Emerging Technology Asset Life Review

Vector Limited

Independent Review of EV Chargers Asset Lives

RZ041400-2 | B

June 14, 2018

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Document history and status

Revision	Date	Description	By	Review	Approved
A	21/05/2018	Draft for Client Review	CJK & PRA	REF	REF
B	14/06/2018	Final	CJK	REF, PRA	REF

Cristiano Marantes
Head of Engineering
Vector Limited
101 Carlton Gore Rd
Newmarket
Auckland 1023

14 June 2018

Dear Cristiano

Statement Regarding Independent Engineer's Report on Vector's EV Chargers asset lives

Introduction

Vector Ltd (Vector) requested that Jacobs New Zealand Ltd (Jacobs) undertake an Independent Engineering review of the expected lives of Vector owned Electric Vehicle (EV) and Vehicle-to-grid (V2G) chargers. The output of this review is an Independent Engineer's Report to provide evidence to the Commerce Commission (Commission) that the asset lives are appropriate and meet the requirements of clause 2.2.8(3)(b) of the Electricity Distribution Services Input Methodologies Determination 2012 (Consolidated as of 3rd April 2018) ISSN 1178-2560, dated 3rd April 2018 (EDB IM).

The report accompanying this letter provides information on the justification for asset lives of Vector owned EV chargers for the 2017/18 disclosure year and the conclusions of the physical asset life assessment carried out by Jacobs. The types of EV chargers covered by this report are:

- Alternating Current (AC) EV Chargers up to 22 kW – installed for public use.
- Direct Current (DC) EV Chargers up to 50 kW – installed for public use.
- V2G AC and DC EV Chargers up to 10 kW – pilot scheme.

Conclusions

On review of publicly available information, the Commerce Commission's ODV handbook and warranties issued by manufacturers, the expected useful and economic life for Vector installed public use AC EV chargers up to 22 kW is **15 years** and for DC EV chargers up to 50 kW is **10 years**. V2G AC and DC EV chargers will have the same life expectancy, dependent on the type of current.

Jacobs notes that the V2G chargers currently being trialled by Vector are pre-production versions for R&D purposes and these will not be deployed on a long term basis. The commercial life of these units would be no more than **3 years**, and the equipment will not be utilized publicly following the end of the pilot scheme.

The actual longevity of Vector EV Chargers will depend on technological obsolescence, environmental conditions, frequency of use and employed maintenance programmes. Programmable Logic Controllers (PLCs) and inverter technology are the current drivers for end of life (EOL), due to loss of manufacturer support and warranty lifetime. Replacement of EV connector plugs will also have to be considered, again dependent on the frequency of use, but do not define the EOL of the charging station.

Confirmation of Independence and Qualifications

I, as a chartered professional engineer (as defined in section 6 of the Chartered Professional Engineers Act 2002), can confirm that:

1) Jacobs has acted independently with respect to Vector and its subsidiaries and affiliates;

2) The scope of Jacobs' services is outlined in Vector's Consultancy Assignment Sheet dated 12th April 2018;

3) Jacobs has significant experience in New Zealand, Australia and the United Kingdom in relation to the valuation of electricity networks and equipment for both regulatory and financial reporting purposes. Jacobs' review and preparation of the report has been undertaken by Dr Richard Fairbairn, Mr Peter Apperley and Mr Chris Kiely. Dr Fairbairn is a professional qualified engineer and a Chartered Professional Engineer in NZ (CPEng) and is registered as an International Professional Engineer. Mr Apperley and Mr Kiely are professionally qualified and experienced in the type of work concerned and are familiar with the Vector distribution network;

4) The report may be publicly disclosed by Vector pursuant to an information disclosure determination (clause 2.3.18 of the Electricity Distribution Information Disclosure Determination (EDB IDD) 2012 dated 3rd April 2018).

5) I am satisfied that the results contained in this report can be used in calculating depreciation as described in clauses 2.2.5, 2.2.6 and 2.2.7 of the EDB IM.

SIGNED on behalf of Jacobs New Zealand Ltd by:

Designated Engineer

Dr Richard Fairbairn

Technical Director – Power Systems

Executive Summary

Vector Ltd (Vector) requested that Jacobs New Zealand Ltd (Jacobs) undertake an Independent Engineering review of the expected lives of Vector owned Electric Vehicle (EV) and Vehicle-to-grid (V2G) chargers. The output of this review is an Independent Engineer's Report to provide evidence to the Commerce Commission (Commission) that the asset lives are appropriate and meet the requirements of clause 2.2.8(3)(b) of the Electricity Distribution Services Input Methodologies Determination 2012 (Consolidated as of 3rd April 2018) ISSN 1178-2560, dated 3rd April 2018 (EDB IM).

This report provides information on the justification for asset lives of Vector owned EV chargers for the 2017/18 disclosure year and the conclusions of the physical asset life assessment carried out by Jacobs. The approach taken is as follows:

1. Review the current and planned technology that Vector are utilising for EV and V2G charging installations within its network;
2. Assess against Vector provided and publicly available information on the asset lives of EV and V2G charging technology, and
3. Make a recommendation on the expected asset life to be disclosed to the Commerce Commission as part of Vector's regulatory information disclosure for 2018.

And covers the following types of EV battery charging equipment:

- Alternating Current (AC) EV Chargers up to 22 kW – installed for public use.
- Direct Current (DC) EV Chargers up to 50 kW – installed for public use.
- V2G AC and DC EV Chargers up to 10 kW – pilot scheme.

EV Chargers End of Life (EOL)

In the context of Vector's regulatory disclosure commitments, the useful life of depreciable EV and V2G charging assets is the estimated lifespan during which the assets can be expected to contribute to company operations. This is driven by two independent criteria:

1. Equipment failure and performance degradation
2. Obsolescence

EV Charging Background

There are two widely used standards for EV charging, the European IEC 61851 and the US SAE J1772. These define the different charging types or modes and requirements for each of them. New Zealand has adopted the use of IEC 61851, the modes and requirements of which are summarized in the following table:

	Mode 1	Mode 2	Mode 3	Mode 4
Phase	AC Single or Three	AC Single or Three	AC Single or Three	DC
Voltage	250 V single phase 480 V three phase	250 V single phase 480 V three phase	250 V single phase 480 V three phase	600 V
Max Current	16 A	32 A	250 A	400 A
Max Power	4 kW (1-phase) 13.3 kW (3-phase)	8 kW (1-phase) 26 kW (3-phase)	62.5 kW (1-phase) 208 kW (3-phase)	240 kW
Notes	EVSE to Household Socket. No control pins	EVSE with Control pilot function & RCD (EVSE)	Installed EVSE	Installed EVSE

*EVSE: Electric Vehicle Supply Equipment

As of 1st November 2016, Worksafe published guidelines for EV charging safety which provides further information on what Modes can and cannot be installed in public locations in New Zealand. Modes 1 and 2 can only be installed in a domestic or similar location and cannot be installed in public locations. Modes 3 and 4 EVSE can be installed for public use, in accordance with the guidelines.

AC EV Charging

Vector utilises Schneider Electric's EVlink Parking system for AC charging. Vector has installed this model with the capability of delivering up to 22 kW at three-phase. The chargers are IEC 61851 Mode 3 compliant, rated to 32 A and either use Type 2 or Type 3 connectors. Vector currently use the IEC 62196 Type 2 and SAE J1772 connectors for AC charging. The CCS Combo 2 Type 2 can also be used for single phase AC Modes 2 and 3.

The main charging equipment within the AC charger will typically last for 20-25 years. However, the communication and control equipment will drive EOL due to lack of vendor support and software updates. ABB, who recommend their AC500 PLCs for EV charging units, have a product lifecycle for PLCs of between 12-20 years of support before it is obsolete.

Similar equipment is covered in the ODV Handbook under SCADA and Communications Equipment with an asset life of 15 years, matching well with the range provided by ABB for control equipment. Based on this information, Jacobs estimates that the expected useful and economic life of Vector installed AC chargers for public use up to 22 kW would be **15 years**.

Jacobs does not expect that the difference in power delivery capacity between Mode 1 and Mode 2 AC chargers would impact the overall useful life of the EV chargers.

DC EV Charging

Vector has installed ABB's Terra 53 multi-standard charging system that allows a combination of different charging approaches. Vector has only implemented the CCS Combo 2 Type 2 and CHAdeMO (CHArge de MOve) connectors for DC charging.

DC chargers have similar components to AC chargers in terms of communications module, control units, RFID, HMI display etc. The main difference is driven by the need to convert from AC to DC. Key components for this functionality include, but are not limited to: filter, power factor correction (PFC), DC Link and snubber capacitors, diodes and rectifiers, power resistors, gate drivers and IGBT or MOSFET switches (inverter).

The useful life of DC chargers is expected to be driven by the inverter components, specifically switches and capacitors (depending on design). The life span is typically affected by the quality of the components and manufacturing process, the environment that the inverter is located in (such as ambient temperature, salt air corrosion, ingress of insects etc.) and the adequacy of ongoing maintenance (typically routine such as ensuring cooling fans are cleared of dust etc.).

The lifetime of the switches (IGBTs) is a factor of the number of cycles, the operating temperature, the voltage and current. DC charger inverters are similar to those used in solar PV installations and there is a wealth of statistical information on the historical performance of these components:

IGBT Study – Uses per day		PV Inverter Study – 10% Failures		PV Inverter Warranties	IRD DEP100: Rapid DC Charging Stations
2	4	Denmark	Arizona		
27 yrs	14 yrs	66 yrs	13 yrs	5-10 yrs	10 yrs

Given the impact of different environmental conditions and charging scenarios, equipment choices, and frequency of use, there is a wide range of possible inverter lives that will limit the estimated useful life of the DC EV charger. A good quality inverter in normal operating conditions should comfortably last between 10 and 15 years. Given the warranties offered on solar PV inverters of 5-10 years, the studies performed on inverters and the IRD recommendation, a useful life of **10 years** for inverters and hence DC EV chargers is recommended.

V2G EV Charging

Vector are currently trialling V2G EV chargers via a small pilot scheme. A V2G system offers the flexibility to provide power back to the grid from the battery on-board the EV, and it can be either AC or DC. In terms of the hardware required in order to achieve this, AC and DC EV chargers can be slightly modified to allow switching the direction of power transfer. IGBT switches in the DC chargers are unidirectional, however the inclusion of freewheeling diodes across the switches allows for reverse current flow.

Considering V2G EV chargers have similar hardware to conventional AC and DC EV charging, useful life will be limited by the same issues. For AC charging systems, Jacobs expect that communication hardware will drive a 15 year estimated useful life, and the inverter technology in DC systems will drive a 10 year estimated useful life for V2G applications.

Conclusions

On review of publicly available information, the Commerce Commission’s ODV handbook and warranties issued by manufacturers, the expected useful and economic life for Vector installed public use AC EV chargers up to 22 kW is **15 years** and for DC EV chargers up to 50 kW is **10 years**. V2G AC and DC EV chargers will have the same life expectancy, dependent on the type of current.

Jacobs notes that the V2G chargers currently being trialled by Vector are pre-production versions for R&D purposes and these will not be deployed on a long term basis. The commercial life of these units would be no more than 3 years, and the equipment will not be utilized publicly following the end of the pilot scheme.

The actual longevity of Vector EV Chargers will depend on technological obsolescence, environmental conditions, frequency of use and employed maintenance programmes. Programmable Logic Controllers (PLCs) and inverter technology are the current drivers for EOL, due to loss of manufacturer support and warranty lifetime. Replacement of EV connector plugs will also have to be considered, again dependent on the frequency of use, but do not define the EOL of the charging station.

Important note about your report

The sole purpose of this report and the associated services performed by Jacobs is to provide a review of the expected lives of EV and V2G chargers in accordance with the scope of services set out in the contract between Jacobs and the Client. That scope of services, as described in this report, was developed with the Client. This report is for Vector's regulatory compliance purposes and is not intended to be relied upon by third parties.

Jacobs derived the data in this report from information sourced from the Client (if any) and/or available in the public domain at the time or times outlined in this report. The passage of time, manifestation of latent conditions or impacts of future events may require further examination of the project and subsequent data analysis, and re-evaluation of the data, findings, observations and conclusions expressed in this report. Jacobs has prepared this report in accordance with the usual care and thoroughness of the consulting profession, for the sole purpose described above and by reference to applicable standards, guidelines, procedures and practices at the date of issue of this report. For the reasons outlined above, however, no other warranty or guarantee, whether expressed or implied, is made as to the data, observations and findings expressed in this report, to the extent permitted by law.

This report should be read in full and no excerpts are to be taken as representative of the findings. No responsibility is accepted by Jacobs for use of any part of this report in any other context.

This report has been prepared on behalf of, and for the exclusive use of, Jacobs' Client, and is subject to, and issued in accordance with, the provisions of the contract between Jacobs and the Client. Jacobs accepts no liability or responsibility whatsoever for, or in respect of, any use of, or reliance upon, this report by any third party.