



Impact of Solar Photovoltaic Laminate Membrane Systems on Roofs

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1.0 Introduction and Background

In 2008, CH2M HILL performed a solar site analysis of the HP Pavilion facility for the City of San José under the Department of Energy's Solar America Showcase program. Based on weight loading requirements of the facility's roof, CH2M HILL recommended a building integrated photovoltaic (BIPV) product that consists of thin-film, flexible photovoltaic modules that can be thermally welded to rolls of roofing membrane. The City of San José has requested information from the Tiger Team to address the following question: *"The HP Arena is due for roof improvements. If this roof work is done prior to the installation of the recommended thin-film products, can the DOE Tiger Team estimate what affect (if any) would the proposed PV thin film installation have on the lifetime of the new roof?"*

Flexible, PV laminate products that can be "rolled" and adhered to single ply membrane roofs have been commercially available in the U.S. for the past 8 to 10 years. Uni-Solar is the manufacturer of this product and distributes it through several original equipment manufacturers (OEMs). Many of these OEMs are roofing contractors who integrate the PV laminates into their roofing product. Typically roofing manufacturers offer warranties for



Figure 1. Examples of BIPV Laminate integrated into rolls of roofing membrane. (Source: Solar Integrated Technologies)

their product for up to 20 years which is similar to the warranty offered by PV modules (including Uni-Solar). Since BIPV laminates on roofs are a relatively new solar technology, CH2M HILL was not able to identify any field performance data of a BIPV laminate project whose roof and/or system is nearing the end of its lifetime/warranty.

However most building owners that CH2M HILL spoke with perform roof replacement at

the same time as the PV system installation so that the warranties coincide with each other or are under the same warranty provision.

When studying the impact that a BIPV laminate product will have on a roof, the following factors should be considered:

- BIPV laminates are relatively new to the building market, and installed applications on membrane roofs are limited. Proven installations have yet to be quantified.
- Warranties must be reviewed in detail and coordinated with the warranty for the roofing membrane. Both the roofing and PV vendors will seek to indemnify themselves with disclaimers of liability.
- Installations on existing membrane roofs must be analyzed for roof type, condition and age with the PV vendor and contractor prior to installation to confirm that the PV laminate and the roofing system are compatible.
- Training of facility maintenance personnel regarding necessary precautions to take when servicing or performing O&M on any rooftop equipment (PV system, HVAC equipment located on the roof, window washing equipment that requires roof access, etc.).

Initial results of literature searches and integrator personnel interviews indicate that with minimum maintenance and general servicing that is provided to maintain any roof, a BIPV laminate installed on a membrane roof will have the same impact on the lifetime of a membrane roof as any rooftop equipment. Individuals performing O&M on the roof for any reason must take precautions to protect the roof membrane regardless of the presence of the BIPV system (such as the use of sharp tools or equipment that may damage the membrane). Some integrators claim that the presence of a BIPV laminate system on a roof can extend the lifetime of the roof, however supporting data was not able to be obtained.

Each integrator of BIPV laminates for roofs has a different methodology of affixing the rolled product onto a roof. When researching technologies or reviewing bids, the City of San José should note each vendor's details regarding:

- The method of attachment (thermal weld, adhesive, etc.)
- Ability for their product to become the roofing membrane or to adhere to a new or existing roofing membrane
- The type of roofing membrane their product is able to be affixed to (PVC, TPO, EPDM, etc.)
- Warranty coverage (roof and PV system, PV system only, etc.)
- Expertise of installation contractors (solar expertise only or solar and roofing expertise)
- Fire rating of the PV roof membrane (if the BIPV laminate membrane becomes the roof membrane)

2.0 Factors to consider regarding the impact of a BIPV laminate on a roof.

The following information was obtained from integrators of BIPV laminate systems for roofs through direct conversations and product literature review:

Expertise of the BIPV Laminate Roofing Membrane Contractor

Uni-Solar appears to be the leading (if not the only) manufacturer of BIPV laminates that are integrated into rolls of roof membrane by OEMs. As such, Uni-Solar has a list of OEMs that they supply PV modules to. These OEMs vary in expertise. However several of them are companies whose origins are in the roofing industry. Some of the OEMs are roofing companies who have also recently added BIPV laminates as a roofing product (such as Soprema) and some have aligned themselves with specific roofing manufacturers (such as Solar Integrated Technologies). Others are solar energy providers that have manufactured a BIPV laminate product for roofs using Uni-Solar technology (such as Advanced Green Technologies) but their product is installed by roofing contractors who also install the roofing system.

Method of Attachment of the BIPV Laminate to the Roof

As mentioned earlier, the method of attachment to the roof varies among the different BIPV vendors. The preferred methodology would depend on the state of the current roof. If a building's roof is nearing the end of its lifetime, some integrators (as roofing contractors) can replace the existing roof with either a single layer BIPV laminate or a double layer BIPV laminate. In a single layer configuration, the BIPV laminate becomes the roofing membrane (see Figure 2). In this example, the integrator applies the same techniques to the install the BIPV as they would any roof membrane.

When installed as a double layer, the BIPV laminate is rolled directly onto a roof membrane (see Figure 3). The method of attachment to the roof membrane can vary among integrators. Solar Integrated Technologies thermally welds the laminate to the roof membrane while Advanced Green Technologies uses a chemical adhesive-sealant. Their BIPV product can be installed either directly onto the existing roof membrane (they recommend roofs no older than 5 years) or onto a "sacrificial sheet" of roofing membrane so that the BIPV product does not come into contact with the primary roofing membrane.



Figure 2. BIPV Laminate Becoming the Roof Membrane (Source: Solar Integrated Technologies)



Figure 3. BIPV Laminate Rolled Onto A Roof Membrane (Source: Solar Integrated Technologies)

Additionally, the type of roof that a BIPV laminate product can be attached to depends on the BIPV integrator (which determines the method of attachment). For example, Solar Integrated Technologies is affiliated with Sarnafil roofs. When they replace a roof prior to a BIPV laminate installation, the roofing product they offer is Sarnafil. Correspondence with Solar Integrated Technologies indicated that although not a preferred method, they are able to affix their product to other roofs provided they meet certain specifications (16 mil PVC membrane or TPO membrane). Advanced Green Technologies will affix their product to EPDM or TPO membranes that also meet certain specifications.

Warranties

The warranty that a BIPV integrator provides for its rooftop system is an important consideration when addressing its impact on the life of the roof. The terms of the warranty vary greatly depending on the integrator and the method of attachment that is employed, however since PV modules typically have warranties for 25 years, BIPV integrators offer 25 year warranties for their laminate product as well. According to correspondence with Advanced Green Technologies, their standard warranty covers the BIPV installation only, but since their product is installed by a roofing contractor, the entire roof is covered under the warranty of the roofing contractor and/or roofing manufacturer. Their BIPV product can be installed either directly onto the existing roof membrane (they recommend roofs no older than 5 years) or onto a “sacrificial sheet” of roofing membrane so that the BIPV product does not come into contact with the primary roofing membrane.

Integrators such as Solar Integrated Technologies who are also roofing contractors will provide a warranty for the entire roofing system (roof membrane and BIPV laminate) provided that they have also installed a new roofing membrane. (See Attachment A for a sample standard warranty document.) If their product is installed on an approved existing roof, then they assume the warranty of the roof portion that is directly underneath their BIPV installation. The terms of this warranty are identified through a negotiating process with the roofing contractor/manufacturer.

Operations & Maintenance (O&M) and Personnel Training

Many BIPV integrators offer O&M procedures and training to building owners and their facility maintenance personnel for the performance of the PV system as well as the roof. Some integrators will also provide O&M service contracts for the PV system as well as the roof. BIPV installers will instruct buildings owners of maintenance schedule and procedures as well as precautions to take to not damage the PV system or the roof membrane. For example, in its O&M manual Solar Integrated Technologies recommends regular cleaning of the solar panels and roof to remove dust, dirt and other debris that might reduce the PV systems’ performance. However they issue a caution that “using high pressure can cut into or through the roof causing leaks and damage. Spray washing should be done using a continuous sweeping motion of the spray along the long direction of the solar panels.” If a roof leak occurs resulting from improper washing techniques employed by a building owner, repairs would not be covered under the warranty.

3.0 Conclusions

The purpose of this memo is to address concerns about the lifetime of the HP Pavilion roof if roof improvements are made prior to the installation of a BIPV laminate roof membrane. Based on a review of product literature, discussions with facility owners and discussions with system integrators, the lifetime of the roof should not be compromised due to the PV system provided that the installing contractor is knowledgeable about the roofing industry. Uni-Solar, the manufacturer of flexible PV laminates, has strong partnerships with the roofing industry and many of their distributors have been roofing contractors for decades and prior to entering the solar industry. All of Uni-Solar's partners who install their product are knowledgeable about roofing requirements necessary to maintain roof warranties (waterproofing, fire rating, etc.) as well as ensure product longevity. CH2M HILL makes the following recommendations to the City of San José regarding a BIPV laminate rooftop system:

- The City should be highly selective in its screening process when identifying qualified contractors and specifying requirements. To determine the best warranty terms to specify when it issues a bid for a PV system, the City could first issue a Request for Information from BIPV roof laminate vendors for details of their warranty terms if their product is installed on an existing but recently replaced roof and if the vendor installs both the BIPV system as well as a new roof. The RFI should include as many details as possible regarding a potential existing roof so the BIPV vendor can describe the attachment methodology as it relates to the warranty terms.
- The City should specify warranty requirements so that one entity is responsible for both the PV system and the roof. Based on its review of warranty terms when the products are installed independently, there may be too many uncertainties of responsibility. This can be accomplished by selecting one contractor to install the PV system as well as complete the roof improvements.
- If the City decides to install a BIPV rooftop laminate system independently from the roof improvement it plans, then the City should purchase a warranty for the same coverage period as the PV system (20-25 years). There is no benefit to installing a roofing product with a warranty period shorter than that of the PV system:
 - Often shorter warranties (such as 10 year) involve cheaper products (i.e. 45 mil TPO product instead of a 60 mil TPO product) whose performance will not be extended by its expected lifetime with the addition of a BIPV laminate.
 - Depending on the BIPV vendor, if a PV system is installed on an existing roof with a shorter warranty period, the BIPV vendor may assume the warranty provided by the roofing manufacturer/contractor but only for the remainder of the existing warranty, **or** the roof will continue to be covered by the roofing manufacturer/contractor and the warranty will terminate once the term has expired.

References:

1. Solar Integrated Technologies, Andrew Sinnott (telephone and email correspondence)
2. Advanced Green Technologies, Yann Brandt (Telephone and email correspondence)
3. Operations and Maintenance Manual (sample), Solar Integrated Technologies
4. "Building Integration - what is possible" Presentation by Dr. Ing. Claas Helmke, Director of Product Development, Solar Integrated Technologies GmbH

ATTACHMENT A

EXAMPLE WARRANTY STATEMENT
FROM A BIPV LAMINATE COMPANY

- Warranties must be reviewed in detail and coordinated with the warranty for the roofing membrane. Vendors will seek to indemnify themselves with disclaimers of liability.
- Copies of United Solar Ovonic (Uni-Solar) limited warranty are noted below.

DISCLAIMER OF LIABILITY

The information contained in this manual is based on United Solar Ovonic LLC knowledge and experience, but such information and suggestions do not constitute a warranty expressed or implied. The methods of installation, use and maintenance of membrane roofing materials are beyond the control of United Solar Ovonic LLC. United Solar Ovonic LLC assumes no responsibility and expressly disclaims liability for any loss, damage or expense associated with the use, installation or operation of the membrane roofing system. Any liability of United Solar Ovonic LLC is strictly limited to the Limited Warranty. United Solar Ovonic LLC reserves the right to make changes to product specifications or to this manual without notice.

Approved Substrates and Suppliers:

Approved substrate	Approved vendors	Comments
GenFlex II EPDM, GenFlex FRM II, GenFlex AFR, GenFlex II FR EPDM, and GenFlex FRM-FR II Firestone Building Products: Standard RubberGard, Standard Reinforced RubberGard, FR RubberGard, Fire Retardant Reinforced RubberGard or LS-FR, 60 mil	Firestone (GenFlex)	EPDM meets ASTM 4637 Type 1, Grade 1, Class U
GenFlex White TPO, GenFlex Gray TPO, GenFlex Charcoal Grey TPO, 60 mil	Firestone (GenFlex)	

3.3 Warranty

UNI-SOLAR® BIPV Products with 60 mil TPO or 60 mil EPDM

Warranty

**Product: UNI-SOLAR Factory and/or field applied PV Laminate to approved
60 mil TPO and 60 mil EPDM Roof System:
PVL-68T/PVL-124T/PVL-136T**

Five-year System Warranty :

United Solar Ovonic LLC warrants the PVL on approved 60 mil TPO and 60 mil EPDM solar electric system, including the balance of system components, to be free of defects for a period of five years of operation. This five-year period commences with the successful completion of the local building inspection, in the case of installed systems, and from receipt of the system shipments by customer, if customer is responsible for installation. All system components which upon inspection from United Solar Ovonic or its appointed agent are determined to have defects in materials or workmanship will be repaired or replaced.

Limited Warranty – Twenty Year

United Solar Ovonic LLC warrants each UNI-SOLAR PV laminate adhered to an approved 60 mil TPO or 60 mil EPDM Roof system against lost power output as follows: For a period of twenty (20) years from the date of sale to the original purchaser, PV Laminates which upon inspection by United Solar Ovonic LLC or its appointed agent are determined to exhibit a power output of less than 80% of the Rated Power specified at the time of sale up to the quick connects, due to defects in materials or workmanship of the PV Laminate and/or of the bonding of the PV Laminate to the approved 60 mil TPO or approved 60 mil EPDM roof system, will be repaired or replaced, or, at the option of United Solar Ovonic LLC, it will refund an amount equal to such lost power times the amount paid for the laminates per watt of Rated Power. Lost power is the difference between exhibited power and 80% of the Rated Power.

What is not covered by the Warranty?

This warranty does not apply to any PV Laminates which in the judgment of United Solar Ovonic LLC has been subject to misuse, neglect or accident or which has been damaged through abuse, alteration, improper installation or application, or negligence in use, storage, transportation or handling, or repaired by anyone other than United Solar Ovonic LLC. The warranty does not cover any transportation costs for return of PV Laminates, or for reshipment of any repaired Laminate, or costs associated with installation, removal or reinstallation of PV Laminates.

This warranty does not apply to damage or loss caused in whole or in part by :

- a. Natural disasters, including but not limited to lightning, wind gusts in excess of 90 mph, hail, hurricanes, or similar natural disasters;
- b. Vandalism, acts of war, or civil disturbances;
- c. Environmental fallout or overexposure to commercial/industrial solvents, acids, caustic fluids, oils, waxes, greases, absorbent clays, bleaches, plasticizers or other harmful chemicals.

Warranty Limitations

United Solar Ovonic LLC shall have no responsibility for damage to person or property or other loss or injury resulting from defect in laminate or from improper use or installation. Under no circumstances will United Solar Ovonic LLC be liable for any incidental or consequential damage. Any warranties implied by law, including those of merchantability and fitness for a particular purpose are hereby expressly disclaimed. This warranty is in lieu of all other warranties, expressed or implied. The purchaser's exclusive remedy shall be only as stated herein.

Obtaining Warranty Performance

United Solar Ovonic LLC will not accept the return of any component of the solar electric system unless it has given prior written authorization.