Introduction

Thinking about getting rid of your fossil-fuel powered car and going electric? If so, great! Electric vehicles, or EVs, are economical, fun, and easy on the environment. But first there are a few things you need to know before you are ready to own and operate your own electric vehicle – such as how to charge your new car.

This manual guides you through the process of installing an electric vehicle charging station so you can use your electric vehicle whenever you want. An online version is also available at: location@url. We hope this guide proves to be a useful reference for you as you enter the brave new world of electric transportation.

What is an Electric Vehicle?

Insert photo of electric vehicle

An electric vehicle (EV) is a vehicle that uses an electric motor for propulsion and is powered by a battery located on-board the vehicle. Section _____ of this manual describes the kinds of EVs on the market today, as well as upcoming technologies in the world of EVs.

EV batteries are fully rechargeable, although the time it takes to recharge an EV depends both on the type of vehicle and type of power supply equipment used. Below is a brief description of the power supply equipment used with today's EVs.

Electric Vehicle Supply Equipment and Wiring

Insert photo or graphic of car plugged into EVSE

There are three main components to Electric Vehicle Charging Infrastructure: electric vehicle supply equipment (EVSE), premises wiring, and electrical service and electric panel capacity:

1) **The Electric Vehicle Supply Equipment (EVSE).** This consists of a supply device, power cord and connector.

   - **Supply Device**: This device is the main component of the electric vehicle charging station. Typically it supplies electrical power, provides shock protection, and may also contain information systems for measuring the amount of energy delivered while an EV is charging. For Level 1 and 2 charging (see below), the actual charger is located on board the EV.
   - **Power cord**: This is a cable that carries electrical current and communication signals from the supply device to the connector. For Level 1 and 2 charging, this cord conducts alternating current from the EVSE to the on-board charger.
   - **Connector:** This is a plug on the power cord that connects the EVSE to charging sockets on the electric vehicle. In fall of 2009 the Society of Automotive Engineers is expected to approve the SAE J1772 "SAE Electrical Vehicle Conductive Charge Coupler" as the national standard for EVSE connectors which will be used in virtually all Electric Vehicles in the U.S.

Insert photos or graphics of all three EVSE components

2) **Premises wiring.** This is the wiring that runs from the electric panel to the EVSE.

3) **Electrical service and electric panel capacity to charge an EV.** Electrical service includes the utility lines and the electric meter, both of which are owned and controlled by the local electric utility. Installation of EVSE may require new or upgraded electrical service. A local electrical contractor can determine if the existing

service can support the additional load of EVSE and coordinate with the local utility if an upgrade is needed.

Insert "EV Charge Residential Install" Drawing

EV charging can be performed at three different voltage and current levels. Each level has advantages and disadvantages, and the EVSE installation requirements will differ depending upon the desired charging level.

Level 1 Charging
Level 1 Charging is done with a standard outlet and voltage level that is present in all homes and businesses. Using this level of charging rarely requires an upgrade to existing electrical service. However, this level of charging can take between 8 to 14 hours to fully charge an EV and for this reason, Level 1 charging may not be your preferred method of charging.

Level 1 Charging specifications:

- 120-volt ac single-phase nominal electric supply
- 12 to 16 amp maximum continuous current with 15 to 20 amps minimum branch circuit protection

Level 2 Charging
Level 2 Charging is faster than Level 1 charging and is expected to be the primary option for home charging. This level of charging may require an upgrade to existing electrical service and will require a permanently wired and fixed charging station location. Level 2 charging can fully recharge an electrical vehicle in 3 to 6 hours.

Level 2 charging specifications:

- 240-volt ac single-phase nominal electric supply
- 32 to 70 amp maximum continuous current with 40 amps minimum branch circuit protection
- Safety features: grounding, ground fault protection, no-load make/break interlock, cable/connecter safety breakaway

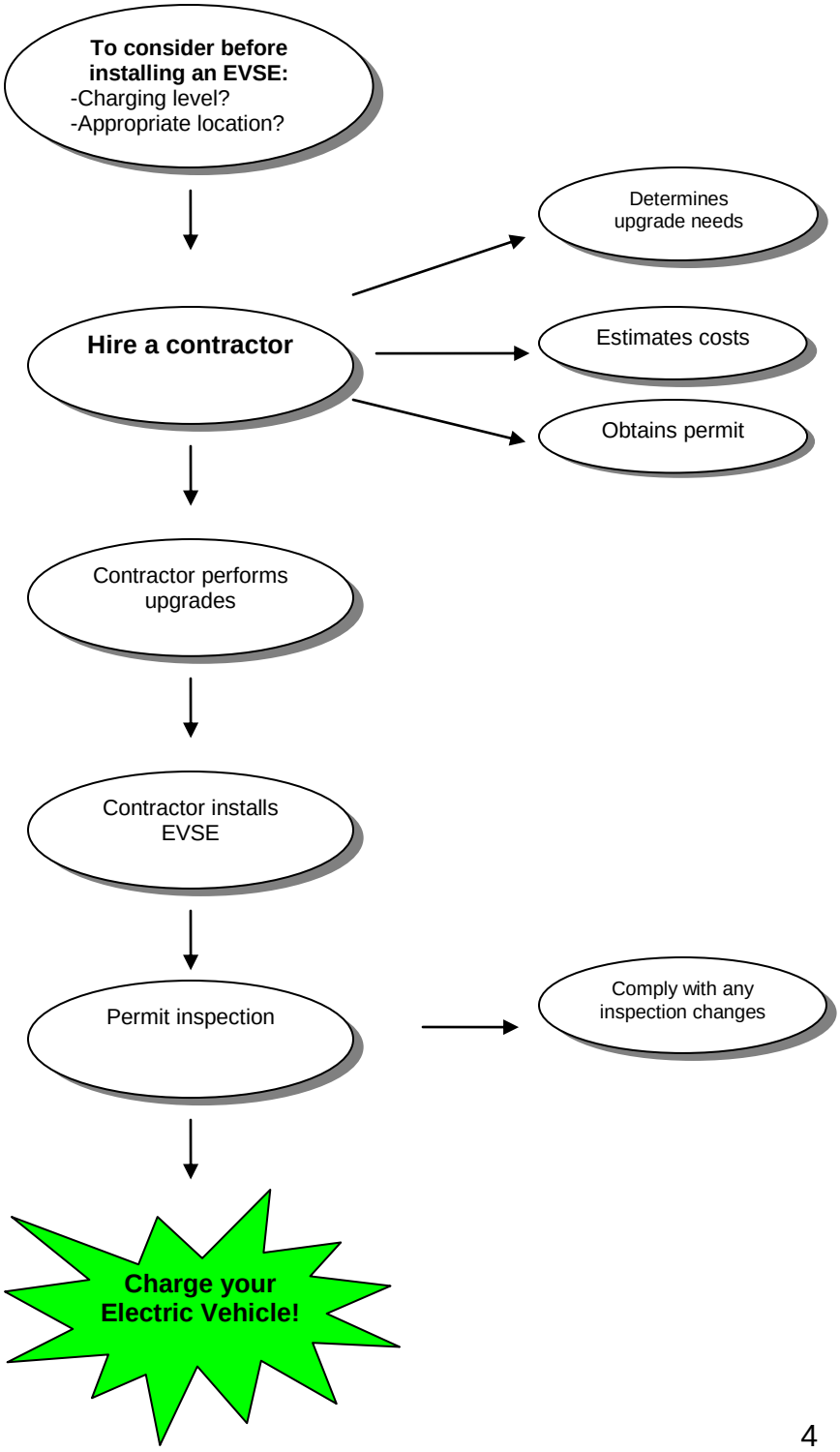
Insert photo of chosen vendor's EVSE in a garage

Level 3 Charging
Level 3 Charging, also known as fast charging, is a high-powered charging technology that can fully charge a vehicle in 20 to 30 minutes. However, the amount of power required for Level 3 charging is beyond the capacity of most residential electric service providers. For this reason, Level 3 charging is not recommended for most residential use.

Installing Electric Vehicle Supply Equipment at Your Residence

Installing Electric Vehicle Supply Equipment (EVSE) in a residence is not difficult, but there are important steps to follow and details to consider. Following is a flowchart showing the process of installing an EVSE in a residential setting.

Figure 1: Residential EVSE Installation Flowchart.



Is my Home Ready for EVSE?

When purchasing an electric vehicle, it is important to think about three things:

1) Your home's electrical capacity and the desired level of charging;
2) A good location for the EVSE station; and
3) Installation requirements.

Insert photo or graphic of EVSE in garage

Electrical Capacity

Many homes already have sufficient electrical capacity for a Level 1 or 2 charging station. Level 1 charging uses a regular three-prong 120 volt outlet and most electric clothes dryers or stoves use the same voltage as Level 2 charging. However, the placement of outlets may be incompatible with EV charging, and placing new wiring may require some construction or improvements in your home or garage.

If your home does not have sufficient electrical capacity for your desired level of charging it will be necessary to make upgrades to your electrical service, such as installing a new service panel or placing new wiring in your home. If you are not sure if your electric service is adequate for electric vehicle charging, you should contact a qualified electrical contractor (see Appendix 1). If you increase your electricity load when installing EVSE it is your responsibility to alert your utility company. For a link to Oregon utility companies by region, see Appendix 2

Insert drawing of electrical panel or wall-mounted EVSE unit

EVSE and On-Street parking

It is possible to install EVSE in an outdoor setting, such as a driveway or carport, but if your home does not have dedicated off-street parking this may not be an option. City codes may prevent obstacles such as power cords across sidewalks, which may mean you cannot install EVSE without a dedicated private parking spot. If your home does not have off-street parking you should speak with an electrical contractor and check with city officials, or ensure that you can charge your vehicle elsewhere.

EVSE Requirements

Once you determine that your home has electrical capacity to charge your vehicle, there are some additional things you will need to consider when installing EVSE. Some requirements of EVSE include:

- An electrical circuit that is used only for the EVSE;

- A location that allows direct connection to the vehicle from the EVSE within 25 feet; and/or
- Ventilation for indoor EVSE installations if your EV uses batteries that require ventilation.

These requirements, and others, are regulated by the National Electrical Code (NEC) as adopted by the Oregon Electrical Specialty Code (OESC). Speaking to an electrical contractor will help you to determine if your home is ready for EVSE installation.

Permits and Inspections

You will be required to obtain a permit before installing EVSE and a post-installation inspection is required before you can use the EVSE. It is important to hire an electrical contractor who employs licensed electricians to perform the installation; the contractor can acquire the necessary permit, perform the installation and obtain an inspection. This will streamline your installation experience and ensure that your EVSE is installed properly and safely.

You may decide to do the work yourself, which would require that you evaluate your existing electrical capacity, purchase the permit, coordinate with your utility and perform all upgrades. If you choose to install EVSE yourself, be sure to contact your local building department to obtain a permit and final inspection.

Although it is possible to perform EVSE installation yourself, we recommend you hire an electrical contractor.

For a guide on finding an Oregon licensed electrical contractor, see Appendix 1.

Expected Costs

Installation Costs

The total cost of installing EVSE in your garage or carport will vary greatly depending upon the type of upgrades needed, the placement of your electrical panel in relation to your desired EVSE station and the electrical contractor's fees. If the desired location of the EVSE is near the existing electrical panel and a new service panel is not needed, the installation could be fairly inexpensive. The price of installation rises if multiple upgrades are needed, particularly in situations where you need extensive concrete cutting, trenching, or wiring upgrades. Depending on the amount of upgrades needed, installing EVSE could cost as little as $200 or as much as several thousand dollars; your electrical contactor should be able to give you an estimate of your expected installation costs. Appendix 2, 'Other Resources,' also features a link to an estimated EVSE installation cost breakdown from the United States Department of Energy's Vehicle Technology program.

There are multiple tax credits available to help you offset the cost of installing EVSE in your home; see Section _____ for a description of these and other benefits.

Estimated Charging Costs

The cost to recharge your EV will vary depending upon the type of EV and your electricity rate. Electricity rates vary by utility company; in 2008 the average cost of electricity to a residential consumer in the state of Oregon was approximately 8 cents per kilowatt-hour (kWh). The number of miles per kWh varies by type of EV but many models average around 4 miles per kWh. Using these figures, operating cost would be approximately 2 cents per mile. In comparison, a gas vehicle that gets 20 miles per gallon and pays $3.00 for a gallon of gas pays 15 cents a mile. This is just an estimate; the exact cost could be more or less depending upon your utility rate and the range of the EV per charge.

Time-of-Use Rates

Some utility companies offer different utility rates depending upon the time of use, with lower rates offered during times of low electricity demand. If time-of-use rates are available, you could save money by charging your vehicle during times of low demand (for example, overnight). Check with your local utility provider to see if they offer time-of-use rates before deciding upon a charging plan for your EV. If your utility offers time-of-use rates, you will need to have a special meter installed at your home.

Even if time-of-use rates are not in effect, we recommend you avoid charging your EV during times of peak demand, such as early evening. In order to simplify off-peak charging, you could have a timer installed that will control when the EVSE can charge your vehicle. Some vehicles may come with the option of setting a delay option for charging similar to the delayed start of a washing machine, dryer or dishwasher.

If you are considering using time-of-use rates and want to have a timer installed, tell your electrical contractor before the installation begins.

EVSE Installations in Multifamily Residences

Insert photo of EVSE installation in Apartment or Condo

Installation of EVSE in a multifamily residence such as an apartment complex or condominium will resemble EVSE installation in a single-family home in many ways. However, if you are a multifamily property owner or resident, you have several issues specific to this type of installation to consider before you purchase an electric vehicle. Some of these issues include:

- **Permission to install the EVSE:** In an apartment or rental situation, the landlord will typically need to approve any EVSE installation, and in a condominium, it is likely that a homeowners' association would also need to give approval before EVSE can be installed.

- **Ownership of EVSE:** The EV buyer should settle the issue of EVSE ownership before any additional planning begins as this will affect who pays for the installation, who is responsible for permits, metering issues, and electricity payments, and whether or nor the EV owner can take the EVSE when they leave the residence.

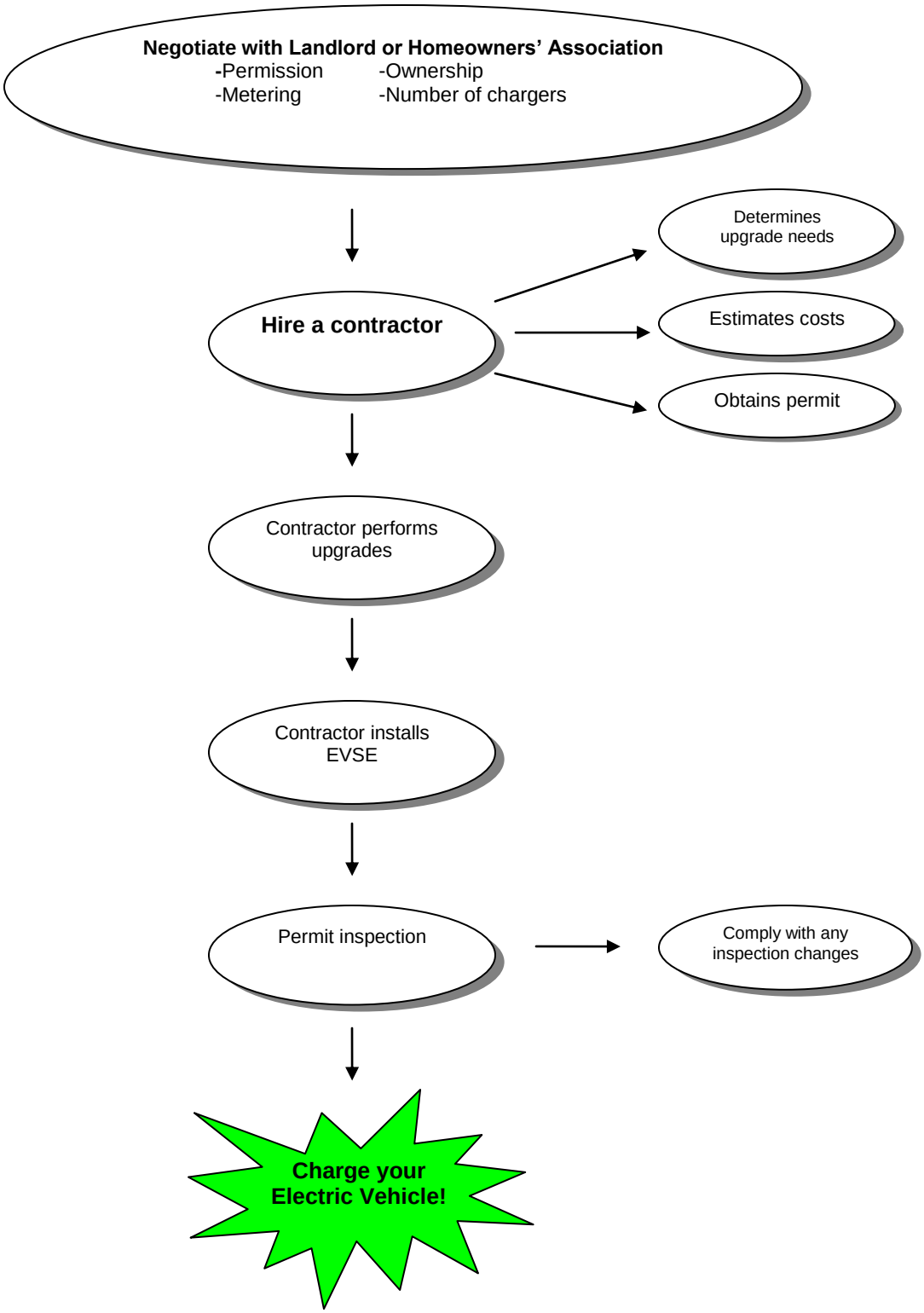
- **Metering arrangements:** The property owner, EV owner (if different people) and utility company must decide how metering and billing will be handled. In a situation with multiple EV parking spaces the property owner may want to meter each space separately and bill the EV owner directly, or they may choose to run all EVSE off one meter and charge EV users a base fee.

- **Electrical capacity:** When planning the installation of EV charging stations, the property owner must determine if there is adequate electrical capacity for the planned number of EVSE stations. It may be necessary to upgrade feeder lines and transformers. When considering the installation of EVSE, the property owner or EV owner should speak with an electrical contractor to determine capacity and the appropriate number of EVSE stations.

Insert " EV Charge Commercial Install" Drawing

Following is a flowchart of steps for installing EVSE in a multifamily residence.

Figure 2: Multifamily Residence Installation Flowchart



State and Federal Tax Credits for Electric Vehicles

There are various state and federal tax credits for residential consumers installing EVSE or purchasing one or more electric vehicles.

Oregon State Tax Credits

1) Oregon Residential Energy Tax Credit for Vehicles

Under this program, there are two tax credits for electric vehicles that can normally be combined for a total tax credit of $1,500. The first tax credit is for the purchase of the electric vehicle itself. This tax credit only applies to new electric vehicles, meaning that the original use of the car must begin with the person applying for the tax credit. The tax credit is based on the incremental difference between the base price of the electric vehicle and the base price of the gasoline-only version of the same make and model of vehicle. The tax credit is 25 percent of the incremental difference or $750, whichever is less.

A second tax credit is available for the purchase of Electric Vehicle Supply Equipment that will charge the EV. This tax credit is equal to 25 percent of the cost of installing the EVSE or $750, whichever is less. Taken together, the total tax credit for purchasing an EV and corresponding EVSE is $1,500.

It is also possible to get a state tax credit for converting an existing gasoline-only car into an EV. The tax credit for this is equal to 25 percent of the conversion cost up to $750.

Federal Tax Credits for Purchasing an Electric Vehicle

1) Energy Improvement and Extension Act of 2008

New Electric Vehicles: Currently, there is a federal tax credit for new plug-in electric vehicles, ranging from $2,500 to $7,500 for cars and trucks, and from $10,000 to $15,000 for larger commercial vehicles. For each make and model of EV, this tax credit will begin to phase out after 200,000 EVs have been sold. See the adjacent table for phase-out periods and amounts. This tax credit applies to vehicles acquired after December 31, 2009, and expires December 31, 2014.

Vehicle Size (lbs)	Maximum credit	Phase-out level	50 Percent credit Qtrs 1 & 2 post phase -out	25 Percent credit Qtrs 3 & 4 post phase-out
< 10,000	$7,500	200,000 sold	$3,750	$1,875
10,000-14,000	$10,000	200,000 sold	$5,000	$2,500
14, 000-26,000	$12, 500	200,000 sold	$6,250	$3,125
> 26, 000	$15, 000	200,000 sold	$7,500	$3,750

Low-Speed Electric Vehicles (LSV)
A tax credit of up to 10 percent of the cost of qualified low-speed electric vehicles, electric motorcycles, and three-wheeled electric vehicles, not to exceed $2,500, is available through December 31, 2011.

Electric Vehicle Conversions: Through December 31, 2011, qualified plug-in electric vehicle conversions are also eligible for a tax credit of 10 percent of the conversion cost, up to $4,000.

2) Alternative Fuel Infrastructure Tax Credit

The federal government is offering a tax credit for the cost of installing alternative fueling equipment, including electric vehicle charging stations. Individual consumers may receive a tax credit of up to $2,000 for equipment that was placed into service after December 31, 2008.

The Alternative Fuel Infrastructure Tax Credit expires December 31, 2010 for electric vehicle supply equipment. Form 8911(PDF 247 KB) provides additional information and must be used to claim the tax credit.

Electric Vehicles Today

NEV (neighborhood EV) or LEV (low-speed EV)

Most of the EVs currently on the road are known as NEVs or LEVs that have a maximum speed of 35 mph in Oregon. These vehicles are not crash tested or safety certified and in Oregon, many are registered with Driver and Motor Vehicles as motorcycles. An example includes the GEM car:

Insert photo of GEM Car

PHEV (Plug-in Hybrid Vehicle)

Another type of EV is the plug-in hybrid. This vehicle includes the standard hybrid gasoline/electric engine but is augmented with additional battery cells and a charging mechanism. Example includes Toyota's plug-in Prius, scheduled for release in the U.S. in 2010:

Insert photo of Toyota Plug-in Prius

Some hybrids can also be converted to a PHEV with a conversion kit that adds an additional battery pack.

BEV (Battery Electric Vehicle) or PEV (Pure Electric Vehicle)

Almost every major car manufacturer has announced plans to introduce all-electric vehicles in the next couple of years. Examples include:

Smart Electric Vehicle. This is an electric version of the existing Smart Car, which continues to grow in popularity in the

Insert photo of Smart EV

U.S. Electric Smart Cars will be available to select customers in the U.S. in June 2010, with greater availability by 2011.

Insert photo of Mitsubishi MIEV.

The Mitsubishi Innovative Electric Vehicle (MIEV). This car is currently in production in Japan and should be available worldwide in 2010.

Nissan EV-02. This car should be released in Oregon for fleet use in 2010, with planned expansion to the consumer market in 2012. The Nissan EV-02 is capable of highway speeds and should have a 100 mile battery range.

Insert Photo of Nissan EV-02

The Future of Electric Vehicles

Many new and exciting technologies are being developed in the world of electric vehicles. Below is a list of cars that are scheduled for availability in the near future, along with brief highlights of some of the developing EV technology. For a link to an updated list of new EVs and EV technology, see Appendix 3.

Future EVs

Insert photo of Phoenix Motorcar SUT

Phoenix Motorcars SUT. This is a four passenger sport utility truck that can go highway speed and travel over 100 miles on a single charge.

Think "Ox" vehicle. This is a small four-door sedan with a 124 mile range that is rechargeable with a normal household outlet, Level 2 charging, or rapid-charging technology.

Insert photo of Think Ox

Future EV Technology

Smart Grid Technology and Vehicle to Grid Charging

Many new and exciting technologies are being developed to increase the convenience and affordability of EVs. Some developments that should be available in the near future include Smart Charging and Vehicle to Grid (V2G) charging.

Smart Charging
In very basic terms, "Smart Charging" refers to a variety of technologies that allow the EV to interact with the electrical grid beyond the simple charging of EV batteries, communicating with the grid in real time and charging exactly when the grid needs it to. Although still being developed, Smart Charging could simplify Time-of-Use charging, help consumers avoid charging vehicles during peak demand, and allow for point-of-sale charging at public EVSE locations.

Vehicle to Grid (V2G) and Vehicle to Building (V2B)
Both V2G and V2B charging would allow two-way energy flow between the EV and the power grid or building. This would allow the EV to act as an energy storage system and provide power either to the electrical grid in the case of V2G charging or directly to a building's energy management system with V2B charging.

Smart Grid
The use of Smart Charging and V2G or V2B technologies is contingent upon the upgrade of the nation's electric grid to what is being called a new "Smart Grid" that would allow communication between the electric grid and home appliances such as EVs. This technology could potentially expand the economic and environmental benefits of EVs by allowing the consumer to save money and by decreasing utility companies' reliance upon more polluting energy sources when demand for electricity is high. Smart Grid and V2G technologies are still being developed and many questions, such as who will control the flow of electricity, are still being debated. Once implemented, V2G

capabilities on a Smart Grid could significantly increase the convenience and affordability of EVs.

In the meantime, using EVs today is a smart choice for many people, and Oregonians are, once again, leading the way to a smarter, more sustainable future for everyone.

See the following appendices for resources, utility information and more.

Appendix 1: Hiring a Licensed Electrical Contractor

The state of Oregon has resources available to help ensure that the contractor you hire to install EVSE will be licensed and reputable. Before hiring a contractor, you should consult the Construction Contractors Board's office or Web site, where you can find a licensed contractor, check a known contractor's license, or register a complaint about a contractor.

The Construction Contractors Board also features information on "Best Practices" when hiring a contractor and can help mediate any conflicts that may arise during or after your installation.

You can access the Construction Contractors Board online at:

http://www.oregon.gov/CCB/index.shtml

In addition to the Construction Contractors Board, you can find referrals for qualified electrical contractors through the following organizations:

The National Electrical Contractors Association (NECA) at 503-233-5787 or 541-736-1443

Independent Electrical Contractors of Oregon (IEC) at 503-598-7789.

You can also learn more about permitting in Oregon at the "Permits Protect" website:

http://www.permitsprotect.info/

Appendix 2: Other Resources

Utility Companies in Oregon, by region:

- http://www.oregon.gov/ENERGY/Power.shtml

Cost-estimates for EVSE installations in residences and commercial facilities:

- U.S. Department of Energy Vehicle Technologies Program: *"Plug-in Hybrid Electric Vehicle Charging Infrastructure Review"* http://avt.inel.gov/pdf/phev/phevInfrastructureReport08.pdf

Updates on EVs entering the market:

- Plug-In America's *"Plug-in Vehicle Tracker"* **http://www.pluginamerica.org/plug-in-vehicle-tracker.html**

Oregon Electric Vehicle Association: www.oeva.org

Appendix Four: Glossary of Acronyms

Glossary of Acronyms

ADA: Americans with Disabilities Act

BEV: Battery Electric Vehicle (see also EV)

EV: Electric Vehicle

EVSE: Electric Vehicle Supply Equipment

KWh: Kilowatt-hour

LSV: Low-speed Electric Vehicle

NEV: Neighborhood Electric Vehicle

NEC: National Electric Code

ODOT: Oregon Department of Transportation

OESC: Oregon Electric Specialty Code

OSSC: Oregon Structural Specialty Code

Appendix Five: Glossary of Terms

Ampere (amp): A unit of measurement for current, or the amount of electricity flowing through a circuit.

Battery: A vessel made up of a number of battery cells which produces and stores an electric charge. It can also be used to refer to an individual battery cell.

Battery Electric Vehicle (BEV) : An automotive-type vehicle for highway use, such as passenger automobiles, buses, trucks, and vans, primarily powered by an electric motor that draws current from a rechargeable storage battery, fuel cell, photovoltaic array, or other source of electric current. (EV definition from 2008 National Electric Code 625.2). *See also: Electric Vehicle*

Capacity: The total number of ampere hours (Ah) that can be withdrawn from a fully charged cell of battery for a specific set of operating conditions.

Charge: *(verb)* Conversion of electrical energy into chemical potential energy within a cell by the passage of a direct current. *(noun)* Couloumbs or ampere-hours of energy available in a cell or battery.

EV Connector: An off-board component that, by insertion into an inlet on the electric vehicle, establishes connection to the EV for the purpose of energy transfer and information exchange.

Coupler: The device connected to the electric vehicle supply equipment that transfers power to the electric vehicle for charging the energy storage system and permits the exchange of information between the EV and the EVSE. The coupler contains the primary coil of the take-apart transformer, an antenna for communications, a magnet for connection check, and provisions for locking the coupler in the vehicle to prevent tampering.

Electric Vehicle (EV): An automotive-type vehicle for highway use, such as passenger automobiles, buses, trucks, and vans, primarily powered by an electric motor that draws current from a rechargeable storage battery, fuel cell, photovoltaic array, or other source of electric current. (EV definition from 2008 National Electric Code 625.2).

Electric Vehicle Supply Equipment (EVSE): The conductors, including the ungrounded, grounded, and equipment grounding conductors, the electric vehicle connectors, attachment plugs, and all other fittings, devices, power outlets, or apparatus installed specifically for the purpose of delivering energy from the premises wiring to the electric vehicle. (EVSE definition from 2008 National Electric Code 625.2).

Power Cord: The off-board cable that connects the EV plug with the EV power controller to provide power and communications for the vehicle during charge.

Range: The maximum distance that an electric vehicle can travel on a single battery charge over a specified driving cycle to the battery manufacturer's recommended maximum discharge level.

Time-of-Use rates: Discounted electricity rates established by utilities to encourage use of electricity during off-peak hours.

Volt: Basic unit of electrical potential. One volt is the force required to send one ampere of electrical current through a resistance of one ohm.