobil Gas Station New Haven, Connecticut **1964**
Repsol Service Station Spain **1996**
Sierra Nevada Brewery Chico, California **2009**
Telsa Supercharger Los Angeles, California **2009**
Greenway Self-Park Chicago, Illinois **2010**
GE EV Carport Plainview, Connecticut **2010**
Geotectura's Green Gasoline Station Haifa, Israel **2010**
Solar Big Wheel St.Louis, Missouri **2011**
Electric Avenue Portland, Oregon**2011**
Plug and Play Los Angeles, California **2012**
Volvo Pure Tension Pavilion Gothenburg, Sweden **2013**
KKA Electric Charging Station Soleil, Sweden **2013**
Point.One BMW Charging Station Germany **2013**

Featured Precedents

Non-Featured Precedents

Photos credited on following pages.

Greenwa Self Park

Chicago, Illinois, USA

HOK Architects

The city of Chicago was built around the car and in our culture, people are always going to have privatized vehicles. Rather than dramatically altering the urban fabric of the city and forcing new modes of transit this design was a smaller intervention used to raise environmental impact awareness. Offering a sustainable alternative to driving in hopes of positively changing behavioral patterns.

The garage is the first LEED certified green parking garage, it has become a vibrant force bringing strong publicity to green consciousness and the carbon footprint. The construction included pre cast concrete, minimizing cost and resources at construction site and all labor and materials were sourced from within 100 mile radius. [1]

This renewable energy infrastructure uses an exterior glazed screen that naturally ventilates the structure, it has a green roof system, cistern rain water collection system, gives privilege to electric cars and uses a double helix wind turbines to power all garage lighting. The electric wind turbines extend higher than the roof and are designed to harvest available wind power. Excess power that is not used for lighting, is returned back into the city's grid. [2]

The Chicago Green way houses 12 versicle-axis, stacked Helix wind turbines. Each is about 16'x4', weighs over 1,330lbs and are supported by steel support base plates. [3] Unlike horizontal axis wind turbines, the helical form is able to harness wind coming from any direction, they take up less space and are less noisy making them perfect for urban environments.

[1] *Cilento, Karen, "Chicago Greenway Self-Park/HOK," ArchDaily, Aug 24, 2010, http://www.archdaily.com/?p=74468*

[2] *Cilento, Karen, "Chicago Greenway Self-Park/HOK," ArchDaily.*

[3] *Cilento, Karen, "Chicago Greenway Self-Park/HOK," ArchDaily.*

Photos Credited to John Picken

The eli S
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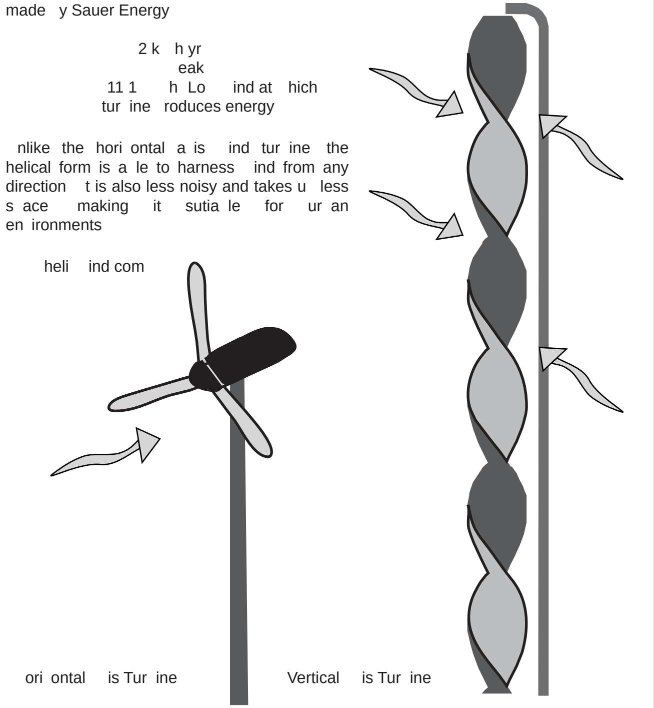

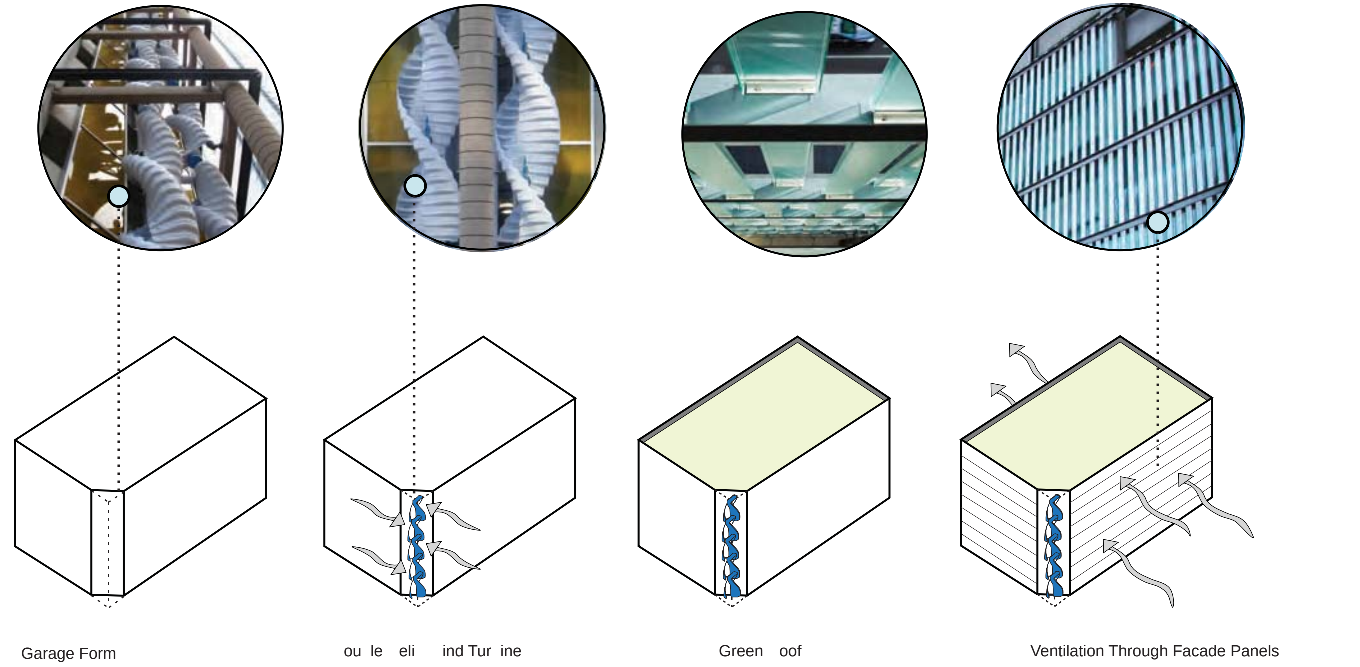

Arcollab Architects 2012

Plug and Pla
Design Competition

Plug and PLay was the winning entry for a the DesignByMany competition for an Electric Vehicle Charging Station. Arcollab designed a form that would generate consciouness regarding energy, creating an intersection between the aspects of production and consumption. Ironically, the charging station units take the shape of traditional power plant smoke stakes, hoping to reverse the negative stigma associated with this form and are made of photovoltaic film, led lights, and lightweight aluminum pipes make up the frame.

The project challenges the idea of a centralized gas station and scatters the modulated system through the city with an awareness about where people are travelling to and from. They map out "play" zones in the city (food, exercise, shopping, coffee etc,) that might act as destinations points and places the charging stations in close proximity to them.[1] The facade surface acts as an urban battery that displays amount the vehicle has been charged.

[1] *Furuto, Alison, " Electric Vehicle Charging Station Winning Proposal: Plug + Play/ Arcollab," ArchDaily, March 01, 2010, www.archdaily.com/?p=212842.*

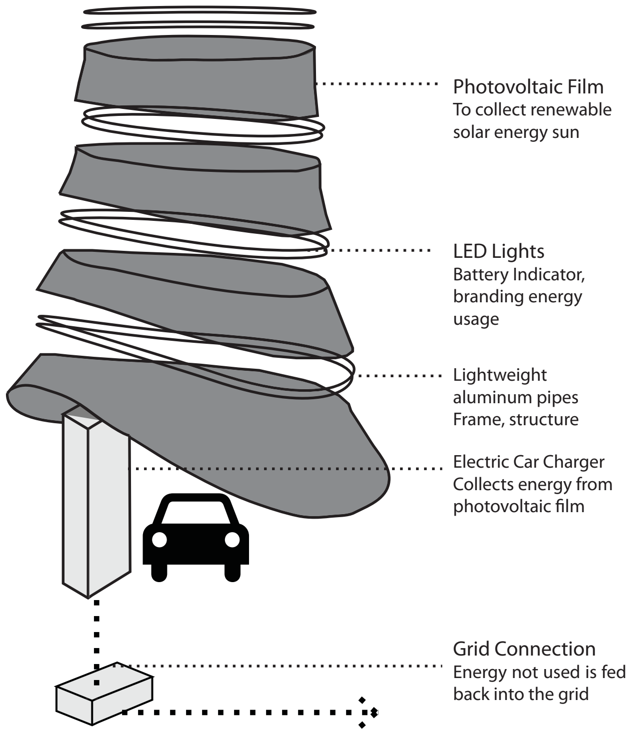

Photo Credit : Arcollab

Photo Credit : Arcollab

LAVA Architects

The Eight Point.one is a solar charging station designed to be marketable, yet very innovative. It had evolved through a design charette from LAVA architects, Consuplan Structural Engineerging and Designtoproduction Planning all on behalf of EIGHT mbH & Co. KG in SuBen, Germany.

The charging station was designed for the top-end market sector and would target companies who are committed to sustainiable, green technology. The design was developed based on an arch framework called a dihedral, exploiting metal manufacturing technologies including laser cutting and integrated 3-d data sets. The 55 sqm aluminium structure is meant to be easily assembled, disassembled and recycled.

“The solar charging stations from EIGHT enables sustainable and emissions-free e-mobility which enthuses people and therefore helps electric vehicles to become a key element of a new modern urban lifestyle. Based upon a holistic approach that combines design, technology manufacturing and process intelligence with recycling-efficient materials and intuitive user-interfaces the Point.One solar charging stations are visi le s m ols for a new and emissions free mo ilit .”[1]

[1] *“EIGHT Point.One S/Lava,” Archdaily, Aug, 2013. http://www.archdaily.com/414995/ .*

Eight Point.One
German

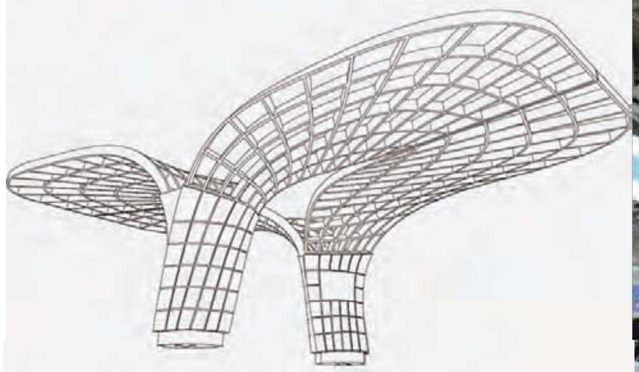

Image Credit : EIGHT GmbH & Co. KG.

Photo Credit : EIGHT GmbH & Co. KG.

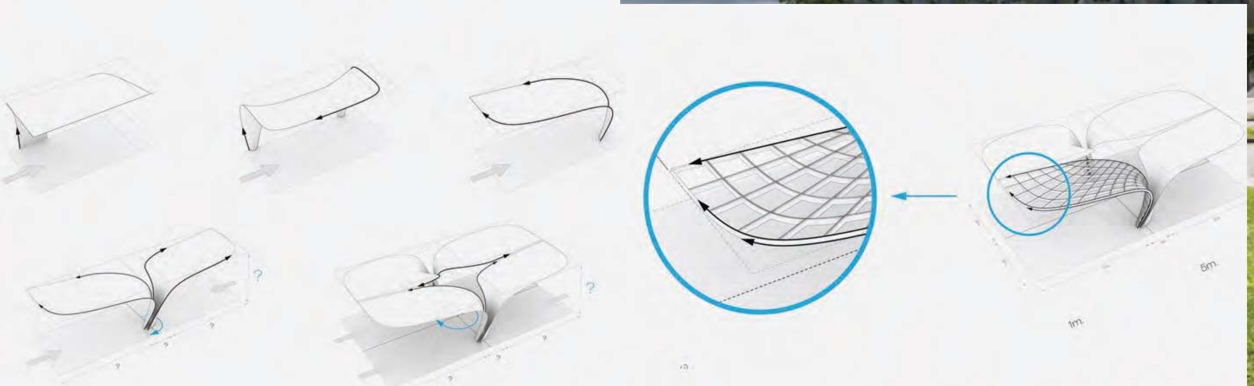

Image Credit : EIGHT GmbH & Co. KG.

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Photo Credit : EIGHT GmbH & Co. KG.

Repsol Service Station
Spain 1 1 7

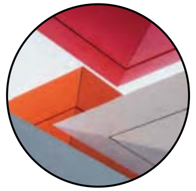
Martinez Lapena - Torres Arquitectos

Foster and Partners were hired to re-design the Spanish Repsol Oil Company's new roadside image. The solution was a flexible and easily replicated system that has been implemented onto over 200 Spanish sites. The result included a canopy system made up of inverted factory made pyramids in orange, red and white (red always the highest and most prominent). The umbrellas were clustered based on the amount of pumps needed, creating an interesting three dimensionality that breaks tradition of a simple flat service station canopy.

The variables in the modulated umbrellas include height, quantity, and distance between each according to different site needs. The construction is simple and the modulated system can be reconfigured based on site conditions. The entire design is associated with a family of forms including the signage, petrol pumps, store unit and a car wash.

"Even from the air Repsol's identity is announced unmistakably. On the road, the stations are clearly identifiable from a distance and vivid and inviting when approached." [1]

[1] *"Repsol Service Station, Spain 1997," Foster and Partners, 2013, http://www.fosterandpartners.com/projects/repsol-service--stations/*



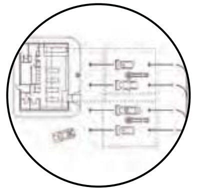



Photo Credit : Foster and Partners

Traditional Gas Station **Repsol Station**

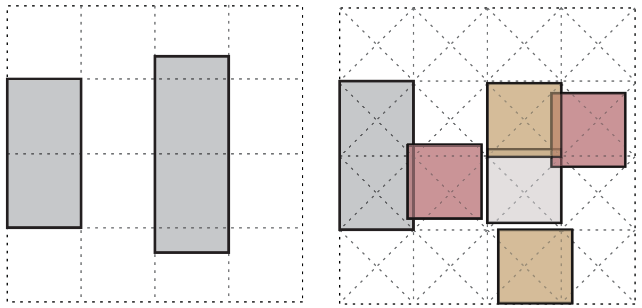
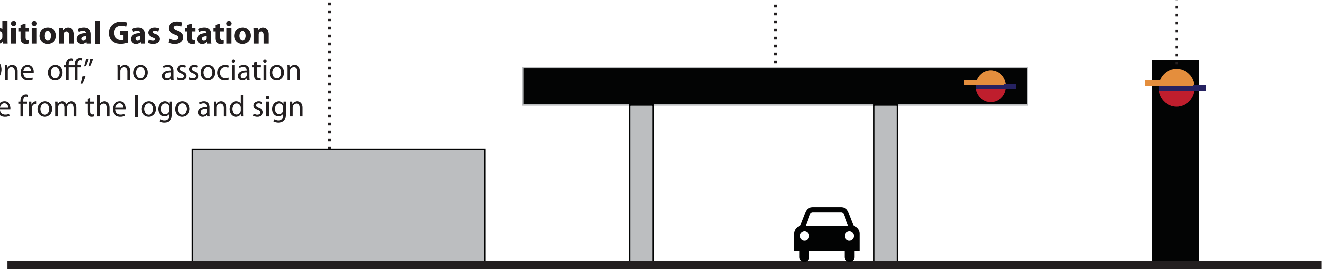


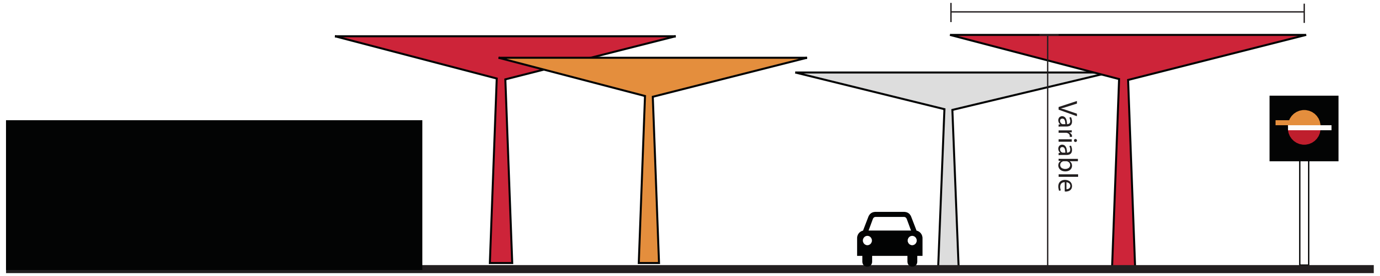
Photo Credit : Foster and Partners

Photo Credit : Foster and Partners

Traditional Gas Station
A "One off," no association aside from the logo and sign



Repsol Station
Moves away from traditional filling station typology and towards a visual identity



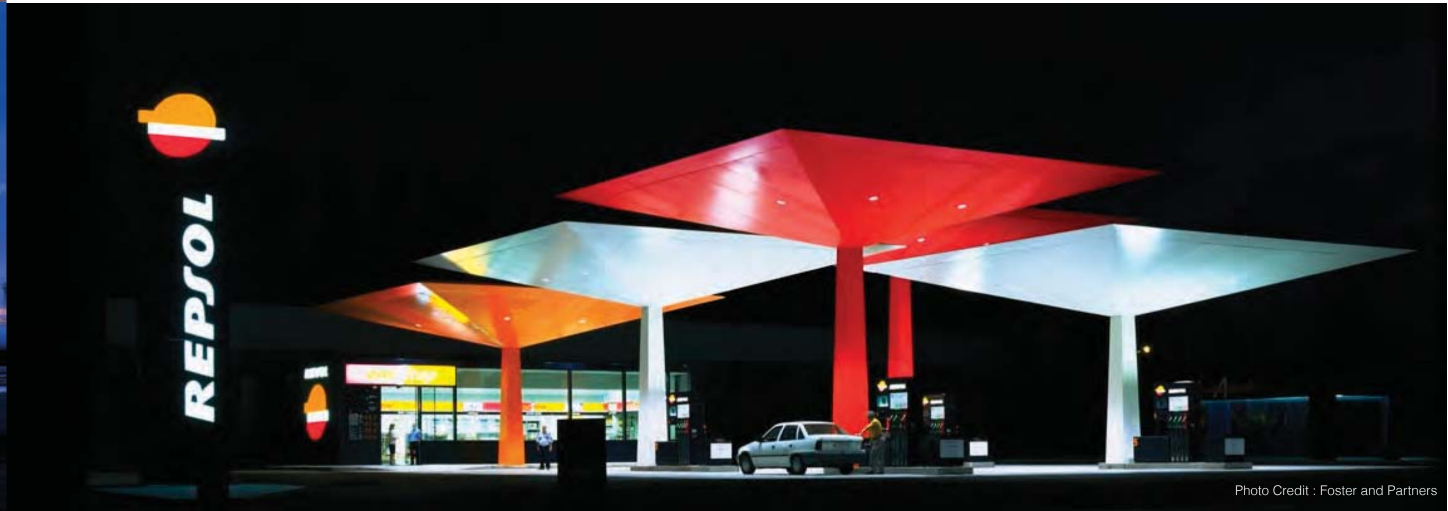


Photo Credit : Foster and Partners

Volvo Pure Tension Pavilion
Gothen urg, Sweden

Synthesis Design + Architecture

Synthesis Design + Architecture, a Los Angeles firm, won a design competition for an iconic and portable charging pavilion used to brand Volvo's new electric hybrid V60.

"We wanted to challenge the notion of solar power as something that is an additive piece of engineering infrastructure," said Synthesis founder and principal, Alvin Huang. "The solar panels became a design feature and design driver, rather than something applied after the fact." [1]

The portable design disassembles to fit into the trunk of a car.

The pavilion is made up of 252 photovoltaic panels (7" x 7" panels by Ascent Solar Technologies) that are dispersed along the skin in a particular pattern based on sun exposure and optimization. A vinyl polyester mesh skin is stretched along a structure is made up of CNC milled aluminum pipes. Photovoltaic wiring is strung through the seams of the mesh fabric and connect to a battery used to charge the EV.

When tested, the pavilion generated about 450 watts of energy under optimum solar conditions.

"Pure Tension is an experimental structure that, similar to a concept car, is a working prototype that speculates on the potential future of personal mobility and alternative energy sources for transportation while also exploring digital design methodologies and innovative structural solutions." [2]

[1] *"Volvo Pure Tension Pavilion that charges an Electric Car by Synthesis Design + Architecture," Dezeen Magazine, November 14, 2013 http://www.dezeen.com/2013/11/14/volvo-pure-tension-pavilion/*

[2] *"Volvo Pure Tension Pavilion that charges an Electric Car by Synthesis Design + Architecture," Dezeen Magazine.*

Image Credit : Synthesis Design and Architecture

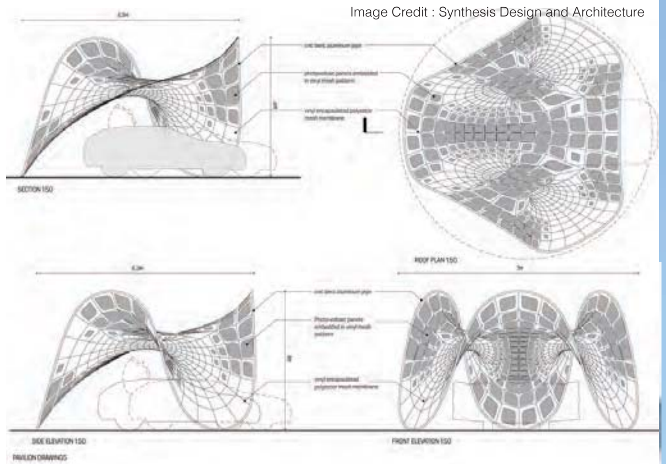


Photo Credit : Synthesis Design and Architecture

Photo Credit : Synthesis Design and Architecture

Photo Credit : Synthesis Design and Architecture

Image Credit : Synthesis Design and Architecture

PSU Campus and the City of Portland

Electric Avenue
Portland State Universit

It is important to the City of Portland to brand themselves as a 'Green City.' Electric Avenue is a research initiative developed by the City of Portland, Portland State University and Portland General Electric. The research partnership developed a two-year project in downtown Portland at the geographical center of the Portland Sixth Avenue Transit Mall, PSU's campus and the city center. "It is a perfect place to understand the fit and flow of electric vehicles in the larger mobility context of the city." [1]

The initiative began as a response to the increase in the number of Portland electric streetcars and was meant to study the performance of charging stations, driver preference and charging habits. The programs slogan is "Visit Electric Avenue soon! Plug in, Charge up. Drive on." [2]

The intervention includes a number of host partners (City of Portland, Portland General Electric and PSU), charging station partners (Eaton, ECOtality, General Electric, Northwrite Inc., Shorepower etc.) and supporting partners (Nissan North America, Toyota Motor Sales, Mitsubishi North America etc.)

"With a whole range of all-electric and plug-in hybrid vehicles now coming to market, we made the choice not simply to react to their appearance, but to understand and document how they worked, how well they performed, and if they served the region's long-view interests in urban planning, personal and freight mobility, economic development, public health, and quality of life." [3]

[1] *"Electric Avenue on the PSU Campus at SW Broadway and SW Montgomery," 2013, http://www.pdx.edu/electricavenue/*

[2] *"Electric Avenue on the PSU Campus at SW Broadway and SW Montgomery."*

[3] *"Electric Avenue on the PSU Campus at SW Broadway and SW Montgomery."*

Image Credit : Portland State University

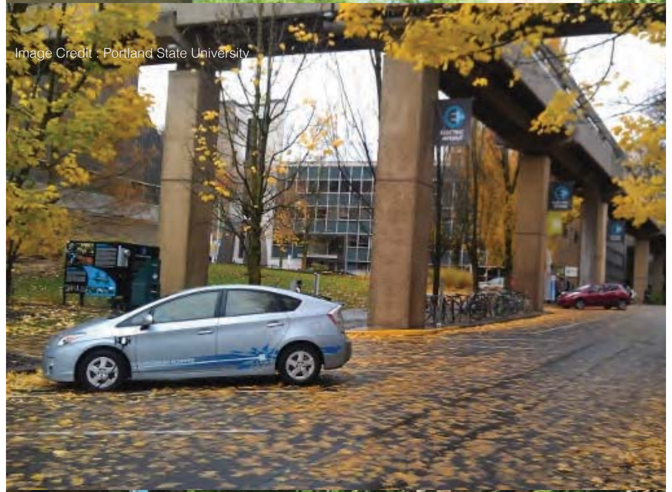


Image Credit : Portland State University

Image Credit : Portland State University

Image Credit : Portland State University

Image Credit : Portland State University

Sierra Nevada Brewer
Chico, California

BREWERY STAINABILITY GOALS

“At Sierra Nevada Brewing Co., stainability means recognizing the impacts associated with our operations and making a conscious effort to reduce them. We are committed to leaving the smallest footprint possible without jeopardizing our high standards for quality. We strive to maintain a healthy balance between environmental stewardship, social equity, and economic stability. By engaging in an active stainability program, we intend to leave a better world for future generations.” [1]

Sierra Nevada Brewery has a Stainability Department that promotes zero waste action hoping to inspire change. They monitor their waste and energy consumption, produce their own biodiesel, research alternative fuel options, and produce a large amount of their own energy through solar panels and hydrogen fuel cells.

The Brewery owns 10,573 solar panels, one of the largest array of solar panels in the United states, that produce about 20% (2 Megawatts of DC power) of the total energy they consumer. They also use non combustion hydrogen fuel cells that produce another 40% of energy the brewery consumes.

Since day one, the Sierra Nevada Brewery has stuck to an important business model: Reduce, Reuse, Recycle,” which has “helped solidify our commitment to the environment. We have been recognized locally, statewide, and nationally for our commitment to reducing our environmental impact.” [2]

[1] *“Sustainability, On-Site Power Generation,” Sierra Nevada Brewery Chico California, 2013, http://www.sierranevada.com/brewery/about-us/sustainability.*

[2] *“Sustainability, On-Site Power Generation,” Sierra Nevada Brewery Chico California*

Photo Credit : Sierra Nevada Brewery


Photo Credit : Sierra Nevada Brewery

Photo Credit : Sierra Nevada Brewery

Photo Credit : Sierra Nevada Brewery


Photo Credit : Sierra Nevada Brewery

Electric Vehicle Charging Station

Gothen urg, Sweden

Kjellgren Kaminsky Architecture (KKA)

Kjellgren Kaminsky Architects was commissioned by the Gothenburg Traffic Department to design a charging station, powered by almost entirely by solar energy. As the design was meant to represent the city's commitment to this mode of transit, these stations will be an iconic "symbol of a more sustainable city." [1]

A south facing sloped roof is covered with solar panels and covers an elevated ramp that houses bikes, scooters and cars. "The design, fabricated entirely from FSC-certified local wood, strategically separates vehicles from bikes and scooters on an elevated ramp capped with a south-facing, solar cell roof." [2]

The structure is equipped with amenities that the user can engage in while waiting the 20 minutes for their charge including an outdoor gym, Wi-Fi connected courtyard, cafe and bicycle repair shop.

[1] *Rosenfield, Karissa, "KKA Designs Electric Vehicle Charging Stations in Sweden" Aug 06, 2013. www.archdaily.com/?p=412281*

[2] *Rosenfield, Karissa, "KKA Designs Electric Vehicle Charging Stations in Sweden."*

Photo Credit : Kjellgren Kaminsky Architecture

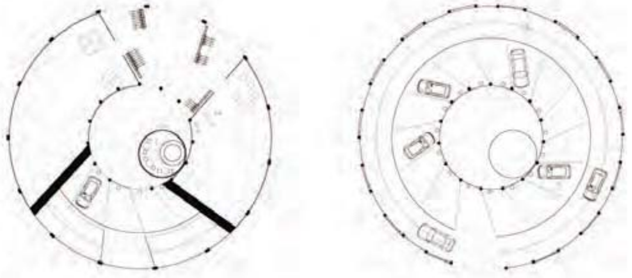


Image Credit to Kjellgren Kaminsky Architecture

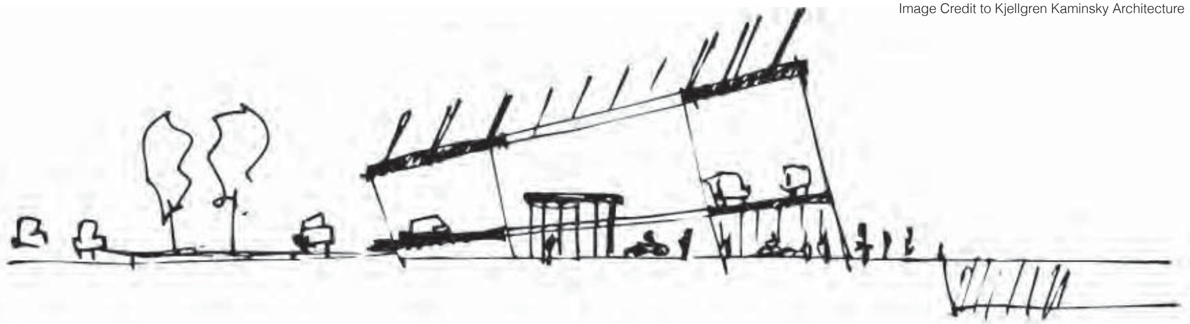


Image Credit to Kjellgren Kaminsky Architecture

Photo Credit : Kjellgren Kaminsky Architecture

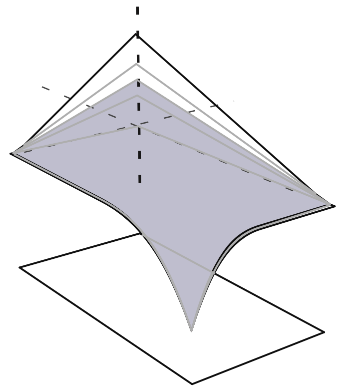
+ TECHNOLOGY

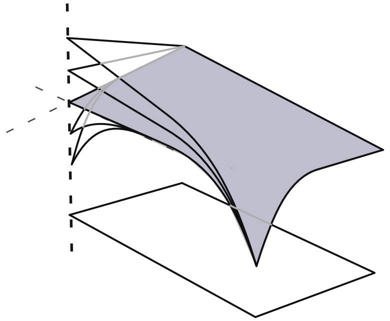
Maximizing Solar Gain

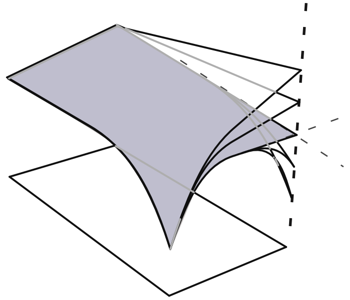
Ecotect Testing

Form Manipulation

TECHNOLOGY



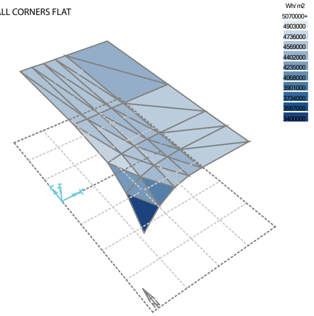




Form K1
Total Radiation
Value Range: 3400000.0 - 5070000.0 Wh/m2
© ECOTECT v5

Object ID	Object Type	Area (ft2)	Total Radiation Wh/m2	Direct Radiation Wh/m2	Diffuse Radiation Wh/m2
SUM TOTAL		166.17	178707520	91979536	86727976
MAXIMUM		20.25	4725604.5	2645517.75	2336090
MINIMUM		1.25	3164218.75	1859791.375	1304427.125
AVERAGE		4.15	4467688	2299488.4	2168199.4

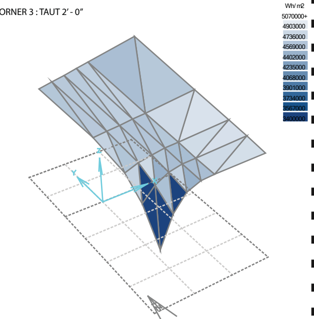
ALL CORNERS FLAT



Form K2
Total Radiation
Value Range: 3400000.0 - 5070000.0 Wh/m2
© ECOTECT v5

Object ID	Object Type	Area (ft2)	Total Radiation Wh/m2	Direct Radiation Wh/m2	Diffuse Radiation Wh/m2
SUM TOTAL		162.51	168468944	87193736	81275192
MAXIMUM		19.97	4824823	2807346	2336819.5
MINIMUM		1.22	448741.031	0	443933.594
AVERAGE		4.06	4211723.6	2179843.4	2031879.8

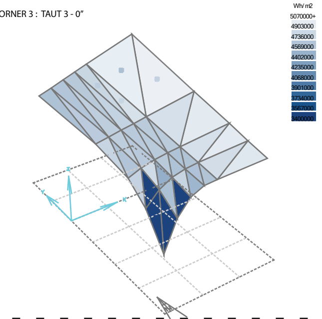
CORNER 3 : TAUT 2' - 0"



Form K3
Total Radiation
Value Range: 3400000.0 - 5070000.0 Wh/m2
© ECOTECT v5

Object ID	Object Type	Area (ft2)	Total Radiation Wh/m2	Direct Radiation Wh/m2	Diffuse Radiation Wh/m2
SUM TOTAL		162.79	199453856	88512928	80940976
MAXIMUM		20.61	4894146	2802462.25	2316628
MINIMUM		1.22	470543.969	0	465607.312
AVERAGE		4.12	4236346.4	2212823.2	2023524.4

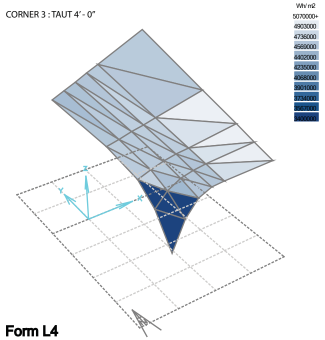
CORNER 3 : TAUT 3 - 0"



Form K4
Total Radiation
Value Range: 3400000.0 - 5070000.0 Wh/m2
© ECOTECT v5

Object ID	Object Type	Area (ft2)	Total Radiation Wh/m2	Direct Radiation Wh/m2	Diffuse Radiation Wh/m2
SUM TOTAL		162.61	168657440	89100736	80556728
MAXIMUM		21.81	4947375	2691077.5	2315008.25
MINIMUM		1.22	476049.75	1746.814	474302.938
AVERAGE		4.19	4241436	2227518.4	2013918.2

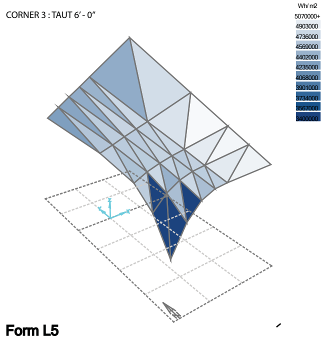
CORNER 3 : TAUT 4' - 0"



Form K5
Total Radiation
Value Range: 3400000.0 - 5070000.0 Wh/m2
© ECOTECT v5

Object ID	Object Type	Area (ft2)	Total Radiation Wh/m2	Direct Radiation Wh/m2	Diffuse Radiation Wh/m2
SUM TOTAL		163.24	168678576	90829696	78848896
MAXIMUM		23.4	5020282.5	2783910	2294225
MINIMUM		1.21	486788.781	0	484371.594
AVERAGE		4.33	4231964.4	2270742.4	1971222.4

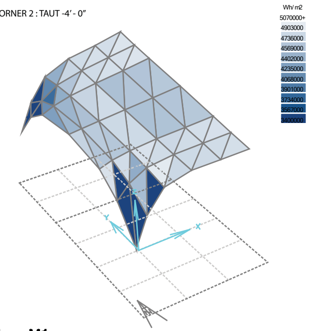
CORNER 3 : TAUT 6' - 0"



Form L1
Total Radiation
Value Range: 3400000.0 - 5070000.0 Wh/m2
© ECOTECT v5

Object ID	Object Type	Area (ft2)	Total Radiation Wh/m2	Direct Radiation Wh/m2	Diffuse Radiation Wh/m2
SUM TOTAL		162.76	244759168	125246880	119512288
MAXIMUM		5.07	4890851	2867581.5	2336527
MINIMUM		1.16	439272.562	0	439272.562
AVERAGE		2.8	4079319.467	2087448	1991871.467

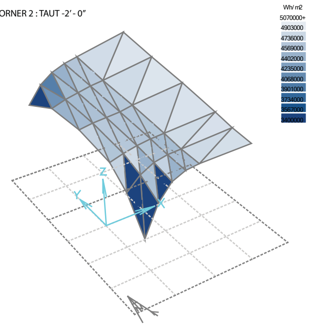
CORNER 2 : TAUT -4' - 0"



Form L2
Total Radiation
Value Range: 3400000.0 - 5070000.0 Wh/m2
© ECOTECT v5

Object ID	Object Type	Area (ft2)	Total Radiation Wh/m2	Direct Radiation Wh/m2	Diffuse Radiation Wh/m2
SUM TOTAL		162.03	168012256	107656240	101356032
MAXIMUM		9.99	4848104	2807346	2336819.5
MINIMUM		1.22	448741.031	0	443933.594
AVERAGE		3.3	4180245.12	2153124.8	2027120.64

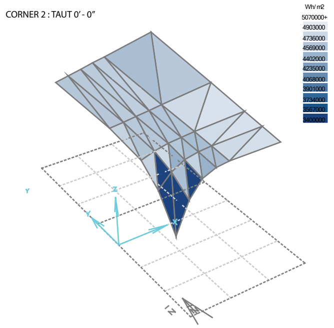
CORNER 2 : TAUT -2' - 0"



Form L3
Total Radiation
Value Range: 3400000.0 - 5070000.0 Wh/m2
© ECOTECT v5

Object ID	Object Type	Area (ft2)	Total Radiation Wh/m2	Direct Radiation Wh/m2	Diffuse Radiation Wh/m2
SUM TOTAL		162.17	178707520	91979536	86727976
MAXIMUM		20.25	4725604.5	2645517.75	2336090
MINIMUM		1.25	3164218.75	1859791.375	1304427.125
AVERAGE		4.15	4467688	2299488.4	2168199.4

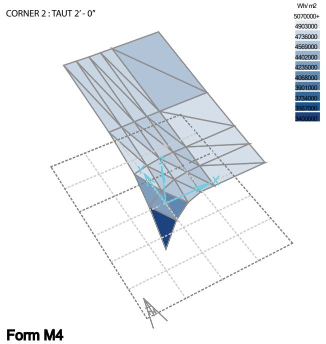
CORNER 2 : TAUT 0' - 0"



Form L4
Total Radiation
Value Range: 3400000.0 - 5070000.0 Wh/m2
© ECOTECT v5

Object ID	Object Type	Area (ft2)	Total Radiation Wh/m2	Direct Radiation Wh/m2	Diffuse Radiation Wh/m2
SUM TOTAL		162.72	174496848	98328160	86168736
MAXIMUM		19.57	4803906.5	2740240.25	2314645.5
MINIMUM		1.22	3339092.25	1977392.875	1361699.5
AVERAGE		4.04	4612421.2	2458204	2154218.4

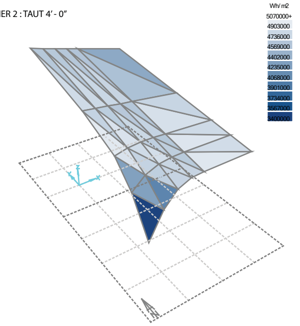
CORNER 2 : TAUT 2' - 0"



Form L5
Total Radiation
Value Range: 3400000.0 - 5070000.0 Wh/m2
© ECOTECT v5

Object ID	Object Type	Area (ft2)	Total Radiation Wh/m2	Direct Radiation Wh/m2	Diffuse Radiation Wh/m2
SUM TOTAL		162.62	164773280	99289200	85484096
MAXIMUM		20.06	4882661.5	2801511.5	2316517.75
MINIMUM		1.23	3350563.75	1987491.75	1363072
AVERAGE		4.12	4619332	2482230	2137102.4

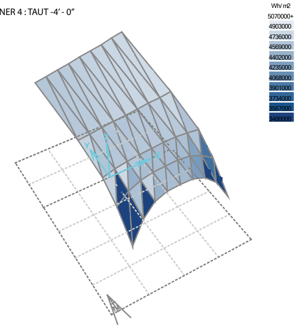
CORNER 2 : TAUT 4' - 0"



Form M1
Total Radiation
Value Range: 3400000.0 - 5070000.0 Wh/m2
© ECOTECT v5

Object ID	Object Type	Area (ft2)	Total Radiation Wh/m2	Direct Radiation Wh/m2	Diffuse Radiation Wh/m2
SUM TOTAL		162.82	185186512	138051760	129134784
MAXIMUM		5.01	4762901.5	2807346	2270270.25
MINIMUM		1.22	425838.375	0	421030.906
AVERAGE		2.61	4174789.25	2157058.75	2017731

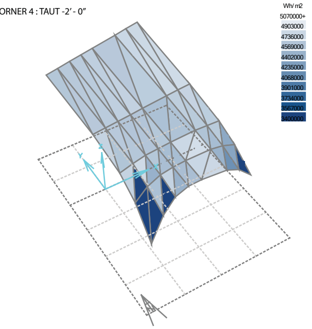
CORNER 4 : TAUT -4' - 0"



Form M2
Total Radiation
Value Range: 3400000.0 - 5070000.0 Wh/m2
© ECOTECT v5

Object ID	Object Type	Area (ft2)	Total Radiation Wh/m2	Direct Radiation Wh/m2	Diffuse Radiation Wh/m2
SUM TOTAL		162.9	186750112	122572040	114178120
MAXIMUM		9.99	4788033	2807346	2336499.25
MINIMUM		1.22	425838.375	0	419493.406
AVERAGE		2.93	4227680.571	2188786.429	2038895

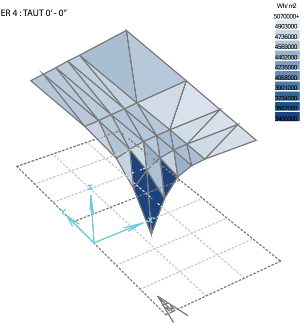
CORNER 4 : TAUT -2' - 0"



Form M3
Total Radiation
Value Range: 3400000.0 - 5070000.0 Wh/m2
© ECOTECT v5

Object ID	Object Type	Area (ft2)	Total Radiation Wh/m2	Direct Radiation Wh/m2	Diffuse Radiation Wh/m2
SUM TOTAL		162.17	189707520	91979536	86727976
MAXIMUM		20.25	4725604.5	2645517.75	2336090
MINIMUM		1.25	3164218.75	1859791.375	1304427.125
AVERAGE		4.15	4467688	2299488.4	2168199.4

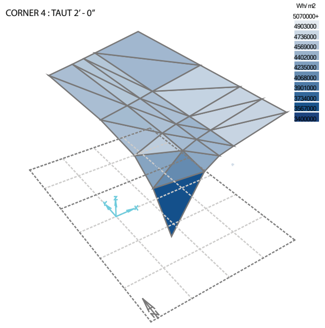
CORNER 4 : TAUT 0' - 0"



Form M4
Total Radiation
Value Range: 3400000.0 - 5070000.0 Wh/m2
© ECOTECT v5

Object ID	Object Type	Area (ft2)	Total Radiation Wh/m2	Direct Radiation Wh/m2	Diffuse Radiation Wh/m2
SUM TOTAL		162.04	143459648	74721528	68738120
MAXIMUM		19.94	4699183	2518435	2295952.5
MINIMUM		1.25	3537344.5	2118732.5	1418612.125
AVERAGE		5.19	4483114	2335047.75	2148066.25

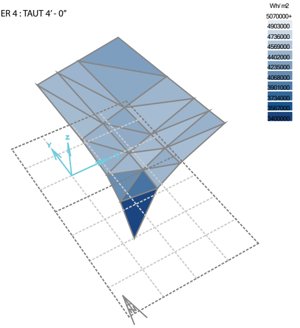
CORNER 4 : TAUT 2' - 0"

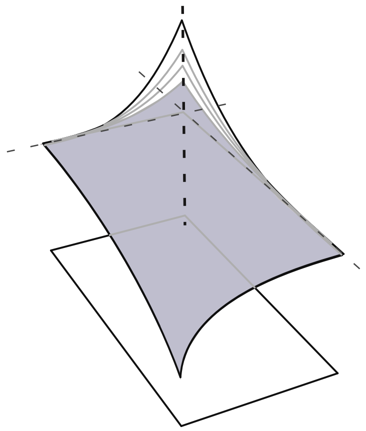


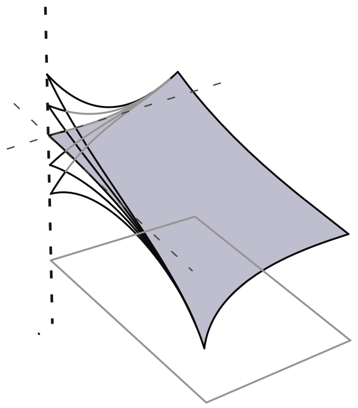
Form M5
Total Radiation
Value Range: 3400000.0 - 5070000.0 Wh/m2
© ECOTECT v5

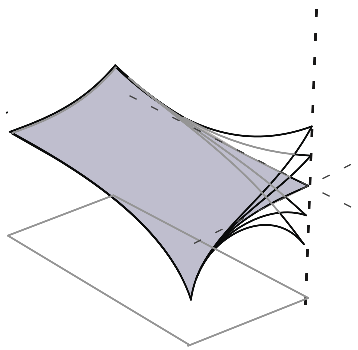
Object ID	Object Type	Area (ft2)	Total Radiation Wh/m2	Direct Radiation Wh/m2	Diffuse Radiation Wh/m2
SUM TOTAL		162.71	104183944	54002276	50181668
MAXIMUM		20.27	4533718	2398849.5	2235089.25
MINIMUM		2.61	3434070.25	2031563.625	1402506.75
AVERAGE		7.07	4340997.667	2250094.833	2090902.833

CORNER 4 : TAUT 4' - 0"





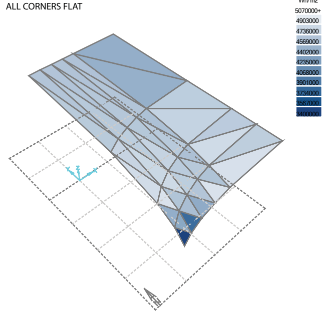




Form H1
Total Radiation
Value Range: 3400000.0 - 5070000.0 Wh/m2
© ECOTECT v5

Object		Area	Total Radiation	Direct Radiation	Diffuse Radiation
ID		(ft2)	Wh/m2	Wh/m2	Wh/m2
SUM TOTAL		162.64	181757072	96502520	85254568
MAXIMUM		20.63	4822250.5	2799523.5	2336094
MINIMUM		0.69	3041195.75	1822539.375	1218656.5
AVERAGE		4.07	4543926.8	2412563	2131364.2

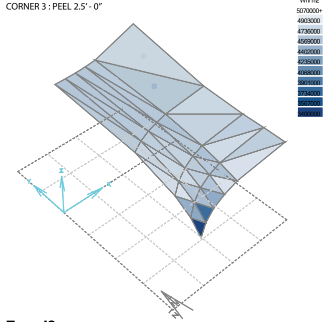
ALL CORNERS FLAT



Form H2
Total Radiation
Value Range: 3400000.0 - 5070000.0 Wh/m2
© ECOTECT v5

Object		Area	Total Radiation	Direct Radiation	Diffuse Radiation
ID		(ft2)	Wh/m2	Wh/m2	Wh/m2
SUM TOTAL		162.6	182398944	97326120	85072808
MAXIMUM		21.28	4822258.5	2799523.5	2315637.5
MINIMUM		0.69	3041195.75	1822539.375	1218656.5
AVERAGE		4.12	4559973.6	2433153	2126820.2

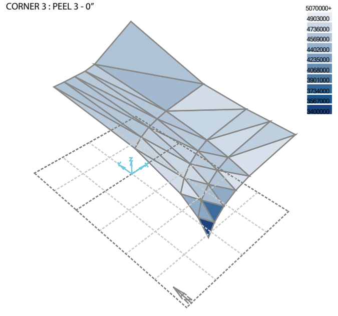
CORNER 3 : PEEL 2.5' - 0"



Form H2.1
Total Radiation
Value Range: 3400000.0 - 5070000.0 Wh/m2
© ECOTECT v5

Object		Area	Total Radiation	Direct Radiation	Diffuse Radiation
ID		(ft2)	Wh/m2	Wh/m2	Wh/m2
SUM TOTAL		166.84	182346992	97548120	84798848
MAXIMUM		23.36	4822350	2799523.5	2315640.25
MINIMUM		0.69	3041195.75	1822539.375	1218656.5
AVERAGE		4.17	4558674.8	2438703	2119971.2

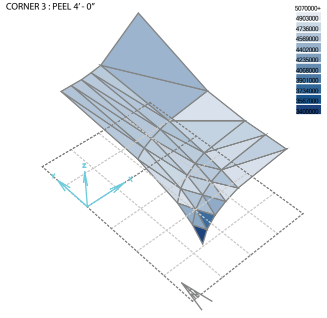
CORNER 3 : PEEL 3 - 0"



Form H3
Total Radiation
Value Range: 3400000.0 - 5070000.0 Wh/m2
© ECOTECT v5

Object	Object	Area	Total Radiation	Direct Radiation	Diffuse Radiation
ID	Type	(ft2)	Wh/m2	Wh/m2	Wh/m2
SUM TOTAL		162.68	182195008	97690936	84504064
MAXIMUM		26	4822352.5	2799523.5	2315642.75
MINIMUM		0.69	3041195.75	1822539.375	1218656.5
AVERAGE		4.24	4554875.2	2442273.4	2112601.6

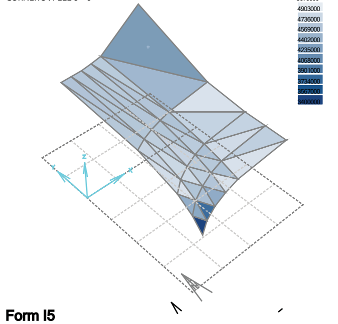
CORNER 3 : PEEL 4' - 0"



Form H4
Total Radiation
Value Range: 3400000.0 - 5070000.0 Wh/m2
© ECOTECT v5

Object	Object	Area	Total Radiation	Direct Radiation	Diffuse Radiation
ID	Type	(ft2)	Wh/m2	Wh/m2	Wh/m2
SUM TOTAL		162.68	182195008	97690936	84504064
MAXIMUM		26	4822352.5	2799523.5	2315642.75
MINIMUM		0.69	3041195.75	1822539.375	1218656.5
AVERAGE		4.24	4554875.2	2442273.4	2112601.6

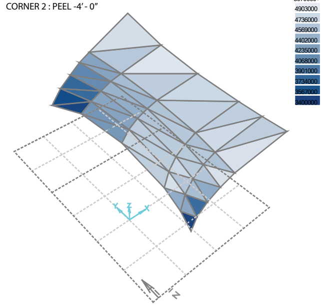
CORNER 3 : PEEL 6' - 0"



Form I1
Total Radiation
Value Range: 3400000.0 - 5070000.0 Wh/m2
© ECOTECT v5

Object		Area	Total Radiation	Direct Radiation	Diffuse Radiation
ID		(ft2)	Wh/m2	Wh/m2	Wh/m2
SUM TOTAL		162.5	180672256	115597008	105075240
MAXIMUM		11.21	4853159.5	2784629.5	2315627.75
MINIMUM		0.69	3040804.75	1473792.75	1218635.125
AVERAGE		3.41	4413445.12	2311940.16	2101504.8

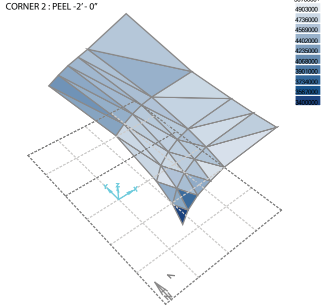
CORNER 3 : PEEL 2.5' - 0"
CORNER 2 : PEEL -4' - 0"



Form I2
Total Radiation
Value Range: 3400000.0 - 5070000.0 Wh/m2
© ECOTECT v5

Object		Area	Total Radiation	Direct Radiation	Diffuse Radiation
ID		(ft2)	Wh/m2	Wh/m2	Wh/m2
SUM TOTAL		162.47	180414784	95975952	84438824
MAXIMUM		21.7	4822073	2790340.75	2315629.75
MINIMUM		0.69	3040526.75	1821880.125	1218646.625
AVERAGE		4.19	4510369.6	2399398.8	2110970.6

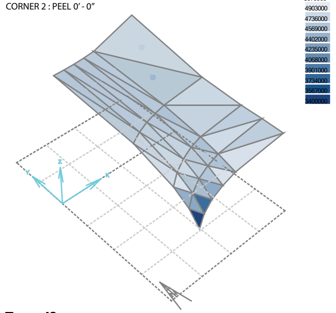
CORNER 3 : PEEL 2.5' - 0"
CORNER 2 : PEEL -2' - 0"



Form I3
Total Radiation
Value Range: 3400000.0 - 5070000.0 Wh/m2
© ECOTECT v5

Object		Area	Total Radiation	Direct Radiation	Diffuse Radiation
ID		(ft2)	Wh/m2	Wh/m2	Wh/m2
SUM TOTAL		162.6	182398944	97326120	85072808
MAXIMUM		21.28	4822258.5	2799523.5	2315637.5
MINIMUM		0.69	3041195.75	1822539.375	1218656.5
AVERAGE		4.12	4559973.6	2433153	2126820.2

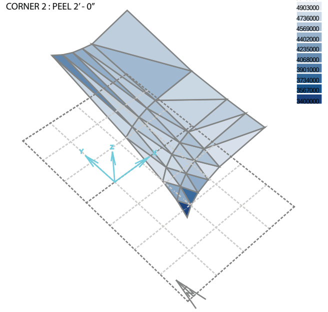
CORNER 3 : PEEL 2.5' - 0"
CORNER 2 : PEEL 0' - 0"



Form I4
Total Radiation
Value Range: 3400000.0 - 5070000.0 Wh/m2
© ECOTECT v5

Object		Area	Total Radiation	Direct Radiation	Diffuse Radiation
ID		(ft2)	Wh/m2	Wh/m2	Wh/m2
SUM TOTAL		162.06	181474304	97042968	84431344
MAXIMUM		20.9	4826410.5	2803615.5	2315642.75
MINIMUM		0.69	3041347.5	1822679.75	1218667.875
AVERAGE		4.15	4536857.6	2426074.2	2110783.6

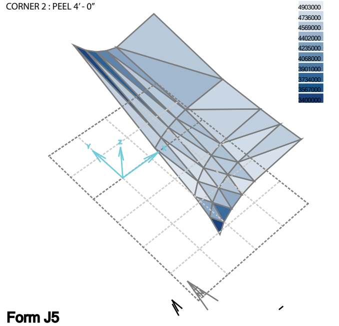
CORNER 3 : PEEL 2.5' - 0"
CORNER 2 : PEEL 2' - 0"



Form I5
Total Radiation
Value Range: 3400000.0 - 5070000.0 Wh/m2
© ECOTECT v5

Object		Area	Total Radiation	Direct Radiation	Diffuse Radiation
ID		(ft2)	Wh/m2	Wh/m2	Wh/m2
SUM TOTAL		162.97	179433792	96175416	83258392
MAXIMUM		20.7	4862361	2808132.75	2315647.75
MINIMUM		0.69	3041337	1622670.75	1218677.125
AVERAGE		4.27	4485844.8	2404385.4	2081459.8

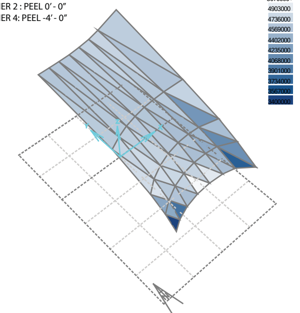
CORNER 3 : PEEL 2.5' - 0"
CORNER 2 : PEEL 4' - 0"



Form J1
Total Radiation
Value Range: 3400000.0 - 5070000.0 Wh/m2
© ECOTECT v5

Object		Area	Total Radiation	Direct Radiation	Diffuse Radiation
ID		(ft2)	Wh/m2	Wh/m2	Wh/m2
SUM TOTAL		162.48	179521728	134489088	119032672
MAXIMUM		11.26	5021015.5	2800992.75	2318878.25
MINIMUM		0.69	3042855.25	1797122.125	1218591.75
AVERAGE		3.01	4527173.714	2401590.857	2125583.429

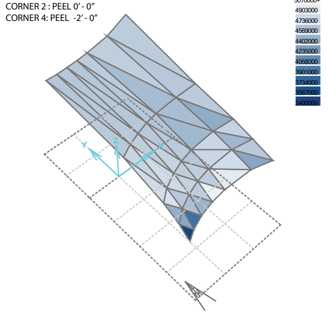
CORNER 3 : PEEL 2.5' - 0"
CORNER 2 : PEEL 0' - 0"
CORNER 4: PEEL -4' - 0"



Form J2
Total Radiation
Value Range: 3400000.0 - 5070000.0 Wh/m2
© ECOTECT v5

Object		Area	Total Radiation	Direct Radiation	Diffuse Radiation
ID		(ft2)	Wh/m2	Wh/m2	Wh/m2
SUM TOTAL		165.43	179157808	116505280	102652536
MAXIMUM		11.2	4958328.5	2800468.75	2338924.5
MINIMUM		0.69	3041507	1822882.125	1218625
AVERAGE		3.45	4525787.667	2427193.333	2138594.5

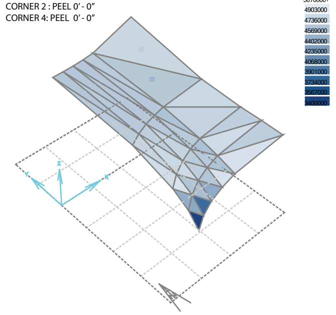
CORNER 3 : PEEL 2.5' - 0"
CORNER 2 : PEEL 0' - 0"
CORNER 4: PEEL -2' - 0"



Form J3
Total Radiation
Value Range: 3400000.0 - 5070000.0 Wh/m2
© ECOTECT v5

Object		Area	Total Radiation	Direct Radiation	Diffuse Radiation
ID		(ft2)	Wh/m2	Wh/m2	Wh/m2
SUM TOTAL		162.6	182398944	97326120	85072808
MAXIMUM		21.28	4822258.5	2799523.5	2315637.5
MINIMUM		0.69	3041195.75	1822539.375	1218656.5
AVERAGE		4.12	4559973.6	2433153	2126820.2

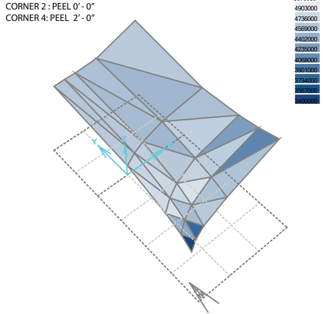
CORNER 3 : PEEL 2.5' - 0"
CORNER 2 : PEEL 0' - 0"
CORNER 4: PEEL 0' - 0"



Form J4
Total Radiation
Value Range: 3400000.0 - 5070000.0 Wh/m2
© ECOTECT v5

Object	Object	Area	Total Radiation	Direct Radiation	Diffuse Radiation
ID	Type	(ft2)	Wh/m2	Wh/m2	Wh/m2
SUM TOTAL		162.49	143726848	76565032	67161824
MAXIMUM		21.18	4821119	2798338	2315266.5
MINIMUM		0.69	3040374.75	1817271.5	1218687
AVERAGE		5.2	4491464	2392657.25	2098807

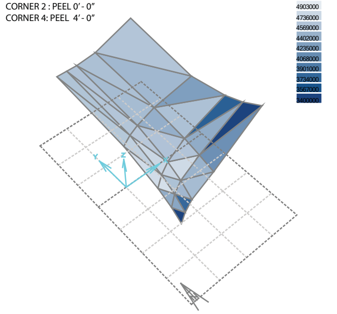
CORNER 3 : PEEL 2.5' - 0"
CORNER 2 : PEEL 0' - 0"
CORNER 4: PEEL 2' - 0"

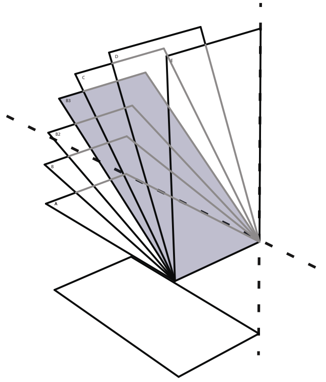


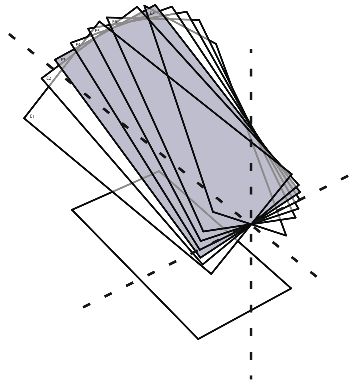
Form J5
Total Radiation
Value Range: 3400000.0 - 5070000.0 Wh/m2
© ECOTECT v5

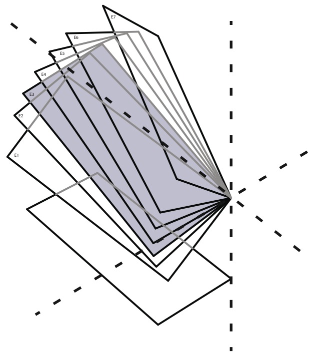
Object		Area	Total Radiation	Direct Radiation	Diffuse Radiation
ID		(ft2)	Wh/m2	Wh/m2	Wh/m2
SUM TOTAL		162.27	140468096	74402624	66065476
MAXIMUM		20.68	4792463	2792530.75	2275382.25
MINIMUM		0.68	3039572.75	1328134.125	1218719.875
AVERAGE		5.23	4389628	2325082	2064546.125

CORNER 3 : PEEL 2.5' - 0"
CORNER 2 : PEEL 0' - 0"
CORNER 4: PEEL 4' - 0"



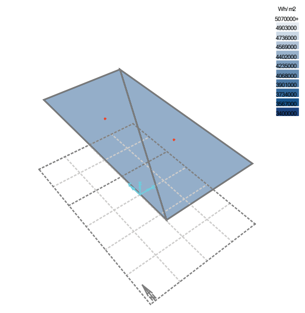






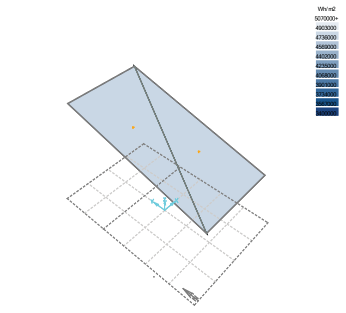
Form A
Total Radiation
Value Range: 3400000.0 - 5070000.0 Wh/m2
© ECOTECT v5

Object		Tilt (deg)	Area (ft2)	Total Radiation Wh/m2	Direct Radiation Wh/m2	Diffuse Radiation Wh/m2
		90	81	4372597.5	2173925.75	2198672
		90	81	4372597.5	2173925.75	2198672
SUM TOTAL			162	8745195	4347851.5	4397344
MAXIMUM			81	4372597.5	2173925.75	2198672
MINIMUM			81	4372597.5	2173925.75	2198672
AVERAGE			81	4372597.5	2173925.75	2198672



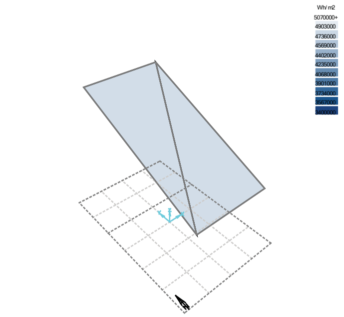
Form B
Total Radiation
Value Range: 3400000.0 - 5070000.0 Wh/m2
© ECOTECT v5

Object		Orient. (deg)	Tilt (deg)	Area (ft2)	Total Radiation Wh/m2	Direct Radiation Wh/m2	Diffuse Radiation Wh/m2
		-180	74.8	81	4719922	2558994.75	2160926.75
		-180	74.8	81	4719922	2558994.75	2160926.75
SUM TOTAL				162	9439844	5117989.5	4321853.5
MAXIMUM				81	4719922	2558994.75	2160926.75
MINIMUM				81	4719922	2558994.75	2160926.75
AVERAGE				81	4719922	2558994.75	2160926.75



Form B2
Total Radiation
Value Range: 3400000.0 - 5070000.0 Wh/m2
© ECOTECT v5

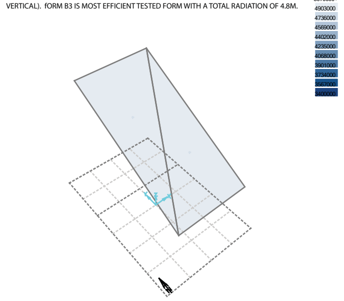
Object		Orient. (deg)	Tilt (deg)	Area (ft2)	Total Radiation Wh/m2	Direct Radiation Wh/m2	Diffuse Radiation Wh/m2
		-180	66	81	4777125	2696064.25	2081060.375
		-180	66	81	4777421.5	2696361	2081060.375
SUM TOTAL				162	9554546	5392425	4162120.75
MAXIMUM				81	4777421.5	2696361	2081060.375
MINIMUM				81	4777125	2696064.25	2081060.375
AVERAGE				81	4777273	2696212.5	2081060.375



Form B3
Total Radiation
Value Range: 3400000.0 - 5070000.0 Wh/m2
© ECOTECT v5

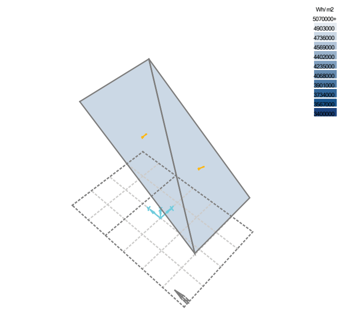
Object		Orient. (deg)	Tilt (deg)	Area (ft2)	Total Radiation Wh/m2	Direct Radiation Wh/m2	Diffuse Radiation Wh/m2
		-180	62	81	4804763	2739602.75	2065160.125
		-180	62	81	4804466.5	2739306	2065160.125
SUM TOTAL				162	9609230	5478909	4130320.25
MAXIMUM				81	4804763	2739602.75	2065160.125
MINIMUM				81	4804466.5	2739306	2065160.125
AVERAGE				81	4804615	2739454.5	2065160.125

NOTE: RESULTS PROVE THAT MAXIMUM EFFICIENCY IS +62 DEGREES (TILT FROM THE VERTICAL). fORM B3 IS MOST EFFICIENT TESTED FORM WITH A TOTAL RADIATION OF 4.8M.



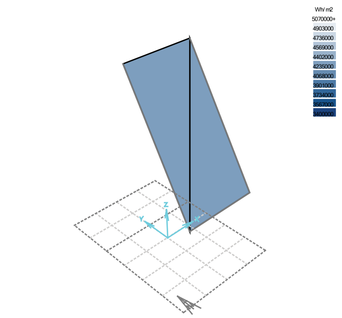
Form C
Total Radiation
Value Range: 3400000.0 - 5070000.0 Wh/m2
© ECOTECT v5

Object		Orient. (deg)	Tilt (deg)	Area (ft2)	Total Radiation Wh/m2	Direct Radiation Wh/m2	Diffuse Radiation Wh/m2
		-180	55	81	4770592	2782542.75	1988049
		-180	55	81	4770767	2782718	1988049
SUM TOTAL				162	9541359	5565261	3976098
MAXIMUM				81	4770767	2782718	1988049
MINIMUM				81	4770592	2782542.75	1988049
AVERAGE				81	4770679.5	2782630.5	1988049



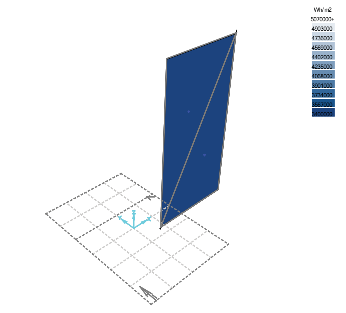
Form D
Total Radiation
Value Range: 3400000.0 - 5070000.0 Wh/m2
© ECOTECT v5

Object		Orient. (deg)	Tilt (deg)	Area (ft2)	Total Radiation Wh/m2	Direct Radiation Wh/m2	Diffuse Radiation Wh/m2
		-180	30.1	81	4227511	2601710	1625801
		-180	30.1	81	4227503.5	2601702.25	1625801
SUM TOTAL				162	8455014	5203412	3251602
MAXIMUM				81	4227511	2601710	1625801
MINIMUM				81	4227503.5	2601702.25	1625801
AVERAGE				81	4227507	2601706	1625801



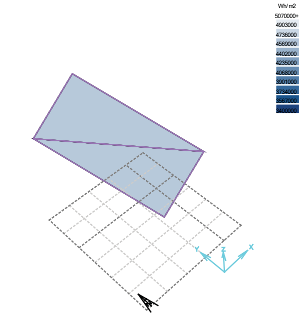
Form E
Total Radiation
Value Range: 3400000.0 - 5070000.0 Wh/m2
© ECOTECT v5

Object		Orient. (deg)	Tilt (deg)	Area (ft2)	Total Radiation Wh/m2	Direct Radiation Wh/m2	Diffuse Radiation Wh/m2
		-180	0	81	2900558.75	1755416.5	1145142.25
		-180	0	81	2900551	1755408.75	1145142.25
SUM TOTAL				162	5801110	3510825.25	2290284.5
MAXIMUM				81	2900558.75	1755416.5	1145142.25
MINIMUM				81	2900551	1755408.75	1145142.25
AVERAGE				81	2900555	1755412.625	1145142.25



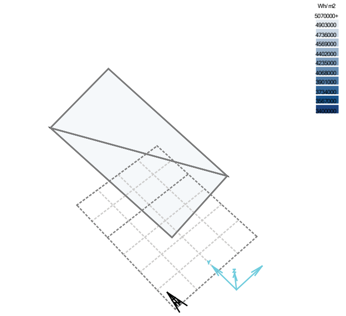
Form E1
Total Radiation
Value Range: 3400000.0 - 5070000.0 Wh/m2
© ECOTECT v5

Object		Orient. (deg)	Tilt (deg)	Area (ft2)	Total Radiation Wh/m2	Direct Radiation Wh/m2	Diffuse Radiation Wh/m2
		-129.6	42.6	81	4606551	2723107.25	1883444
		-129.6	42.6	81	4606551	2723107.25	1883444
SUM TOTAL				162	9213102	5446214.5	3766888
MAXIMUM				81	4606551	2723107.25	1883444
MINIMUM				81	4606551	2723107.25	1883444
AVERAGE				81	4606551	2723107.25	1883444



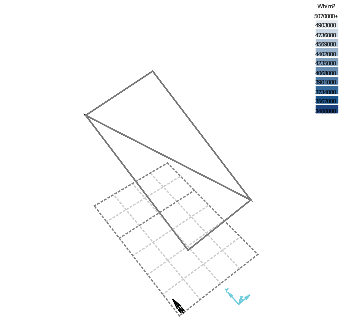
Form E2
Total Radiation
Value Range: 3400000.0 - 5070000.0 Wh/m2
© ECOTECT v5

Object		Orient. (deg)	Tilt (deg)	Area (ft2)	Total Radiation Wh/m2	Direct Radiation Wh/m2	Diffuse Radiation Wh/m2
		-147.2	56.1	81	5010460.5	2910201.5	2100259.5
		-147.2	56.1	81	5010461.5	2910201.5	2100259.75
SUM TOTAL				162	10020922	5820403	4200519
MAXIMUM				81	5010461.5	2910201.5	2100259.75
MINIMUM				81	5010460.5	2910201.5	2100259.5
AVERAGE				81	5010461	2910201.5	2100259.75



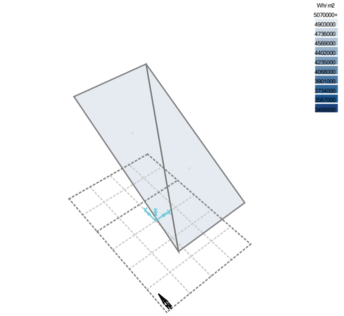
Form E3
Total Radiation
Value Range: 3400000.0 - 5070000.0 Wh/m2
© ECOTECT v5

Object		Orient. (deg)	Tilt (deg)	Area (ft2)	Total Radiation Wh/m2	Direct Radiation Wh/m2	Diffuse Radiation Wh/m2
		-161.9	60.4	81	5067631	2907782.25	2159848.5
		-161.9	60.4	81	5067631	2907782.25	2159848.5
SUM TOTAL				162	10135262	5815564.5	4319697
MAXIMUM				81	5067631	2907782.25	2159848.5
MINIMUM				81	5067631	2907782.25	2159848.5
AVERAGE				81	5067631	2907782.25	2159848.5



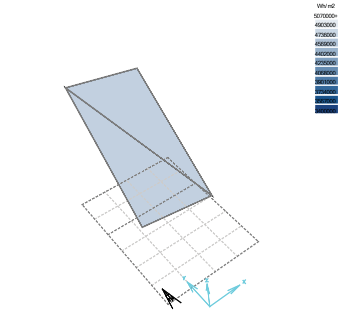
Form E4
Total Radiation
Value Range: 3400000.0 - 5070000.0 Wh/m2
© ECOTECT v5

Object		Orient. (deg)	Tilt (deg)	Area (ft2)	Total Radiation Wh/m2	Direct Radiation Wh/m2	Diffuse Radiation Wh/m2
		-180	62	81	4804763	2739602.75	2065160.125
		-180	62	81	4804466.5	2739306	2065160.125
SUM TOTAL				162	9609230	5478909	4130320.25
MAXIMUM				81	4804763	2739602.75	2065160.125
MINIMUM				81	4804466.5	2739306	2065160.125
AVERAGE				81	4804615	2739454.5	2065160.125



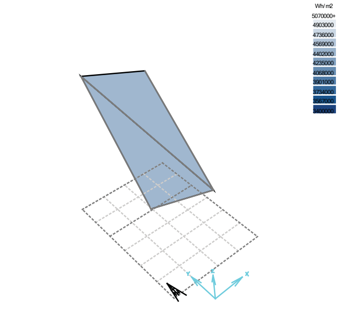
Form E5
Total Radiation
Value Range: 3400000.0 - 5070000.0 Wh/m2
© ECOTECT v5

Object		Orient. (deg)	Tilt (deg)	Area (ft2)	Total Radiation Wh/m2	Direct Radiation Wh/m2	Diffuse Radiation Wh/m2
		161.9	60.4	81	4666710.5	2621377.5	2045332.625
		161.9	60.4	81	4666710.5	2621377.5	2045332.625
SUM TOTAL				162	9333421	5242755	4090665.25
MAXIMUM				81	4666710.5	2621377.5	2045332.625
MINIMUM				81	4666710.5	2621377.5	2045332.625
AVERAGE				81	4666710.5	2621377.5	2045332.625



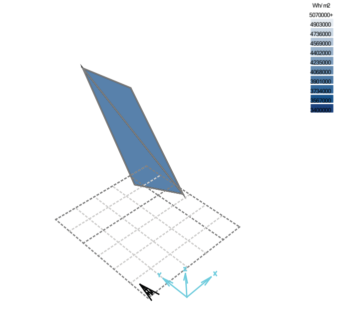
Form E6
Total Radiation
Value Range: 3400000.0 - 5070000.0 Wh/m2
© ECOTECT v5

Object		Orient. (deg)	Tilt (deg)	Area (ft2)	Total Radiation Wh/m2	Direct Radiation Wh/m2	Diffuse Radiation Wh/m2
		147.2	56.1	81	4449740	2463999	1985740.875
		147.2	56.1	81	4449283	2463542.25	1985740.875
SUM TOTAL				162	8899023	4927541	3971481.75
MAXIMUM				81	4449740	2463999	1985740.875
MINIMUM				81	4449283	2463542.25	1985740.875
AVERAGE				81	4449511.5	2463770.5	1985740.875



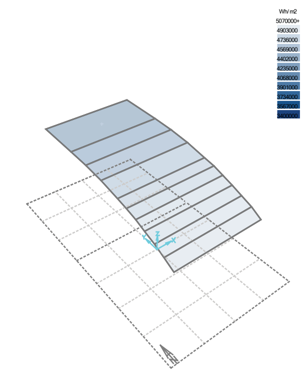
Form E7
Total Radiation
Value Range: 3400000.0 - 5070000.0 Wh/m2
© ECOTECT v5

Object		Orient. (deg)	Tilt (deg)	Area (ft2)	Total Radiation Wh/m2	Direct Radiation Wh/m2	Diffuse Radiation Wh/m2
		129.6	42.6	81	3969486	2108937	1860549.125
		129.6	42.6	81	3969486	2108937	1860549.125
SUM TOTAL				162	7938972	4217874	3721098.25
MAXIMUM				81	3969486	2108937	1860549.125
MINIMUM				81	3969486	2108937	1860549.125
AVERAGE				81	3969486	2108937	1860549.125



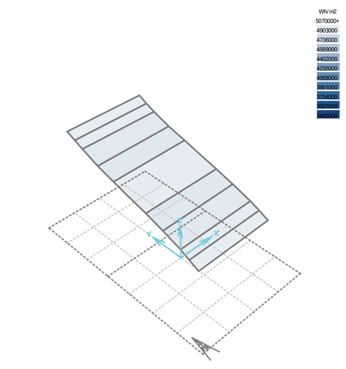
Form F
Total Radiation
Value Range: 3400000.0 - 5070000.0 Wh/m2
© ECOTECT v5

Object			Tilt (deg)	Area (ft2)	Total Radiation Wh/m2	Direct Radiation Wh/m2	Diffuse Radiation Wh/m2
SUM TOTAL				82.95	48013696	25627612	22386084
MAXIMUM				20.25	4924144.5	2772473.25	2336101.25
MINIMUM				5.18	4627549.5	2323676	2151671.75
AVERAGE				8.3	4801369.6	2562761.2	2238608.4



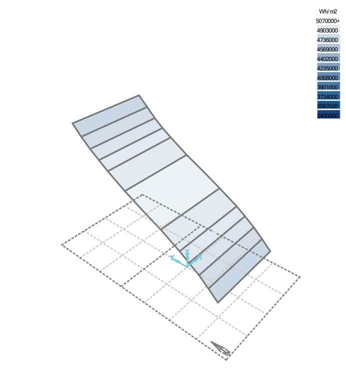
Form G
Total Radiation
Value Range: 3400000.0 - 5070000.0 Wh/m2
© ECOTECT v5

Object			Tilt (deg)	Area (ft2)	Total Radiation Wh/m2	Direct Radiation Wh/m2	Diffuse Radiation Wh/m2
SUM TOTAL				75.11	44082624	24325922	19756706
MAXIMUM				10.72	4924533	2772809.5	2274490.75
MINIMUM				5.48	4866355.5	2635922	2151723.25
AVERAGE				8.35	4898069.333	2702880.222	2195189.556



Form H
Total Radiation
Value Range: 3400000.0 - 5070000.0 Wh/m2
© ECOTECT v5

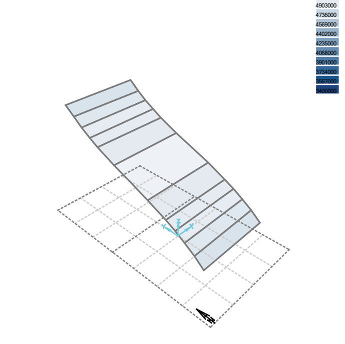
Object			Tilt (deg)	Area (ft2)	Total Radiation Wh/m2	Direct Radiation Wh/m2	Diffuse Radiation Wh/m2
SUM TOTAL				195	53238476	31023130	22215350
MAXIMUM				11.67	4958834.5	2833259.5	2155000
MINIMUM				6.06	4732732	2799984	1917291.375
AVERAGE				7.86	4839861.455	2820284.545	2019577.273



Form H2
Total Radiation
Value Range: 3400000.0 - 5070000.0 Wh/m2
© ECOTECT v5

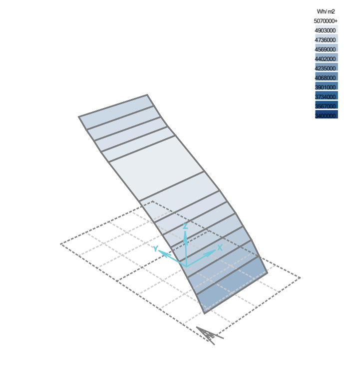
Object		Orient. (deg)	Tilt (deg)	Area (ft2)	Total Radiation Wh/m2	Direct Radiation Wh/m2	Diffuse Radiation Wh/m2
SUM TOTAL				195	53774580	30800938	22973642
MAXIMUM				11.67	4964124	2834082.75	2214389.5
MINIMUM				6.06	4828055.5	2749519.25	1994170.75
AVERAGE				7.86	4888598.182	2800085.273	2088512.909

NOTE: FORM H IS TILTED TOWARDS 62 DEGREE ANGLE RESULTING IN HIGHER EFFICIENCY.



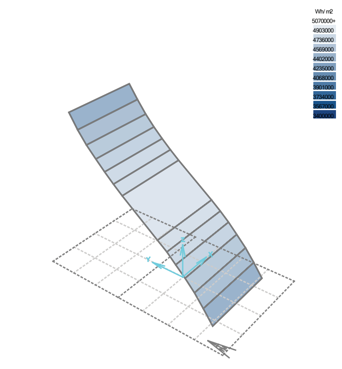
Form I
Total Radiation
Value Range: 3400000.0 - 5070000.0 Wh/m2
© ECOTECT v5

Object			Tilt (deg)	Area (ft2)	Total Radiation Wh/m2	Direct Radiation Wh/m2	Diffuse Radiation Wh/m2
SUM TOTAL				106.34	56896872	33664248	23232626
MAXIMUM				23.77	4926410.5	2833716.25	2095157.625
MINIMUM				6.13	4412736	2690130	1722605.875
AVERAGE				8.86	4741406	2805354	1936052.167



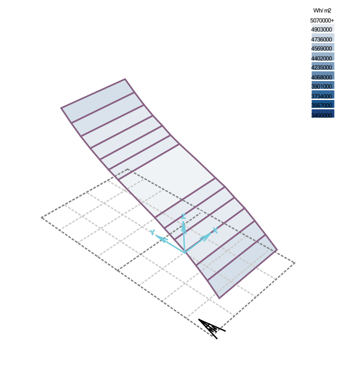
Form J
Total Radiation
Value Range: 3400000.0 - 5070000.0 Wh/m2
© ECOTECT v5

Object			Tilt (deg)	Area (ft2)	Total Radiation Wh/m2	Direct Radiation Wh/m2	Diffuse Radiation Wh/m2
SUM TOTAL				230	60488076	36211264	24276812
MAXIMUM				12.75	4852120.5	2835293.5	2016826.5
MINIMUM				6.56	4412420	2689773	1722647.25
AVERAGE				7.88	4652928.923	2785481.846	1867447.077



Form J1
Total Radiation
Value Range: 3400000.0 - 5070000.0 Wh/m2
© ECOTECT v5

Object		Orient. (deg)	Tilt (deg)	Area (ft2)	Total Radiation Wh/m2	Direct Radiation Wh/m2	Diffuse Radiation Wh/m2
SUM TOTAL				230	63483348	36382744	27100598
MAXIMUM				12.75	4970246	2824156.25	2215072.75
MINIMUM				6.56	4795223	2755173	1974958.875
AVERAGE				7.88	4883334.462	2798672.615	2084661.385

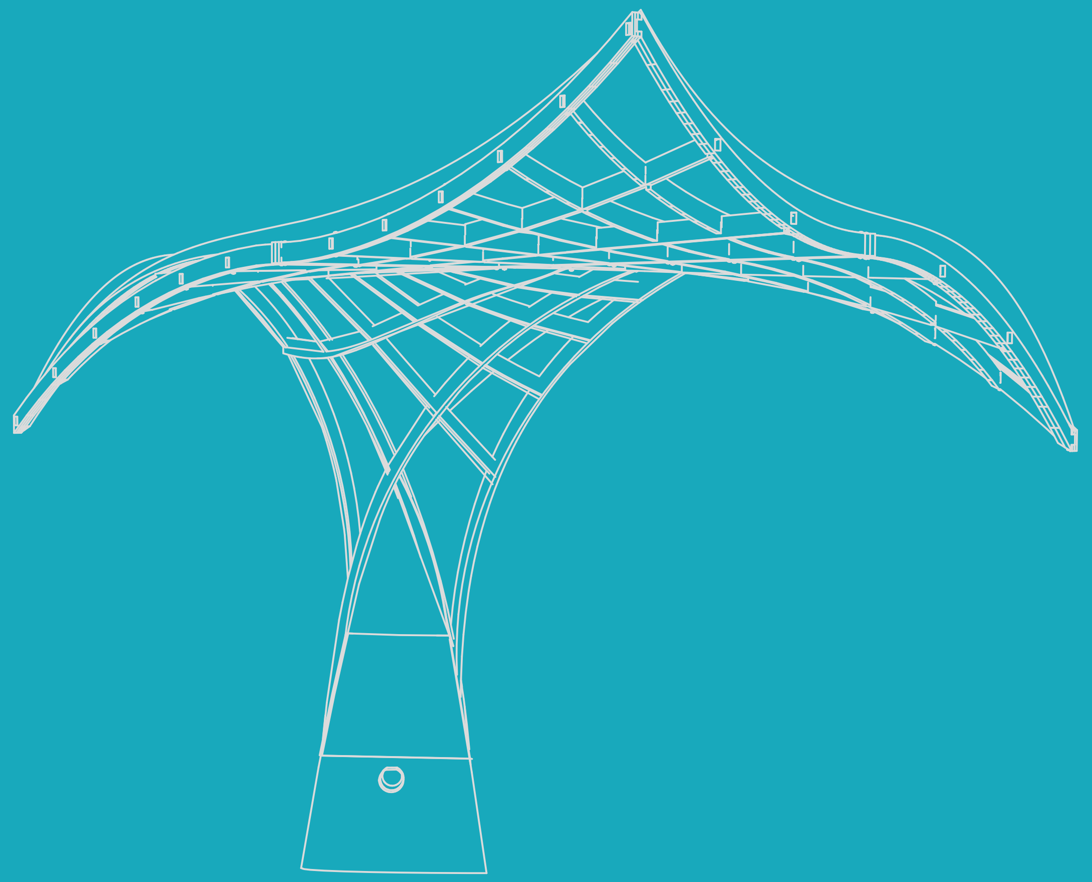


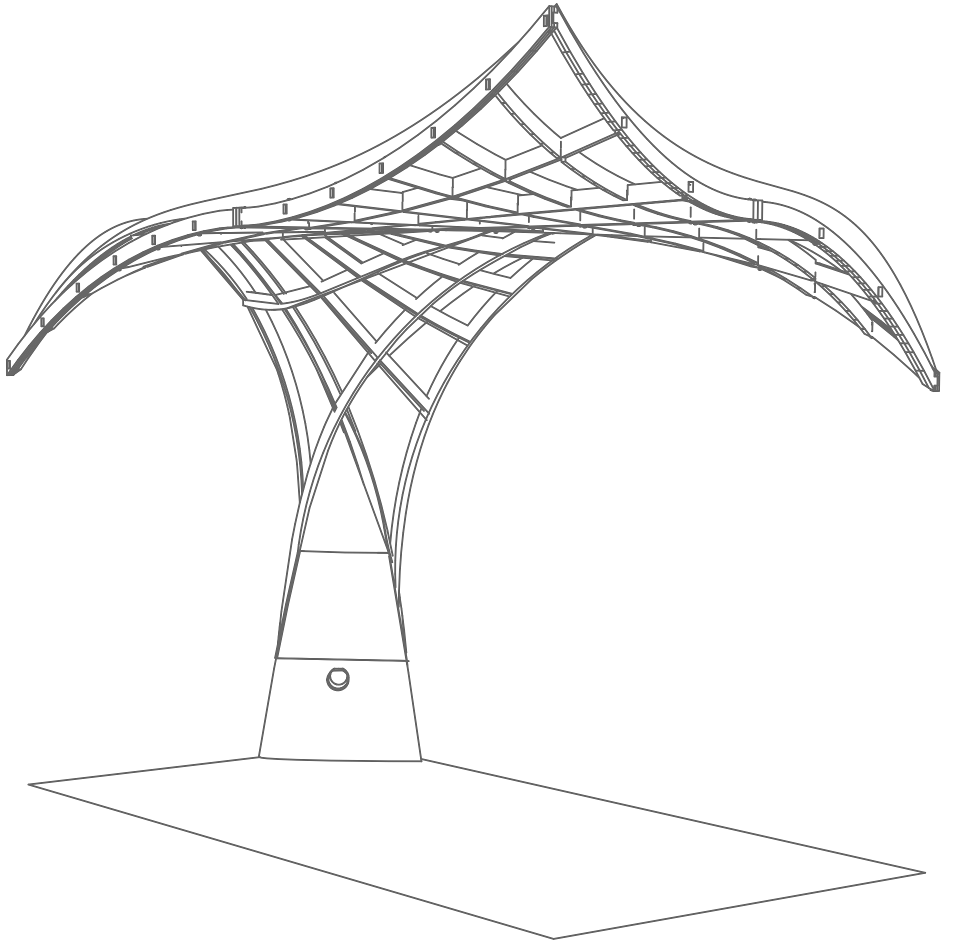
+ CONSTRUCTION MANUAL

- o To Build hargePoint
  - Parking Lot rientation to the Sun
  - Foundation onnection to the Ground
  - Structure
  - Solar Film onnection
  - Panels and Base

CONSTRUCTION MANUAL

CHARGE.POINT





CONGRATULATIONS! You are now the proud owner of a CHARGE.POINT charging station.

FELICIDADES! Usted es ahora el orgulloso propietario de una estación de carga CHARGE.POINT.

FÉLICITATIONS! Vous êtes maintenant le fier propriétaire d'une station de charge CHARGE.POINT.

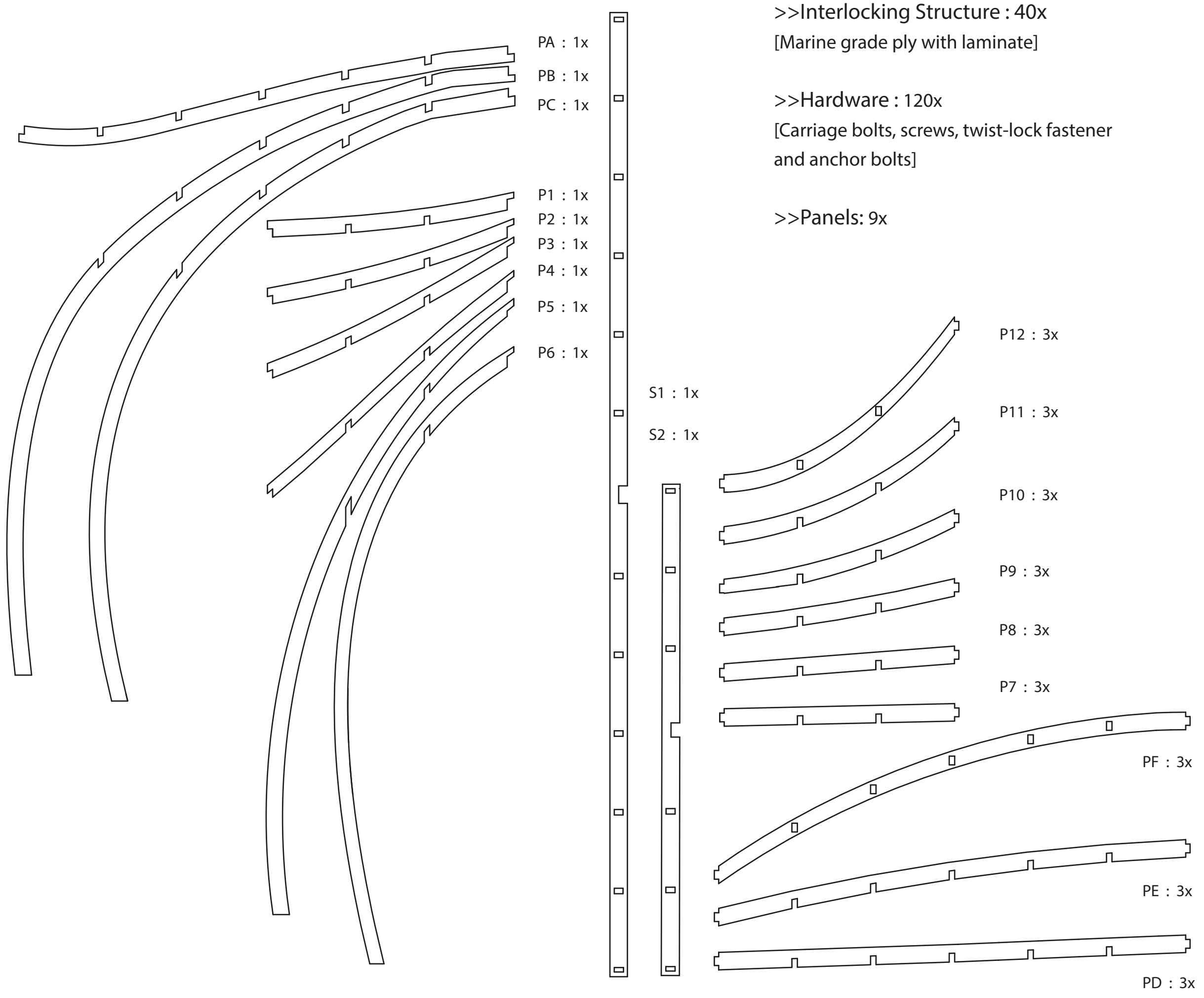
恭喜你，你在是一个
CHARGE.POINT 充站傲的主人。

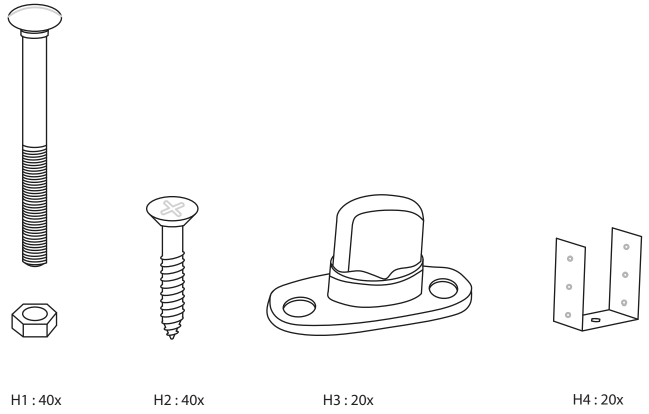
[c]

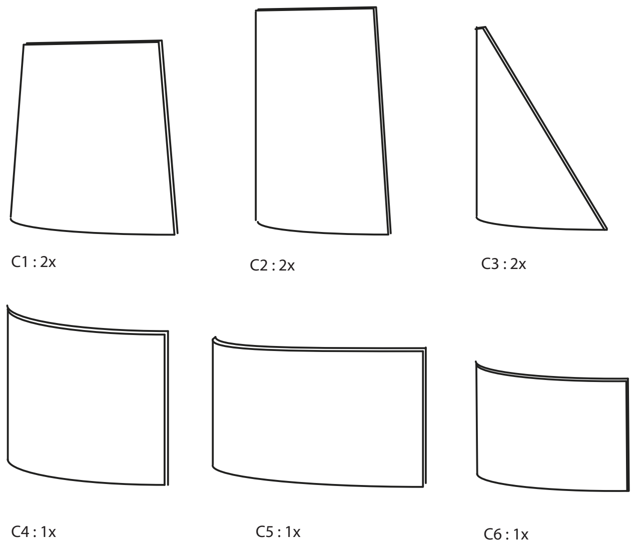
>>Interlocking Structure : 40x
[Marine grade ply with laminate]

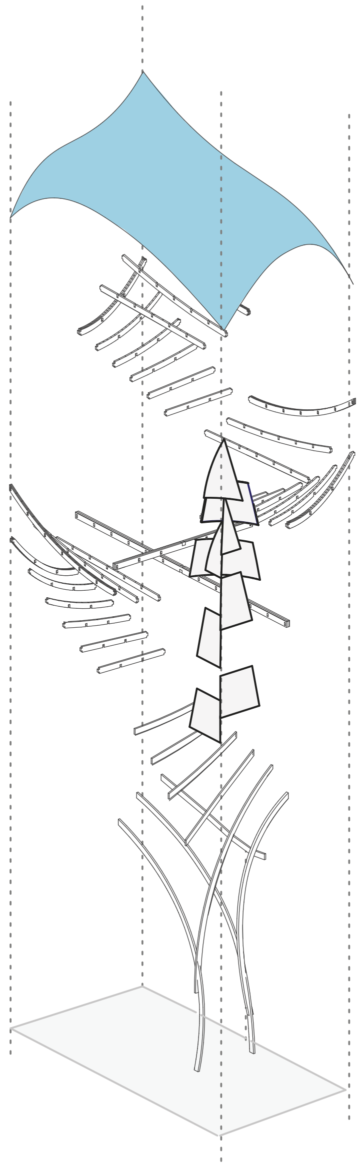
>>Hardware : 120x
[Carriage bolts, screws, twist-lock fastener and anchor bolts]

>>Panels: 9x









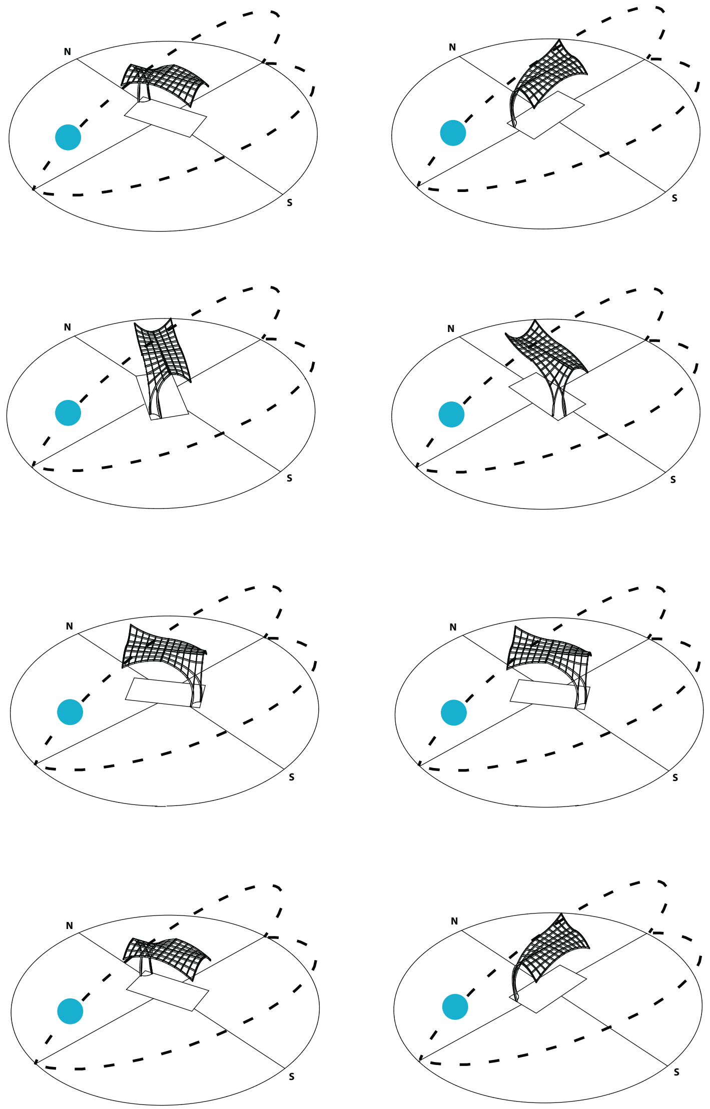
[1]

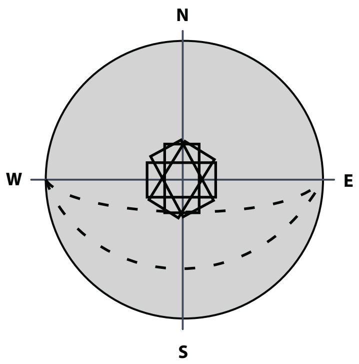
ORIENTATION :

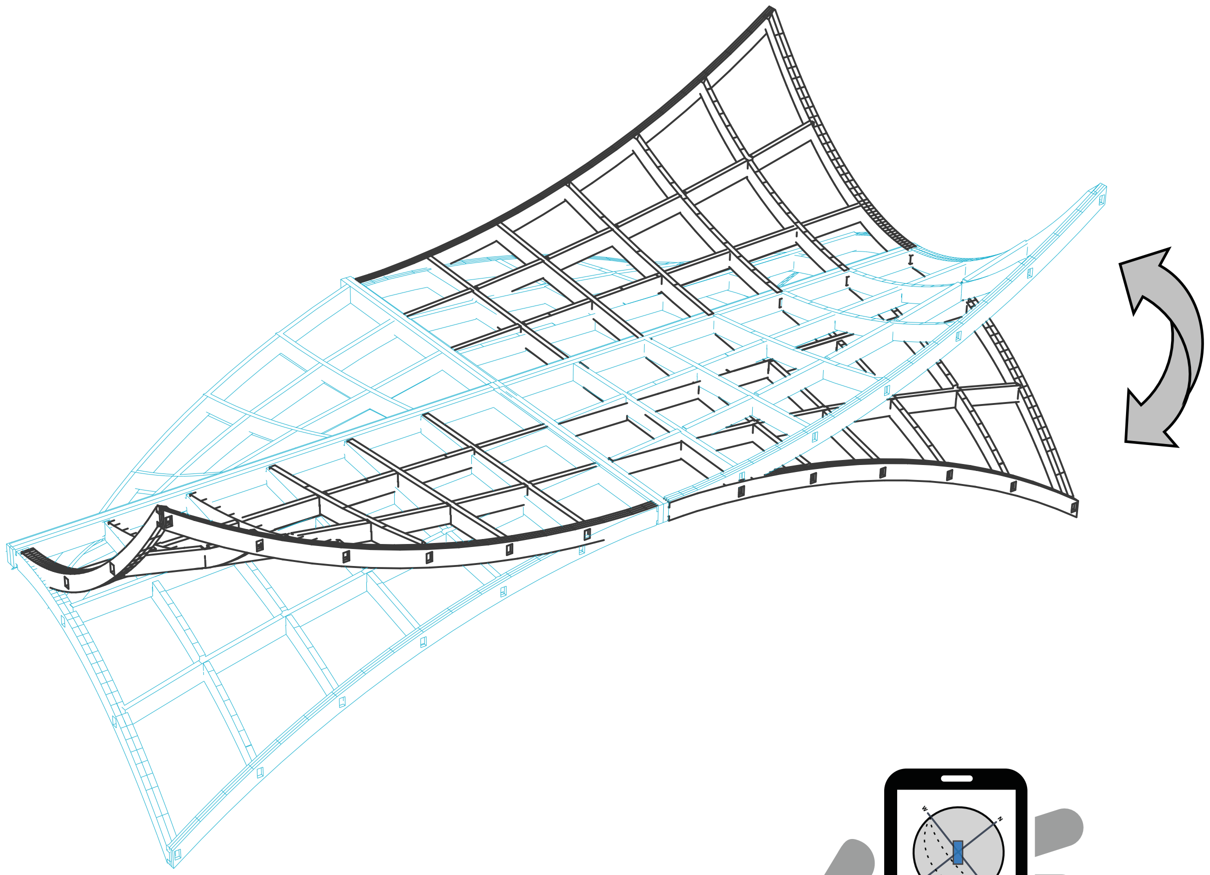
NOTE: The components for corners 2, 3 and 4 may be constructed in two different ways based on solar orientation. See section for assembly instructions.

1. Please use the Charging.Station App to locate your parking space and orient your Charging Station.

2. Based on your orientation the App should help you understand how part are assembled i.e. either tilted up or down on the Z-axis.

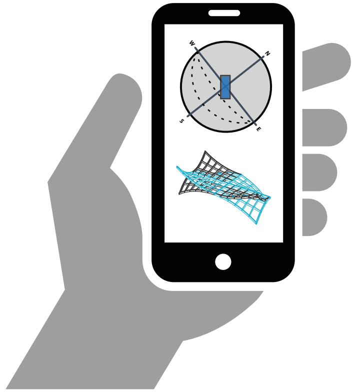






>> Connect to the **Charge.Point App** and locate your parking spot before installing!

>> Components for corners 2,3 and 4 are assembled in different ways to maximize your solar energy gain. For questions please call 1 (800) CHARGE.



[2]

FOUNDATION :

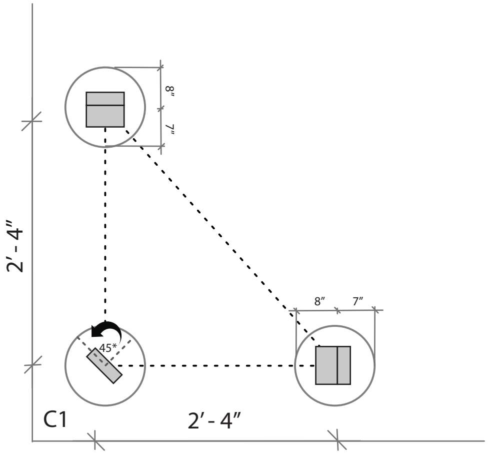
5x Adjustable Anchors
15x Anchor Bolts

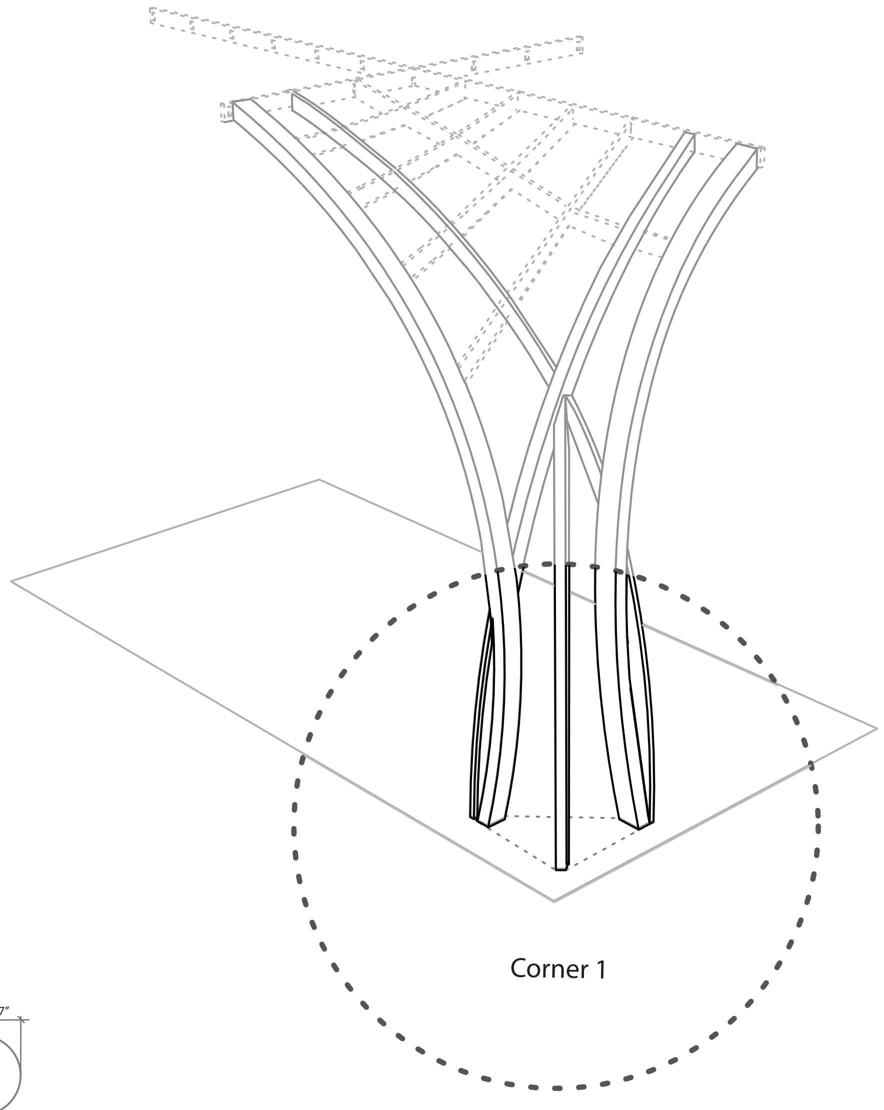
Components:
- PA : 1x
- PB : 1x
- PC : 1x
- P5 : 1x
- P6 : 1x

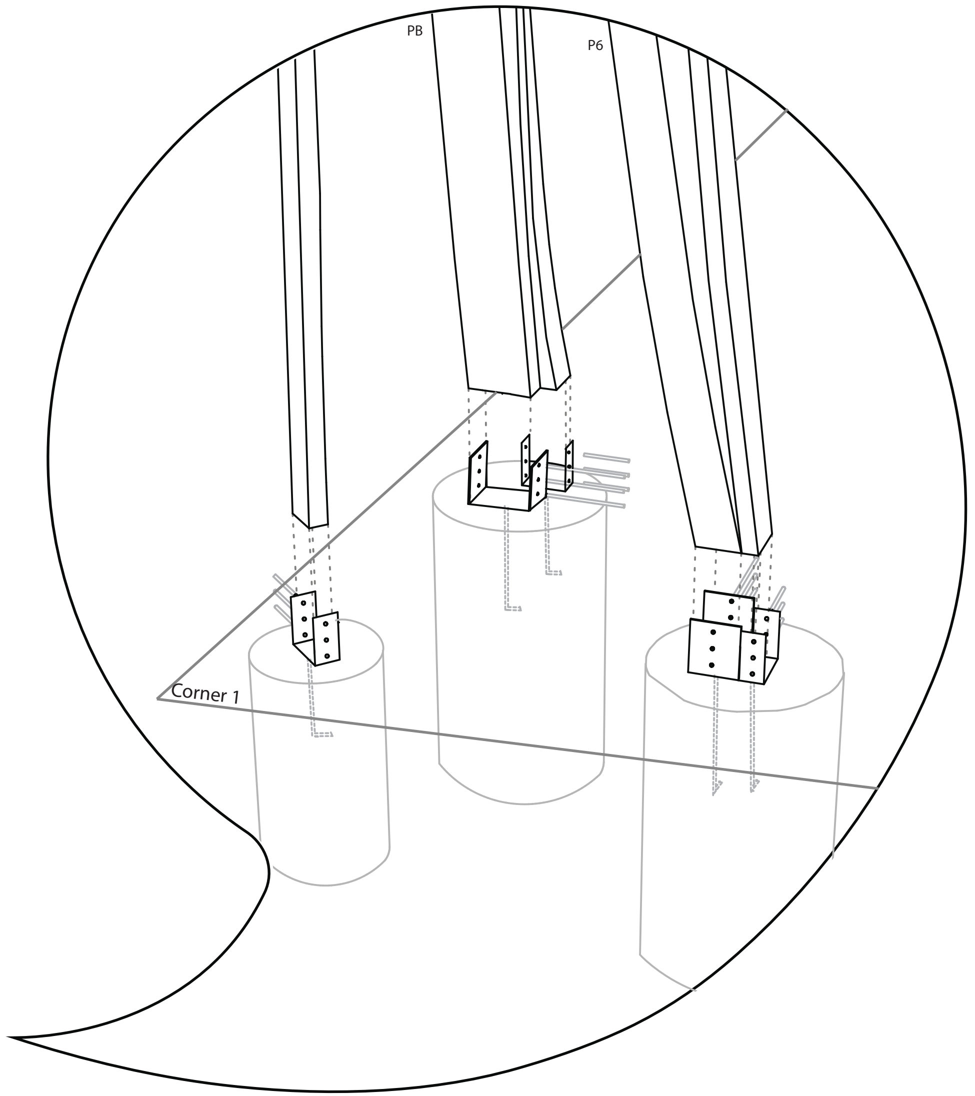
1. Set concrete footings into 3'-0" holes (6"below the frost line) and 15" in diameter.

NOTE: Make sure that forms are perfectly horizontal and 2'-4" apart.

2. Set adjustable anchors in locations using diagram below.





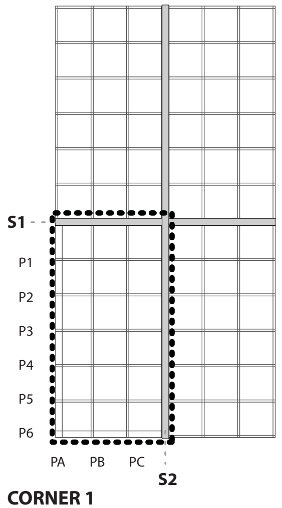


[3]

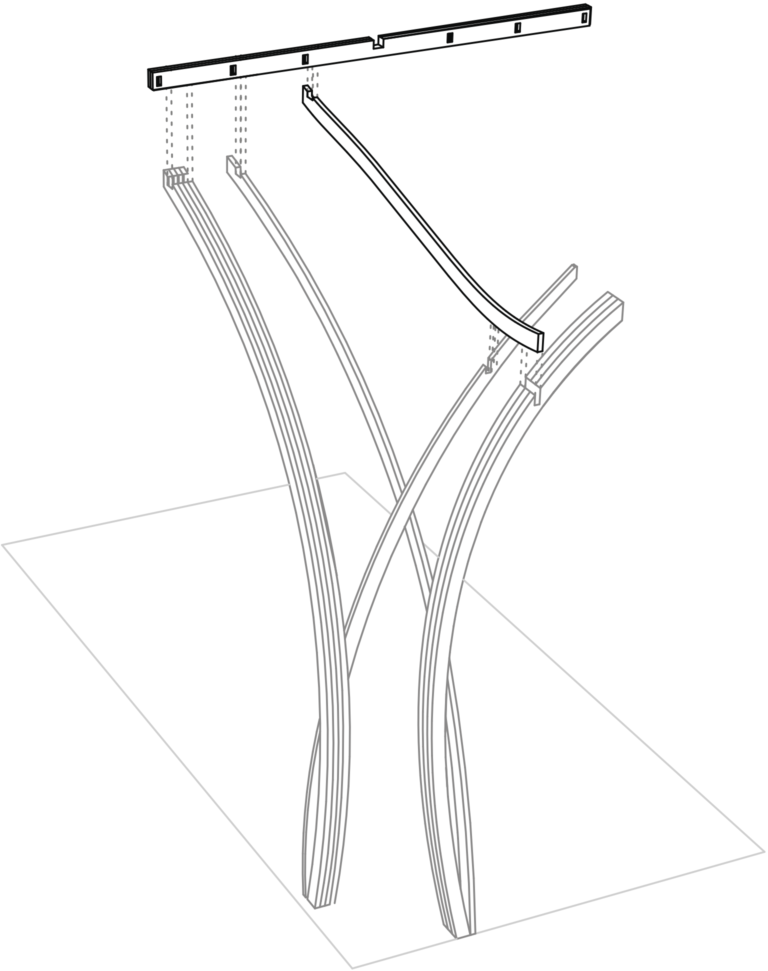
STRUCTURE :

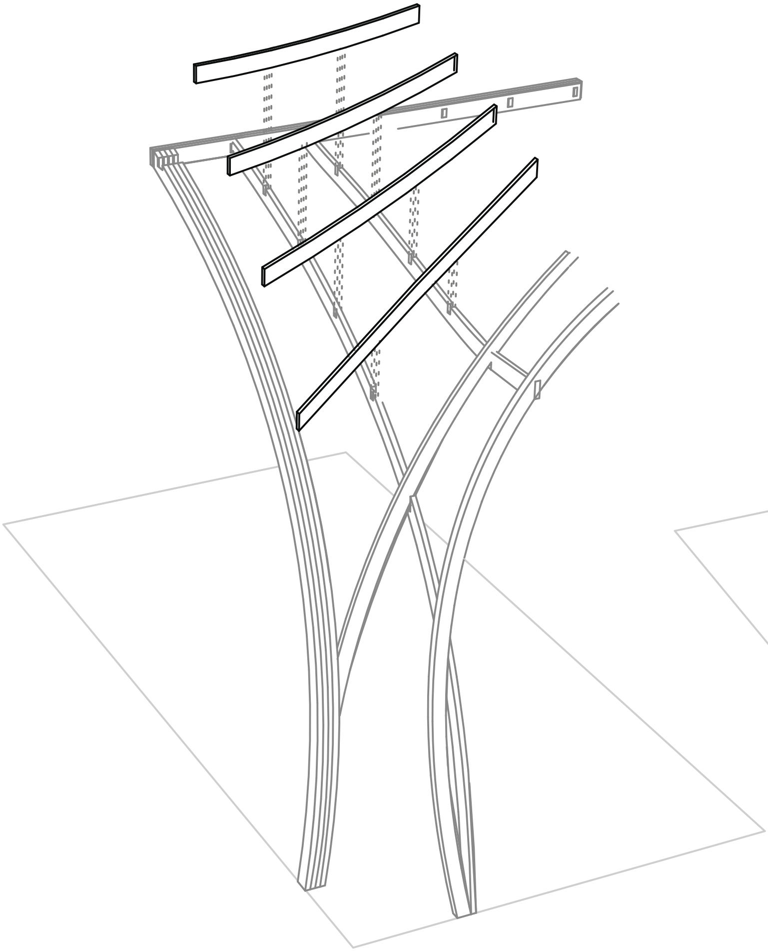
Components:
- PA : 1x
- PB : 1x
- PC : 1x
- P5 : 1x
- P6 : 1x

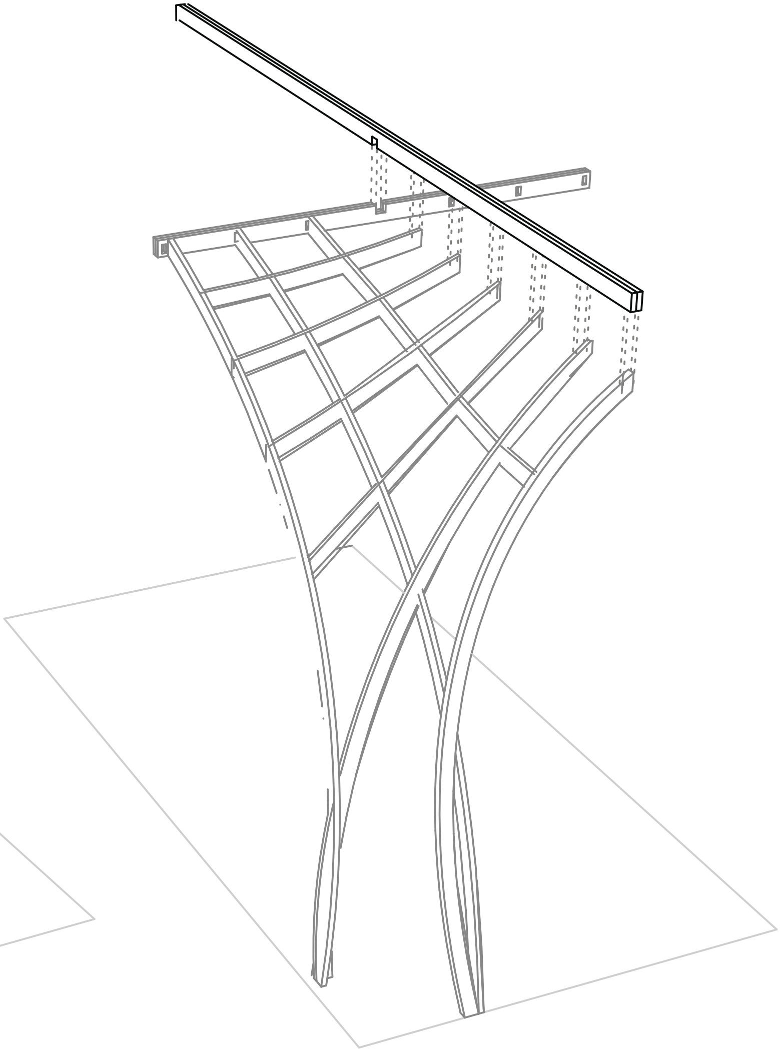
1. Assemble interlocking structure for Corner 1 [C1].



CORNER 1





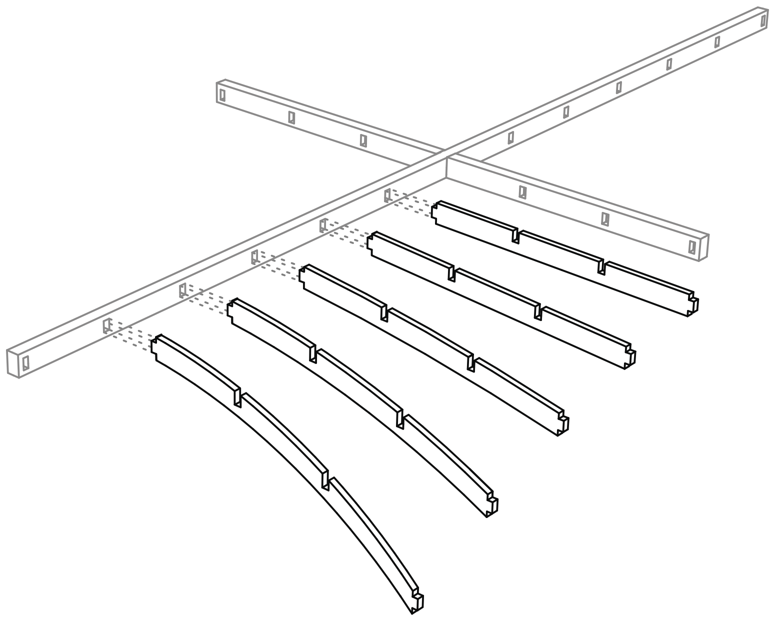


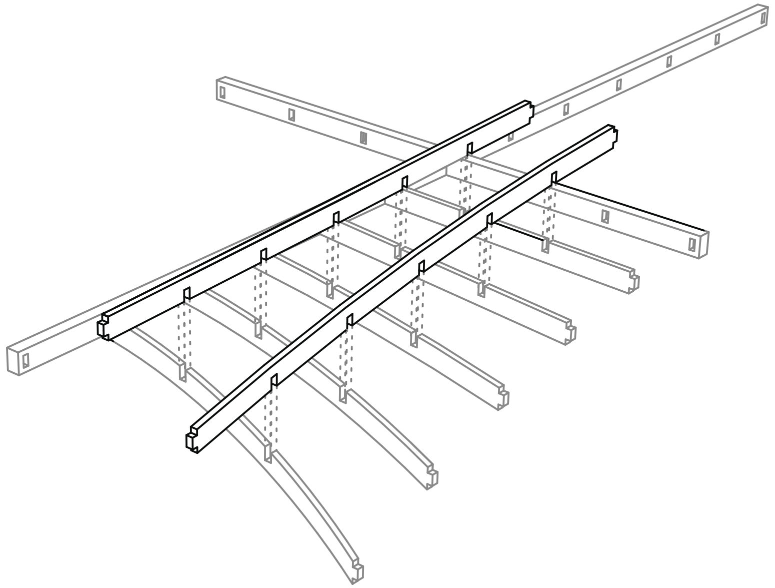
[4]

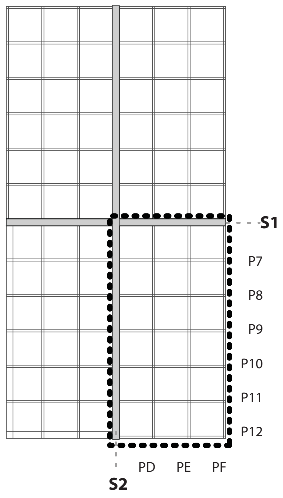
STRUCTURE :

Components:
- PA : 1x
- PB : 1x
- PC : 1x
- P5 : 1x
- P6 : 1x

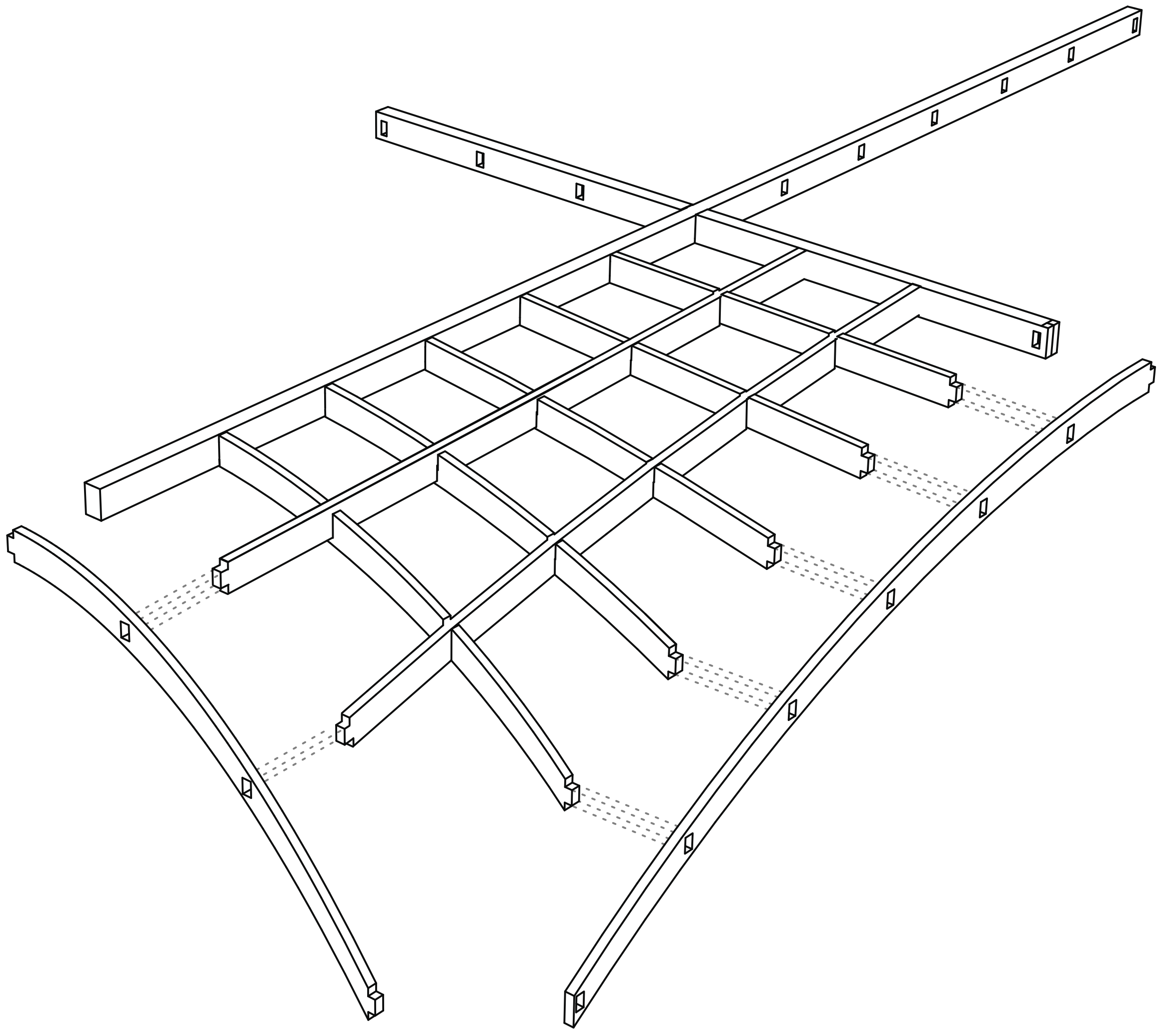
1. Assemble interlocking structure for Corner 1 [C1].







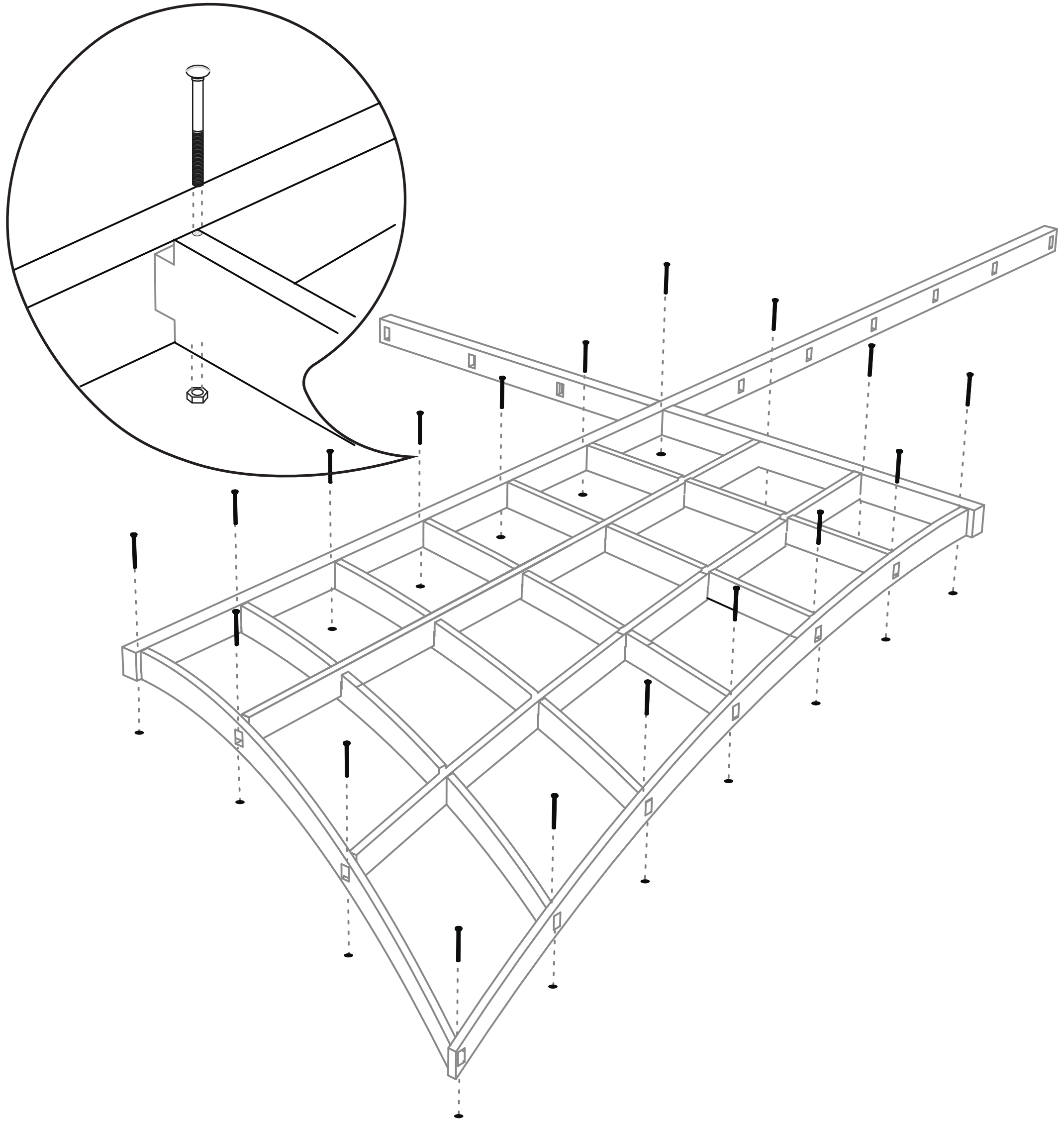
CORNER 4

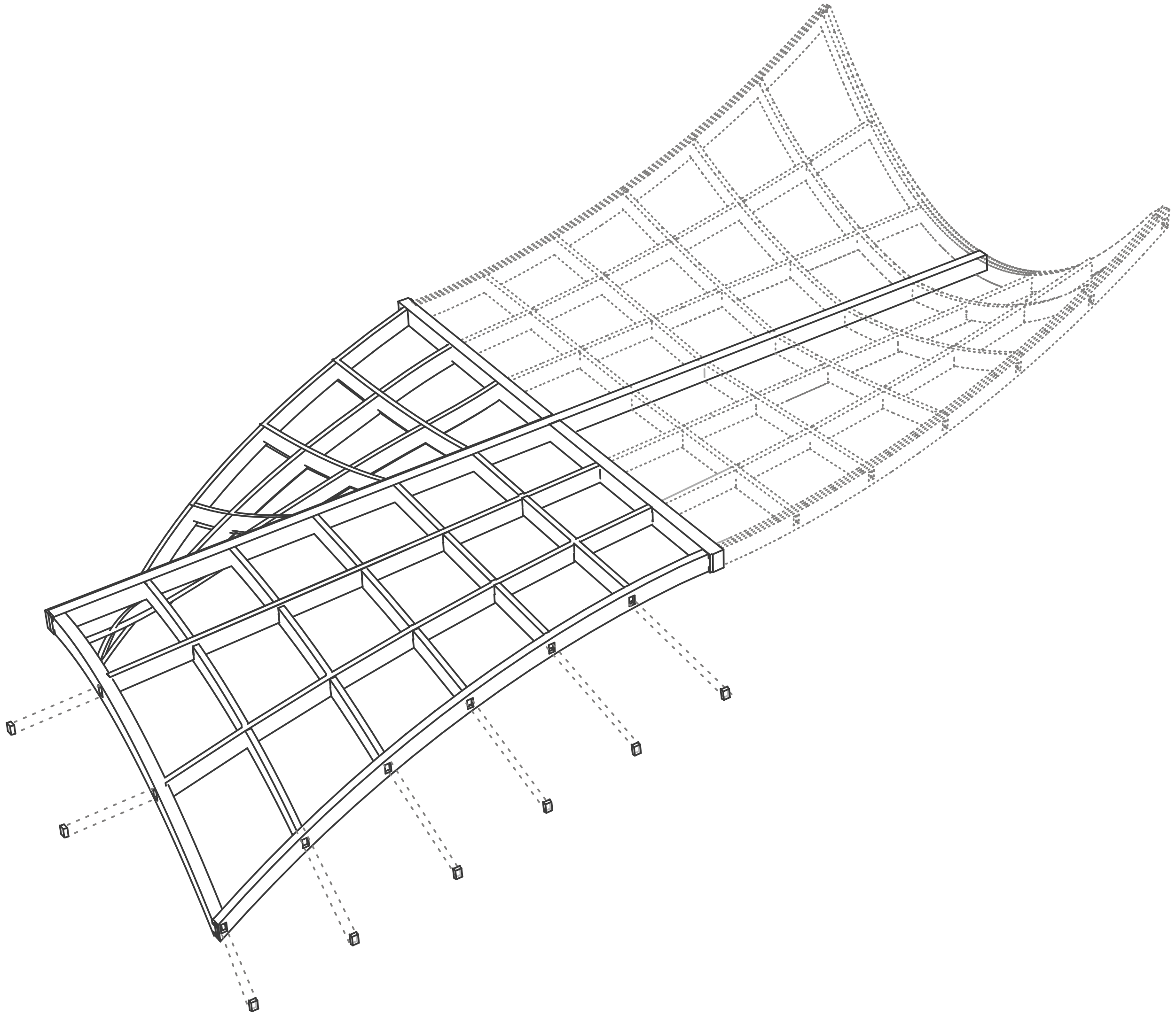


>> Repeat at corners 2 and 3.

>> Note Assembly might change based on which corner is south facing. Please see **Charge.Point App.**

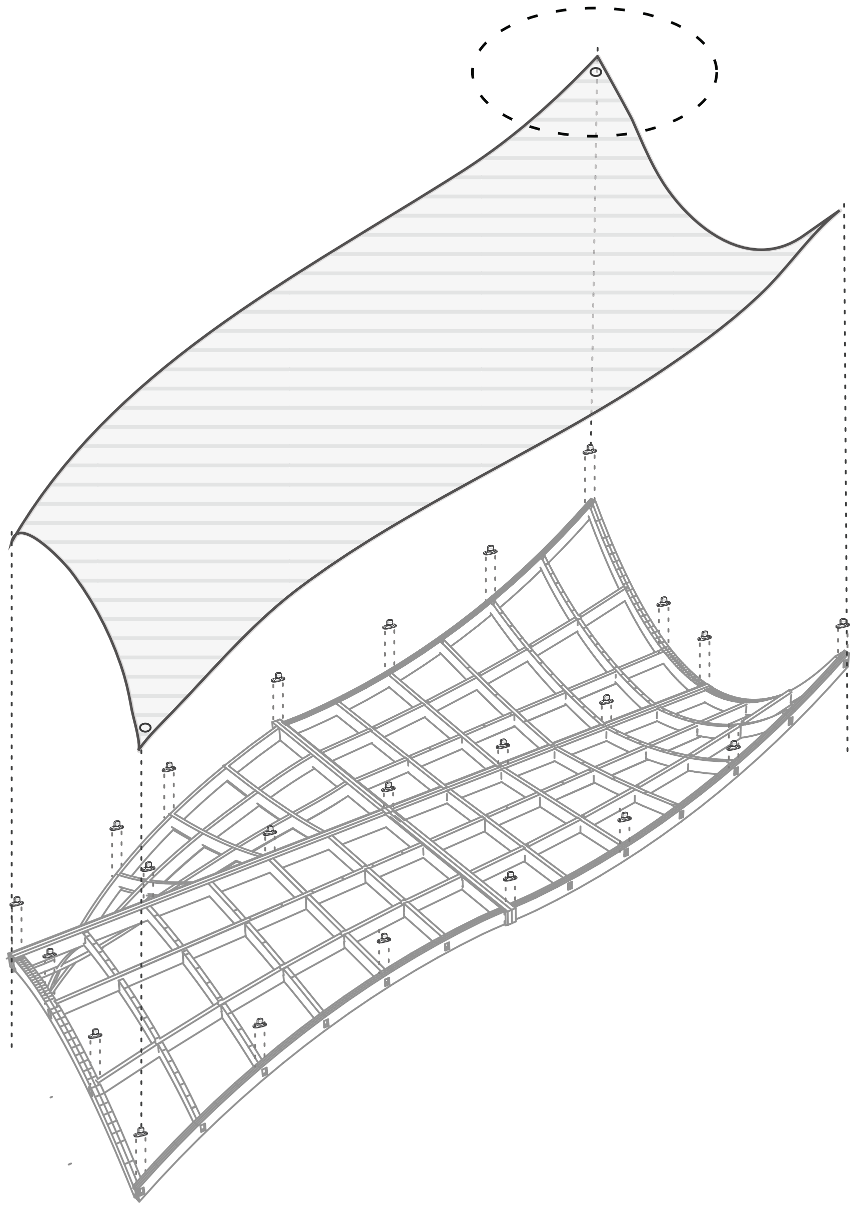
[5]

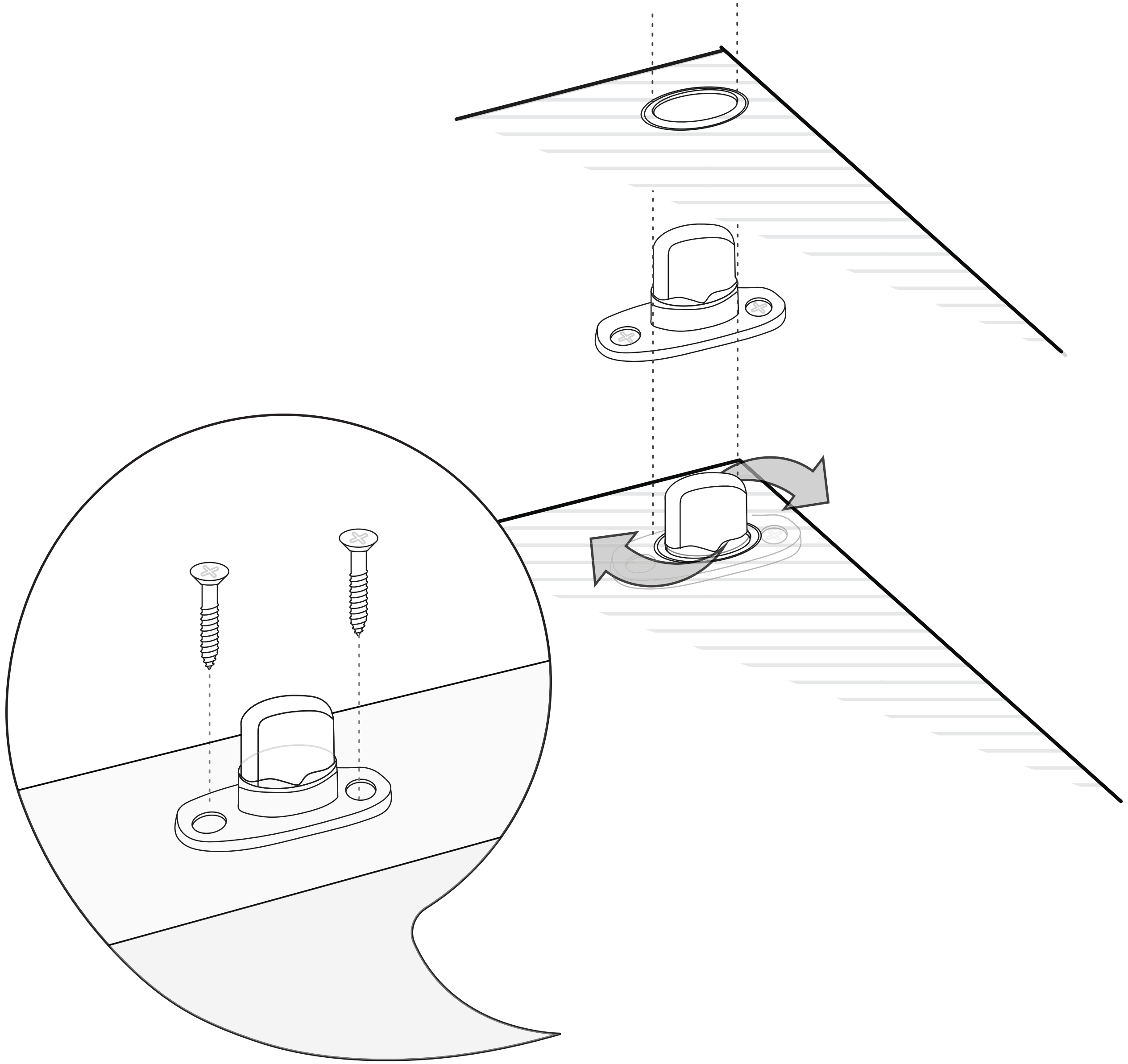




[6]

SOLAR FILM :

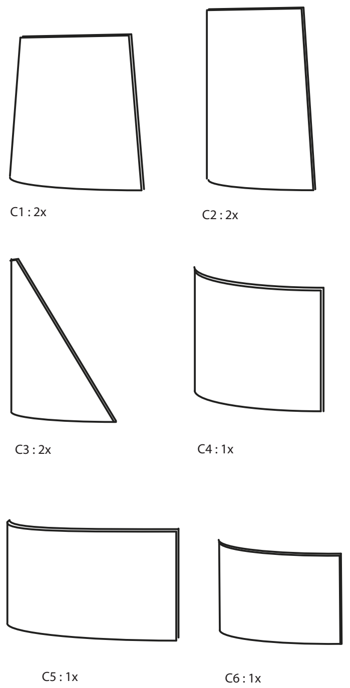


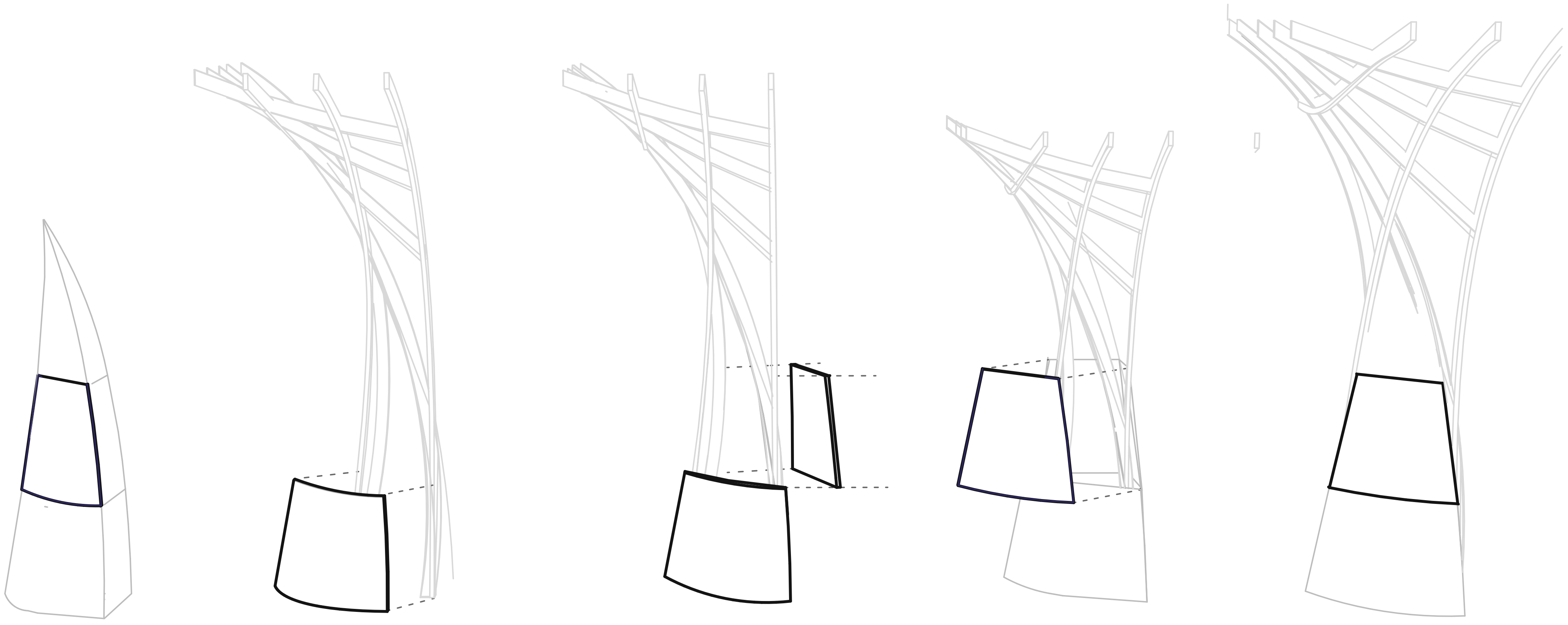


[7]

BASE :

Charge.Point units must have access to grid system as the unit acts as a self-sufficient all year round, grid tied system, feeding the grid when not charging an EV



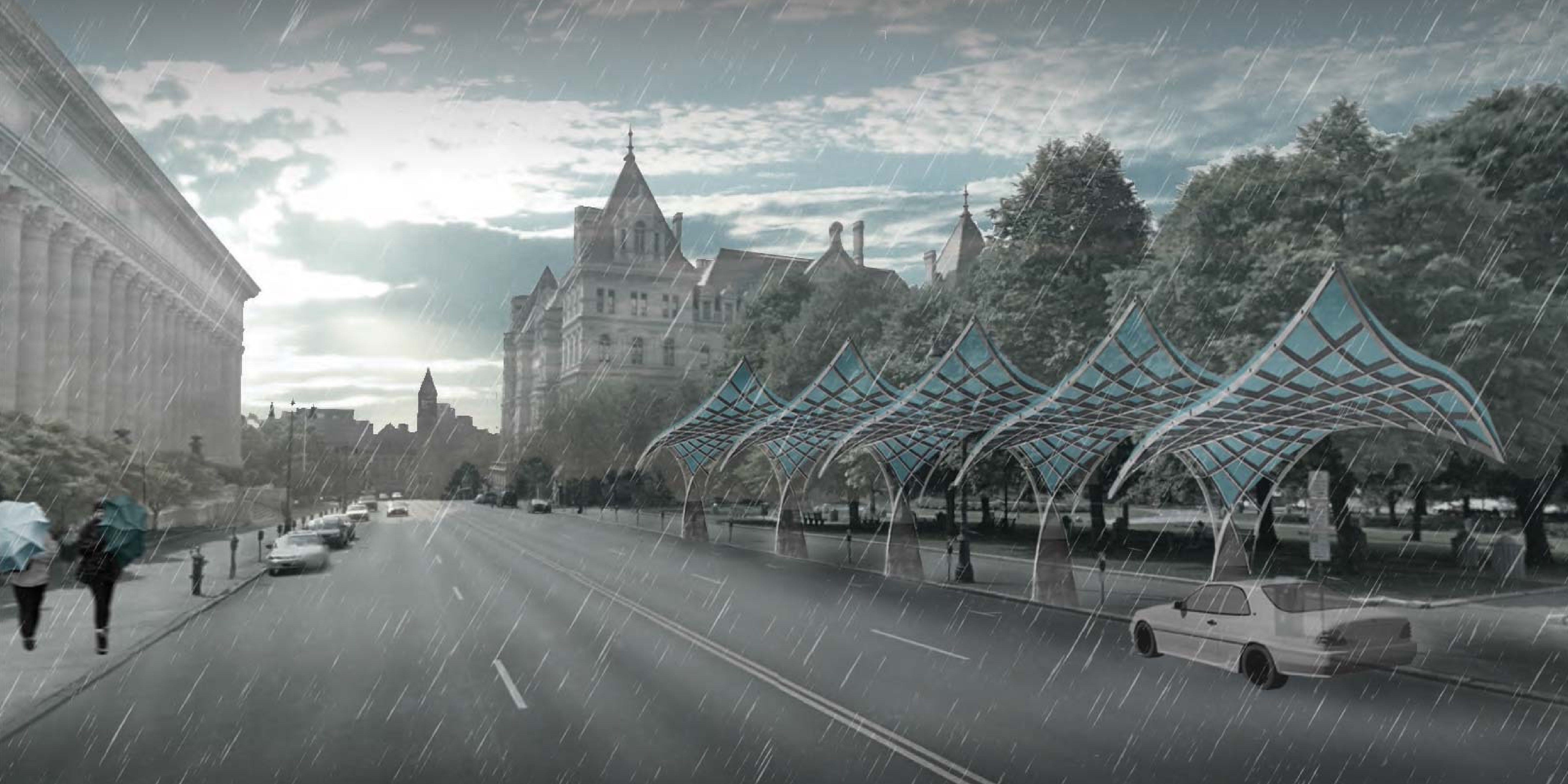


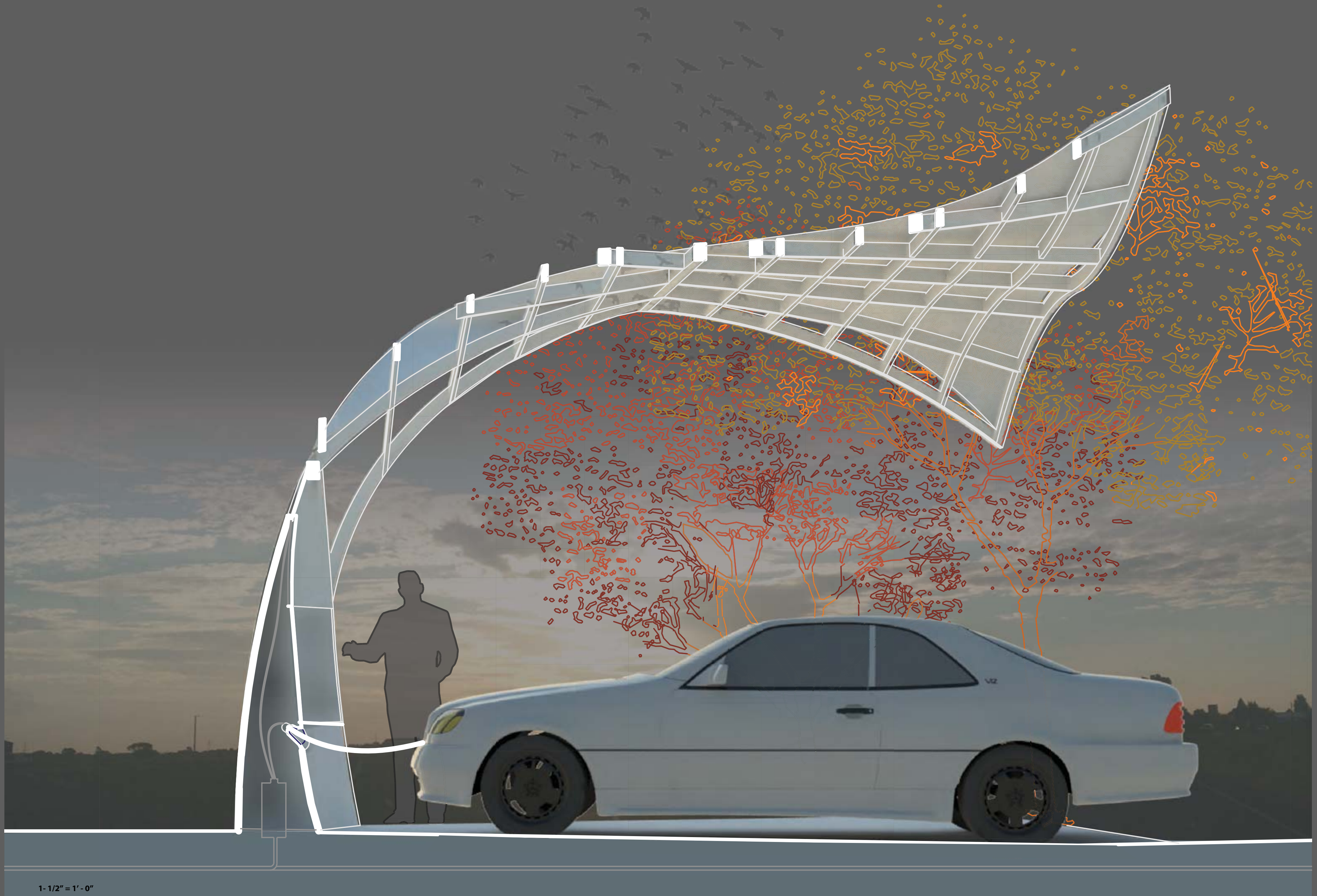
+ APPLICATION & SITE

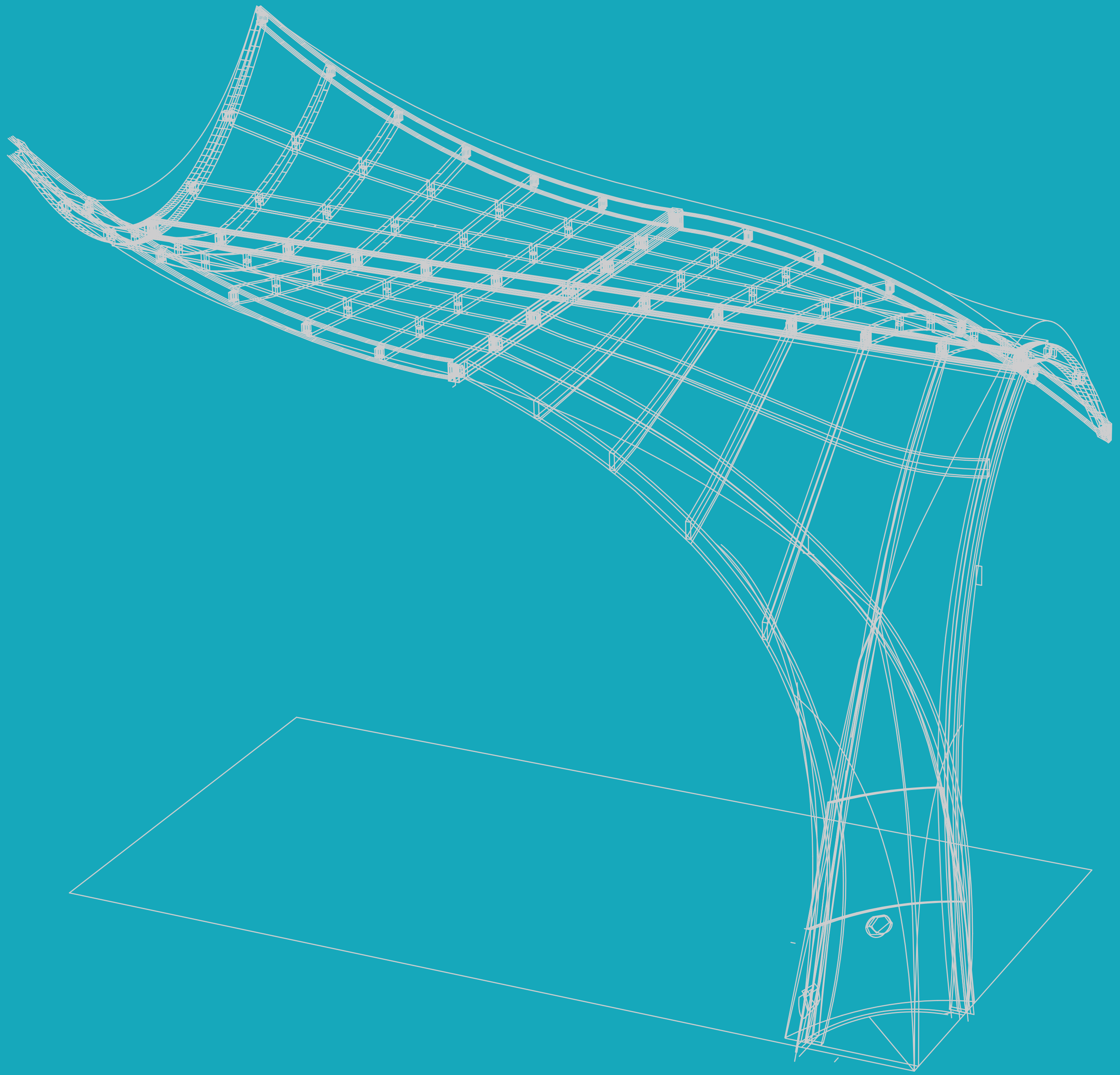
Site and nterface

- Single S ace
- Tested on Site l any e ork
  - edia nterface and

APPLICATION & SITE

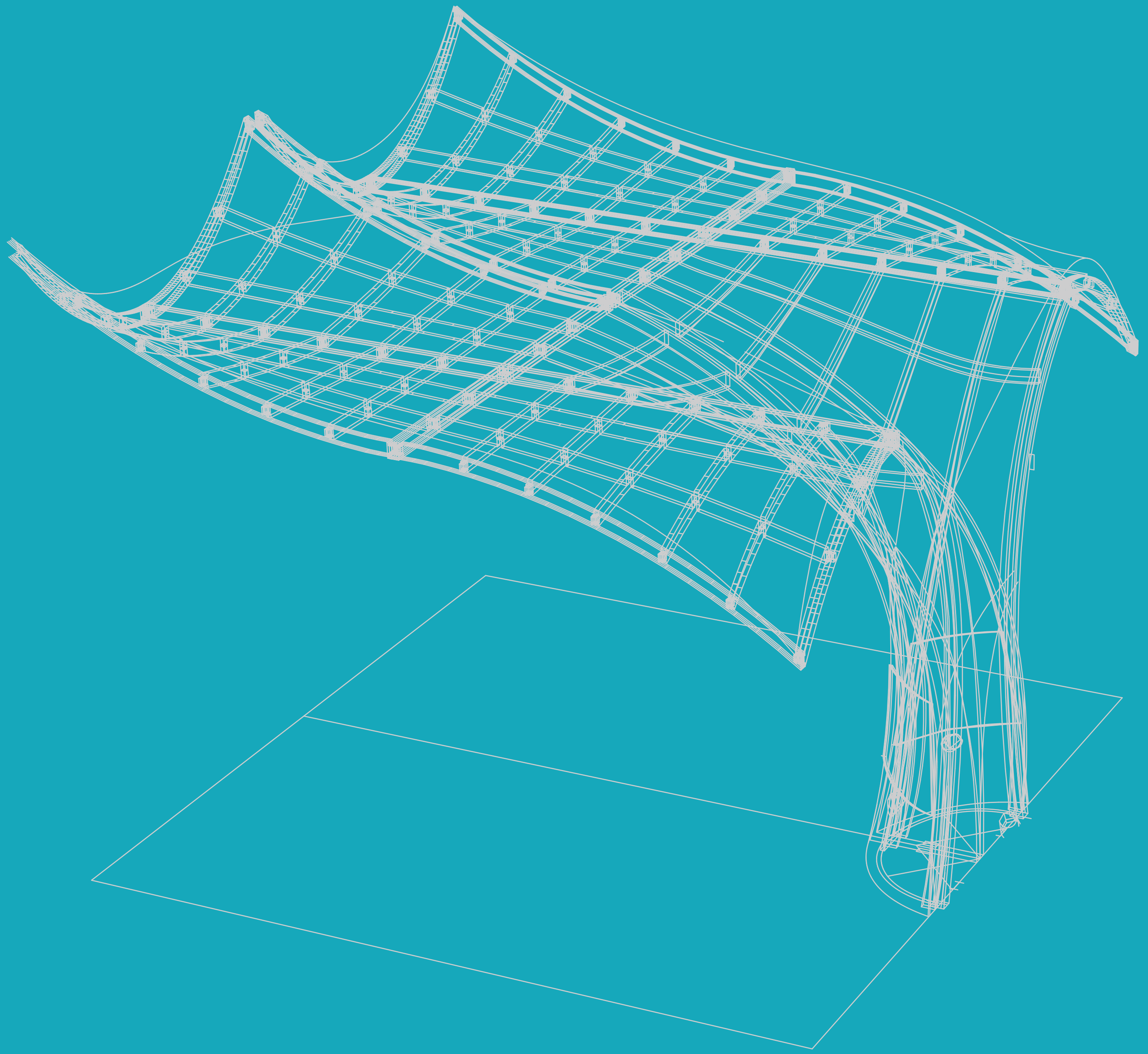



1- 1/2" = 1' - 0"



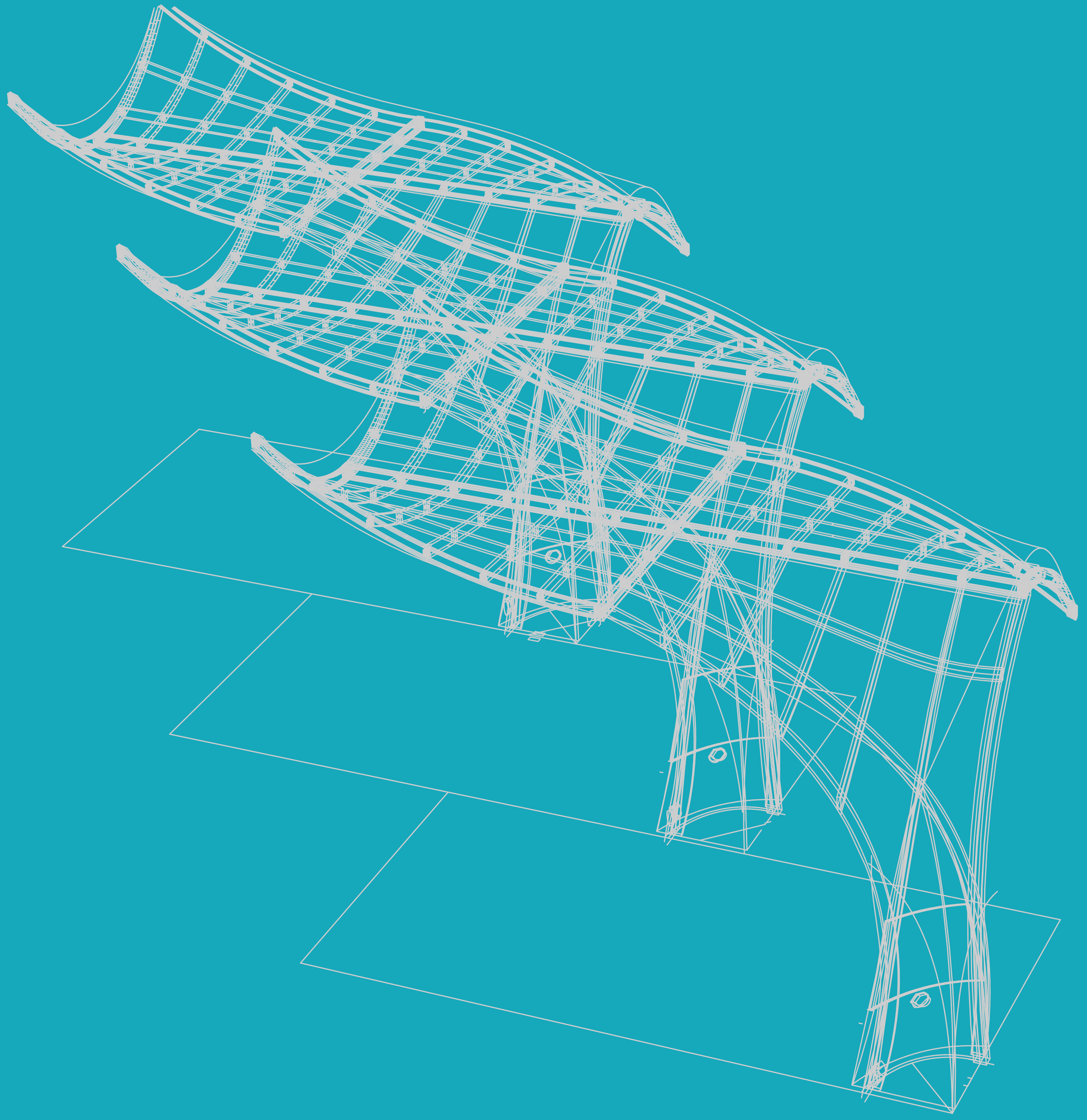
CHARGE.POINT

SINGLE SPACE -- STREET PARKING



CHARGE.POINT

SINGLE SPACE -- STREET PARKING



CHARGE.POINT

STREET PARKING