ENGINEERING REPORT

TO: Ecolibrium Solar, Inc.
340 W. State Street
Athens, Ohio 45701

DATE: January 7, 2016

NO: 19021D-4-0116-10

ATTN: Mr. Ben Stuart
Validation Engineer

Re: Summary Report of Review of EcoX Gen 2 Engineering Design Calculation Methodology and the EcoX Gen 2 Calculator for the EcoX Gen 2 Mounting System for Photovoltaic (PV) Arrays; State of Connecticut; CBC Report No. 19021D-4-0116-10

To Whom It May Concern,

As requested by Ecolibrium Solar, Inc., CBC Engineers and Associates, Ltd. has thoroughly reviewed the details of the EcoX Gen 2 Mounting System for photovoltaic arrays and the engineering design calculation methodology to be used in conjunction with that product with regards to the capacity of EcoX Gen 2 to support localized snow and wind loads applied to the photovoltaic (PV) array which it supports. The EcoX Gen 2-approved solar panels, supplied and designed by others, are to be attached to the EcoX Gen 2 components. EcoX Gen 2 and the attached PV arrays must be installed according to the instructions and requirements of Ecolibrium Solar, Inc. The EcoX Gen 2 mounting system has been reviewed and it was determined that it is in compliance with the structural requirements of the 2009 International Building Code, ASCE 7-05, and ASCE 7-10.

CBC has also thoroughly reviewed the implementation of the reviewed EcoX Gen 2 engineering design calculation methodology known as the EcoX2 Calculator. The reviewed EcoX2 Calculator is a Microsoft Excel spreadsheet ("EcoX2 Calculator v3_0.xlsx") dated June of 2015. It is understood that the EcoX Gen 2 engineering design calculation methodology referenced above is to be further implemented as an interactive, end-user design tool on the Ecolibrium Solar company website for the purpose of aiding in the design of EcoX Gen 2 mounting systems for PV arrays, and that this Online EcoX Gen 2 Calculator will emulate the same assumptions and calculations as, and produce equivalent maximum-allowable-spacing-between-EcoX-Gen-2-roof-attachments to, the reviewed EcoX2 Calculator. It is the sole responsibility of Ecolibrium Solar to ensure that the online tool is developed in exact accordance with, and produces equivalent results to, the reviewed EcoX2 Calculator.

The engineering design calculation methodology and EcoX2 Calculator implementation use the allowable stress design (ASD) approach (ASCE 7 Chapter 2.4). CBC has confirmed that the design loads, load factors, and load combinations for dead loading, snow loading, and wind loading, along

with the design resistances, resistance safety factors, and calculations used in the engineering calculation design methodology as implemented in the EcoX2 Calculator, are in compliance with the following codes and standards, as applicable:

- ASCE 7-05 – Minimum Design Loads and Other Structures, by ASCE/SEI, 2005
- ASCE 7-10 – Minimum Design Loads and Other Structures, by ASCE/SEI, 2010
- 2006 International Building Code, by International Code Council, Inc., 2006
- 2009 International Building Code, by International Code Council, Inc., 2009
- Aluminum Design Manual: Specifications and Guidelines for Aluminum Structures, by The Aluminum Association, 2010
- ASD/LRFD NDS – National Design Specification for Wood Construction with Commentary, by American Wood Council., 2012
- UL 2703 – Mounting Systems, Mounting Devices, Clamping/Retention Devices, And Ground Lugs for Use With Flat-Plate Photovoltaic Modules and Panels, by Underwriter's Laboratories, 2012

The PV array and EcoX Gen 2 mounting system are considered to be components and cladding as defined by ASCE 7. In order to determine the design wind loads applied to the PV array and resisted by the EcoX Gen 2 system, the engineering design methodology as implemented in the EcoX2 Calculator uses the *Simplified Low-Rise Building Method* per ASCE 7 (see chapter 6.4 of 7-05; chapter 30.5 of 7-10), and the *Low-Rise Building Method* per ASCE 7 (see chapter 6.5 of 7-05; chapter 30.4 of 7-10), as applicable. As such, it is understood that all EcoX Gen 2 support system projects designed using this engineering design calculation methodology as implemented in the EcoX2 Calculator and as well as the Online EcoX Gen 2 Calculator will conform to the following design assumptions:

- Building importance category of I, II, III, or IV (ASCE 7-05 only)
- An enclosed, regular shaped gable roof, OR an enclosed, regular shaped hip roof
- Maximum mean roof height of no more than 60 feet as defined by ASCE 7-05 or ASCE 7-10, as applicable
- Roof zones 1, 2, 3, 4, or 5 as defined by ASCE 7-05 or ASCE 7-10, as applicable
- Buildings not located in an extreme geographic location, on a bluff, or the top of a hill (i.e., topographic factor $K_{zt} = 1.0$)
- EcoX Gen 2-approved solar panels (by others than CBC)
- Minimum specific gravity of framing members of 0.42
- Full penetration of at least 2½ inches of thread length into the center of framing members by the 4 inch lag screw roof attachments (designed by others than CBC), which assumes 1.1 inches or less total thickness of roofing material between the exterior roof surface and the framing members or rafters
- Lateral loading of lag screws, which is assumed to be in the direction of the sloping roof, parallel to the wood grain
- Effective wind area determined as consistent with ASCE 7-05 or ASCE 7-10 requirements, as applicable, with a minimum total effective wind area of 20 ft^2

It is assumed that all proposed projects utilizing the engineering design calculation methodology reviewed by CBC, including those utilizing the EcoX2 Calculator or the Online EcoX Gen 2 Calculator, will conform to the above design assumptions. Ecolibrium Solar should be contacted for further information about EcoX Gen 2 for any project that does not conform to the design assumptions listed above.

The reviewed engineering design calculation methodology as implemented in the EcoX2 Calculator provides results in the form of the maximum allowable spacing between roof attachments (lag screws) for various design conditions for a given rooftop and PV array. The maximum spacing between roof attachments is calculated based on maximum allowable upward, downward and lateral loads applied to the EcoX Gen 2 components and to the lag screws. In reviewing the EcoX Gen 2 mounting system, CBC has not independently verified the design resistances of the EcoX Gen 2 components and lag screws. These values have been considered consistent with the following design assumptions, combined with industry standard resistance safety factors.

- The maximum allowable loads for EcoX Gen 2 components have been determined from manufacturer-provided calculations and load tests.
- The maximum allowable loads for the lag screws have been determined from industry standard design information and adjustment factors per the NDS for Wood Construction.
- The lag screws are to be fastened to the existing roof framing members in accordance with the manufacturer's recommendations and accepted industry standards, with at least 2.5 inches of penetration into the center of existing framing members.

While every effort has been made to ensure its accuracy, it is emphasized that the EcoX2 Calculator is intended to be a design aid only, and the validity of its results, including the maximum spacing between roof attachments, is totally dependent on the validity of the design data entered by the end user, and on the conformance of the actual project conditions to that input data, as well as conformance of actual project conditions to the design assumptions specified in this report. The actual design criteria used, input values, and all results from the EcoX2 Calculator should be independently verified by a competent, licensed professional engineer possessing the technical ability to design rooftop PV mounting systems. Any liability resulting from the final design and/or analysis of any specific project is the responsibility of the end user of the EcoX2 Calculator, and is not the responsibility of Ecolibrium Solar or CBC Engineers and Associates. Under no circumstances shall Ecolibrium or CBC, their directors, officers, employees or agents be liable for indirect, consequential, special, incidental, punitive, or exemplary damages of any kind (including, without limitation, damages for loss of business profits, business interruption, loss of business information, or any other pecuniary loss) resulting from the furnishing, performance, use, or inability to use the EcoX2 Calculator, whether due to a breach of contract, breach of warranty, or the negligence of Ecolibrium, CBC, or any other party, even if Ecolibrium or CBC is advised beforehand of the possibility of such damages and known defects. To the extent that the applicable jurisdiction limits Ecolibrium and CBC's ability to disclaim any implied warranties, this disclaimer shall be effective to the maximum extent permitted. Usage of the EcoX2 Calculator to aid in the design of an EcoX Gen 2 mounting system shall constitute acknowledgement of the assumptions and limitations in this report, and agreement to the terms above.

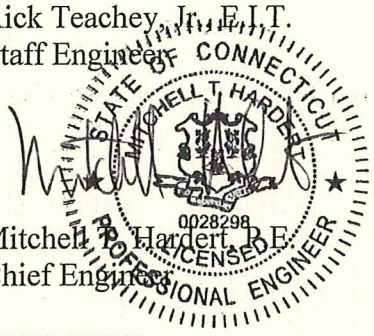
CBC Engineers and Associates is not responsible for the evaluation of any existing building structures and recommends that a qualified structural engineer be consulted to determine if the existing building structure is capable of supporting the additional loads imposed by the proposed PV system.

Our professional services have been performed and our findings obtained in accordance with generally accepted engineering principles and practices. No other warranty, expressed or implied is made. This report should be used in its entirety. This report may be reproduced as necessary by the end user in conjunction with use of the Online EcoX Gen 2 Calculator in accordance with the agreement between CBC Engineers and Ecolibrium Solar, Inc.

Thank you for the opportunity to provide this report. If you have any questions, or require any further assistance, please contact us.

CBC Engineers & Associates, Ltd.

Rick Teachey, Jr., E.I.T.
Staff Engineer



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