



# Insuring Solar Photovoltaics: Challenges and Possible Solutions

Bethany Speer, Michael Mendelsohn, and  
Karlynn Cory

*Technical Report*  
NREL/TP-6A2-46932  
Revised February 2010

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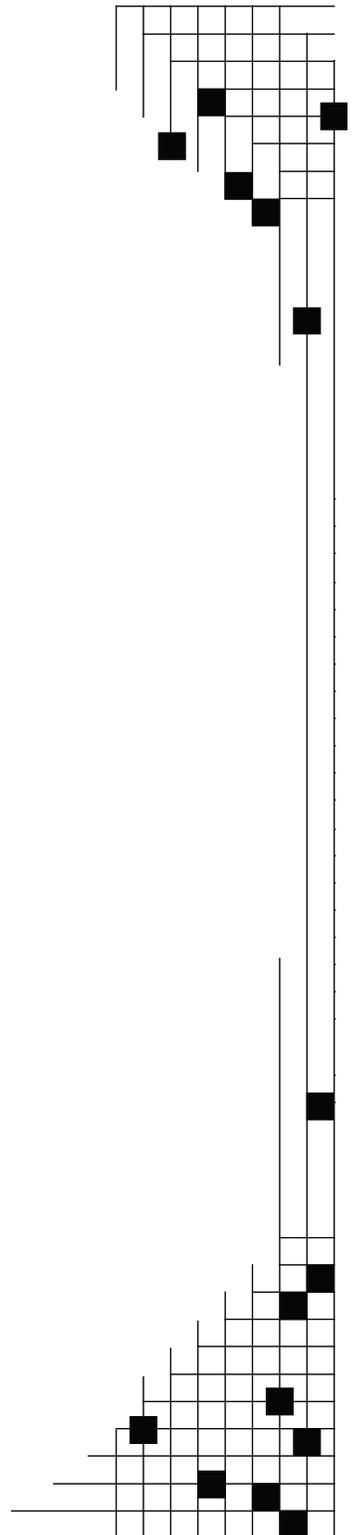


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### ***A Note on the Revisions***

This report, as originally published, contained editorial errors that have been corrected in this revision. Only the following revisions changed the authors' intent.

Page 3, fourth paragraph: Because some of the information gathered is viewed as proprietary or sensitive, the identities of the companies and interviewees will not be tied to specific ideas presented in the report.

Page 21, fourth bullet: This typically approximates the customer's current retail rate in the first year and then usually escalates annually.

Page 25, third paragraph: ~~One developer referred to the annual cost of insurance as 0.25% of the total installed cost of the project, which could be as high as 0.5% annually in areas where extreme weather events are likely to occur.~~

## Executive Summary

Although the market for insurance products that cover photovoltaic (PV) systems is evolving rapidly, PV developers in the United States are concerned about the cost and availability of insurance. Annual insurance premiums can be a significant cost component, and can affect the price of power and competition in the market. Moreover, the market for certain types of insurance products is thin or non-existent, and insurers' knowledge about PV systems and the PV industry is uneven. PV project developers, insurance brokers, underwriters, and other parties interviewed for this research identified specific problems with the current insurance market for PV systems in the United States and suggested government actions that could facilitate the development of this market through better testing, data collection, and communication.

Insurance premiums make up approximately 25% of a PV system's annual operating expense. Annual insurance premiums typically range from 0.25% to 0.5% of the total installed cost of a project depending on the geographic location of the installation. PV developers report that insurance costs comprise 5% to 10% of the total cost of energy from their installations, a significant sum for a capital-intensive technology with no moving parts.

Because insurance is purchased annually and future premiums are uncertain, developers who offer fixed-price contracts for the electric output of their systems must use estimated future insurance costs. Developers generally pass the risk of higher future insurance premiums on to their customers through higher escalation rates or other contract elements, thereby increasing the cost of solar electricity to entities that host PV systems on their property under power purchase agreements.

The fledgling nature of the renewable energy industry makes obtaining affordable insurance challenging. These challenges include insurers' unfamiliarity with PV technologies, a lack of historical loss data (i.e., insurance claims), and limited test data for the long-term viability of PV products under real-life conditions. The lack of information and insight about the solar PV industry contributes to perceived risk associated with the technology and installation techniques among insurance underwriters and brokers, which leads to higher premiums than would likely prevail in a more mature market. Finally, the PV industry's ongoing innovation in contractual structures and business models necessitates corresponding innovation in insurance products to match the industry's requirements.

Our research identified several areas for action on the part of the federal government, national laboratories, and other stakeholders to support and accelerate the development of insurance products for PV technologies and systems:

- **Expand Availability of PV Historical Loss Data**  
Centrally assembled and evaluated data for historical insurance claims for PV systems would allow the insurance industry to better gauge the risks associated with PV installations. A large database—potentially comprising several proprietary industry data sets—that includes parameters related to system operation, availability, and insurance

loss would be highly useful for the insurance industry in assessing risk and setting competitive rates. The U.S. Department of Energy (DOE) or the National Renewable Energy Laboratory (NREL) could represent an objective third-party data aggregator.

- **Evaluate Expansion of Renewable Energy Business Classification**

Insurance professionals interviewed for this report indicated current business classification systems are insufficient to gauge various risks of renewable energy businesses. The Standard Industrial Classification (SIC) and North American Industry Classification System (NAICS) codes combine most renewable energy industries into a narrow range of classifications. Additional delineation—perhaps through an incremental coding system—would allow insurance underwriters to better assess insurance claims related to workers’ compensation, operating loss, and other risks highly specific to the renewable energy industry.

- **Develop Module and Component Testing Capabilities and Services Offered by Federal Labs**

The PV industry would benefit from better access to detailed testing procedures for assessing PV systems for vulnerability to weather-related stresses, including severe wind, hail, and extreme temperatures. NREL should coordinate with other national laboratories and testing facilities to ensure that advanced testing capabilities are available to PV module and inverter manufacturers and system integrators.

- **Advance Industry Standards for Installers**

At present, there are guidelines but no standards to ensure the competency of PV system installers. The DOE has been involved in developing these guidelines. However, the insurance industry interviewed for this analysis clearly communicated that unified state or federal standards could reduce risk associated with PV installation and operation and could thus lead to lower insurance premiums for solar developers and the commercial, industrial, and government entities that host PV installations on their rooftops or land. Extended reliance on the North American Board of Certified Energy Practitioners (NABCEP) certification process could improve quality and reduce accidents, and could thus lead to reduced insurance premiums. In addition, opening communication among the insurance industry, the DOE, and the development community could lead to better understanding of PV systems, improved guidelines, and lower costs.

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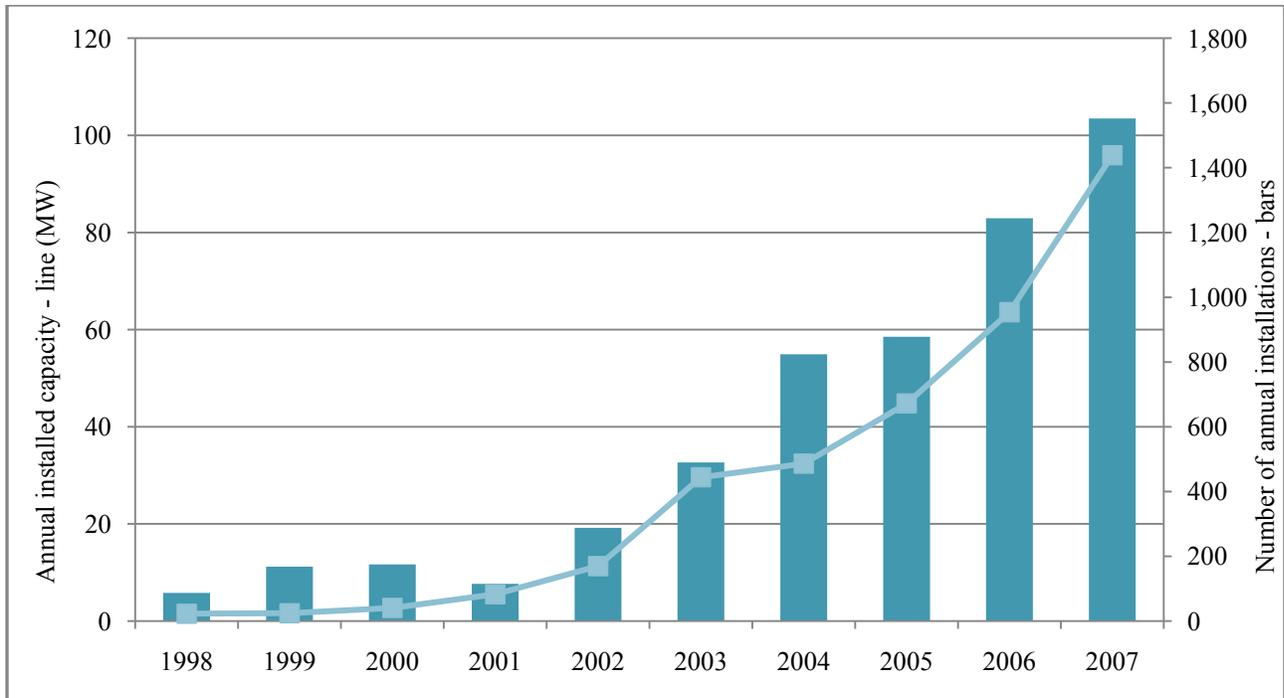
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# 1 Introduction

Allocation of risk is the principal concern of the insurance industry. Individuals, families, and corporations buy insurance to protect against financial damages or loss of property or persons. Insurance underwriters provide insurance to protect against potential damage or loss based on the associated risks. According to the Insurance Information Institute, risk is: “[t]he chance of loss to the person or entity that is insured” (Ins. Info. Inst. 2009a). In each situation, the actual risk depends upon what is being insured, what events might occur, and how likely each occurrence might be. For example, geography and weather often play key roles in contributing to potential risks. Therefore, the insurance industry assesses the total risk they are covering for any particular situation and determines the likelihood that they will have to make a payment if that risk becomes an actual loss. The annual insurance premium payment is determined based on the potential for the risks to become actual losses. For insurance companies to be profitable, the premiums they receive for insuring against losses must be greater than the actual payouts in the event of losses occurring.

Investments in PV are often viewed by underwriters as quite risky for two main reasons: the technologies are newer (i.e., most systems do not have a long history of operational data) and there are fewer installations relative to other technology deployments (e.g., the automobile). Insurers use the “law of large numbers,” which says that “the larger the group of units insured, the more accurate the predictions of loss will be” (Ins. Info. Inst. 2009b). Although PV technology has been in existence since the 1950s, deployment of PV at a significant level occurred much later. Between 1998 and 2007, new annual on-grid installations in the non-residential sector increased from 87 to more than 1,500 (Sherwood 2008), as indicated in Figure 1. Thus, enough solar PV installations have not been in place for long enough for underwriters to feel they can accurately predict what the losses associated with them would be. Because insurers have access to data on only projects that their companies insure, the more insurers there are, the less data each insurer has.

Adding to the complexity of insuring PV installations is the typical involvement of many parties, including installers, developers, investors, lenders, and insurance companies. Each party to the transaction attempts to minimize the risks it assumes while defining the recourse available in case a risk event occurs and leads to actual losses. In fact and in many cases, insurance products can be used to mitigate and manage the allocations associated with complex contractual arrangements.



**Figure 1. Annual new on-grid installations in the commercial and utility sectors in the United States by numbers installed and capacity installed (Sherwood 2008)**

Until the recent growth in the PV market, demand for PV system coverage was not adequate to encourage insurance underwriters to develop PV-specific products. If the upward trend of new PV installations continues, there will be a great demand for insurance products for PV. This growing market of new solar installations, which is being driven by state policies, federal incentives, and corporate responsibility, represents a possible market opportunity for insurance underwriters.

The focus of this report is commercial-scale and utility-scale PV systems as they represent most of the new market for insurance products. Utility-scale PV projects represent a fledgling but growing market as indicated by the number of proposed projects, many of which have long-term power purchase agreements (PPAs) for power generated. Residential PV installations do not draw attention from insurance companies because they can usually be included under a homeowner's policy (DOE 2003) as long as they are rooftop-mounted.<sup>1</sup> Interviews with developers of both commercial- and utility-scale PV projects indicate that acquiring insurance at a reasonable cost is a continuing concern for both developers and their customers.

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<sup>1</sup> Residential owners who have ground-mounted solar PV systems installed may need additional insurance coverage. However, ground-mounted PV systems for residential customers are not common and are not within the scope of this report.

## 2 Goals and Methodology

Solar technologies are still developing. The insurance industry considers the understanding of the technology and the operational performance of PV systems to be still evolving. A primary goal of this report is to identify financial and informational barriers that developers encounter when insuring solar PV systems. Another goal is to examine information challenges that insurance underwriters and brokers confront when managing risk for PV systems. From these investigations, this report also provides suggestions to the U.S. Department of Energy (DOE) program managers and staff on how these information gaps could be addressed.

Ancillary goals for this report are to (1) help developers and system owners better understand risk management products and the underwriting process for solar PV systems, and (2) inform end users and DOE program managers on how insurance costs can affect solar PV deployment. This report also provides renewable energy researchers and policy makers with information regarding insuring solar PV.

Most of the information for this report was gathered through interviews with experts from the relevant industries. In all, NREL interviewed 26 industry professionals, including those representing:

- four underwriting companies,
- three insurance brokerages,
- seven solar development companies,
- one risk modeling company,
- one electronic PV monitoring company, and
- six representatives from solar power industry associations, research centers, and news organizations.

Because some of the information gathered is viewed as proprietary or sensitive, the identities of the companies and interviewees will not be tied to specific ideas presented in the report. Instead, a list of contacts of those who granted permission to be included in the report can be found in Appendix A.

The interviews consisted of telephone and in-person conversations from November 2008 through June 2009. A complete list of the initial set of questions addressed during the conversations is contained in Appendix B. Follow-up correspondences were also conducted, and all participants were given the opportunity to comment on an earlier draft of the report.

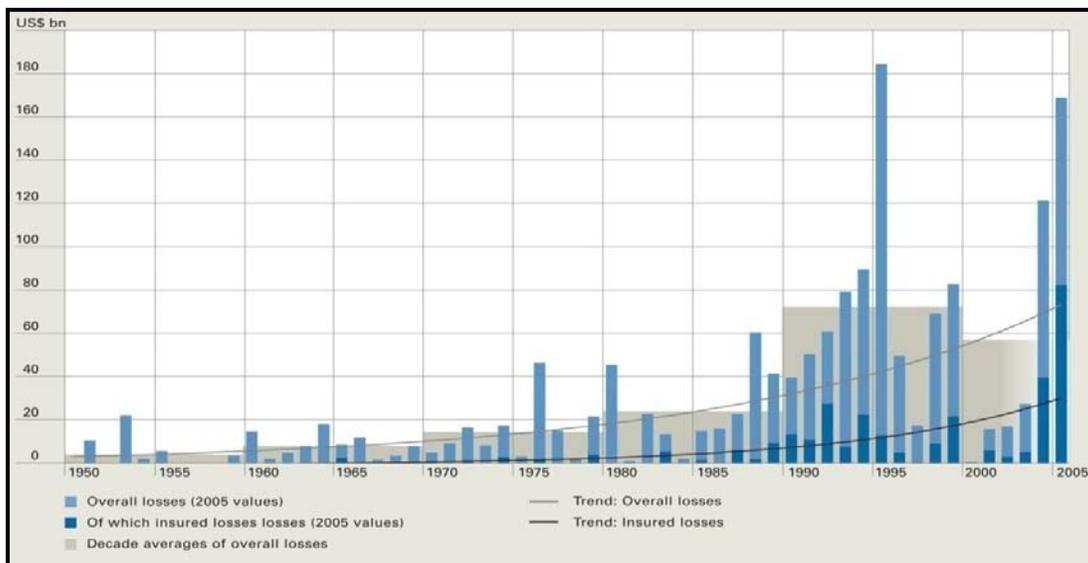
### 3 The U.S. Insurance Industry

Underwriters, brokers, and re-insurers all play important roles within the insurance industry and are vital to the U.S. economy. However, the industry is being significantly affected by the current economic downturn, new regulation requirements, and increased losses to policyholders. In the context of these large-scale forces shaping the insurance industry as a whole, the insurance market for PV systems is evolving and maturing rapidly.

The insurance industry is a large part of the U.S. economy. From sales of final goods and services in 2006, the industry produced revenue of \$281 billion or more than 2% of the total national GDP (\$13 trillion in 2006) (Ins. Info. Inst. 2009c). In all, there were 2,723 property/casualty companies in 2007 and 1,190 liability/health underwriters (Ins. Info. Inst. 2009d). However, the industry has recently experienced major changes that may alter its dynamics.

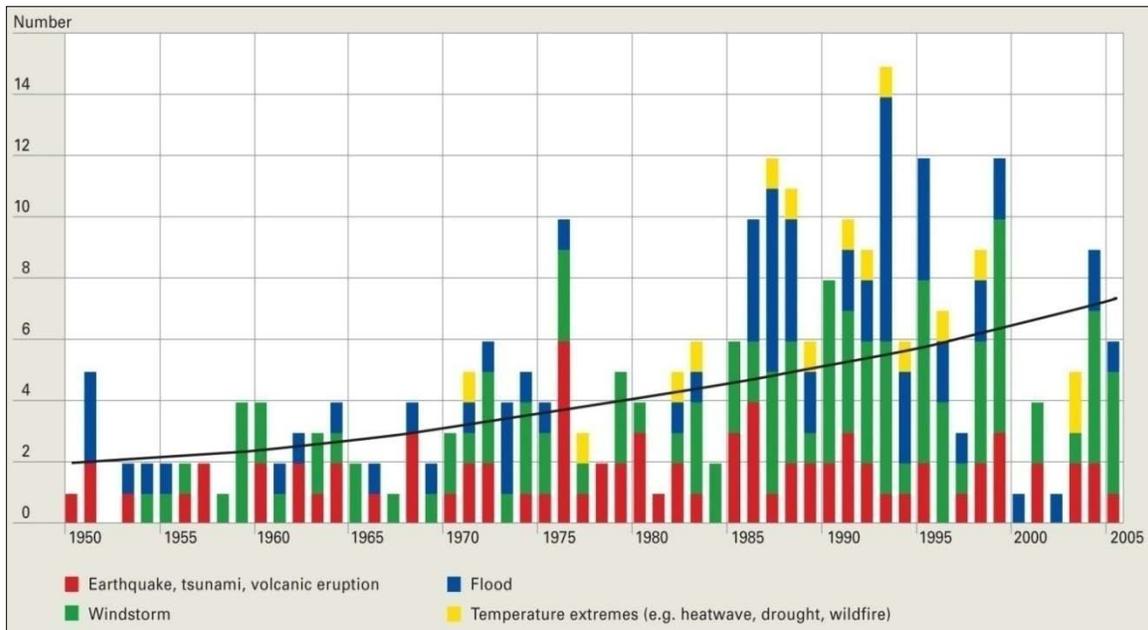
Industry revenues have declined significantly in the past year, leading to an average annualized rate of return of 1.1% in the first nine months of 2008, down from 13.1% during the same period in 2007 (Hartwig 2008). This sharp decline in revenues is attributed to the financial and economic crises of late 2008, which negatively affected even the most conservative portfolios (Ins. Info. Inst. 2009d). The economic downturn is expected to lead to additional bankruptcies and concentration in the industry.

Financial losses in the insurance industry resulting from natural disasters appear to be increasing. As Figure 2 indicates, total losses (and the subset of insured losses) have increased significantly since 1960. In fact, insured losses rose from negligible amounts during the mid-century to around \$30 billion in 2005. Uninsured losses increased from around \$5 billion in 1950 to well over \$70 billion in 2005. Figure 2 also shows that the spikes in insurance losses since 1990 are greater than earlier ones.



**Figure 2. Overall losses and insured losses in the industry: Absolute values and long-term trends (Munich Re 2005)**

Figure 3 illustrates the number and type of natural catastrophic events that have occurred over the latter half of the 21<sup>st</sup> century through 2005. Some insurers are concerned about the link between greenhouse gas emissions and climate change and the potential for increased insurance losses. Insurance industry leaders, such as Munich Re, concluded in a recent report that increased natural disasters, specifically hurricanes, coincide with increased global temperatures, which also coincide with increased greenhouse gas emissions (Munich Re 2005).



**Figure 3. Annual number of great natural catastrophes by event type<sup>2</sup> (Munich Re 2005)**

Starting in 2010, new regulations by the National Association of Insurance Commissioners (NAIC)<sup>3</sup> require insurance companies with annual premiums of \$500 million or more to disclose all financial risks associated with climate change as well as any plans for mitigating exposure to these risks (NAIC 2009). NAIC put this requirement into place so that insurers would disclose how climate change risk would affect their portfolios and how they plan to change their investment strategy. This disclosure provides insurance underwriters with an additional financial incentive to assess climate change-related risks in their portfolios as their underwriting practices could be scrutinized by concerned investors.

<sup>2</sup> Black line indicates trend.

<sup>3</sup> The National Association of Insurance Commissions (NAIC) should not be confused with the North American Industry Classification System (NAICS) codes that are discussed later in the report.

### 3.1 Role of Insurance Underwriters

Insurance underwriters are the companies that pay the insured when claims are made. Underwriters formulate the payment estimates designed to cover their risk, which is outlined in a binding contract. Underwriters define the price and risk allocation terms under these contracts through a multitude of processes, including research, engineering analysis, risk modeling, contractual negotiations, and modification of pre-existing underwriting forms, which are described in Figure 4. Insurance underwriters tend to specialize in either property- or liability-oriented policies. According to one interviewee, specialization allows an underwriter to gain expertise in a particular area, which leads to a better understanding of the risks involved. In turn, this might allow customers to receive lower insurance premiums and faster turnaround on the creation of an insurance policy. Nonetheless, some underwriters will write policies for both liability and property, depending on the project.

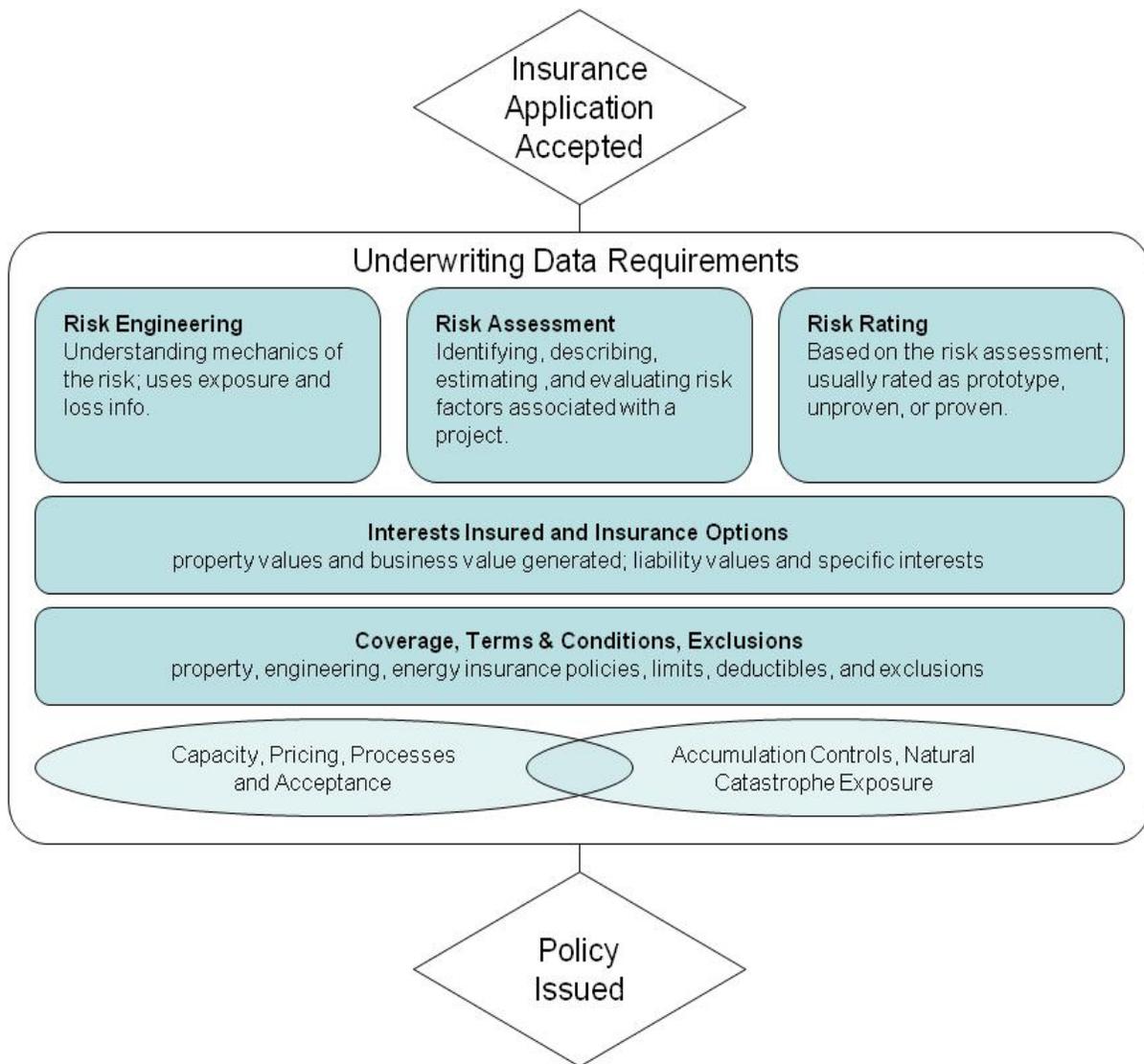


Figure 4. Insurance underwriting process

### **3.2 Role of Insurance Brokers**

Within the type of insurance they provide, most insurance companies' products are generic and homogenous, and therefore are not easily adapted to provide protection for renewable energy technologies. However, industry-specialist brokers work with renewable energy product manufacturers, facility developers, and project finance clients to create unique product offerings and the necessary underwriting support that are not well covered by traditional insurance. The goal of an industry-specialist or consultative insurance broker is to strategically partner with clients and provide innovative, responsive, and cost-effective solutions that mitigate the risk and uncertainty of renewable energy systems.

The process of establishing insurance policies begins with developers or project owners identifying the risks that they need or want to cover. This can be done with the help of an insurance broker who might have suggestions for what to cover. The broker then approaches underwriting companies with an outline of the insurance products that interests its client. The client is presented with the range of policies, premiums, and terms of coverage from which to choose. Once the customer decides which policy it wants, the broker returns to the underwriter to complete the policy formation process.

Several U.S.-based companies underwrite policies specific to solar PV, a couple of which receive underwriting capacity from Lloyds of London. The role of these companies, which are known as managing general agents (MGAs), is to formulate the insurance policy and sell portions of it to various investors.

### **3.3 Major U.S. Insurance Underwriters**

The top ten major U.S. insurance companies that underwrite commercial policies (Ins. Info. Inst. 2009e) are listed in Table 1. Insurance products for renewable energy are mostly offered by large insurance companies that provide other commercial and residential insurance products. Of the top ten commercial underwriters, NREL research for this report identified at least six companies that actively write renewable energy policies (Munich Re 2009, AIG 2009a; Zurich 2008; Chubb 2008; Ace Limited 2009; Manning 2009):

- Munich Re (a reinsurer that typically backs the main insurance companies listed above)
- Chartis (formerly AIG)
- Zurich Insurance Group
- The Hartford Financial Services Group
- ACE Limited
- Chubb Group of Insurance Companies

However, it is unclear how the financial crisis might affect the insurance industry and their business practices with respect to renewable projects. Thus, the companies that are able or choose to provide insurance for renewable energy technologies may change.

**Table 1. Top Ten Writers of U.S. Commercial Lines Insurance by Direct Premiums Written, 2008<sup>a</sup>**

Name of Insurance Group	Market Share (%)		2-year Growth (CAGR) <sup>b</sup>	Direct Premiums Written (in \$ billions)	
	2008	2007		2008	2007
Chartis <sup>c</sup>	9.03%	10.64%	-9.78%	\$20.2	\$24.7
Liberty Mutual Group	6.57%	5.45%	13.36%	\$14.7	\$12.6
Travelers Group	6.26%	6.19%	-1.42%	\$14.0	\$14.4
Zurich Financial Services	6.04%	6.29%	-3.72%	\$13.5	\$14.6
Hartford Financial Services Group	3.11%	3.15%	\$0	\$6.9	\$7.3
CNA	3.10%	3.22%	-6.09%	\$6.9	\$7.4
ACE Group	3.10%	3.12%	-1.43%	\$6.9	\$7.2
Chubb Group	2.91%	2.88%	-2.60%	\$6.5	\$6.7
Nationwide Mutual Insurance Co.	2.35%	2.36%	\$0	\$5.2	\$5.4
Allianz	2.12%	1.95%	3.86%	\$4.7	\$4.5
TOTAL	200844.59 %	200745.25 %	--	\$2107.5 0	\$2111.8 0

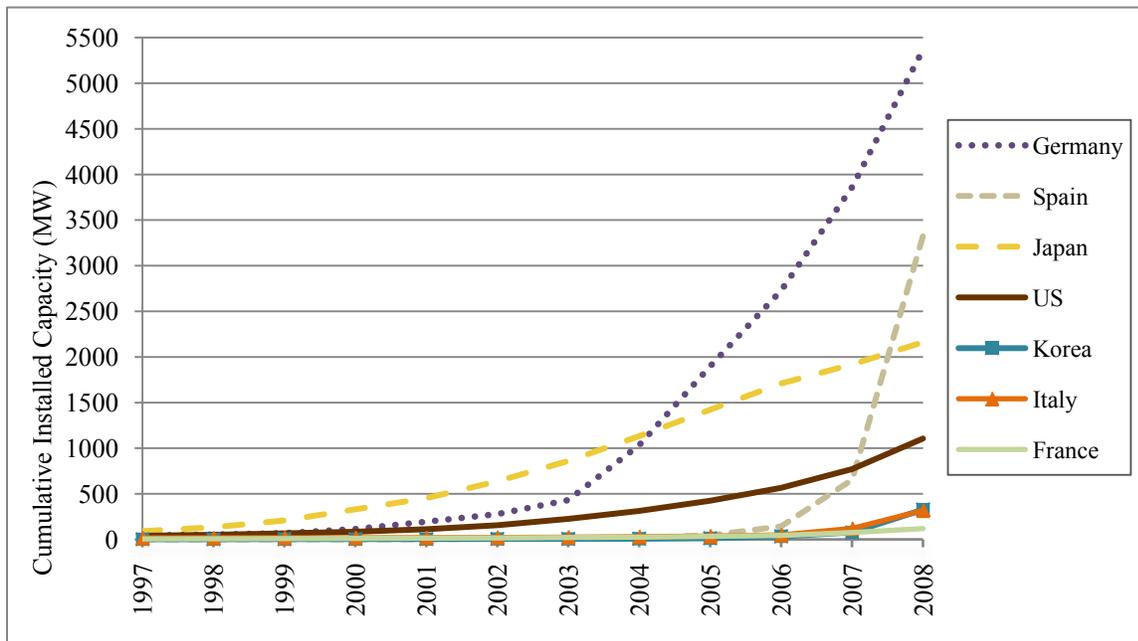
<sup>a</sup> Source: National Association of Insurance Commissioners (NAIC) Annual Statement Database, via Highline Data, LLC. Copyrighted information. No portion of this work may be copied or redistributed without written permission of Highline Data, LLC.

<sup>b</sup> Compound annual growth rate

<sup>c</sup> Formerly known as AIU Holdings and American International Group/AIG

### **3.4 Interaction between the Insurance Industry and a Maturing U.S. Solar PV Market**

The European and Japanese solar markets are more mature than the U.S. solar market, as indicated in Figure 5. Most of the growth in PV capacity in Europe has occurred in Germany, which was the world leader in cumulative installed capacity with 5,367 MW in 2008. However, Spain and Japan also have robust PV markets with nearly 3,326 MW and 2,176 MW installed in 2008 respectively. The new PV capacity in Spain and Japan is noteworthy when compared to the United States, which has only around 1,106 MW of installed capacity as of 2008.



**Figure 5. Cumulative installed PV in top seven countries**  
 (IEA 2008, REN21 2009, EurObserv'ER 2009, Sherwood 2008)

The maturity of the European PV market gives European insurance companies more experience underwriting renewable energy generation systems than the U.S. market. Because of Europe's greater experience with solar PV installations, some U.S. insurance companies use loss data from Europe to project probabilities of future losses and risk in the United States.

### 3.5 Solar PV Industry and Insurance Industry Views of One Another

During the interviews conducted for this research, insurance underwriters raised concerns about the maturity of PV technologies. Other concerns they raised had to do with the lack of widely accepted certification or regulation among installers. Underwriters indicated that owners and developers do not have adequate knowledge about all the risks associated with PV systems. However, underwriters also expressed that the solar PV industry has excellent risk fundamentals and is maturing. These positive insurance and risk fundamentals include:

- Bundled and pooled small-scale projects
- Passive systems with no or few moving parts
- Modularity of construction
- Improved electronic performance diagnostics.

During interviews, insurance industry experts offered the following view of the PV industry.

### *Insurance Industry View of the Solar Energy Industry*

Developers are not educated about the coverage they need.

If the broker does not understand solar PV technology, ensuring that the project is properly covered can be problematic.

Because developers focus on project development, not insurance, they may not know what coverage they need.

Most developers think they pay too much for insurance. However, if they have not fully covered themselves, they may be paying less than they need to pay to cover all possible risks.

The solar PV market is a maturing industry, but it is not yet mature (even for crystalline silicon).

The solar PV industry has excellent fundamentals (e.g., strong product demand, declining input costs).

Similarly, solar PV industry experts also feel that there is a lack of appropriate information among the insurance industry. For example, the PV industry thinks that insurance companies' rates for PV policies are not affordably priced; that the industry is lacking in information about PV technologies; and that insurance brokers may or may not fully understand PV technologies. Developers offered the following view of the insurance industry during interviews.

### *Developers View of the Insurance Industry*

Insurance premiums for solar PV systems are too high.

Insurance companies sometimes lack the background knowledge of solar PV technologies.

Many do not understand how the technology works.

For a PV system, one insurer asked about the use of molten salt, which is relevant for solar-CSP technology but not for PV technology. Technology information is needed.

If the insurance industry had better data about system operation and historical losses, insurance premiums could go down.

Insurance brokers are considered the “800 pound gorilla” in the room.

Brokers represent the most common way for renewable energy insurance policies to be instigated with underwriters.

If brokers are not educated on the technologies and the risks, then the underwriters will not be educated either.

Some brokers pretend they understand solar technologies and place policies that do not fully cover what needs to be covered. This is an issue for the brokers who do not understand the true system risks.

### **3.6 Insurance as a Financial Backstop**

Some form of insurance is essential to deploying solar energy projects. Investors look for a structured insurance program that transfers identified project risk to a third-party insurance company. Lenders look to the project and its revenue stream as the collateral asset being financed in their loan underwriting.

However, PV system owners may find obtaining affordable insurance difficult for several reasons. First, only a small subset of the insurance industry insures renewable energy projects. Interviewees indicated that until recently only Lloyds of London underwrote insurance for solar projects in the United States. Reduced competition between large insurance companies likely leads to higher insurance premiums. The following descriptions of the market for solar-specific policies were given by insurance industry experts during interviews.

### *Insurance Industry View of Insurance*

More insurance companies are seeing the opportunity of a new market.

Some companies are leaders in providing solar-specific projects; others are waiting. The more opportunities companies have to understand the technologies and see actual operational data, the more likely competition is to occur and the more likely premiums will go down.

The insurance industry, including insurance brokers and underwriters, is a large and important one in the United States. However, it is experiencing a number of challenges, such as the financial crisis and increased losses from natural disasters that could alter its dynamics. Importantly, U.S. insurance regulation will require climate-change risk disclosure starting in 2010. In addition, the industry is developing new risk management products for the maturing PV industry, which will create information uncertainties for both the insurance and PV industries. The following sections describe the insurance products available for PV, as well as the information the insurance industry needs to develop products that advance PV technologies.

## 4 Solar PV Insurance

To remain feasible in terms of risk, non-residential PV installations require a variety of insurance products,<sup>4</sup> including general liability, property, and environmental risk insurance. By purchasing these types of coverage, developers create a financial backstop for the project, without which it would be difficult for the developers to obtain favorable financing.

### 4.1 Insurance Products Relevant to Solar PV

Most large PV systems require liability and property insurance, and many developers may opt to add policies such as environmental risk insurance (see Appendix C for a full list of PV testing and certification laboratories). The following section discusses insurance products from a high level; however, it is important to note that policies may vary from underwriter to underwriter and on a project-by-project basis.

#### 4.1.1 General Liability Insurance

General liability covers policyholders for death or injury to persons or damage to property owned by third parties. Rooftop installations typically require additional liability insurance given the risks inherent in working on roofs and the higher likelihood of wind loading. Ground-mounted systems tend to be far from other structures and in less-populated areas, which may reduce the premiums for general liability insurance or may reduce the requirement for additional insurance.

General liability coverage is especially important for installers, as risk is greatest during installation. However, solar power generation system owners may also purchase builders' risk insurance in addition to general liability coverage to indemnify themselves from damage to other property or persons during the construction phase.

#### 4.1.2 Property Risk Insurance

Property risk insurance covers “damage to or loss of policyholders’ property” (Ins. Info. Inst. 2009f). While the manufacturer’s warranty will provide some limited defect coverage, the system owner usually purchases property insurance to protect against risks not covered by the warranty or to extend the coverage period. Property insurance also protects the owner against financial loss from theft of system components, which insurance underwriters and brokers consistently mentioned as a concern, especially before the panels are affixed during construction. In addition, property insurance can indemnify system owners of certain natural catastrophe risk, which—according to one insurance underwriter—is the second largest risk component of property coverage after the risk of theft.<sup>5</sup> If natural catastrophe risk is perceived to be too high, separate policies may be needed to provide additional risk coverage capacity. Examples of additional policies for location-specific natural catastrophe risks include:

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<sup>4</sup> Residential PV installations can usually be included under a homeowner’s policy.

<sup>5</sup> Theft is only a risk for small rooftop PV systems after panels are installed, according to other insurers interviewed for this report.

- Earthquake coverage in California
- Hurricane coverage in Florida
- High-wind coverage in Colorado.

Property risk insurance also covers the transit of goods, such as material shipped to the project site, particularly for modules and components that are manufactured internationally and are needed during the construction phase or are later returned to the manufacturer for repair.

#### **4.1.3 Environmental Risk Insurance**

Environmental damage coverage indemnifies system owners of the risk of either environmental damage done by their development or preexisting damage on the development site. There are a variety of environmental policies that can cover an assortment of risks (Jones 2001), such as:

- **Pollution legal liability policies** cover the insured from risk with unknown pollution conditions as well as liability for harm caused to persons by the pollution. This type of policy also covers business interruption and transportation claims, but it does not cover the cost of long-term cleanup efforts (Jones 2001).
- **Property transfer policies** transfer the risk from the insured for existing pollution claims and pays for claims under terms similar to Pollution Legal Liability (Jones 2001).
- **Cleanup cost cap or stop loss policies** are customized policies that create a cost stopgap for continued cleanup efforts or for newly found contamination as well as bodily injury. This type of policy does not usually cover property damage or legal costs (Jones 2001).
- **Brownfields restoration and redevelopment policies** indemnify policy owners who are developing projects on sites that are known to be contaminated from ongoing high costs, bodily harm, legal costs, costs for cleaning up of unknown additional pollutants, and property damage (Jones 2001).

Only a few of the major U.S. underwriters, including Chartis (formerly AIU Holdings/AIG), Zurich, and some smaller entities, offer environmental risk coverage (AIG 2009b).

#### **4.1.4 Business Interruption Insurance**

Business interruption insurance is often required to protect the cash flow of the project. This coverage ensures that policyholders can recover:

1. Lost sales as a result of the system not being operational and loss of production-based incentives also resulting from the lack of electricity production

2. Recapture of tax incentives lost because of the project not being rebuilt or not being rebuilt quickly enough.<sup>6</sup>

Projects financed under third-party ownership structures (described in Section 5.1) generally require the procurement of business interruption coverage.

#### **4.1.5 Contractor Bonding and Construction Risk Management**

Construction of PV and other renewable energy facilities entails unique risk properties and solutions. Because of an array of risks related to performance and safety, contractors and sub-contractors are generally required to be bonded (i.e., hold a surety bond to cover liens held for poor performance or misappropriated funds). Banks and insurance agencies provide contractor bonding. However, because of the minimal track record for developing renewable energy systems, all but the largest contractors are often unable to obtain bonding. Project lenders almost universally require that all contractors and sub-contractors be fully bonded relative to the value of work to be completed. Without adequate bonding, contractors may not participate in project development, thus lowering competition for contractor services.

One company, Broadlands Financial Group, LLC (Broadlands), offers a unique alternative to bonding requirements. Services similar to Broadlands' (referred to as construction risk management) negate the need for contractor bonding. Construction risk management is a series of due diligence, system performance, and funds control protocols designed to assess and off-load various risks related to contractor performance. Broadlands' services are offered by a number of competing firms for non-renewable energy projects but—according to the company—Broadlands is the only provider of third-party construction risk management services for renewable energy projects. The company's first renewable energy project was the 64 MW Nevada Solar One facility where they managed \$120 million in construction and more than 100 suppliers and contractors (Broadlands 2009).

Construction risk managers, such as Broadlands, are generally engaged by the lender. The services offered by a construction risk manager include, but are not limited to:

- Reviewing plans and ensuring bid sufficiency
- Assessing contractor financial qualifications (check that the contractor is not overextended)
- Assessing bids to ensure proposed costs are consistent with generally accepted levels
- Establishing bank account similar to an escrow
- Verifying that the work invoiced was completed
- Ensuring funds are properly disbursed to sub-contractors, if relevant
- Coordinating lien releases.

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<sup>6</sup> The federal investment tax credit is realized in the first year that operation begins but vests linearly over the first five years of a project at 20% of the 30% ITC each year (LBNL 2009). Thus, if a project is not rebuilt, the owner must repay the portion of the ITC not yet vested.

According to Broadlands, construction risk management can save up to half the cost of surety bonds, which represent approximately 3.0% of total construction costs. Broadlands guarantees system performance for facilities for which it manages construction risk. And according to the company, the services are available to small installations of approximately \$0.5 million in total development costs.<sup>7</sup>

#### **4.2 Interaction between Insurance and Warranties**

Property insurance typically covers system components beyond the terms of the manufacturer's warranty. For example, if a PV module fails for reasons covered by and during the manufacturer's warranty, the manufacturer is responsible for replacing it, not the insurer. However, if the module fails for a reason not accounted for in the warranty, or if the failure is beyond the warranty period, the insurer must provide compensation for the replacement of the module. In this way, warranties can have a positive impact on insurance premiums as they indemnify the PV system owner in the event a product defect leads to losses.

Although very rare, manufacturers can also seek risk coverage from insurance companies for serial defects on their products. A manufacturer can be held accountable for replacing all products associated with a serial defect. This was the experience of several wind turbine manufacturers during the early 1990s that were unable to maintain adequate quality controls during a period of very high demand. Also, recent examples of massive recalls involved Suzlon wind blades and REC Solar, Inc. solar panels (Greentech Media 2009, CompositesWorld.com 2008). According to one underwriter, warranties can be guaranteed for up to ten years. However, underwriters limit the capacity they will provide to a single manufacturer for serial defects on a specific PV module or component. This type of coverage is therefore specialized and expensive, but it is still available and used in the market. Munich Re, Marsh Insurance Brokers, and Signet Solar recently announced the development of a new insurance product that guarantees the performance of Signet's solar PV modules for 25 years (Signet, Munich Re, and Marsh 2009). This warranty guarantees performance up to 90% of capacity for the initial 10 years and 80% of capacity for the remaining 15 years, which provides greater business certainty for project developers and is expected to lead to more favorable financing and better project economics (Signet, Munich Re, and Marsh 2009).

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<sup>7</sup> At \$5 per watt, this represents a 100 kW system.

## 5 Insurance Issues Specific to the Third-Party Ownership Model

To take advantage of federal financial incentives,<sup>8</sup> developers have structured solar power projects to enable third parties to invest equity and take advantage of the tax benefits. In such a case, the interested third party has “tax appetite” or taxable income that it desires to shelter. And, the solar project developer (potentially the same entity as the equity investor) acts as an intermediary with the customer, providing critical services such as system design, installation, contractual arrangement, and system maintenance. The contract between the project developer and the customer regarding the procurement of the system’s power takes the form of a power purchase agreement (PPA) or, as offered more recently, an operating lease to private entities. This financial and development structure, which is generally referred to as the third-party ownership model, has increasingly become a common, cost-effective means of developing PV and other renewable energy projects.

Because of the increasing importance of the third-party ownership/PPA model, NREL formulated specific questions for interviews held with PV project developers, insurance brokers, and underwriters about the complexities of obtaining affordable insurance products for projects structured this way. According to the interviews conducted, the price and difficulty of obtaining insurance is of significant concern when developing solar PV projects using this model. And some interviewees claimed that the price of insurance has had a “dramatic impact” on the feasibility of certain PV installations and has been high enough to stop development of some facilities. However, underwriters interviewed pointed out that property insurance is directly tied to property values. Therefore, property coverage costs will decrease as PV costs decrease. Also, PV installations have no fuel costs, low O&M costs, and low taxes because of accelerated depreciation. Thus, insurance costs may appear to be high in relation to other operating costs, although they are more reasonable when compared to the total installed cost.

The following section explains the structure of the third-party ownership/PPA model and the particular challenges it poses for third-party owners and developers.

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<sup>8</sup> Federal tax incentives include the investment tax credit (ITC) and accelerated depreciation schedules (Modified Accelerated Cost Recovery System or MACRS).

## 5.1 Third-Party Ownership/PPA Finance Model

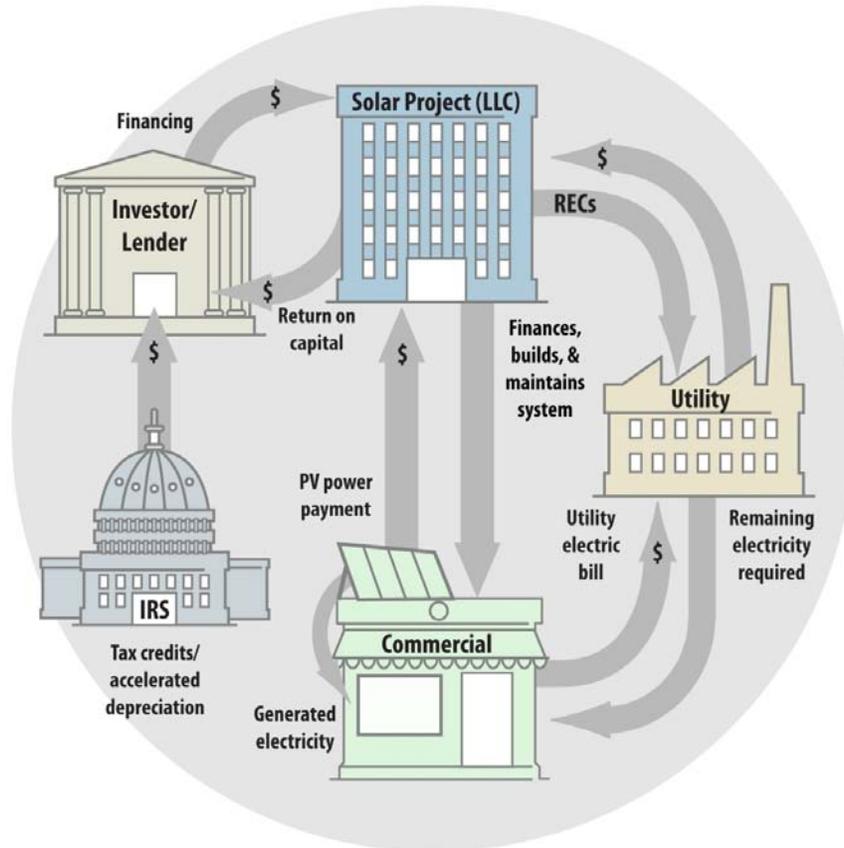
The third-party ownership/PPA model allows a private or public entity to host a system on its property; another entity that can take advantage of the tax benefits (or treasury grant) owns the system. The host enters into a long-term contract (the PPA) with a third party to purchase the electricity generated on its property. The electricity price is typically set at a level competitive with the host's retail rate for the first year and then typically increases at a fixed rate over time. The developer manages all aspects of the system (financing, installation, and maintenance) and bears all operating risks. The developer also monetizes the environmental attributes of the PV system by separately selling the renewable energy certificates (RECs) to an electric utility (generally, the investor-owned utility that serves the customer), allowing the utility to meet its renewable portfolio standard (RPS) as established by the regulating public utility commission. In most cases, the third-party ownership/PPA model incorporates an infusion of equity capital from an external entity seeking to reduce its taxable profits.

The details of the roles and responsibilities of different parties for one variation of the third-party ownership/PPA model are shown in Figure 6. Benefits of the third-party ownership/PPA structure include (Cory et al. 2009):

- **The ability to monetize federal tax incentives** (ITC and MACRS), through a third-party project investor, lowering the overall cost to the host entity
- **Low/no up-front costs** for the site host. Instead, the up-front costs are transferred to the developer and project investors.
- **A pre-determined electricity price for term of contract**, for the portion of load served by the PV system. This typically approximates the customer's current retail rate in the first year and then usually escalates annually.
- **A shift of operations and maintenance responsibilities** to a qualified third-party project developer
- **A path to PV system ownership.** If negotiated as an option in the PPA, the host entity can usually purchase the PV system at some time after year six.<sup>9</sup>

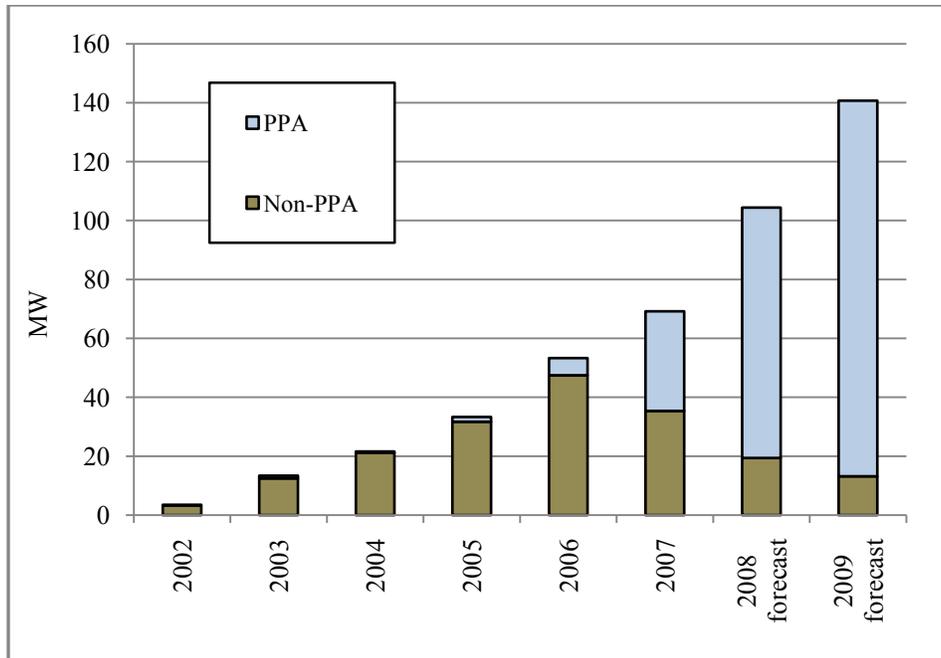
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<sup>9</sup> After year six, the ITC is no longer subject to the recapture rules applied by the IRS.



**Figure 6. Contracts and cash flow in the third-party ownership/PPA model**

Before 2008 was over, Greentech Media estimated that 65% to 70% of the commercial market in that year would use a PPA for PV installations, an increase from previous levels of 50% in 2007 and 10% in 2006 (Greentech Media 2008). Because the third-party ownership/PPA model now represents the majority of commercial and industrial installations, insurance issues relevant to this financial structure are likely to be an important factor for continued development of the solar PV industry.



**Figure 7. Annual commercial PPA PV installations (Greentech Media 2008)**

Developers interviewed who use a third party/PPA financing model indicated they generally develop systems 100 kW or larger; however, one developer seeks projects with a minimum size of 500 kW. Developers tend to focus on medium- to large-scale projects because smaller installations suffer from a lack of economies of scale, and thus are difficult to develop cost effectively. The lack of economies of scale is relevant to smaller projects for reasons beyond insurance, including installation costs, legal fees, maintenance, and other factors. Some developers seek out “structured policies” that are volume-driven (i.e., multiple installations) or scalable to the size of the project.

## **5.2 Insurance Needs Relative to Solar PV Systems**

Under a PPA structure, the unique risks and associated insurance needs are allocated among the various participants. Generally, the developer needs to procure the majority of the insurance products, but each developer may prefer to structure projects in a unique manner.

### **5.2.1 System Owners**

The primary insurance requirements for project developers are property insurance and general liability insurance. Some projects also acquire environmental insurance if environmental issues are associated with the facility site. Separate insurance products are required for the construction period and the operating period. Property insurance protects the owner’s investment in the system itself in case of damage to the insured property. Liability insurance protects against financial losses that result when an insured property damages other property or people. Environmental insurance protects both against environmental damage and personal harm caused by pollution to the property done during development and extant damage discovered during the construction of the project.

The interviews with industry experts revealed that location-specific conditions also affect insurance for PV projects. Certain insurance policy riders, which are often based on geographic considerations, can cost too much and can significantly limit new solar project development. For example, an interviewee from a large solar development company indicated that they do not attempt to develop solar projects in Florida because of the high cost of hurricane-related insurance. Other developers stated that because of price, they forego earthquake insurance in California and hurricane insurance in Florida and “self-insure” against these risks (i.e., do nothing and hope that nothing happens). Others procure separate earthquake or hurricane insurance—as required by third-party investors—and pass the cost to the site host via higher power prices or additional terms of the PPA. Developers that procure projects in these states often reduce their overall exposure by diversifying the locations of their solar installations.

### **5.2.2 Land Owners/Site Hosts**

Depending on the project, specific risks are borne by the property owner. One developer interviewee indicated that for its projects, property owners are only responsible for business interruption insurance. This insurance product generally covers up to one year of business income due to significant property damage associated with the PV installation. Another developer interviewee indicated that it requires all customers (residential and commercial) to incorporate the PV installation into an existing property insurance policy. According to that developer, customers can obtain better quotes from the insurance market and thus lower overall project costs. This can be especially true for federal or state agencies.

### **5.3 Insurance Issues with Third-Party Owned/PPA Projects**

The third-party ownership financing model is prevalent in the solar industry today, and its dominance is expected to continue. Therefore, developers were specifically asked how insurance requirements and premiums have impacted this financing structure.

#### **5.3.1 Risk Assessment under Third-Party Ownership**

Different contract structures applying the third party ownership/PPA model allocate the array of risks to the associated parties in different ways. One underwriter indicated that the strength of the contract between the system host, the developer, and the tax equity investor is very important for determining the types and degrees of risks involved. Some underwriters indicated that they prefer to insure projects that use the third-party PPA model because they view the contract as a positive risk modifier. Other underwriters noted that the contracts vary greatly in content, which can complicate their risk assessment of the project.

### **5.3.2 Conflict between Long-Term PPAs and Short-Term Insurance Premiums**

The third-party ownership model presents a particular challenge to developers when they try to estimate PPA prices for their customers. Insurance products are generally offered for one-year periods, while PPAs are usually offered for 15 to 20 years. Developers cannot determine the cost of insurance two years out, let alone 20. Also, insurance rates can rise on an annual basis during project construction or more likely during project operation. They typically increase to take into account perceived increased risk and inflation. Of course, the increased cost of insurance over time negatively affects project economics. Under these conditions, developers might find it difficult to competitively price their projects to potential customers.

### **5.3.3 Range of Insurance Costs**

Developers estimate the annual cost of insurance to be around 0.25% of the total installed cost of the project, which could be as high as 0.5% annually in areas where extreme weather events are likely. While this sounds quite low, the annual costs do add up over a 20-year contract, especially since annual premiums escalate, usually every year.

In addition, insurance premiums take up a sizable component of the operating budget. One developer indicated that insurance is their biggest operating cost. Another developer indicated the cost of insurance is 25% of annual non-capital costs. While this is less than their annual cost of administration (42%) and operation and maintenance (33%), it is still significant in the context of operating costs for solar PV installations. Although insurance is not the largest operating cost component, it is considered the most uncertain, mainly because the annual premiums can increase significantly if more/larger catastrophic events occur in the region or state than expected. The fact that the developer must estimate these costs up front means that they might hedge themselves to cover the potential costs for the entire 20-year period, based on current-year insurance prices and a significant insurance premium risk escalator.

Property insurance represents the majority of the overall cost of insurance. One interviewee indicated property insurance represents roughly 90% of the total cost of insurance. Another developer indicated 96% of the total insurance budget is allocated to property insurance.

According to one developer, insurance costs 5% to 10% of the total delivered price of energy from the PV installation. The same developer also indicated that lower insurance premiums would make it much easier to increase market penetration. Another developer indicated a low quote for insurance can give a competitive edge when bidding on a project. It was also noted that, historically, a single insurance provider offered coverage for a given project. More bids and better prices have been available to recent projects. Finally, a developer noted that global insurance companies offer better prices than American insurance companies, which have not been as aggressive in trying to underwrite the renewable energy market.

## **6 Insurance Challenges for Renewable Energy Projects**

Obtaining affordable insurance can be challenging for the fledgling renewable energy industry, partly because insurance brokers and underwriters are not as familiar with renewable energy technologies and the associated risks as they are with other technologies they underwrite. Accordingly, only a small niche of the insurance industry serves the renewable energy market. This section explores the specific challenges that solar PV faces when securing insurance.

### **6.1 Unfamiliarity with Solar PV Technologies**

In our interviews, insurance brokers and individual insurance companies consistently viewed insuring PV technologies as an emerging niche market as neither the technical aspects of photovoltaic modules nor the physical infrastructure necessary to support PV – on rooftops or in ground-mount configuration – is widely understood.

Moreover, the solar PV market is booming with new producers and technology. While this boom encourages technological innovation, it complicates underwriting. Many insurers do not have the “risk appetite” (i.e., do not feel it is economic to assume this risk) for PV products that they consider “prototypes.” The definition of “prototype” varies depending on the insurer. Definitions of prototype vary from a solar PV system that has been operating for less than a year to a technology that has not yet been commercially manufactured. The following lists some views from insurance underwriters and brokers on the definition of a prototype that were offered during interviews.

## *Insurance Industry Definitions of Solar PV Prototype*

Fewer than 3,000 total hours of actual time in operation per manufacturer's product (e.g., Sharp PV panel model; First Solar PV panel #)

A range of 3,000 total hours of actual time in operation (for PV and technologies without moving parts) to 8,000 total hours of actual time in operation (for wind and natural gas power plants, i.e., anything with moving parts)

Any technology that is commercially unproven and has not been deployed widely

A technology that is not commercially deployed even if it has one or more full-scale examples installed

Any product with fewer than 8760 hours or one year's worth of operational data

### **6.2 Lack of Test Data for Prototypes**

Although there is not a strict definition of PV product prototype, underwriters are clearly uncomfortable with accepting the risks associated with prototypical technologies at normal premium rates. Several underwriters indicated that to understand fully the risks associated with an installation, they need high-quality data on specific modules presented by company and module number. Thus, data on the performance of certain technologies or various products produced by a company would not help underwriters of different products in their risk assessments.

Often, test data are for "bench-scale" facilities and not full-scale installations. However, developing full-size test installations for every module design can be expensive for developers or manufacturers. In Section 7, we discuss potential opportunities for NREL and DOE to facilitate improved testing capabilities for new module design. Additionally, once a solar technology goes beyond being a prototype (at least a year of operation), one or more additional years may be required for the technology to be considered "proven." Nonetheless, even time series data for less than a year would be helpful, according to underwriters interviewed for this analysis.

### **6.3 Lack of Historical Loss Data**

Risk assessment and pricing requires access to and statistical evaluation of large quantities of verifiable data; the industry uses its analysis of various data (e.g., operational and loss history data) to calculate the probabilities of property, liability, environmental, and other losses. As a nascent industry, the solar industry has relatively little data with which it can assess risks. Some insurers with subsidiary or sister companies in Europe can apply their historical loss data to U.S. applications, assuming they are applicable under similar circumstances. U.S.-based companies without access to such information may be unwilling to pursue renewable energy projects. The absence of loss history data limits the ability of insurance underwriters to assess clearly the risks of insuring solar PV systems. As a conservative industry, the insurers will therefore add a risk premium so that they can be sure to cover any potential risks. Greater access to data will allow the insurance industry to assess more accurately the risks associated with PV facility development and operation and will lead to more accurate insurance premiums.

### **6.4 Poor Classification of Renewable Energy Entities**

Interviewees indicated entities in the renewable energy industry are not properly delineated in existing business classification protocol. For example, manufacturers are classified via Standard Industrial Classification (SIC) and North American Industry Classification System (NAICS) codes, which should be unique to manufacturers of renewable energy components and systems, according to interviewees. Additional delineation—perhaps through an incremental coding system—could allow insurance underwriters to better assess insurance claims related to workers' compensation claims and the associated operating loss data for the renewable energy industry. Interviewees made similar comments with respect to renewable energy project installation, development, and ownership. Insurance industry professionals described generally poor comprehension of entities' business models and the associated risks, which they attributed to poor data collection classifications and risk assessments specific to the renewable energy industry.

### **6.5 Inadequate Testing**

Several interviewees indicated the need for more testing of modules prior to commercialization and better comprehension of risks through scientific evaluation. At present, Underwriter Laboratories (UL) and other organizations (including NREL) test modules and inverters for various risks and performance characteristics. However, both insurance and solar industry representatives recognized the need for more evaluation of different stresses on PV systems, including wind, hail, and extreme temperatures as well as the need for improved coordination of standards and procedures in testing. Members of the insurance industry interviewed would like to see the testing data for a full year for each type of module made by each PV manufacturing company.

### **6.6 Inadequate Catastrophic Risk Models**

Several underwriters indicated that catastrophic risk models are an important part of the risk assessment process. A handful of risk modeling companies develop and produce these risk models exclusively for the insurance industry. Underwriters use these tools either to predict risk based on related criteria or historical loss performance.

Risk Management Solutions (RMS), AIR Worldwide, and EQECAT are among the few major providers of catastrophic risk management models who develop industry-leading predictive software. The models employ modular design to assess the type of occupant and exposure to catastrophic risk, including the likelihood of severe weather events such as earthquakes, storm-strength winds, and floods. The RMS model, for example, evaluates risk based on 32 categories of occupancy and predicts occupancy and liability risk based on mathematical computations of risk scenarios (e.g., how likely a Category 3 hurricane is to occur in a given location and cause equipment damage, business interruption, loss of life, and dismemberment).

The RMS model aggregates all rooftop equipment (such as air conditioners and PV panels) into a single category of relevance that represents RMS's customers for the underwriters. The RMS software also evaluates various manufacturing facilities, including energy production facilities. The model groups energy projects into subsets, including nuclear, fossil, transmission and distribution lines, switchyards, and renewable projects. The model does not distinguish the type of renewable project. The risk models used by the insurance industry could be improved by providing both access to more extensive operational history and better distinctions of rooftop equipment, including design of specific PV modules, installation techniques, and relevant equipment.

### **6.7 Lack of Solar PV Installer Certification**

As the PV industry has grown quickly, the number of PV installers has also grown. Several developers raised concerns that contractors (e.g., electricians and plumbers) working on PV projects often have no formal solar PV installation training. Although thorough voluntary training is available through the North American Board of Certified Energy Professionals (NABCEP), there is no mandatory certification program for installers of solar PV systems. Both developers and insurance underwriters raised quality and safety concerns regarding the lack of consistent certification of contractors and sub-contractors.

## 7 Recommendations and Solutions

A range of policies could be implemented to increase the availability of information, improve the comprehension of the associated risks, and—in time—lead to better availability and lower cost of insurance products.

### 7.1 Improved Information Regarding Solar PV

Specific government policies and assistance can improve the availability of information relevant to the insurance and solar industries. In this section, we explore opportunities to increase the flow of information about solar PV.

#### ***7.1.1 Improved Solar Technology Information Dissemination to the Insurance Industry***

The insurance industry is—almost by definition—risk averse, and thus slow to expand their coverage into unfamiliar terrain. Because the solar industry is evolving quickly and many of its technologies and components are highly technical, maintaining current understanding of the industry can be difficult. Education of the insurance industry (including the technologies available and the installations and operational track records of facilities) could reduce the perception of risk. Specific educational products and services targeted toward the insurance industry could bridge information gaps and lead to more competition among insurance companies vying for PV underwriting opportunities, which could in turn lead to reduced cost of various insurance products.

#### ***7.1.2 Improved Availability of Solar PV Historical Loss Data***

The insurance industry, by definition evaluates and quantifies risk, which requires intensive study of data. As the PV industry is still in its infancy, gathering high-quality, long-term data regarding system performance, property loss, liability, and other factors is difficult. One company, Fat Spaniel Technologies, is assembling a database of PV system experience. Fat Spaniel, a corporation that electronically monitors 2,000 mostly larger renewable energy systems around the world, refers to its product as an “asset management application.” Aggregated data from such continual monitoring systems could be used to assess historic loss data and associated insurance claims.

However, more could be done to assemble and evaluate historical operating data for PV systems. Specifically, the DOE could play a valuable role in working with industry associations, system installers, and operators to assemble data and evaluate the availability and operating statistics, type of module and inverter technology deployed, geographic location, facility orientation, building type, and installation design. For example, by increasing the aggregate information available to the insurance industry, the resulting database tool could lower perceived risk and reduce insurance premiums. Such a database could also inform the market to implement the most productive solar facilities possible given other relevant criteria.

Even if the industry were not interested in partnering, the DOE would likely be able to gather high-quality performance data from PV installations whose developers qualify and who opt to take the federal Treasury Cash Grant in lieu of the federal ITC. This is a result of the DOE requirement that qualifying PV installations report performance in kilowatt-hours annually for five years (Treasury 2009). While this data may be a starting point, it will not provide information regarding the types of losses incurred at the various installations, which is of most use to insurance underwriters.

### **7.1.3 Improved Classification of Renewable Energy Entities**

Further investigation of the classification of renewable energy component manufacturers and system developers, installers, and owners is warranted. Manufacturing entities are classified by the NAICS, which is organized by the National Technical Information Service (NTIS), a branch of the Department of the Commerce. The last NAICS classification was published in 2007 and is based on information prior to 2005.<sup>10</sup> The NAICS groups numerous industries under each code. For example, the code for alternative energy structure construction (# 237130) also covers cable laying, nuclear power plant construction, and microwave relay tower construction. Solar energy power generation via photovoltaics (# 221119) shares the same code with wind, tidal, and concentrating solar power generation.

SIC codes, which were created in 1937, are administered by the Occupational Safety and Hazard Administration of the Department of Labor. The four-digit system, which was generally replaced by the six-digit NAIC system in 1997, is still used by certain agencies such as the U.S. Securities and Exchange Commission. Insurance entities have difficulty gathering and assessing claim and loss data to properly determine the associated risks and price-relevant insurance products. Work could be done with the U.S. Departments of Commerce and Labor to improve the NAICS and SIC code definitions, which would improve the accessibility and specificity of data that are necessary and relevant to the insurance industry.

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<sup>10</sup> The 2007, NAICS was described as including all of the U.S. Economic Classification Policy Committee recommendations for revision presented (FR 70 12390-12399). For more information, see <http://www.ntis.gov/products/naics.aspx>.

#### **7.1.4 Module and Component Testing**

When bringing solar modules and other components to market, it is important for manufacturers to certify the capability of their products under a variety of conditions. Testing by the Underwriters Laboratory (UL) is required to ensure safe operation. While the UL test addresses safety, it does not attempt to ensure performance.<sup>11</sup> The California Energy Commission (CEC)<sup>12</sup> and many other U.S. organizations require safety testing to UL 1703 but do not require qualification testing. The International Electrotechnical Commission (IEC) introduced a series of test procedures (IEC 61215 for crystalline silicon (Si) modules, IEC 61646 for thin-film modules, and IEC 62180 for concentrating PV modules) that is gaining recognition as the standard certification procedure. The IEC procedures, which include 18 tests of PV modules and other solar components, apply various stresses to the modules to identify design flaws that could lead to early failures. These tests are consistently required for installations in Europe. An effort is underway to require both safety and qualification testing within the United States to improve the consistency of performance by PV products in the field.

At present, most European organizations require IEC 61215 for any Si-based modules being brought to market.

California, which aggressively supports PV deployment, requires UL testing (1703) by a nationally recognized test laboratory and additional performance-parameter testing at an International Laboratory Accreditation Cooperation (ILAC) affiliated laboratory. Only four U.S. laboratories conduct the testing on PV equipment required by the CEC:

- Florida Solar Energy Center
- Intertek Testing Services NA, Inc. (formerly known as ETL)
- TÜV Rheinland PTL, LLC (formerly known as ASU/PTL)
- UL Photovoltaic Technology Center of Excellence

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<sup>11</sup> Sarah Kurtz, National Renewable Energy Laboratory, personal communication, April–September 2009.

<sup>12</sup> The CEC requires testing for modules to be eligible for incentives offered by the California Solar Initiative, which are available to all market segments except for new home construction. For more information, see [http://www.californiasolarcenter.org/pdfs/utility/sb1/PV\\_ELIGIBILITY\\_PROCEDURE\\_20090605.pdf](http://www.californiasolarcenter.org/pdfs/utility/sb1/PV_ELIGIBILITY_PROCEDURE_20090605.pdf).

The complete list of national and international testing laboratories that offer the certification required by the CEC is provided in Appendix C.

NREL conducts a variety of tests on PV modules but does not provide certification services with respect to IEC 61215, IEC 61646, or IEC 62180. NREL's testing capabilities are available to cell and module manufacturers, but funding for such services must be provided by the private sector entities. However, cost recovery from module manufacturers is an overly complex process requiring extensive paperwork.<sup>13</sup> NREL and the DOE are working on improving the certification service charge process to enable NREL to expand the availability of these services.

Aside from certification procedures, there is a broader need for testing capabilities of near-market technologies. While certain public-private partnerships develop materials and components, there is no definitive method by which new technologies or technology combinations can be displayed to potential developers in the United States who may be interested in using the products. Fortunately, the Solar Technology Acceleration Center (SolarTAC)—a testing facility offering land and development infrastructure—is in development in Aurora, Colorado. The facility, which is expected to be complete by end of 2010, offers “founding members” five acres of research space, certain site infrastructure, and the opportunity to collaborate with other members. At present, founding membership is limited to Abengoa Solar, SunEdison, and Xcel Energy.

NREL is limited in its participation in SolarTAC because of restrictions on paying membership fees using DOE funds. Moreover, SolarTAC's location in Colorado effectively eliminates testing for higher humidity environments, such as the southeastern United States. Beyond the capabilities of SolarTAC, module manufacturers need to showcase their technologies in commercial-scale projects, including by interconnecting to the grid. The financial community generally wants to fund only projects that have been tested in commercial contexts. Even as government incentives (such as Treasury grants and DOE loan guarantees) provide significant financial support to new PV projects, developers and financiers have minimal desire to incorporate untested technologies in projects. NREL and DOE could play an important role by developing projects in partnership with manufacturers of promising—but untested—technologies. In doing so, NREL could provide a range of technology-related services to assist in commercial deployment and speed access to capital, insurance products, and related market services.

## **7.2 Industry Standards for Installers**

As the industry grows quickly, the number of installers has grown quickly as well. NABCEP offers a voluntary certification process “by which PV installers with skills and experience can distinguish themselves from their competition. Certification provides a measure of protection to the public by giving them a credential for judging the competency of practitioners. It is not intended to prevent uncertified individuals from installing PV systems or to replace state licensure requirements” (NABCEP 2009).

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<sup>13</sup> Sarah Kurtz, National Renewable Energy Laboratory, personal communication, April–September 2009.

NABCEP recently established PV installer certification and its newer solar thermal installer examination<sup>14</sup> in 22 locations throughout North America. These exams are intended to recognize significant experience and expertise of solar professionals. In addition to its full practitioner certifications, NABCEP also offers an entry-level “Certificate of Knowledge” program for solar PV systems.<sup>15</sup> According to the NABCEP, 1,048 individuals have been awarded its Solar PV Installer Certification.

Several states require contractors to be NABCEP-certified for rebate approval (Coughlin 2009).<sup>16</sup> Extended reliance on the NABCEP certification process could increase quality and reduce accidents, thus leading to reduced insurance premiums. In addition, opening communication among the insurance industry, the DOE, and the development community could lead to better-understood and improved guidelines, and thus lower costs of insuring PV systems.

### **7.3 Federal Liability Protection**

The DOE might be able to lower the cost of insurance for renewable energy companies by providing limited protection from liability for relevant companies if it has this authority. The U.S. Department of Homeland Security (Homeland Security) offers limited liability protection for “anti-terrorism technologies” via the SAFETY Act (Subtitle G of the Homeland Security Act of 2002),<sup>17</sup> which is designed to encourage the development of “anti-terrorism technologies” by providing manufacturers and sellers of these technologies with limited liability. The concern is many companies may not “invest” in these technologies without the SAFETY Act. A similar liability protection could be offered to renewable energy companies (including developers, installers, and manufacturers) to promote investment and implementation in this area. Or, Homeland Security could provide renewable energy projects with limited liability if the case could be made that PV is an anti-terrorism technology that qualifies under the SAFETY Act.

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<sup>14</sup> For more information about the PV installer certification, see <http://www.nabcep.org/certification/pv-installer-certification>. For more information about the solar thermal installer certification, see <http://www.nabcep.org/certification/solar-thermal-installer-certification>.

<sup>15</sup> For more information, see <http://www.nabcep.org/certificates/entry-level-certificate-program>.

<sup>16</sup> Jason Coughlin, National Renewable Energy Laboratory, personal communication, September 2009.

<sup>17</sup> The SAFETY Act refers to the “Support Anti-terrorism by Fostering Effective Technologies Act.”

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## Appendix A: Interviewees

The following contact information is for insurance brokers, underwriters, solar developers, and other organizations that agreed to be acknowledged for participating in interviews for this report.

### **Insurance Brokers**

#### **Edgewood Partners Insurance Center**

John Greenfield, Principal  
2000 Alameda de las Pulgas  
Suite 101  
San Mateo, CA 94403  
Tel: 650-295-4618  
[jgreenfield@edgewoodins.com](mailto:jgreenfield@edgewoodins.com)  
[www.edgewoodins.com](http://www.edgewoodins.com)

#### **Hub International Insurance Services**

Charles A. Leone  
400 Taylor Blvd. #300  
Pleasant Hill, CA 94523  
Tel: 925 609-6560  
Tel: 415 272-7530 (m)  
[Charles.Leone@hubinternational.com](mailto:Charles.Leone@hubinternational.com)

#### **Marsh**

Tel: 212-345-6000  
[global.marsh.com/](http://global.marsh.com/)

### **Insurance Underwriters**

#### **Chartis**

[marineandenergy@chartisinsurance.com](mailto:marineandenergy@chartisinsurance.com)  
[www.chartisinsurance.com/us-advanced-energy-solutions-group\\_295\\_182636.html](http://www.chartisinsurance.com/us-advanced-energy-solutions-group_295_182636.html)

#### **Chubb Group**

15 Mountain View Road  
Warren, NJ 07059  
Tel: 908-903-2000  
Fax: 908-903-2027  
Telex: 299719  
[www.chubb.com](http://www.chubb.com)

#### **GCube Insurance Services Inc.**

3101 Westcoast Highway, Suite 100  
Newport Beach, CA 92663  
Tel: 760-880-1646  
[info@gcube-insurance.com](mailto:info@gcube-insurance.com)  
[www.gcube-insurance.com](http://www.gcube-insurance.com)

#### **The Hartford**

Drake Manning, Director  
Strategic Design-Renewable Energy  
One Hartford Plaza  
Mailstop CO 1-46  
Hartford, CT 06155  
Tel: 860-547-9517  
[drake.manning@thehartford.com](mailto:drake.manning@thehartford.com)

#### **The Hartford**

James Gardiner, Assistant Vice President  
Industry Markets  
One Hartford Plaza  
Mailstop CO 1-46  
Hartford, CT 06155  
Tel: 860-547-7994  
[james.gardiner@thehartford.com](mailto:james.gardiner@thehartford.com)

#### **Starr Technical Risk Agency, Inc.**

Jim Devon, Vice President/Regional Manager  
3353 Peachtree Road NE, Suite 1000  
Atlanta, GA 30326  
Tel: 404-946-1435  
Tel: 770-313-8633 (m)  
[james.devon@cvstarrco.com](mailto:james.devon@cvstarrco.com)  
[www.cvstarrco.com/cv/starrtech](http://www.cvstarrco.com/cv/starrtech)

**Solar Developers****MMA Renewable Ventures**

621 E. Pratt St., Suite 300

Baltimore, MD 21202

Tel: 443-263-2900

Fax: 410-727-5387

[mmarenew.com](http://mmarenew.com)

**SunPower**

Corporate Headquarters

3939 N. 1st Street

San Jose, CA 95134

Tel: 408-240-5500

Fax: 408-240-5400

[us.sunpowercorp.com](http://us.sunpowercorp.com)

**Suntech Energy Solutions**

71 Stevenson Street, 10th Floor

San Francisco, CA 94105

Tel: 866-966-6555 (toll free)

Tel: 415-882-9922

Fax: 415-882-9923

[sales@suntechamerica.com](mailto:sales@suntechamerica.com)

[www.suntech-power.com](http://www.suntech-power.com)

**Tioga Energy**

2755 Campus Drive, Suite 145

San Mateo, CA 94403

Tel: 877-333-9787 (toll free)

Fax: 650-288-1011

**Others****Fat Spaniel Technologies**

2 W. Santa Clara Street, 5th Floor

San Jose, CA 95113-1824

Tel: 408-279-5262

Fax: 408-516-9111

[www.fatspaniel.com](http://www.fatspaniel.com)

**RMS**

7015 Gateway Blvd.

Newark, CA 94560

Tel: 1-510-505-2500

Fax: 1-510-505-2501

[info@rms.com](mailto:info@rms.com)

[www.rms.com](http://www.rms.com)

## **Appendix B: Interview Questions**

### **Questions for Solar Power Generation Owners/Developers and Installers**

#### ***Liability/Property***

1. From an installer's perspective, which insurance products are barriers for larger-scale solar PV systems/developments (e.g. property, liability)?
2. How often and to what degree do insurance premiums affect the feasibility of third-party installations?
3. Is there a threshold in system size beyond which insurance becomes a greater issue?
4. What insurance companies/brokers do you typically work with? Who do you prefer to work with and why?
5. Is it true that under a third-party power purchase agreement (PPA), the owner—not the host—has to get both property and liability insurance?
6. What are the primary reasons for—or drivers of—property insurance requirements (e.g., property/building policies, utility demands, interconnection standards)?
7. What are the main risks covered by a property policy (e.g., theft, business interruption, shipping)?
8. What are the primary reasons for—or drivers of—the liability insurance requirements? (e.g., utility demands, interconnection standards, property/building policies)?
9. What are the main risks covered by liability (e.g., worker's compensation, damage to other property/persons, environmental risk)?
10. Are there any differences with liability or property policies with the third-party lease model? For instance, maybe the third-party owner gets the property insurance and the host gets the liability insurance?

#### ***Other Risks***

11. To what degree do guaranties against the following risks play into renewable energy projects?
  - Construction phase: Construction/completion Risk; counterparty risk
  - Operation phase: Performance risk; counterparty risk; Fuel supply/weather resource risk; credit risk
  - All phases: Workers' compensation; auto; financial risk; political risk; force majeure risk, e.g. hurricane, fire, wind

#### ***Costs/Price***

12. Which costs more: the property insurance against damage or the liability insurance to protect utility workers?
13. Can you give a percentage breakdown for the two, as well as a percentage of total project costs that are needed annually?

14. How does this affect the end-user (consumer) price?
15. Do insurance companies have adequate information?

### ***Adequate Information***

16. Do you feel that insurance companies and/or brokers lack adequate information about solar PV systems? If so, what do they need help with?
  - Liability: Potential risks associated with system operation? Adequacy of interconnection standards?
  - Property insurance: Technology risks? Ability to withstand weather concerns?
  - Other risks?

### ***Warranties***

17. Do you or your manufacturers offer warranties? What is the typical duration?
18. What does the warranty cover (e.g. labor, equipment.)?
19. Do the warranties ever substitute or diminish the need for insurance? Do the warranties ever reduce premiums?

### ***Installers***

20. Do your installers have special certification for putting in place solar PV systems?
21. If so, does this help lower premiums for workers' compensation or any other insurance products?

### ***Best Practices***

22. Have particular states or utilities been easier or harder to work with in regards to insurance? Could you point to one that uses a best practice?

### ***What can we do?***

23. Are there any activities you would recommend the Department of Energy and the National Renewable Energy Laboratory undertake to address these barriers?
  - Gathering of historical loss data?
  - Technical information to dispel any myths about PV technology?
  - Certification for installers?
  - Warrantee guarantee backup by the DOE?
  - Product testing for life expectancy? Wind resistance?
  - Testing prototypes?
  - Helping to create catastrophic loss models for PV

### ***What can you do?***

24. Can you aggregate data in an anonymous fashion?

### **Questions for Insurance Underwriters and Brokers**

1. Do you offer both property and liability insurance for solar PV?

### **Property**

2. What are the primary drivers of property insurance requirements with solar PV systems (e.g., system owners, utility and state requirements, utility demands, interconnection standards, property/building policies)?
3. What is the property insurance protecting?

### **Liability**

4. What are the primary sources of liability insurance requirements with solar PV systems (e.g., utility and state requirements, interconnection standards, system owners, property/building policies)?
5. What does liability insurance protect?

### **Other Risks**

6. To what degree do guaranties against the following risks play into renewable energy projects?
  - Construction phase: Construction/completion risk; counterparty risk
  - Operation phase: Performance risk; counterparty risk; fuel supply/weather resource risk; credit risk
  - All phases: Worker's compensation; auto; financial risk; political risk; force majeure risk, e.g. hurricane, fire, wind

### **Solar Industry**

7. What is your view of the industry?
8. How do you define a prototype? Does this definition include a minimum number of hours of operation? Commercialization?
9. How do you feel about research and development? Testing?
10. What is the interaction between insurance and warranties? Do any warranties reduce insurance premiums?

### **Special Insurance Issues with Third-Party Ownership**

11. Are you aware of any special issues—or advantages to—underwriting policies that use the third-party PPA ownership model?
12. Are there any additional issues with the third-party purchase price variance (PPV) *lease* model?

### **Competition**

13. Who are your competitors in financing solar PV projects?
14. Are there recognizable industry leaders for this niche? Are they different for property insurance and liability insurance?

### **Adequate information**

15. Do you feel insurance companies have adequate information for understanding the insurance needs of solar PV technology?
16. How much experience do you have with PV technology? Do you have specific concerns?

17. Do you feel that others within your industry have appropriate knowledge about these technologies?
18. Are there challenges in understanding this technology? Like what? What information would help you?
19. What sources of historical loss data are used to assess the risk of solar energy installations?
20. Is information from Japan and Europe used?

### **Costs**

21. What model or standards are used to establish the pricing, e.g. RMS, NAICS codes? Property? Liability?
  - Which costs more, the property insurance (i.e., against damage) or the liability insurance (i.e., to protect utility workers)?
22. Can you give a percentage breakdown between the two, as well as a percentage of total project costs that are needed annually?
23. How does this affect the end-user (consumer) price?

### **DOE's Role**

24. Are there other issue areas where DOE could play a role (e.g. certification, testing)?

## Appendix C: Solar PV Testing and Certification Laboratories

The following is a non-exhaustive list of laboratories affiliated with International Laboratory Accreditation Cooperation (ILAC), an “international cooperation of laboratory and inspection accreditation bodies formed more than 30 years ago to help remove technical barriers to trade.” See <http://www.ilac.org/> for more information. The asterisks (\*) indicate the four laboratories that conduct the performance-parameter testing on PV equipment that is required by the California Energy Commission.

### **Bodycote**

2395 Speakman Drive  
Mississauga, ON, Canada  
L5K 1B3  
Tel: 905 822-4111  
Fax: 905 823-1446  
[www.bodycote.com](http://www.bodycote.com)

### **CIEMAT – PVIabDER**

Avda. Complutense, 22, 28040  
Madrid, Spain  
Tel: 34-91-3466745  
Fax: 34-91-3466037

**Electronics Test & Development  
Centre (IEC 61215 ONLY)**  
Ring Road, Peenya Industrial Estate  
Peenya, Bangalore 56058,  
India **Error! Hyperlink reference  
not valid.**

### **European Solar Test Installation**

210 20 Ispra, VA, Italy  
Tel: 39-0332-7869145  
Fax: 39-0332-789268

### **Eurotest Laboratori SrL**

Via dell'Industria, 18 35020 Brugine  
(PD)

### **\* Florida Solar Energy Center**

1679 Clearlake Road  
Cocoa, FL 32922-5703  
Tel: 321-638-1000  
Fax: 321-638-1010

### **Fraunhofer ISE**

Institut für Solare Energiesysteme  
Heidenhofstr. 2  
79110 Freiburg, Germany  
Tel: +49 (0) 7 61/45 88-0  
Fax: +49 (0) 7 61/45 88-90 00  
[www.ise.fraunhofer.de](http://www.ise.fraunhofer.de)

### **Fundacion Cener—CIEMAT**

*(IEC 61215 ONLY)*  
Avda. Ciudad de la Innovación nº 7  
31621- Sarriguren, Spain  
Tel: 34-948-25-28-00  
Fax: 34-948-27-07-74  
[info@cener.com](mailto:info@cener.com)

**\* Intertek Testing Services NA,  
Inc.** (formerly known as ETL)

### **JET**

5-14-12 Yoyogi, Shibuya-ku  
Tokyo, 151-8545  
Tel: 81-3-3466-5234  
Fax: 81-3-3466-9219  
[Tokyo@jet.or.jp](mailto:Tokyo@jet.or.jp) (technical)  
[info@jet.or.jp](mailto:info@jet.or.jp) (others)

### **Metrology & Testing Center of China**

Electronics Technology Group  
Corporation  
No. 18th Research Institute

**PI Photovoltaik Institut Berlin AG**

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Tel: 49-30-3142-5977

Fax: 49-30-3142-6617

[info@pi-berlin.com](mailto:info@pi-berlin.com)

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Tel: 49-(0)221-806-0

Fax: +49 (0)221 806 114

[internet@de.tuv.com](mailto:internet@de.tuv.com)

**TÜV Rheinland Japan**

Shin Yokohama Daini Center Bldg.

3-19-5 Shin Yokohama, Kohoku-ku

Yokohama 222-0033

**TÜV Rheinland PTL, LLC**

(formerly known as ASU-PTL)

2210 South Roosevelt Street

Tempe, AZ 85282

Tel: 480-966-1700

[info@tuvptl.com](mailto:info@tuvptl.com)

[www.tuvptl.com](http://www.tuvptl.com)

**\* UL Photovoltaic Technology**

**Center of Excellence**

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<b>13. SUPPLEMENTARY NOTES</b>					
<b>14. ABSTRACT (Maximum 200 Words)</b> Insuring solar photovoltaic (PV) systems poses certain challenges. Insurance premiums, which can represent a significant part of overall costs for PV developers, can affect market competition. The market for certain types of insurance products is limited. Historical loss data is lacking, and test data for the long-term viability of PV products under real-life conditions is limited. Insurers' knowledge about PV systems and the PV industry is uneven even as the industry introduces innovative contractual structures and business models. Interviews conducted for this report with PV project developers, insurance brokers, and underwriters suggest government actions aimed at better testing, data collection, and communication could facilitate the development of a market for PV insurance products. This report identifies actions by governments, national laboratories, and other stakeholders that could accelerate the development of insurance products in support PV systems. Such actions include: increasing understanding of the solar PV industry among insurance professionals; expanding the availability of PV historical loss data; evaluating the expansion of renewable energy business classification; developing module and component testing capabilities and services offered by federal labs; and, advancing industry standards for PV system installers.					
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