Emerging Technology Asset Life Review

Vector Limited

Independent Review of Solar Photovoltaic Module Lives

RZ041400-1 | B

June 14, 2018

JACOBS

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Project No:	RZ041400
Document Title:	Independent Review of Solar Photovoltaic Module Lives
Document No.:	RZ041400-1
Revision:	B
Date:	June 14, 2018
Client Name:	Vector Limited
Client No:	
Project Manager:	Peter Apperley
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File Name:	\\jacobs.com\ANZ\RP\Projects\PI\RZ041400\21_Deliverables\RZ041400-1-B Solar PV Module Asset Life Review 14 June 2018.docx

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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 Solar PV Modules 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 Solar Photovoltaic (PV) modules. 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 the Electricity Distribution Services Input Methodologies Determination 2012 (clause 2.2.8(3)(b)) (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 Solar PV modules in the 2017/18 disclosure year and the conclusions of the physical asset life assessment carried out by Jacobs.

Conclusions

On review of publicly available information and the performance warrantees offered by the identified manufacturers, the expected useful and economic life for both poly-crystalline and mono-crystalline silicon PV modules provided by Tier 1 manufacturers is **25 years**. This is an industry wide standard value for the expected minimum life span of solar PV modules given warranted performance degradation to 80% of the rated output (PMax).

Once a PV module has lost more than 20% of its production capacity, its ability to meet Vector's functional requirements (i.e. the ability to supply electricity load at a specific site) will be significantly reduced. At this point, while it may still be capable of producing electricity, technological obsolescence would likely drive its replacement with a future lower cost higher efficiency solar PV module.

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, generation and infrastructure 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 and equipment.

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 Solar Photovoltaic (PV) modules. 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 the Electricity Distribution Services Input Methodologies Determination 2012 (clause 2.2.8(3)(b)) (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 Solar PV modules in 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 technology that Vector are utilising for solar PV installations within its network;
2. Assess Vector's technology against provided and publicly available information on the asset lives of solar PV 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 31st August 2018.

Solar PV End of Life (EOL)

In the context of Vector's regulatory disclosure commitments, the useful life of depreciable PV assets is the estimated lifespan during which the assets can be expected to contribute to company operations. For PV modules, the end of useful life is the point when the modules no longer meet the required performance level on which the original business case was made. Typically, this point is when the PV modules degrade to approximately 80% of the original guaranteed power performance (PMax).

Vector Solar PV

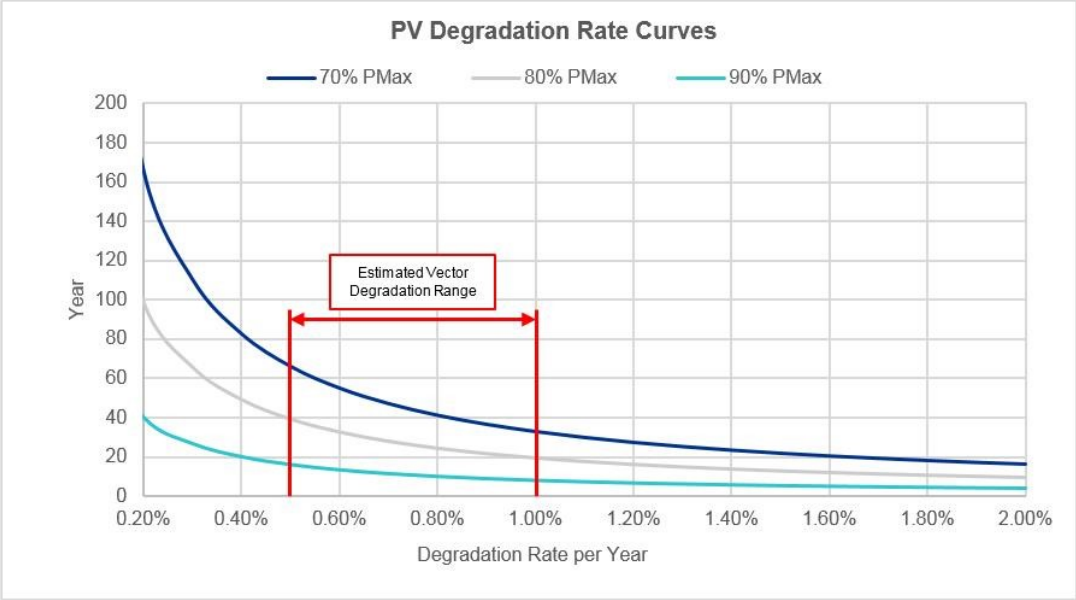
Vector currently has poly-crystalline silicon (poly-Si or multi-Si) PV modules from Trina Solar and Jinko Solar deployed for power supply purposes at various zone substations on its network. With ongoing price reductions, it is also possible that Vector may use mono-crystalline silicon (mono-Si) PV modules from the same (or similar) manufacturers for future installations. These used to be the technology of choice prior to performance improvements of poly-Si, and still offer higher efficiencies.

Failure Rates and Degradation Curves

In terms of performance life, all PV cells (and PV modules) degrade over time as a result of weather, thermal cycles, UV exposure, humidity freeze and damp heat amongst others. There are also a number of potential technical and environmental failure modes that can cause premature retirement of modules.

On review of PV installation data over the last 10 years, module failure rates range between 0.0024% - 0.09% annually, suggesting 2.2% failed modules after 25 years. Failure rates may rise as the PV modules get older.

Given low failure rates, performance degradation has the greater impact on asset life and is calculated in the industry through stochastic rather than deterministic analysis, due to the multiplicity of potential causes of degradation. Statistical information presented by the US National Renewable Energy Laboratory (NREL) indicate that a poly-Si PV module owned by Vector would be expected to have a mean asset life of between 19 and 39 years based on the 80% PMax performance criteria as shown by the grey curve in the following graph. This conclusion closely matches with the values put forward by NREL for photovoltaics of between 25-40 years' useful asset life. In comparison, the mono-Si PV modules asset life would be between 28 and 66 years.



Performance Warranties

Manufacturers provide warranties based on the statistical information of installed fleets and their own long term performance testing. Both Jinko and Trina Solar offer 25-year linear performance warranties and 10-year product warranties.

Conclusions

On review of publicly available information and the performance warrantees offered by the identified manufacturers, the expected useful and economic life for both poly-crystalline and mono-crystalline silicon PV modules provided by Tier 1 manufacturers is 25 years. This is an industry wide standard value for the expected minimum life span of solar PV modules given warranted performance degradation to 80% of the rated output.

Once a PV module has lost more than 20% of its production capacity, its ability to meet Vector's functional requirements (i.e. the ability to supply electricity load at a specific site) will be significantly reduced. At this point, while it may still be capable of producing electricity, technological obsolescence would likely drive its replacement with a future lower cost higher efficiency solar PV module.

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 solar photovoltaic modules 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.