



Charging While You Work

A guide for expanding electric vehicle
infrastructure at the workplace

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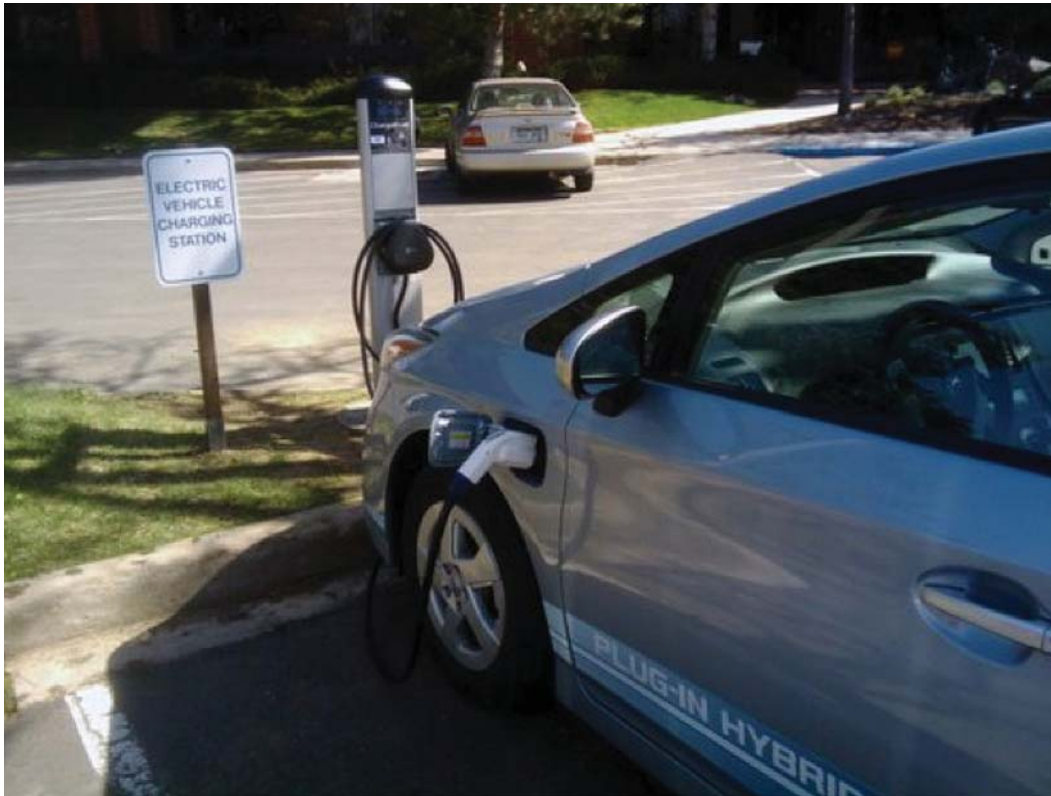
Cover image: Workplace charging infrastructure at Dynamic Sealing Technologies Inc., Andover, MN. Photo from Chris Larson, DSTI.

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Introduction and terminology

Electricity-fueled transportation is expanding across the globe as a result of improved vehicle and battery technologies, concerns about oil supplies, and public policy demanding increasing efficiency in our vehicles. The current electric vehicle (EV) market is made up of two distinct types of vehicles – battery electric vehicles (BEVs) and plug-in hybrid electric vehicles (PHEVs). The primary difference between a BEV and a PHEV is that a PHEV will run partially on fuel other than electricity to extend their range when the stored electricity is exhausted. Throughout this guide we will use the term “EV” to refer to both BEVs and PHEVs, including essentially any type of vehicle (such as electric cars, trucks, bicycles, and motorcycles) that can be plugged in to recharge.

The equipment making connections between the vehicle and the electricity source is known as Electric Vehicle Supply Equipment (EVSE). The EVSE can be as inexpensive and simple as a high-quality, three-pronged extension cord attached to a vehicle and to a 120-volt electrical outlet. Advanced, high-tech EVSE can cost thousands of dollars and provide bi-directional flow of electricity between the EV and the electricity grid and contain software systems used for electronic payment and energy usage tracking. While not technically correct, EVSE is commonly referred to as a “charging station.”

It is expected that most EV owners will recharge their vehicles overnight at their home. Current research shows that about 80 percent of charging by EV owners is taking place at home.¹ Unlike the 115,000 or so gas stations in the U.S. that are fueling most of our vehicles today², there are tens of millions of households across the country that are suitable today to charge and provide “fuel” for electric vehicles.

Why drive an electric vehicle (EV)?

- To save operating costs: four times more efficient than gas-powered vehicles, EVs cost only 2 to 3 cents per mile to power
- To reduce vehicle maintenance due to fewer parts in EVs
- To reduce our dependence on imported fossil fuels
- For zero tailpipe emissions as part of solving our air pollution problems

1 See EV Project, www.evproject.com

2 See U.S Census, <http://www.census.gov/econ/industry/ec07/a4471.htm>

Common Acronyms

EV (Electric Vehicle) Electric vehicles are powered in full (e.g. BEV) or in part (e.g. PHEV) by electricity that they receive by plugging into the electric grid and storing in batteries. Examples include electric passenger vehicles, electric vans, electric bicycles, and electric motorcycles.

EVSE (Electric Vehicle Supply Equipment) commonly referred to as an “EV charging station.” EVSE is the equipment that ultimately delivers energy from an electricity source to an EV’s batteries.

BEV (Battery Electric Vehicle) These EVs derive all their energy from the electricity grid and do not use gasoline/diesel fuel. An example of this is the Nissan Leaf.

PHEV (Plug-in Hybrid Electric Vehicle) These EVs use electricity from the grid and can extend their driving range by switching to another fuel like gasoline/diesel. An example of this is the Chevrolet Volt.

In addition to home charging, a growing network of public and charging stations³ are making EVs more convenient and reducing consumers’ “range anxiety”. In the early stages of a massive, multi-state/city experiment known as “The EV Project”, it has been shown that the percentage of EV owners charging the vehicles outside the home grows as more publicly accessible charging becomes available. Public EV charging is attractive for consumers who might be out and about running errands and want to give their EV batteries a top-off.

Aside from at-home and public EV charging, research strongly supports the need for workplace charging opportunities. The Electric Power Research Institute (EPRI) estimated that 54% of non-residential parking occurs at the workplace where layover is often between 4-8 hours. This extended period where vehicles are sitting in one place is the perfect time to provide EV owners with an extension in range. Workplace charging could provide EV owners an extra 15 – 70 miles of range depending on the charging infrastructure available. This matches well with the characteristics of typical commuters today, of whom 90 percent drive less than 40 miles one-way to work.⁴



3 As of September 2012, over 4,350 public EV charging sites are listed in a federal government database, according to www.afdc.energy.gov/fuels/electricity_locations.html The Charge Point Network listing has over 9,230, according to www.chargepoint.com

4 See U.S. Census, <http://www.census.gov/hhes/commuting/>

Comparing Common EV Charging Options

	Level 1	Level 2	Level 3 (fast charging)
Power Supply	120 V @ 12-20 amps	240 V @ 30-80 amps	up to 600 V (DC) or 480 V (AC) @ 100 amps
Energy Use Characteristics	1-1.5 kW/hr	3-7 kW/hr	75-100 kW/hr
EV Range Boost	2-5 miles/hr	8-20 miles/hr	60-80 miles (< 30 minutes)
Bottom Line	Widely available, low cost (\$10 to \$1000). Ideal solution to provide EV owners with more range, and to gain experience in workplace charging.	Widely available, moderate cost (\$500 to \$6000). Many 3rd party equipment and service providers. Ideal solution to provide EV owners substantial boost in range in less time.	Limited availability, high cost (>\$15,000 + installation). As of late 2012, this solution is not practical for most workplace charging sites.

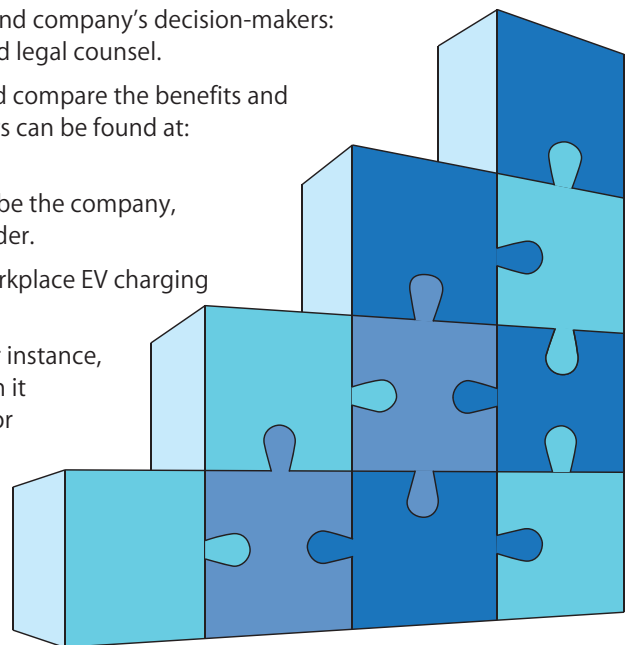
Sources: Department of Energy, Southern California Edison, Plug-In America

Workplace EV charging: start a program today

Successful efforts to establish a workplace charging opportunity for electric vehicle (EV) owners will depend on the employee and employer and/or building owner being fully informed as to the challenges and benefits. Workplace charging programs don't have to be costly or complicated, yet they will provide a valuable service to employees who own EVs, and they will create an increasingly attractive marketing tool for a business or a building owner to attract and retain employees and/or tenants.

Key steps for starting a workplace-charging program

1. Survey employees' interest in a workplace-charging program.
2. Discuss findings and EV charging needs amongst employees and company's decision-makers: supervisors, building owner/manager, facilities technicians and legal counsel.
3. Examine different types of EV charging equipment options and compare the benefits and costs (e.g. Level 1, Level II, Fast Charging). A listing of suppliers can be found at: www.pluginamerica.org/accessories
4. Determine who will own the EV charging equipment. It could be the company, the building/parking lot owner, or a 3rd party EV service provider.
5. Look for any existing incentives that might be available for workplace EV charging infrastructure. Visit www.pluginamerica.org/incentives
6. Create a company policy surrounding workplace charging. For instance, address who gets access, when it will be accessible, how much it should cost to use, and who will oversee ongoing operations or troubleshooting.
7. Contract with a certified electrician to determine ideal location(s), deal with local permitting, and install the equipment.
8. Install signage, alert employees and start charging those EVs!



Workplace EV charging benefits for employers and building owners

• Employee attraction & retention

Employees are always looking for dynamic companies that stay on the leading edge of technological development.



• Publicity & green credentials

Showing leadership in supporting cutting-edge, clean transportation can raise the environmental profile of a business. The business can also use EV charging in promotional and marketing materials.

• Satisfied employees

Workplace charging is a service that many of your employees will highly appreciate. Happier employees are more productive, making your business more efficient.

• Fleet cost savings

Going beyond EV charging for employees, a business can realize cost savings by converting its own fleet of company cars to EVs.

• Tenant attraction and retention

As a building owner offering workplace charging at your facilities, you will send the message that you are interested in providing smart, proactive solutions for both the present and future needs of your tenants. Capitalizing today on this fast-growing niche market can provide benefits over the long run.

Workplace EV charging benefits for EV owners

• Range security

The opportunity to charge at work help consumers can let go of “range anxiety.”

• Range extensions

Workplace charging can potentially double daily driving range.

• Preheating/cooling

Use workplace charging to preheat or pre-cool before you even get in the car.

• More flexibility

Sometimes plans change and workplace charging will make those changes easier to manage.

• Increased incentive to purchase an electric vehicle

Purchasing an electric car can be a wise move, but the decision has many implications. The knowledge that you can charge your vehicle at work may make that decision easier.



Source: Plug-In Connect, U.S. Department of Energy

Planning and implementation process steps

For various questions, the next section will offer some possible actions to consider. Each installation will have unique characteristics so consider the guidance information carefully for your situation.

Implementing EV workplace charging is easiest where a business/organization is in complete control of their entire campus. With singular control of the key pieces of real estate – parking area, building, and electrical service – it will be a straightforward process to establish an EV charging opportunity for employees.

The situation can easily become much more complicated, especially in dense urban situations. Imagine a scenario where a business is leasing space in a building that is owned by one entity, operated and maintained by another entity and with yet another entity operating the parking facility. For employers or employees at companies with a more complex building ownership/parking arrangement at their site, the guidelines below will have to be modified to fit the specific situation. Once the key decision-makers are engaged, the process should usually flow smoothly.

Successful efforts will depend on both employer and employee being fully informed as to the challenges and benefits. Using information in this handbook, employees can come equipped with cost information and process hurdles to show their supervisors that an EV workplace-charging program doesn't have to be complicated and can become an interesting marketing tool for a business or a building owner.

Most of the existing workplaces around the country that offer EV charging for their employees began as a top-down initiative. Providing EV charging is seen by employers as an opportunity for the company to further its sustainability mission and gain additional "green credentials" by promoting efficient transportation among their workforce. Employer-driven workplace charging will certainly continue in the future but more often than not, it will be the employee/EV owner that will have to initiate the conversation within the company and push for a workplace charging program.

The next section offers a discussion and provides guidance on key questions and process points to bring workplace charging from the idea stage to implementation.

Initiate a discussion of charging needs and identify the key decisionmakers.

In small organizations, informal conversation between colleagues is often enough to get the ball rolling. A simple discussion can take place amongst the staff and management to come to an acceptable solution to start the process of potentially bringing EV charging to the workplace. Medium and large-sized businesses may have a more formal process that must be followed.

Typically the key decision-makers will include a management level designee, the building owner (if different from employer), parking lot operator (if necessary), facilities operation staff, human resources, and legal counsel.

With an understandable slant towards marketing their EVSE equipment, the ChargePoint Network web site offers some examples of an e-mail letter that an employee can use/modify to begin the process.⁵ Below is a sketch of what they suggest sending to supervisors and/or the heads of company sustainability, human resources, operations and/or facilities departments:

Workplace EV charging scenarios

Easiest – Company owns building, parking lots, electricity accessible (upgrades not needed), and Level 1 or Level 2 EVSE charging.

Easy – Company owns building and parking lots, electricity accessible (upgrades possibly needed), and Level 1 or Level 2 EVSE charging.

Moderate Difficulty – Company leases space in building and parking lots, electricity upgrades potentially needed, and Level 1 or Level 2 EVSE charging.

Difficult – Company leases space in building, independently operated parking, electricity inaccessible.

⁵ See www.chargepoint.com/chargepointnet/email.php

Dear _____,

I am writing to request that we install electric vehicle charging stations in our employee parking lot. I'd like to purchase an electric vehicle to save on fuel costs and also to do my part to contribute to cleaner air and energy independence. But since I can only buy an electric vehicle if I can re-charge it when I get to work, I am asking for your help to support my ability to make this choice.

Many companies are installing charging stations in their parking lots for employees and visitors to use. This single step goes a long way to establishing those companies as leaders in environmental sustainability. It also sends a public message that those companies are committed to supporting employees' personal choices, and it enhances their image as a great place to work.

Will you please consider installing EV charging stations, to support a choice that is important to me?

Respectfully yours,

P.S. Companies who have installed ChargePoint stations for employees include Google, Microsoft, Intuit, Dell, Netflix, Adobe, AAA, Johnson & Johnson, MasterCard, Verizon Wireless, Honeywell, Consumer Reports, SAP, AMD, 3M, The Hartford and others.

Evaluate employees' interest in workplace EV charging.

Regardless of whether an EV charging effort is an employer- or employee-initiated, it will be useful to know how much interest and need there is for workplace EV charging among employees. A survey could be developed and sent to the entire staff with results compiled for discussion. The survey should focus on both short- and longer-term interest in owning EVs and the need for charging options at the workplace. Potential questions⁶ include:

- Do you own an electric vehicle?
 - If so, how often do you drive it to work?
 - If so, would the option to charge your car at work be desirable?
- If you drive to work, approximately how far is your trip (one-way)?
- Are you considering purchase or lease of an electric vehicle in the future?
- How soon do you plan on buying or leasing your next vehicle (any type)?
- If workplace charging were an option, would you be willing to pay for the service?

⁶ Modified from City of Anaheim survey,
<http://survey.constantcontact.com/survey/a07e2z3rg5kgbtqlfwi/a017nh76gor5k/questions>

Company decision-makers should evaluate results and determine the potential number of charging stations that might be needed. It will be important in the planning stage to give thought to long-term needs of your employees. EV ownership is expected to grow rapidly over the coming decade as production of EVs ramps up significantly, so implementing a workplace charging program should be done deliberately and with an eye for potential expansion in the future. For example, Google has a goal for 5% of their employee parking spots to be designated EV charging areas.

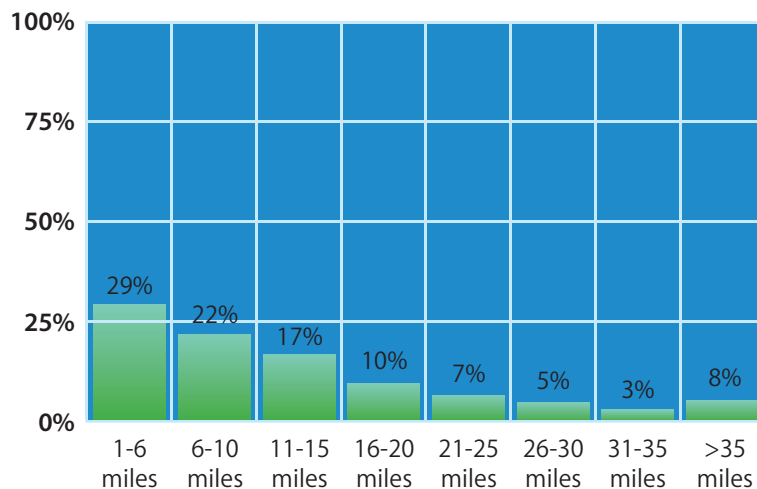
For employers who don't own their buildings or control the parking facility that are used by their employees, there is an additional hurdle to cross: engaging and convincing the parking lot or building management entity to allow the installation of EVSE at their site. At the U.S. EPA's San Francisco office, the installation of EV chargers was negotiated as part of the process of extending the agency's lease. As a result, EPA employees now have access to a pair of Level 2 charging stations by Coulomb and Eaton.

Identifying the type of EVSE that is needed (e.g. Level 1, Level 2, Fast Charging).

Determining what type of charging option to provide at the workplace is critical. Factors such as EVSE system cost, electricity accessibility to parking, potential electric supply upgrades, EVSE security and potential maintenance will influence decisions. Perhaps most importantly, it is wise to have a good estimate on how much electricity the company's EV owners will require to top off their EV batteries.

Employers can examine the responses from the companywide survey to gauge their particular situation. In the Minneapolis/St. Paul area, Metro Transit conducted a survey in 2012 and found that the average commute was approximately 16 miles one-way.⁷ The following chart shows national characteristics of the mileage driven by commuters.

Miles Traveled (One-Way) to Work by Commuters⁸



Source: U.S. Department of Transportation, Bureau of Transportation Statistics, Omnibus Household Survey.

⁷ Metro Transit, 2012 State of the Commute, June 2012.
<http://www.metrocouncil.org/newsletter/transit2012/CommuterSurveySept5.htm>

⁸ Omnistats data U.S. Department of Transportation,
http://www.bts.gov/publications/omnistats/volume_03_issue_04/

Expansion of Level 2 charging (providing 8-20 miles per hour of EV range) is a goal many EV advocates and owners share. Level 2 EVSE at the workplace would give EV owners additional range security and allows one EVSE unit to serve many different vehicles throughout the day as long as the EVs were swapped out when they finished charging. With a host of smart phone apps, it is easy for users to be notified when their EV is charged up; the difficulty for some employers will be in having two (or more) employees take time out during the work day to move their cars.

Identify every 120V outdoor outlet at the workplace, professionally inspect, and place an EV charging spot sign for employee access.

*– Britta Gross,
General Motors*

With the long time periods that EV owners might be parked at work, combined with the fact that EVs used for commuting will likely only be partially depleted upon arrival at the workplace, Level 1 charging (providing 2-5 miles per hour of EV range) is an excellent charging solution. Implementing Level 1 charging at the workplace is a perfect entry point for companies that want to get a feel for the technology and how it works before investing resources in faster charging solutions.

Keeping in mind that Level 1 EVSE can be as simple as a three-pronged extension cord combined with a standard electric outlet, many EV advocates (including Google) believe that Level 1 charging is the easiest and most cost-effective way to rapidly expand EVSE infrastructure outside the home and, in particular, at workplace settings. Since most, if not all, electric cars on the market today come with a free Level 1 charging cord, analysts predict in 2017 that 2.9 million of the total 4.1 million charging stations in the U.S. will be the Level 1 type.⁹

Using Level 1 as a stepping stone, a business can gain experience and information about how their employees are using workplace charging and gauge their happiness (or not) with Level 1 EVSE, then they can make the decision to move (or not) to faster charging options.

Options for Keeping Costs Down

- ▶ Starting a workplace-charging program using a Level 1 EVSE is the easiest way to keep costs low.
- ▶ Purchasing a non-networked Level 2 EVSE is less expensive but advanced features such as card readers and energy data tracking may be unavailable.
- ▶ Using the employer's on-staff electricians will cut down on installation costs
- ▶ Siting EVSE close to existing electrical infrastructure will cut down installation costs

Decisionmakers looking at Level 2 options can use online resources to help them wade through the growing offerings of EVSE manufacturers and service providers. Perhaps the most extensive listing of EV charging equipment is available online via Plug-In America: <http://www.pluginamerica.org/accessories>. Another good listing is at Plug-In Recharge: <http://www.pluginrecharge.com/evse-vendors.html>

Level 1 charging solutions range in cost from \$10 to \$1,000 according to the Department of Energy. Level 2 installations have a wider range of costs, from \$500 to \$6,000 (plus installation) depending on the physical layout of the parking area, the existing electric infrastructure, and what type equipment is purchased. Level 3 fast-charging EVSE is unlikely to be a good match for most workplace situations. Costs are coming down but still are over \$15,000 per unit.

There are a growing number of vendors that not only sell Level 2 equipment but also will offer installation and ongoing service and maintenance. The most common vendor in Minnesota is Coulomb Technologies and their ChargePoint Network that has dozens of publicly accessible Level 2 EVSE in and around the Twin Cities metropolitan area. If a business would rather not have to be intimately involved in the ongoing operation of a workplace EVSE, it would be prudent to contact one or more of these providers to see if they have a solution for your specific needs.

⁹ Frost & Sullivan, *Strategic Technology and Market Analysis of Electric Vehicle Charging Infrastructure in North America*, May 2012. <http://www.frost.com/prod/servlet/report-toc.pag?repid=N9F0-01-00-00-00>

Some vendors of EVSE units require users who purchase their equipment to subscribe to a charging service that uses credit card, cash or radio-frequency identification (RFID) devices to control access to the EVSE and enable the owner of the EVSE to collect usage data in addition to payments for charging. (Charging can also be set up to be free for all or some users.) The EVSE vendor typically shares in the revenue generated by the EVSE and charges service fees for managing payment transactions, maintenance and troubleshooting services for the EVSE.

What does a typical EVSE Installation budget look like?

Itemized costs for workplace EVSE will vary for each site. Factors such as trenching new electrical circuits, surface refurbishment, panel upgrades and permitting will play a role. In some places, there may be incentive programs to help cover the cost of EVSE for workplace-sited charging.

A typical budget might include the following line items:

- Material/Incidentals
- Equipment Rental (trencher for conduit)
- Sidewalk Demolition/Repair
- Labor (in house)
- Labor (outside)
- EVSE (charging station)
- Incentives (if available)
- Optional EVSE equipment (e.g. RFID card reader)
- Signage and/or Paint



Are there any financial incentives for workplace EV charging?

Employers and employees should remain vigilant about policy developments and incentives for EV infrastructure. For example, there was a generous federal tax credit available to businesses installing workplace charging equipment but it expired at the end of 2011. At this writing, there are no incentives in Minnesota for EV charging equipment or to cover installation. Employers considering EV charging installations should check with their local electric utility to see if they have established any programs. EV incentives are being tracked by Plug-in America <http://www.pluginamerica.org/incentives> and DOE's Alternative Fuels Data Center at <http://www.afdc.energy.gov/laws/matrix/tech>.

How much electricity will be used in EV workplace charging?

The potential electricity consumption and related cost is small in terms of typical business expenses. That's why many businesses with EVSE have opted to provide the charging service free to their employees. Maximum potential electricity usage from the EVSE at Level 1 will be about 3,000 kWhs/year and at Level 2 the usage could range from 6,500 kWhs to 13,000 kWhs depending on the vehicles using the EVSE and the electrical circuit's capacity.

What should be addressed in a company policy on workplace charging?

It will be useful to have some clear internal company policy about the workplace EV charging opportunity. Some issues to include:

- **Who gets access to the EVSE parking area?**

Proper signage should clearly indicate that the EVSE parking space(s) are only to be occupied by EVs that are charging their vehicles (see section below for more on signage). It would be up to the company to decide whether visitors as well as employees could use the EVSE. A company might also want to lay out a policy on whether there should be a time limit per car on charging.

- **Is there are registration/liability form required?**

Some workplace charging programs require users to register to use the equipment and sign a standard waiver of liability. A registration form could include language requiring vehicle owners to agree that the business is not responsible for any costs related to vehicle purchase or repairs, nor for any damage to the vehicle while parked at the charging station. It could also provide a specific timeframe within which the business would be obligated to correct maintenance issues with the charging stations upon notice of the problem.

- **What time of day can the EVSE be used?**

A company will have to decide whether the EVSE can be used outside of normal business operating hours.

- **How will security of equipment be ensured?**

Particularly in the case of Level 1 charging, the EVSE will often consist of connectors and cables that are owned by the EV owner. Some of these cables can cost as much as \$600, so it will be important to create as secure an environment as possible to prevent vandalism and theft. Around the country, vandalism to charging units have been rare but in some instances, even in St. Paul, MN, cables have been severed.

- **What happens when multiple employees have EVs and want access to a limited number of EVSE sites?**

A company will have to decide what to do when EVs are fully charged. Are employees allowed to move their vehicles and/or swap for another EV to use the spot? A growing set of smart phone apps enable EV drivers to plan, monitor, and schedule the charging of their vehicle. It is up to the company to determine whether they want to limit car switching when charging is completed. Ideally, the charging spot should be used as efficiently as possible so that any vehicle in the spot is actually charging up.

How much should it cost for employees to use workplace charging equipment?

Many existing EV workplace charging programs have been set up to be free for employees to use. Since the level of EVs on the streets today is relatively small, this can be a reasonable approach to provide employees with a small incentive for their clean transportation choice. As the penetration of EVs expands, providing free charging may have to be reconsidered.

A reasonable fee for using the workplace charging equipment can make sense. Capital and operational costs could be recovered over time through a charge-per-use or setting a monthly/yearly subscription rate for the employees that want to use the EVSE.

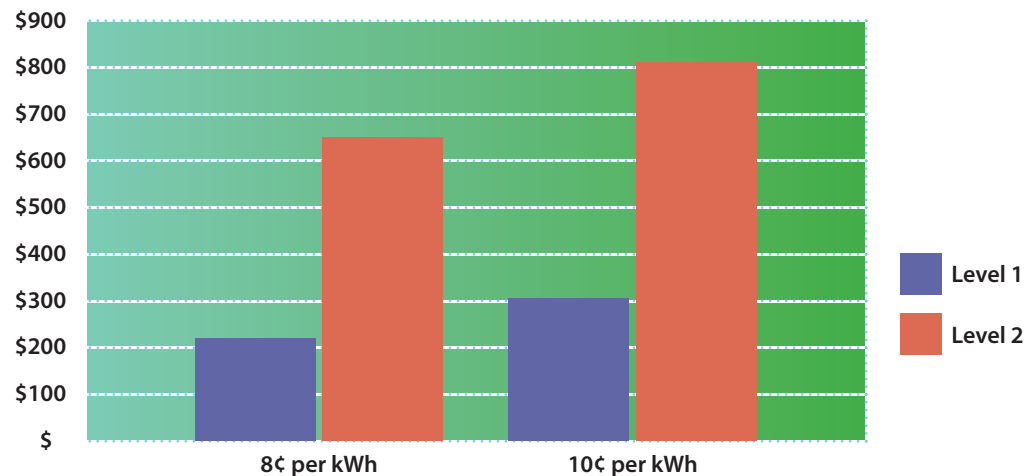
In the largest survey to date, the California Center for Sustainable Energy (CCSE) and the California Air Resources Board (ARB) found that California EV owners are willing to pay 40% – 70% more for



public and workplace charging compared to standard residential electricity rates¹⁰. Translating that information to Minnesota's average electric rate of approximately 8.5 cents/kWh means that most EV owners would likely pay 20 cents per hour for Level 1 charging and up to 50 cents per hour for Level 2 charging.

The cost of the electricity used to charge EVs is minimal, in line with the costs that a business might pay to provide its employees with coffee or snacks in a break room. The chart below shows the difference in annual electricity costs between Level 1 and Level 2 charging systems in a situation where the workplace EVSE use is maximized – charging taking place 5 days/week 8 hours/day.

Annual cost of electricity for a workplace EV charging spot



Note: Data assumes charging takes place 8 hr/day for 260 days per year

It should be noted that if a company decides to make EV charging free for its employees, some legal experts think that it could be considered a reportable employee benefit. Others disagree, so a check with your company's tax attorney would be advisable.

Where should the EVSE be installed?

Ideally, an evaluation of the parking configuration and should take place with the electrical contractor that is bidding on doing the installation. Project costs can be minimized if the charging spots are close to the existing electrical infrastructure. Attention to ADA (Americans With Disabilities Act) requirements is wise at this point even though there are not formal requirements to make EVSE spots accessible. As more EVs hit the roads, concerns over accessible charging spots will likely come up. Some local jurisdictions, like San Diego, already require EV workplace charging installations to be accessible.

Building an accessible EVSE spot also includes making sure that cables and outlets are installed at accessible heights.

Aside from following ADA and National Electric Code guidelines on installation, safety considerations should also include efforts to reduce the potential of people tripping over EVSE cords, proper and sufficient lighting, potential shelter from weather, general personal/property security (cameras are one option), signage that contains emergency contacts, and sufficient barriers to prevent a car from colliding with the EVSE.

¹⁰ California Plug-in Electric Vehicle Owner Survey, California Center for Sustainable Energy (CCSE) and the California Air Resources Board, July 2012. Online at <http://energycenter.org/>

Who will complete the installation of the EVSE?

A certified electrician should carry out the installation. When hiring a contractor to install EVSE at a workplace, select one who is familiar with the National Electric Code Guidelines found in NEC Article 625, the specific guidelines for EV charging equipment and installation. It is smart to have key



decisionmakers in the business and any prospective employees that might use the EVSE walk through the parking area with the certified electrician/contractor prior to beginning the installation.

The electrician will be the point person in coordinating local permitting, inspections, utility upgrades (if needed), equipment purchasing and installation of the EVSE. After installation, the electrician should walk through the EVSE and its operation with the owner of the equipment.

With the growing interest in EVs, targeted training and certification programs for EVSE installations are expanding. For example, UL (formerly Underwriters Laboratories) now offers a training program that has been designed with the help of key

electricity utility partners for electrical contractors (see <http://lms.ulknowledgeservices.com/catalog/display.resource.aspx?resourceid=303396>) and there is also a link to companies/individuals that have completed the course (see <http://www.ul.com/global/eng/pages/offerings/industries/powerandcontrols/electricvehicle/evinstallers/>).

Should the electric utility be notified about the workplace EVSE installation?

While not required by law in Minnesota and most other places, notifying the utility when Level 2 charging infrastructure is being installed is recommended. Business locations for EV charging infrastructure will generally have robust electric service so that the addition of EVSE up to Level 2 will not likely make any noticeable difference to the electric load and will not negatively impact the local electrical distribution network and equipment. Any certified electrician will be able to quickly determine whether utility upgrades will be necessary to meet the electrical demands of the workplace-charging infrastructure under consideration.

Check with the utility to see if they offer special EV charging rates that can make filling up an EV even cheaper. Typically, these rates have been established to get people to charge their vehicles during off-peak times when electricity consumption is low (e.g. overnight hours). Since most workplace charging sites will be utilized during the day, it is less likely that a utility would offer a rate incentive, but it's always good to check.

In general, electric utilities are keen to know whenever any EVSE is installed so that they can make sure to maintain reliable transformer and distribution system capacity. This becomes much more important as more and more EVs hit the road.

Types of signage that should be used.

Best practice indicates that the signage should clearly show that the parking spot is only to be used by an EV and preferably only by an EV that is physically charging infrastructure. Since enforcement is likely to be non-existent in most situations and jurisdictions, the signage will be the only deterrent to people parking in the spot with non-EV vehicles, which can be a source of frustration for users. EV owners refer to “getting ICE’d” when they come to a public charging station spot only to find an Internal Combustion Engine (ICE) parked there. The cost of signs will range between \$15 – \$30.¹¹

To the right is a proposed sign that has come out of the largest EV monitoring experiment in the United States, The EV Project. The sign is being considered as a national standard.

Public charging stations in Minnesota currently use a variety of signage. The most common type of parking sign and way-finding signs are shown right.

It can also be useful to paint the pavement of the parking space to provide further visual guidance for the EV charging space.

Can EVSE supply renewable energy for charging?

Solar powered charging

A distinct benefit of driving electric vehicles is the capability of powering them with clean, locally-produced solar and wind-generated sources of electricity. Use of these renewable, green sources of electricity to power EVs is encouraged to prevent pollution from energy generation and to keep energy costs in our local economy.



This solar e-car charging station on the campus of the University of Iowa provides charging spaces for approximately 20 electric vehicles for Facilities Management and other departments. The project was completed in summer 2011.

The cost of a solar power is on a steep decline across the globe but the systems will still require an up-front investment. A recent example in Iowa might be illustrative. The solar charging station pictured below will generate approximately 70,000 kWhs/year. This is enough electricity for 250,000 miles of electricity-fueled driving. The cost of the system was approximately \$950,000. A solar project sized for fueling a single EV at 2-kW would generate enough electricity in a year to drive about 10,000 miles. The cost of such an installation at the time of this writing is up to \$20,000.¹²



Installing a solar array adjacent to a plug-in charging station demonstrates how natural energy from the sun can be used to power vehicles. This source of solar electricity is typically tied to the grid so power produced during the day can offset any power drawn at night to charge EVs.

The solar power flows into the grid with a separate meter tracking how much electricity has been generated and simply offsets the grid power that is supplied to EVs through the EVSE.

¹¹ For example, see <http://www.smartsign.com>

¹² Minnesota Department of Commerce, www.mn.gov/commerce/energy/images/Solar-System-FAQ.pdf

Wind Powered Charging

The second option, which does not require an up-front investment, is to take advantage of an electric utility's green power program. In Minnesota all the state's electric utilities offer the option for their customers to purchase renewable energy (primarily wind energy) to cover all or a portion of their electricity consumption. These purchases show up on your bill as a renewable energy surcharge. To make your workplace EV charging 100 percent renewable, simply purchase enough



renewable energy from your utility to cover the estimated electricity that is going to be used for charging.

The cost for using a utility-sponsored green power program to cover EV charging is relatively small. For instance, traveling 15,000 miles per year using only electricity will require approximately 4,285 kWhs (assuming EV can travel 3.5 miles per kWh). Typically, green power is sold in 100 kWh blocks with a typical surcharge of \$1.50 - \$3.50 per block. In this example, an EV owner would pay for 43 blocks of green power for an annual surcharge of between \$65 and \$150. Your electric utility representatives could provide more complete guidance for your unique situation.

Minnesota-specific electric vehicle resources

Websites

Drive Electric Minnesota – www.driveelectricmn.com

Minnesota partnership of EV advocates pushing to expand electric transportation options and related infrastructure throughout the state. The partnership includes representatives from government, nonprofit organizations, utilities, EV equipment manufacturers and other businesses.

GE Vehicle Innovation Center - www.gefleet.com/home

GE Capital's Fleet Services division operates this center with opportunities for employers and the general public to learn about electric transportation and get behind the wheel and drive EVs and other alternative fueled vehicles.

Minnesota Electric Auto Association - www.mneaa.com

The Minnesota branch of electric transportation enthusiasts has been raising awareness of EVs for decades.

Minnesota Pollution Control Agency – www.pca.state.mn.us

MPCA provides solutions and regulatory oversight on efforts to reduce pollution in Minnesota including emissions from the transportation sector.

Minnesota Renewable Energy Society – www.mnrenewables.org

Promoting the use of renewable energy in Minnesota for more than 30 years through education and through the demonstration of practical application

Workplace Charging – www.workplacecharging.com

A Minnesota-based website devoted to providing comprehensive information to help expand workplace charging opportunities.

Highlights of existing EV workplace charging programs

Large and small companies across the country, including Google, Disney, Bank of America and Cisco Systems, have installed or announced plans for charging stations specifically for their employees. There are even a few examples in Minnesota.

Carleton College – Northfield, MN

In late 2010, Carleton professor David Tompkins inquired about the potential for charging an EV on campus. In February 2012, Carleton's Capital Funding & Priorities Committee (CF&PC) approved signage and the ability to issue permits for EV charging at 3-4 existing 120v outlets near the Facilities Building. Subsequent to this decision, Professor Tompkins noted that it would only be practical for him to use his EV for commuting if an option to charge his Nissan Leaf using Level 2 charging were available.

A proposal was developed by Prof. Tompkins and Martha Larson, Manager of Campus Energy and Sustainability, for consideration by the college to purchase and install two dual-car charging stations that would be available to Carleton's students, staff and visitors to campus. After completing educational and outreach efforts, the college modified the proposal and approved the installation of and funding for a single dual-charge charging station. The ChargePoint® Networked station from Coulomb Technologies was installed



and operational in early September 2012. The school does not currently provide Level 1 charging options. Carleton College has about 850 parking spaces used by staff and students on campus so the two spots represent ¼ of one percent of the available spots.

The approximately \$12,000 cost of the equipment and installation is on the high side of Level 2 charging options. The College decided on a Coulomb station in part because it was most common installation in the Twin Cities Metro

Area and Carleton wanted their staff and visitors to see a familiar piece of equipment on campus that they might run into in other locations around the Twin Cities. Using custom features of the ChargePoint® network software, Carleton could allow employees to pay a lower hourly rate for charging than the public and allow employees to reserve the station in advance (via a smart phone app).

Contact: Martha Larson, Manager of Campus Energy and Sustainability at Carleton College, (507) 222-7893



Dynamic Sealing Technologies, Inc. – Andover, MN

Dynamic Sealing Technologies, Inc. has implemented a workplace EV charging project at their headquarters in Andover, MN. DSTI specializes in designing and manufacturing fluid rotary union & swivel joint products for a wide range of Industries worldwide. The workplace charging initiative was triggered by requests from two employees that wanted to use electric vehicles to commute to work.

Tim Gray was the company’s employee charged with overseeing the purchase, installation and operation of the EVSE unit. After examining various options, he chose a dual Level 2 EVSE unit on a pedestal mount from Eaton. Factors such as cost, appearance, and warranty led DSTI to the Eaton equipment. The cost of the EVSE unit was around \$4,200 and the unit will be sited outdoors in the parking lot outside their headquarters. Final installation costs were not available at this time.

DSTI noted that the installation was straightforward and in an effort to make it easy to expand in the future, the company trenched in the electrical infrastructure to easily add more two more dual EVSE units in the future.



“The installation of these charging stations was an easy decision,” DSTI President Jeff Meister said. “With employee demand for EV support, this was another great opportunity to keep our culture committed to environmental sustainability.”

DSTI has not adopted a formal internal policy on usage and they do not charge their employees for the electricity. Guests visiting the building are also allowed to use the charging station.

Tim Gray, Dynamic Sealing Technologies, Inc.,
763-786-3758



3M – Maplewood, MN

At 3M Company's Maplewood, MN, headquarters, there are two Level 2 charging units that are available to employees as well as guests. The EVSE units were purchased from Coulomb Technologies and are tied together via the ChargePoint® Network with other Coulomb stations around the country (see <http://www.chargepoint.com/>). Drivers can use their smart phones to see if the charging spots are occupied and get a message when their car is fully charged. Coulomb's dual Level 1/2 charging stations cost between \$4,000 - \$7,000 (not including installation).

In addition to the Level 2 charging options, 3M employees with EVs can also sign up for parking spaces that are located near existing and upgraded 120 V power outlets (Level 1 charging). 3M does not charge employees for using the Level 1 or Level 2 options.

The workplace charging options at 3M were the result of a push from employees. Once it was known that there was interest, the company was eager to set up a program, indicating that it fit well with their company's mission to be a leader in environmental stewardship.

Contact: Bill Nelson, 651-733-6516





Google – Mountain View, CA

At Google's Mountain View, CA, headquarters you'll find perhaps the world's largest workplace charging program. Google's parking lot features Level 2 charging stations managed by the ChargePoint® Network as well as Level 1 charging spots. The charging stations are used by employees and by the company's growing car sharing program for their employees called GFleet. The GFleet is made up of Chevrolet Volts, Nissan LEAFs, Mitsubishi iMiEVs, Ford Focus Electrics, Ford Transit Connect Electrics, and a Honda Fit EV. Google has a goal to make 5 percent of its campus parking EV-ready.

At this writing, the charging program at Google headquarters consists of 227 Level 2 charging stations at 34 buildings, 160 Level 1 charging spots (cord reels), a pilot project to test a wireless charging system, and in the future a DC Fast Charging station is planned for their fleet vehicles. Google does not charge its employees or guests to use these charging stations. Usage is growing and more than 200 employees and more than 50 EV fleet vehicles are charging every day.

Rolf Schreiber is the technical program manager for electric transportation at Google (see <http://www.google.org/recharge/>). Schreiber noted, "Our EVs and charging stations are part of our broader green transportation system that includes biodiesel shuttles that Googlers use to commute to work instead of driving their own cars. But we're only one company among many, so we hope our green transportation initiatives serve as a model for other companies to incorporate sustainability programs into their own workplaces."

Google cites the following benefits of its EV charging program:

- Enables employees with long commutes or without access to Level 2 charging at home to purchase and use an EV.
- Free workplace charging is a great employee benefit and recruiting perk.
- Use of EVs improves air quality and reduces corporate carbon footprint.
- EV charging program meets a requirement to gain points as part of their buildings LEED certification



**Minnesota Pollution
Control Agency**

www.pca.state.mn.us