RE XX( ) e-FILING REPORT COVER SHEET

REPORT NAME:

Portland General Electric Schedule 344 Electric Vehicle Highway Pilot Report

COMPANY NAME:

Portland General Electric

DOES REPORT CONTAIN CONFIDENTIAL INFORMATION?

Yes, Confidential and subject to the terms and conditions of OAR 860-001-0070

If known, please select designation:

RE XX( )

Report is required by:

Submitted as a Summary of PGE's electrification transportation in Oregon

Is this report associated with a specific docket/case?

No

Key words:

Portland General Electric Schedule 344 Electric Vehicle Highway Pilot Report

If known, please select the PUC Section to which the report should be directed:

Electric Rates and Planning

Portland General Electric
121 SW Salmon Street • Portland, Ore. 97204
PortlandGeneral.com

December 15, 2016

Public Utility Commission of Oregon
Attn: Filing Center
201 High St. SE, Suite 100
P.O. Box 1088
Salem, OR 97308-1088

RE: Portland General Electric Report on Electric Vehicle Highway Pilot

Summary

On March 14, 2012, Portland General Electric Company (PGE or Company) submitted a proposal to the Oregon Public Utility Commission (OPUC or Commission) for an Oregon Electric Vehicle Highway Pilot (pilot). The purpose of the pilot was to allow PGE to assist Electric Vehicle Service Providers (EVSPs) in siting and installing publicly available charging stations in PGE's service area. In the pilot, the EVSPs own and maintain the charging stations, and only charging stations fully funded through a public grant are eligible for inclusion in the program. The learning objectives targeted by PGE were threefold: 1) to study the impact of charging on the grid infrastructure, 2) learn more about location and siting costs of Direct Current Quick Chargers (DCQCs) and implications for the Company's business processes, and 3) gain information to support outreach and education to customers about EVs and the equipment that supports their charging.

As detailed in PGE's supplement to the initial pilot program filing (dated April 3, 2012 with an effective date of April 11, 2012), PGE proposed to provide power to the EVSPs under either Schedule 32 (Small Nonresidential Standard Service) or Schedule 38 (Large Nonresidential Optional Time of Day Standard Service). Charging infrastructure in the pilot was to include up to 20 DCQCs and up to 40 Level II (240 volt) stations along the Interstate 5 and Interstate 205 corridors and related arterials. The rider associated with the filing of the pilot – Schedule 344 – was proposed as supplemental to Schedules 32 and 38. The pilot was approved on the April 10, 2012 public meeting, effective April 11, 2012, with a planned termination date of December 31, 2013.

From this pilot PGE gained valuable experience in the transportation electrification field, and captured three key learnings:

i) **Driver demand for DCQC stations is growing** – both the number of charges and total energy used has increased at PGE-partnered DCQC stations throughout the life of the pilot (as shown in Figure 6);

ii) **A non-demand (energy only) site host price is crucial for DCQC stations that are not highly utilized** – customers with a charging station load factor of <20% would see a significant impact on their bill from demand charges[1]. Providing an energy-only price allows PGE to recover costs while encouraging further development of charging stations;

iii) **Partnership between PGE and the EVSPs was essential** – by actively listening to the needs of customers and the voices of stakeholders, we were able to use our partnership with EVSPs to give peace of mind to site hosts regarding installation costs, maintenance responsibilities, and charger siting. This partnership also allowed PGE to take an active role in keeping the charging stations operational and available, when necessary.

[1] https://avt.inl.gov/sites/default/files/pdf/EVProj/EffectOfDemandChargesOnDCFCHosts.pdf

Partnership with ECOtality

In August 2009, ECOtality (synonymously referred to as "Blink" or "eTec") announced the receipt of $99.8 million of federal funds to test and analyze electric vehicle usage and charging infrastructure throughout five markets in the United States. On August 9, PGE was announced as ECOtality's partner in the United States Department of Energy (USDOE) "EV Project" for public charging infrastructure deployment within the Portland Metropolitan Statistical Area (MSA). As part of this agreement, PGE took a lead role in site selection, customer outreach, and facilitation of DCQC site agreements between ECOtality and local business owners. The locations of the ECOtality installations are shown below in table 1.

Site[2]	Infrastructure Installed	Service Address[3]	PODID[4]
1	Blink DCQC and 2 Blink L2	Redacted Portland, Ore.	N/A
2	Blink DCQC	Redacted Portland, Ore.	N/A
3	Blink DCQC and 1 Blink L2	Redacted Keizer, OR	N/A
4	Blink DCQC and 1 Blink L2	Redacted Sherwood, Ore.	N/A
5	Blink DCQC and 2 Blink L2	Redacted Wilsonville, Ore.	N/A
6	Blink DCQC and 3 Blink L2	Redacted Portland, Ore.	N/A N/A
7	2 Blink L2	Redacted Salem, Ore.	N/A
8	Blink DCQC and 2 Blink L2	Redacted Silverton, Ore.	N/A
9	Blink DCQC and 2 Blink L2	Redacted Woodburn, Ore.	Removed[5]

Table 1 – Blink/PGE charging stations installations as part of EV Highway Pilot

PGE assumed the business relationship with ECOtality through a Charging Station Host Agreement, allowing the site partner/property owner to sign a Property Owner Consent (POC) agreement with ECOtality. This arrangement allowed the DCQC and Level II chargers to be placed on the customer's premise, but left the operational challenges (maintenance, installation costs, electricity costs, potential revenue collection) to the ECOtality/PGE partnership. We found this to be a helpful and necessary arrangement, as at the time many business owners were unfamiliar with electric vehicle charging and were hesitant to invest in an upstart company and a nascent market with so many potential challenges (A few of the barriers we heard from potential site partners during our outreach are shown in Figure 2). We found that the participation of PGE in the siting, facilitation, and maintenance of chargers helped to ease the concerns of potential customers.

[2] Customer name redacted under OAR 860-001-0070. Available in confidential Appendix A.
[3] Service address redacted under OAR 860-001-0070. Available in confidential Appendix A.
[4] Redacted under OAR 860-001-0070. Available in confidential Appendix A.
[5] Infrastructure removed at customer request

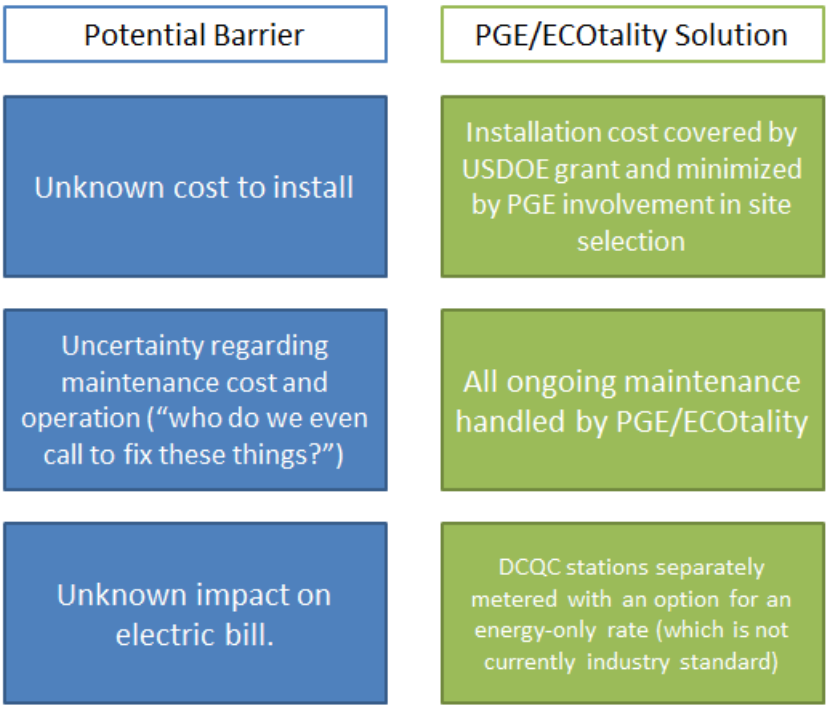

Figure 2 – barriers to charging infrastructure development and PGE/ECOtality solution

As of September 2013, PGE and ECOtality had completed 8 sites (with the 9th site in progress and close to completion) with 11 sites still to be selected. On September 16, 2013, ECOtality filed for Chapter 11 bankruptcy protection, with all assets scheduled for auction the following month.

Pilot Extension and Revisions

Advice number 13-21 was filed by PGE on October 28, 2013, officially notifying the OPUC of the impact of the ECOtality bankruptcy on the pilot and detailing progress under the pilot to date. The advice filing requested an extension of the program termination date from December 31, 2013 to December 31, 2015.

In the initial pilot program filing, PGE did not anticipate that EV charging equipment manufacturers and automakers may have an interest in donating EV charging equipment to demonstrate their technology[6]. Since the pilot originally targeted "publicly funded" projects, PGE declined any offers of donated infrastructure prior to the filing of Advice 13-21. Along with extending the term of the pilot, Advice 13-21 added a special condition for donated equipment that allowed PGE to accept no-cost charging infrastructure or funding from manufacturers. The program modifications requested were approved at the November 26, 2013 public meeting and became effective the following day.

Following the extension and revision of the pilot, PGE worked closely with two auto manufacturers [7]who provided a majority of the funding to install 5 additional DCQC stations (shown in Table 3 below). In accordance with Advice 13-21, PGE contracted with an Oregon company – Powin – to own and maintain the five donated chargers.

[6] As additional standards emerged for the rapid charging of battery-only EVs during the course of the pilot, interest in funding sites grew among auto manufacturers.
[7] The signed agreements between PGE and the auto manufacturers contain "no publicity" language, thus the names of the automakers have been omitted under the terms and conditions of OAR 860-001-0070. Further information can be provided upon Staff request.

Site Name[8]	Equipment	Service Address	Point of Delivery ID # (PODID)[9]
1	Efacec DCQC and Opconnect L2	Redacted Tigard, Ore.	N/A
2	Efacec DCQC and Opconnect L2	Redacted Tigard, Ore.	N/A
3	Efacec DCQC and Opconnect L2	Redacted Salem, Ore.	N/A
4	Efacec DCQC and Opconnect L2	Redacted Gladstone, Ore.	N/A
5	Efacec DCQC and Opconnect L2	Redacted Portland, Ore.	Removed

Table 3 – PGE/Powin Charging Station installations as part of EV Highway Pilot

The original tranche of ECOtality-installed charging stations was under the CHAdeMO standard, which could charge only a limited number of auto manufacturers' electric vehicles. As technology evolved and more products were launched in the EV space, a standard called Combined Charging System (CCS) Standard or SAE Combo emerged. Tesla Motors also came out with their own standard to support their vehicles. The table below shows the current charging standards and the vehicles supported by each standard.

Table 4 – DC Quick Charge Standards and vehicles supported

Standard	Vehicles supported
CHAdeMO (9 Blink Sites)	Nissan Leaf, Kia Soul EV, Mitsubishi iMiEV, Tesla (with a Tesla made adapter)
Combined Charging System (CCS) or SAE COMBO (5 Powin Sites)	Chevy Spark EV, BMW i3, VW e-Golf, Chevy Bolt
Tesla Supercharger	Tesla Model S and Model X, Model 3 Total

The five Powin installations detailed in Table 3 – as part of the revised pilot program – comprised the first network of chargers in North America to have dual connectors supporting the CHAdeMO DCQC Standard and the CCS Standard.

PGE Ownership of Sites

Following the bankruptcy of ECOtality, resulting in stranded DCQC and Level II charging stations, there was understandable concern heard from customers, automakers, and interested stakeholders about the future of the Blink charging portion of the West Coast Electric Highway in the Portland MSA. PGE assumed ownership and maintenance of the Blink charging infrastructure that was installed through partnership with PGE (both DCQC and Level II). There was no financial transaction associated with this change in ownership; PGE considered the assets abandoned in place upon expiration of the site agreements and notified Car Charging Group, Inc. (CCG), the ultimate purchaser of ECOtality's bankruptcy assets. The letter sent from PGE to CCG/Blink is included as Appendix B; acknowledgement of receipt of the letter is included as Appendix C. PGE has coordinated maintenance of these sites with CCG and other third parties in the time since. PGE will return the assets to CCG upon the end of useful life, upon request.

Shortly following the completion of the five installations undertaken after approval to extend the pilot, Powin decided they would not continue to own and maintain EV infrastructure in Oregon. PGE stepped in and purchased the assets from Powin in an effort to ensure the continued functioning of charging stations, and has kept the charging infrastructure operational and available for customers in the time since.

[8] Customer name redacted under OAR 860-001-0070. Available in confidential Appendix A.
[9] Redacted under OAR 860-001-0070. Available in confidential Appendix A.

Figure 5 below shows the locations of all the current public DCQC locations in the PGE service area. The sites that were installed through EV Highway Pilot partnerships with PGE are circled – the nine Blink sites are in blue and the 5 former Powin sites are in red. The book value of both the Blink and Powin sites that PGE has assumed custodianship of is zero and the total cost to PGE has been negligible.

Portland and Salem Service Area
PGE partnership locations with Blink/Powin are circled

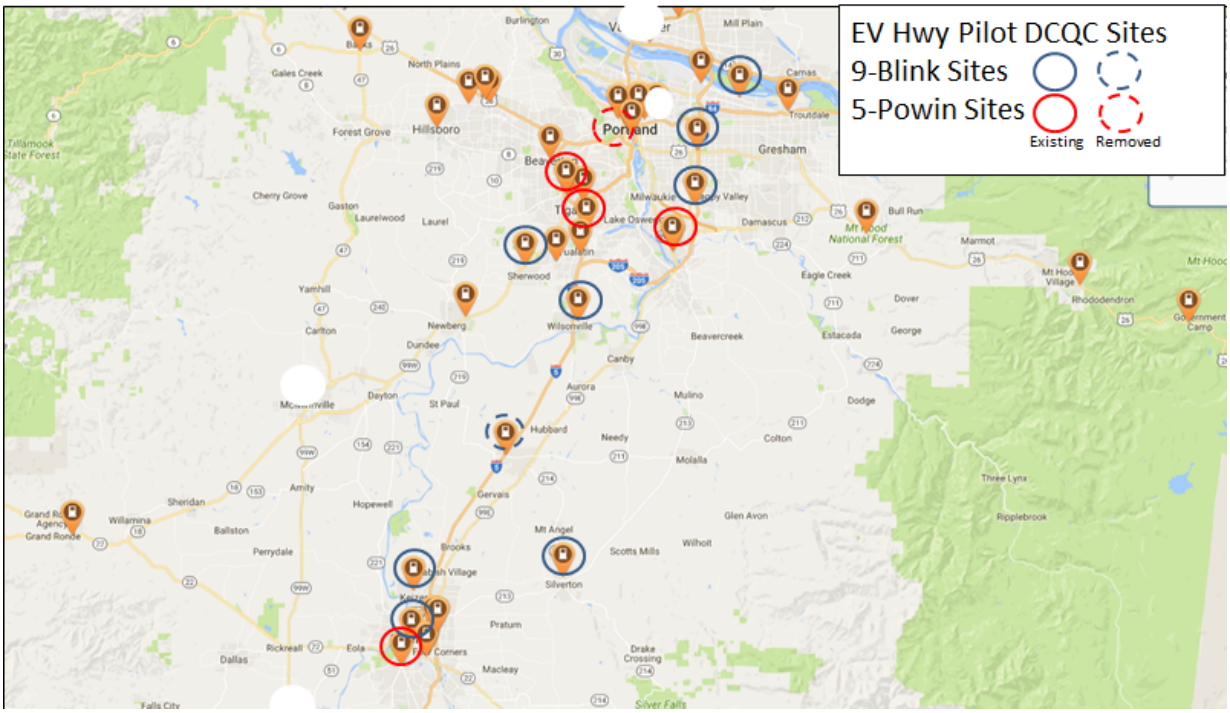

Figure 5 – Blink and Powin sites of which PGE has assumed custodianship.

Pilot Costs

A full summary of pilot installation costs – including PGE's share where applicable – is included in Appendix D.

PGE, working in part with ECOtality, managed the installation of a total of 14 DCQC and 21 Level 2 (including one installation on the State Capitol grounds that PGE does not own or maintain) stations as part of this pilot. Most sites installed one DCQC and one level 2 station at each location. The IBEW site was just a DCQC as they had already installed level 2 stations previous to PGE's involvement. PGE has since assumed custodianship of all sites installed in partnership with Blink and Powin. A high-level summary of infrastructure costs is shown below:

Charging Equipment Costs	Installation Costs	Total Project Costs	PGE Amount
$626,910	$279,325	$906,235	$44,182
		PGE paid percentage	4.88%

Table 6 – Infrastructure cost summary

Average cost per DCQC Site $64,731

Lessons Learned

1) Driver demand for DCQC stations is growing:

- DCQC infrastructure is in demand from customers, and the utilization of the assets installed through these partnerships has grown as EVs have become more prevalent in PGE's service area. We have seen steadily increasing use of these charging stations since their installation in both number of charging events and total energy used[10]. A summary of utilization of the original nine installations is shown in the tables below.

Energy Use (kWh)	2012	2013	2014	2015	2016[11]	Total
DCQC	762	38,420	30,576	53,486	51,857	175,100
L2	304	3,320	8,766	10,307	5,917	28,613
Total	1,065	41,739	39,343	63,793	57,774	203,714

Charges	2012	2013	2014	2015	2016	Total
DCQC	80	4,317	3,529	6,548	6,392	20,866
L2	77	505	1,091	1,456	1,150	4,279
Total	157	4,822	4,620	8,004	7,542	25,145

Table 7 – kWh used and number of charges, 2012 – November 2016.

2) Pricing and grid impact:

- Generally speaking, a DCQC does not draw the rated demand from the grid. In our experience, a 50 kW nameplate rated DCQC resulted in a peak demand of 22 to 25 kW. This is due to the load shape of a typical charge and PGE's interval metering (30 minute intervals): the charger typically draws nameplate rated demand for less than 10 minutes on the initial part of the charge, followed by either termination of the charge or drastically reduced demand as the charge completes. Subsequent observations and technological advancements may identify higher peak impacts due to the development of adapter technology. Chargers manufactured by Tesla now allow a Tesla Model S or X, and soon the Model 3, to charge at a DCQC station using the CHAdeMO connector. A typical Model S or X can draw the full rated load of the charger for up to 120 minutes to fully charge a 60-100 kWh battery. Future vehicles such as the Chevrolet Bolt and longer range Nissan Leaf may show similar load characteristics.

- The finding that DCQC infrastructure typically has a lower peak demand compared to rated nameplate capacity may have an impact on how electric utilities approach pricing power sold to site hosts. The current standard is generally to assess commercial and industrial customers (an approximate peer to a DCQC in terms of nameplate peak capacity) a demand charge to compensate the utility for the transmission and distribution infrastructure built to serve the customer's facility. However, we have had a considerable amount of success with our Schedule 38 offering through this pilot, which assesses site hosts an energy-only price and is seen as EV friendly by automakers and charging providers.

- The impact of PGE's Schedule 38 price offering (an optional schedule that extends to 200kW while maintaining an energy-only construct; Schedule 83 serves the same customer class but with a demand charge) was the subject of an Idaho National Laboratory white paper[12] examining the impact of demand

[10] 2016 data is only available through November, extrapolating energy and charge numbers will likely lead to all-time utilization highs for 2016.
[11] 2016 data is only available through November.
[12] https://avt.inl.gov/sites/default/files/pdf/EVProj/EffectOfDemandChargesOnDCFCHosts.pdf

charges on 50kW DCQC. The paper concluded that the low load-factor characteristics associated with DCQC would lead to a higher bill if a demand component were included in the pricing.

- PGE has since received requests for information from numerous utilities, Idaho National Laboratory, Edison Electric Institute (EEI), and Georgetown Climate Research Center regarding the pricing construct of Schedule 38 and how that construct could be adapted to other utilities.

3) Location and siting costs of DC quick chargers and implications for the Company's business processes:

- PGE's active involvement in the location and siting process has reduced the need for system upgrades. PGE worked with ECOtality to select general areas where DCQC stations were needed. Scoping drives were then done to look for suitable locations (suitability was focused on lower cost sites and included but was not limited to: 24 hour services nearby, ample parking, close to existing PGE distribution infrastructure). Site visits by staff knowledgeable in the distribution system worked to eliminate site locations where major system upgrades would be needed. Transformers were checked for capacity and room for service conductors. When working with Powin, a similar process was undertaken, although one site needed a new pole-mounted transformer.

- We were able to reduce installation costs by using 208v DCQC installations rather than 480v. Blink DCQCs came in two configurations: one for 480 volt 3-phase service and the other for 208 volt three-phase service. In most areas of the country, Blink DCQCs were 480 volt installations; this installation requires an extra transformer and extra panel to serve level 2 stations at the site, which typically adds $4k to $5k to an installation. Additionally, the 480v units had a longer delivery times.

- PGE has gained additional knowledge about the load requirements of DCQC and Level II chargers, which could be used for future line extension allowance requests. Upon initiation of this pilot, PGE's Line Extension Allowance (LEA) did not have any estimates for the estimated added load of EV charging stations. Additionally, we did not have experience in the actual demand drawn from the stations vs. the nameplate connected load. We made some educated assumptions to come up with an LEA for these sites.

- The infrastructure in place as a result of PGE's participation in the EV Highway Pilot allowed greater visibility into customer charging behavior in the Portland Metropolitan Statistical Area. The DCQC white papers completed by Idaho National Lab relied heavily on these installations for the assumptions and learnings in the Willamette Valley.

4) Additional Learnings

- As part of the pilot, we were able to work directly with customers and hear their successes and challenges regarding hosting a charging station on their property. This will factor into future site selection decisions and site partner outreach programs.

- PGE commissioned an engineering study to examine the depth needed for a concrete pad to support DCQCs, which ultimately led reduced installation costs for subsequent charging stations. As part of the installation of the Blink EV Charging stations, the manufacturer initially recommended a concrete pad for the charger to be roughly 3 feet deep. This requirement was very conservative as it used a limitation based on the frost depths across the country.

- National Electric Code allowed a 200 amp service to serve the DCQC stations, a California Authority Having Jurisdiction (AHJ) made a ruling that required a 400 amp Service, which added thousands of dollars in a change order for a project in progress. PGE got a ruling from the state of Oregon Electrical Code Staff allowing the 200 amp service. Ecotality paid for additional costs for that project and future ones they required a 400 amp service.

- The installation of the charging infrastructure through the EV Highway Pilot has allowed far greater visibility into customer charging behavior, system impacts, and technological constraints. The ability for

PGE to represent the Portland MSA has allowed for learning nationwide as evidenced by data inclusion in the following white papers by the Idaho National Labs: "What Were the Use Patterns Observed at the Highly Utilized Direct Current Fast Charge Sites[13]," "What were the Cost Drivers for the Direct Current Fast Charging Installations[14]," "DC Fast Charge – Demand Charge Reduction[15]," and "DC Fast Charger Usage in the Pacific Northwest[16]."

Potential Topics for Further Research

PGE's learning and insight will inform future decisions for EV-related activities. Subsequent learnings could include:

- Further explore opportunities to use price signals to promote public charging – this could potentially include a time of use component to encourage off-peak charging by customers.
- Continue to monitor new technology to determine actual capacity needs of charging stations and how that may modify site selection criteria.
- Continue to explore the relationship between visible charging infrastructure and the willingness of customers to change from an internal combustion engine vehicle to an electric vehicle.
- Explore small pilot activities such as curtailable charging through DCQC infrastructure.

PGE will continue to work closely with OPUC Staff and other interested parties to determine the next appropriate steps regarding the electrification of transportation in Oregon.

[13] https://avt.inl.gov/sites/default/files/pdf/EVProj/WhatWereTheUsePatternsObservedAtHighlyUtilizedDCFCSites.pdf
[14] https://avt.inl.gov/sites/default/files/pdf/EVProj/WhatWereTheCostDriversForDCFCinstallations.pdf
[15] https://avt.inl.gov/sites/default/files/pdf/EVProj/DCFastCharge-DemandChargeReductionV1.0.pdf
[16] https://avt.inl.gov/sites/default/files/pdf/evse/INL_WCEH_DCFCUsage.pdf

Appendices

A. Installed EV Charging Equipment
B. Letter from PGE to CCG/Blink
C. Acknowledgement Letter from CCG/Blink to PGE
D. Site Equipment and Installation Costs

EV Highway Pilot Report

Appendix A

Installed EV Charging equipment as part of pilot

Confidential and subject to the terms and conditions of OAR 860-001-0070

Provided in Electronic Format (CD) only

EV Highway Pilot Report

Appendix B

Letter from Portland General Electric to Blink/CCG

Confidential and subject to the terms and conditions of OAR 860-001-0070

Provided in Electronic Format (CD) only

EV Highway Pilot Report

Appendix C

Acknowledgement Letter from CCG/Blink to PGE

Confidential and subject to the terms and conditions of OAR 860-001-0070

Provided in Electronic Format (CD) only

EV Highway Pilot Report

Appendix D

Site Equipment and Installation costs

Confidential and subject to the terms and conditions of OAR 860-001-0070

Provided in Electronic Format (CD) only