Spring 2014

Charge. Point

Lauren Alessandra Wilson

Follow this and additional works at: https://surface.syr.edu/architecture_theses

Part of the Architecture Commons

Recommended Citation

https://surface.syr.edu/architecture_theses/187

This Thesis, Senior is brought to you for free and open access by the School of Architecture Dissertations and Theses at SURFACE. It has been accepted for inclusion in Architecture Senior Theses by an authorized administrator of SURFACE. For more information, please contact surface@syr.edu.
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. 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.”

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.
CURRENT U.S. ENERGY CONSUMPTION

Total: 99.578 Quadrillion BTU

**Non-renewable**
- Fossil fuel oil: 37%
- Natural gas: 25%
- Coal: 21%
- Nuclear: 9%

**Renewable**
- Biomass: 4%
- Hydro-power: 2.8%
- Wind energy: 0.72%
- Geothermal: 0.4%
- Geothermal: 0.01%

http://geology.com/articles/renewable-energy-trends/
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
CHALLENGES & OPPORTUNITIES

- Limitations of the Electric Vehicle
- Battery Performance
- Energy & The Grid
- Fueling Station Locality

Electric Vehicle Stock [2012]
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). 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.”

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

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

**Electric Motor**

**Rechargeable Batteries**

**Combustion Engine**

**Petrol Tank**

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.”

**ELECTRIC VEHICLES**

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


<table>
<thead>
<tr>
<th>Country</th>
<th>EV Stock 2012</th>
<th>EVSE Stock 2012</th>
</tr>
</thead>
<tbody>
<tr>
<td>UNITED STATES</td>
<td>71,174</td>
<td>15,192</td>
</tr>
<tr>
<td>UNITED KINGDOM</td>
<td>8,183</td>
<td>2,866</td>
</tr>
<tr>
<td>FRANCE</td>
<td>20,000</td>
<td>2,100</td>
</tr>
<tr>
<td>SPAIN</td>
<td>787</td>
<td>705</td>
</tr>
<tr>
<td>PORTUGAL</td>
<td>1,862</td>
<td>705</td>
</tr>
<tr>
<td>DENMARK</td>
<td>1,388</td>
<td>3,078</td>
</tr>
<tr>
<td>NETHERLANDS</td>
<td>6,750</td>
<td>3,674</td>
</tr>
<tr>
<td>SWEDEN</td>
<td>1,285</td>
<td>2,115</td>
</tr>
<tr>
<td>FINLAND</td>
<td>271</td>
<td>(does not include electric block heaters also used for charging)</td>
</tr>
<tr>
<td>GERMANY</td>
<td>5,335</td>
<td>2,821</td>
</tr>
<tr>
<td>ITALY</td>
<td>1,643</td>
<td>1,350</td>
</tr>
<tr>
<td>CHINA</td>
<td>11,573</td>
<td>8,107</td>
</tr>
<tr>
<td>JAPAN</td>
<td>44,727</td>
<td>5,009</td>
</tr>
<tr>
<td>INDIA</td>
<td>1,428</td>
<td>999</td>
</tr>
<tr>
<td>SOUTH AFRICA</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td>SWEDEN</td>
<td>1,285</td>
<td>2,115</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Country</th>
<th>EV Stock 2012</th>
<th>EVSE Stock 2012</th>
</tr>
</thead>
<tbody>
<tr>
<td>UNITED STATES</td>
<td>71,174</td>
<td>15,192</td>
</tr>
<tr>
<td>UNITED KINGDOM</td>
<td>8,183</td>
<td>2,866</td>
</tr>
<tr>
<td>FRANCE</td>
<td>20,000</td>
<td>2,100</td>
</tr>
<tr>
<td>SPAIN</td>
<td>787</td>
<td>705</td>
</tr>
<tr>
<td>PORTUGAL</td>
<td>1,862</td>
<td>705</td>
</tr>
<tr>
<td>DENMARK</td>
<td>1,388</td>
<td>3,078</td>
</tr>
<tr>
<td>NETHERLANDS</td>
<td>6,750</td>
<td>3,674</td>
</tr>
<tr>
<td>SWEDEN</td>
<td>1,285</td>
<td>2,115</td>
</tr>
<tr>
<td>FINLAND</td>
<td>271</td>
<td>(does not include electric block heaters also used for charging)</td>
</tr>
<tr>
<td>GERMANY</td>
<td>5,335</td>
<td>2,821</td>
</tr>
<tr>
<td>ITALY</td>
<td>1,643</td>
<td>1,350</td>
</tr>
<tr>
<td>CHINA</td>
<td>11,573</td>
<td>8,107</td>
</tr>
<tr>
<td>JAPAN</td>
<td>44,727</td>
<td>5,009</td>
</tr>
<tr>
<td>INDIA</td>
<td>1,428</td>
<td>999</td>
</tr>
<tr>
<td>SOUTH AFRICA</td>
<td>N/A</td>
<td>N/A</td>
</tr>
</tbody>
</table>

%: Approximate Percentage of Global Electric Vehicle Stock, 2012 (Total EV Stock = 180,000+)

EV Stock: Cumulative Registration/Stock of Electric Vehicles, 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.
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.

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


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.

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

Brief history of The Filling Station

Timeline

- Evolution of the Filling Station
- Evolution of the Internal Combustion Engine
- The Electric Vehicle

The Gas Station & The Charging 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 manually 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.

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.

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 customers as oppose to offering free auto services.
Few places sold fuel, vehicle owners would have to fill a bucket in the outskirts of town.

The curbside station usually resided on the curb in front of general town stores and 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 ignited 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.

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 services in all weather and were equipped with pits and canopies. They represented comfort and friendly service with a positive association.

The domestic station was influenced by the International Style of architecture and the German Bauhaus. It was an influential design for accessible charging stations around the world.

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 stretched along the edge of the canopy and building.

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 freest glass box station prototype.

Electric and gas powered cars competed until Henry Ford’s assembly line produced the affordable Model T that could be duplicated in any setting. Prefabricated Gas stations using metal and glass were built in any state. Simple bands of color and the company name stretch along the edge of the canopy and building.

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 services in all weather and were equipped with pits and canopies. These split-pump stations offered different gas services in all weather and were equipped with pits and canopies. They represented comfort and friendly service with a positive association.

The domestic station was influenced by the International Style of architecture and the German Bauhaus. It was an influential design for accessible charging stations around the world.

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 stretched along the edge of the canopy and building.

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 freest glass box station prototype.

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.)

An aesthetic 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.

Architecture is a celebration poetics of structure and materiality, which was most important to the design of filling stations during the 1970s...

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

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

Oil Depletion: 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 quantity of clean energy production and distribution.

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

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

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

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

In 2010 there are 5,678 charging stations and 16,256 public charging points in the United States as of March, 2013.
Parking lots have a vast impact on the design of cities and the character of the urban fabric. In some cities, they cover more than 13 of the urban fabric.

of the time cars are immobile

00 million surface parking lots in US where super chargers can potentially be implemented

Fuel Time

3 minutes

Quick on convenience

Branding

Decorated Shed

Logo

Gasoline colors

THE GAS STATION

THE CHARGING STATION

30 mins

Park and charge

Branding

Sustainability

Parking Space [idle EV]

Storage Battery Bank

Solar Panels

n enter
Siting and Design Guidelines for Electric Vehicle Supply Equipment

 levels of charge
charge times & sufficient times

The Surface Lot
Street Parking
Fleet Parking
Parking Garage
The Service Station
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, multifamily, condo and residential. The company works closely with several very loyal retail-garages, multifamily, condo and residential.

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 Carcharging through user payment.)

As CarCharging continues to buy and consolidate charging companies, they are taking 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.

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 25 minutes to fully charge.1 A proper e-chipped 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.)

IKEA and Walgreens are two commercial companies that have recently taken advantage of CarChargings electric vehicle charging services. Installation, maintenance, equipment and supply is taken out of the grid. According to Walgreens, the benefit is to increase property traffic as well as additional time spent on the property. As of June, 2013 IKEA has purchased more than 50 Blink charging stations and has implemented them in more than half of their stores, country-wide.

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 members of the communities in which we operate live more sustainable lives. 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.

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 and that begins to register with the public’s eye helping to diminish range anxiety, represent a community commitment to this idea of sustainable and essentially generate ubiquitous charging.

As filing 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, poten- tally, be charged "anywhere, anytime," at home, on commercial sites, downtown surface parking lots, parking garages, street parking and DC fast charging service.

"The report neglects the opportunity to promote renewable energy and users more aware of their energy consump- tion by only stating their negative cost implica- tion..." design choices such as canopies, alternative power sources will add expense. 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 up- grades and possible branch circuits might be necessary. There is a missed opportunity in the literature to link the cost associated 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 for overnight parking, level 2 is suitable for several hour parking and level 3 is mostly closely associated to gas station.

The charging points will have to be transform- able as technology evolves. "The challenge is to develop the Technology and fast pace, batteries will soon charge more quickly and store greater amounts of energy. Charging stations, according to the report, are categorized 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 paint based around 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 60% of the EV battery with a maximum of 480V."

A network interface is important in connecting the driver to a vacant charging point, either through a cellular device or on-vehicle systems.

"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 interesting 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 promot- ing ease of use and accessibility, "the user experience at the EVSE site presents brand- ing opportunities for the EVSE makes, installer’s or partners’ purposes" (the perspective of the report clearly targets the buyer or developer where my thesis will target the community, user and the environment.)

"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." 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 accessible payment method.

One interesting branding technique discussed included designating priority spaces for EVs that sit directly outside the entrance to buildings.
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 is not as common 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.

**FAST CHARGING**

---

**LEVELS OF CHARGE**

**SLOW CHARGING**

- **LEVEL 1**
  - Uses an Alternating Current (AC)
  - Sufficient for home charging or overnight public charging
  - Standard 1772
  - Least efficient

- **LEVEL 2**
  - Uses an Alternating Current (AC)
  - Sufficient for outdoor locations
  - Several hour parking
  - Site will need utility upgrades
  - Standard 1772
  - Burden on existing electrical system

- **LEVEL 3**
  - Direct Current (DC)
  - Sufficient for public charging
  - Drive in 30 mins
  - Site will need utility upgrades
  - Has high electrical current
  - Uses a Standard 1772
  - Burden on existing electrical system

---

**Non Residential EVSE Stock in EV Countries by Slow/Fast, 2012**

**Source:** EVI.
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 customers 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.” 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

EVSE charging stations are suitable for on-street parking in partially 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.” 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.

Precedent Examples

Electric Avenue Portland, Oregon 2011

1 "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."
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. 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." 

Precedent Examples
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. 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
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...” the service should be re-programmed with activates that users might engage in while waiting, wifi lounges, food or coffee shops, etc.

Precedent Examples
Tesla Supercharger Station Los Angeles, California 2009.
Geoducta’s Green Gasoline Station Haifa, Israel 2010

2 “Siting and Design Guidelines for Electric Vehicle Supply Equipment.”
+PRECEDE NTS
Precedent a and Timeline
Green ay Self Park
Plug and Play
Eight Point ne
esol Service Station
Vol o Pure Tension Pa illion
Electric enue
Sierra ada Bre ery
Gothen urg charging Station
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.

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.

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. 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.


The design was made by Sauer Energy.

Garage Form

Photo Credit: John Picken

Ventilation Through Facade Panels
Plug and Play was the winning entry for the DesignByMany competition for an Electric Vehicle Charging Station. Arcollab designed a form that would generate consciousness regarding energy, creating an intersection between the aspects of production and consumption. Ironically, the charging station units take the shape of traditional power plant smokestacks, 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 may act as destinations points and places the charging stations in close proximity to them. The facade surface acts as an urban battery that displays amount the vehicle has been charged.

The Eight Point.One is a solar charging station designed to be marketable, yet very innovative. It had evolved through a design charrette from LAVA architects, Consuplan Structural Engineering and Design Production 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 sustainable, 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 visible models for a new and emissions free mobility.”

LAVA Architects

http://www.archdaily.com/41149995/
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.”

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.”

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.”
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.”

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.”

The intervention includes a number of host partners (City of Portland, Portland General Electric and PSU), charging station partners (Eaton, ECCity, 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.”

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.
BREWERY SUSTAINABILITY GOALS

“At Sierra Nevada Brewing Co., sustainability 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 sustainability program, we intend to leave a better world for future generations.”

Sierra Nevada Brewery has a Sustainability 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 consume. 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.”


"Sustainability, On-Site Power Generation," Sierra Nevada Brewery Chico California.

Photo Credit: Sierra Nevada Brewery
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.”

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.”

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, café and bicycle repair shop.


Image Credit to Kjellgren Kaminsky Architecture.
Maximizing Solar Gain
EcoTest Testing
Form Manipulation
### Form L1

**Value Range:** 3400000.0 - 5070000.0 Wh/m²

<table>
<thead>
<tr>
<th>ID Type (</th>
<th>Object</th>
<th>Object Area</th>
</tr>
</thead>
<tbody>
<tr>
<td>MAXIMUM</td>
<td>5.07</td>
<td>4890851</td>
</tr>
<tr>
<td></td>
<td>2867581.5</td>
<td>2336527</td>
</tr>
<tr>
<td>MINIMUM</td>
<td>1.16</td>
<td>439272.562</td>
</tr>
<tr>
<td></td>
<td>0</td>
<td>439272.562</td>
</tr>
<tr>
<td>SUM TOTAL</td>
<td>162.76</td>
<td>244759168</td>
</tr>
<tr>
<td></td>
<td>125246880</td>
<td>119512288</td>
</tr>
</tbody>
</table>

### Form M2

**Value Range:** 3400000.0 - 5070000.0 Wh/m²

<table>
<thead>
<tr>
<th>ID Type (</th>
<th>Object</th>
<th>Object Area</th>
</tr>
</thead>
<tbody>
<tr>
<td>AVERAGE</td>
<td>2.93</td>
<td>4227680.571</td>
</tr>
<tr>
<td></td>
<td>2188786.429</td>
<td>2038895</td>
</tr>
<tr>
<td>MINIMUM</td>
<td>1.22</td>
<td>448741.031</td>
</tr>
<tr>
<td></td>
<td>0</td>
<td>443933.594</td>
</tr>
<tr>
<td>SUM TOTAL</td>
<td>162.0</td>
<td>3168012256</td>
</tr>
<tr>
<td></td>
<td>107656240</td>
<td>101356032</td>
</tr>
</tbody>
</table>

### Form L3

**Value Range:** 3400000.0 - 5070000.0 Wh/m²

<table>
<thead>
<tr>
<th>ID Type (</th>
<th>Object</th>
<th>Object Area</th>
</tr>
</thead>
<tbody>
<tr>
<td>AVERAGE</td>
<td>4.06</td>
<td>4211723.6</td>
</tr>
<tr>
<td></td>
<td>2179843.4</td>
<td>2031879.8</td>
</tr>
<tr>
<td>MINIMUM</td>
<td>1.22</td>
<td>448741.031</td>
</tr>
<tr>
<td></td>
<td>0</td>
<td>443933.594</td>
</tr>
<tr>
<td>SUM TOTAL</td>
<td>162.0</td>
<td>3400000.0</td>
</tr>
<tr>
<td></td>
<td>2234000.0</td>
<td>101356032</td>
</tr>
</tbody>
</table>

### Form L4

**Value Range:** 3400000.0 - 5070000.0 Wh/m²

<table>
<thead>
<tr>
<th>ID Type (</th>
<th>Object</th>
<th>Object Area</th>
</tr>
</thead>
<tbody>
<tr>
<td>AVERAGE</td>
<td>3.3</td>
<td>4180245.12</td>
</tr>
<tr>
<td></td>
<td>2153124.8</td>
<td>2027120.64</td>
</tr>
<tr>
<td>MINIMUM</td>
<td>1.22</td>
<td>448741.031</td>
</tr>
<tr>
<td></td>
<td>0</td>
<td>443933.594</td>
</tr>
<tr>
<td>SUM TOTAL</td>
<td>162.0</td>
<td>3400000.0</td>
</tr>
<tr>
<td></td>
<td>2234000.0</td>
<td>101356032</td>
</tr>
</tbody>
</table>

### Form M5

**Value Range:** 3400000.0 - 5070000.0 Wh/m²

<table>
<thead>
<tr>
<th>ID Type (</th>
<th>Object</th>
<th>Object Area</th>
</tr>
</thead>
<tbody>
<tr>
<td>AVERAGE</td>
<td>5.19</td>
<td>4483114</td>
</tr>
<tr>
<td></td>
<td>2335047.75</td>
<td>2148066.25</td>
</tr>
<tr>
<td>MINIMUM</td>
<td>2.61</td>
<td>3434070.25</td>
</tr>
<tr>
<td></td>
<td>2031563.625</td>
<td>1402506.75</td>
</tr>
<tr>
<td>SUM TOTAL</td>
<td>162.62</td>
<td>164773280</td>
</tr>
<tr>
<td></td>
<td>99289200</td>
<td>85484096</td>
</tr>
</tbody>
</table>

### Form L6

**Value Range:** 3400000.0 - 5070000.0 Wh/m²

<table>
<thead>
<tr>
<th>ID Type (</th>
<th>Object</th>
<th>Object Area</th>
</tr>
</thead>
<tbody>
<tr>
<td>AVERAGE</td>
<td>7.07</td>
<td>4340997.667</td>
</tr>
<tr>
<td></td>
<td>2250094.833</td>
<td>2090902.833</td>
</tr>
<tr>
<td>MINIMUM</td>
<td>2.61</td>
<td>3434070.25</td>
</tr>
<tr>
<td></td>
<td>2031563.625</td>
<td>1402506.75</td>
</tr>
<tr>
<td>SUM TOTAL</td>
<td>162.62</td>
<td>164773280</td>
</tr>
<tr>
<td></td>
<td>99289200</td>
<td>85484096</td>
</tr>
</tbody>
</table>

### Form M6

**Value Range:** 3400000.0 - 5070000.0 Wh/m²

<table>
<thead>
<tr>
<th>ID Type (</th>
<th>Object</th>
<th>Object Area</th>
</tr>
</thead>
<tbody>
<tr>
<td>AVERAGE</td>
<td>4.33</td>
<td>4231964.4</td>
</tr>
<tr>
<td></td>
<td>2270742.4</td>
<td>1971222.4</td>
</tr>
<tr>
<td>MINIMUM</td>
<td>2.61</td>
<td>3434070.25</td>
</tr>
<tr>
<td></td>
<td>2031563.625</td>
<td>1402506.75</td>
</tr>
<tr>
<td>SUM TOTAL</td>
<td>162.62</td>
<td>164773280</td>
</tr>
<tr>
<td></td>
<td>99289200</td>
<td>85484096</td>
</tr>
<tr>
<td>Object Area</td>
<td>MINIMUM</td>
<td>AVERAGE</td>
</tr>
<tr>
<td>-------------</td>
<td>---------</td>
<td>---------</td>
</tr>
<tr>
<td></td>
<td>0.69</td>
<td>4.07</td>
</tr>
<tr>
<td></td>
<td>3041195.75</td>
<td>4543926.8</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Object Area</th>
<th>MINIMUM</th>
<th>AVERAGE</th>
<th>MAXIMUM</th>
<th>SUM TOTAL</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>0.69</td>
<td>4.12</td>
<td>21.7</td>
<td>162.49</td>
</tr>
<tr>
<td></td>
<td>3040526.75</td>
<td>4559973.6</td>
<td>4822258.5</td>
<td>143726848</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Object Area</th>
<th>MINIMUM</th>
<th>AVERAGE</th>
<th>MAXIMUM</th>
<th>SUM TOTAL</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>0.69</td>
<td>4.17</td>
<td>23.36</td>
<td>162.68</td>
</tr>
<tr>
<td></td>
<td>3041195.75</td>
<td>4558674.8</td>
<td>4822350</td>
<td>182195008</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Object Area</th>
<th>MINIMUM</th>
<th>AVERAGE</th>
<th>MAXIMUM</th>
<th>SUM TOTAL</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>0.69</td>
<td>5.2</td>
<td>26</td>
<td>162.06</td>
</tr>
<tr>
<td></td>
<td>3041347.5</td>
<td>4491464</td>
<td>4822258.5</td>
<td>97042968</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Object Area</th>
<th>MINIMUM</th>
<th>AVERAGE</th>
<th>MAXIMUM</th>
<th>SUM TOTAL</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>0.69</td>
<td>5.28</td>
<td>27.4</td>
<td>162.68</td>
</tr>
<tr>
<td></td>
<td>3041195.75</td>
<td>4559973.6</td>
<td>4822350</td>
<td>182195008</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Object Area</th>
<th>MINIMUM</th>
<th>AVERAGE</th>
<th>MAXIMUM</th>
<th>SUM TOTAL</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>0.69</td>
<td>5.31</td>
<td>23.36</td>
<td>162.68</td>
</tr>
<tr>
<td></td>
<td>3041195.75</td>
<td>4558674.8</td>
<td>4822350</td>
<td>182195008</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Object Area</th>
<th>MINIMUM</th>
<th>AVERAGE</th>
<th>MAXIMUM</th>
<th>SUM TOTAL</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>0.69</td>
<td>5.23</td>
<td>26</td>
<td>162.68</td>
</tr>
<tr>
<td></td>
<td>3041337</td>
<td>4389628</td>
<td>4822352.5</td>
<td>97690936</td>
</tr>
<tr>
<td>Form</td>
<td>Value Range</td>
<td>AVERAGE</td>
<td>MINIMUM</td>
<td>MAXIMUM</td>
</tr>
<tr>
<td>-------</td>
<td>------------------------------</td>
<td>---------</td>
<td>---------</td>
<td>---------</td>
</tr>
<tr>
<td>B</td>
<td>3400000.0 - 5070000.0 Wh/m²</td>
<td>8.3</td>
<td>5.18</td>
<td>20.25</td>
</tr>
<tr>
<td>E1</td>
<td>81 4372597.5 2173925.75 2198672</td>
<td>8.35</td>
<td>6.13</td>
<td>10.72</td>
</tr>
<tr>
<td>E2</td>
<td>81 4606551 2723107.25 1883444</td>
<td>129.6</td>
<td>-180</td>
<td>161.9</td>
</tr>
<tr>
<td>E3</td>
<td>81 4719922 2558994.75 2160926.75</td>
<td>7.88</td>
<td>6.13</td>
<td>12.75</td>
</tr>
<tr>
<td>H</td>
<td>81 4719922 2558994.75 2160926.75</td>
<td>7.88</td>
<td>6.13</td>
<td>12.75</td>
</tr>
<tr>
<td>H1</td>
<td>81 4804763 2739602.75 2065160.125</td>
<td>8.3</td>
<td>5.18</td>
<td>20.25</td>
</tr>
<tr>
<td>H2</td>
<td>81 4804466.5 2739306 2065160.125</td>
<td>8.3</td>
<td>5.18</td>
<td>20.25</td>
</tr>
<tr>
<td>F</td>
<td>81 4449740 2463999 1985740.875</td>
<td>8.3</td>
<td>5.18</td>
<td>20.25</td>
</tr>
<tr>
<td>F3</td>
<td>81 4227507 2601706 1625801</td>
<td>7.88</td>
<td>6.13</td>
<td>12.75</td>
</tr>
</tbody>
</table>
To Build ChargePoint
Parking Lot Orientation to the Sun
Foundation Connection to the Ground
Structure
Solar Film Connection
Panels and Base
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。
- Interlocking Structure: 40x
  (Marine grade ply with laminate)

- Hardware: 120x
  (Carriage bolts, screws, twist-lock fastener and anchor bolts)

- Panels: 9x
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 parts 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.
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.
STRUCTURE:

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

1. Assemble interlocking structure for Corner 1 (C1).
STRUCTURE:

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

1. Assemble interlocking structure for Corner 1 (C1).

>> Repeat at corners 2 and 3.

>> Note Assembly might change based on which corner is south facing. Please see ChargePoint App.
SOLAR FILM:
ChargePoint 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.

BASE:

<table>
<thead>
<tr>
<th>Base</th>
<th>C1</th>
<th>C2</th>
<th>C3</th>
<th>C4</th>
<th>C5</th>
<th>C6</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
APPLICATION & SITE

Site and interface
SingleSpace
Tested on Site and any network interface and