UNEP e-Learning Course on

Insurance Risk Management for Renewable Energy Projects

Module 3 – Underwriting Guidelines and Policy

Overview

The training is organized in 6 modules and fits into a two day training schedule:

Module	Main Content	Length of Module
1 – Climate Change	Briefing, policy frameworks and business impact	2 hours
2 – Renewable Energy Technologies and Risks	Renewable Energy technologies policy, investment trends and risks	3 hours
3 – Underwriting Guidelines and policy	**Underwriting information, guidelines, risk evaluation, coverage evaluation**	**5 hours**
4 – Claims handling and policy	Claims information, management, reserving, legal and payment	2 hours
5 – Intermediaries and networks	Project development, information and consultation	1 hour
6 – Case study	Renewable Energy case study, risk assessment, impact and suitability of instruments	3 hours
Total		16 hours

Module 3 Contents

Lesson Objectives	
Underwriting principles	**To provide an overview of the basic underwriting principles and guidelines that are considered in the context of insurance underwriting.**
Insurance availability	**To explain the main insurance offerings for RET.**
Specific consideration for RET	**To describe specific considerations for the four primary RET: wind, hydro, solar and biomass.**

Introduction

Insurance for Renewable Energy Technologies (RET) follows the same structure and processes as do traditional insurance interests such as energy power plants and machinery. The same underwriting principles and guidelines apply. A clear underwriting philosophy, reliable pricing mechanisms and stable underwriting guidelines are required elements to successfully insure RET.

RET insurance products cover the main lines of insurance such as property, engineering, marine, energy and liability. Additional special types of insurance can be made available; such as credit, political and weather risks, Errors & Omission (E&O), and Directors & Officers (D&O) are underwritten, carbon and CDM registration insurance.

For RET, there are no new underwriting processes and guidelines. The basic information required for diligent underwriting of RET is mainly the same as for traditional businesses such as machinery or energy installations.

RET poses some specific risks and barriers. Technologies applied are relatively new and the available expertise and actuarial data is still low. There are few standard products and underwriting is primarily done on a case-by-case basis.

Some specific underwriting considerations for wind, hydro, solar and biomass apply. The remainder of the module walks through these specific requirements and introduces standard insurance application forms for these four RET.

Section 1 – Basic Underwriting Principles

This section provides an overview of the main ingredients of successful underwriting, understanding the market mechanisms, applying sensible pricing and reliable underwriting guidelines. This also fully applies for RET.

Section 2 – Basic Insurance Product Offerings for RET

This section covers the available basic insurance offerings for RET. Products offered are property, marine, engineering, energy and liability. Also special lines such as crime, E&O, D&O and credit, political, weather risks and emission reductions are considered in the context of RET offerings.

Section 3 – Basic Underwriting Process and Guidelines

This section provides an overview of the basic underwriting process and guidelines and gives a short introduction into the main standard information elements required for underwriting as well as the basic guidelines and clauses that normally are applied in insurance underwriting.

Section 4 – Risks and Barriers in RET Underwriting

This section lists the main risk and barriers for RET underwriting. Key barriers for RET underwriting include the missing expertise and lack of actuarial loss data.

Sections 5 through 8 – Specific Considerations for Different Technologies

This section introduces the specific underwriting requirements for Wind, Hydro, Solar and Biomass.

1 Basic Underwriting Principles

Insurance is used to hedge against the risk of a contingent loss triggered by a physical, human or natural peril. The insured transfers a defined risk of a loss in exchange for a premium, which is an insurance rate used to determine the amount to be charged for a certain amount of insurance coverage. An insured is thus said to be "indemnified" against the loss events covered in the policy.

Insurers underwrite risks within clear constraints. Their available equity or surplus is limited and thus the risk-taking capacity cannot exceed a certain amount. Also, certain regulatory and legal limitations apply, especially in emerging and developing countries. Risks that qualify for underwriting must be diligently assessed, rated and priced.

Any insurance company relies on an underwriting philosophy, and is confronted with specific market conditions. The market conditions are defined by the insurance cycle. The degree of understanding of the insurance cycle will influence the risk appetite of the insurer and insured.

Risk Philosophy	The risk philosophy describes the balance between risk taking, risk tolerance, risk management and risk ownership.

Insurance Cycle	Non-life insurance business is characterized by the insurance cycle. The insurance cycle refers to the periodic oscillation of the market between "*soft*" and "*hard*" phases. The *soft market* is characterized by decreasing premiums, less capital and less competition. The *hard market* exhibits growing premiums, new capital influx and more stringent underwriting guidelines. A hard market can be triggered by a large loss event such as natural catastrophes. A soft market follows the hard market once the insurance market is saturated, that competition has taken off and premiums has started to decline.

Taking risks is the core of the insurance business. The key challenge for the insurers is to balance the risk appetite and the risk tolerance in a sustainable way:

- The risk appetite is the additional marginal amount of risk a company is willing to accept in order to gain a business benefit.
- The risk tolerance is the setting of a maximum exposure level an insurance company is willing to accept in order to be able to meet all of its obligations. Normally this is the surplus capital or the available risk capital.
- Risk management is the process of defining the project's objectives, assessing, reporting, deciding on, treating and monitoring the risk.
- Risk ownership refers to the ultimate owners of the risk. In an insurance company these are the shareholder representatives in the Board of Directors and their delegates in the Executive Team. In a project these are the project sponsors.

The cycle Management is the active management of the insurance cycle. Depending on the state of the market (soft or hard) different underwriting policies will apply. Normally in a soft market, the following guidelines are suggested:

- Set premiums in a prudent and risk-based way;
- Install state-of-the-art risk management tools;
- De-link underwriting from available surplus or high investment returns;
- Redeploy capital to sustainable insurance lines and implement smart incentives.

Depending on the frequency and severity of the losses, different insurance mechanisms will apply. For low-severity and low-frequency events, self-insurance or risk retention is used. National insurance markets are strongly positioned for high-frequency and low- to mid-severity events. Higher severity risks are covered by international insurance and reinsurance groups. The highest severity risks might be securitized on the global capital markets or covered by public risk finance tools such as credit delivery guarantees.

Insurance companies must be able to price their products in an economically sustainable way. The price depends mainly on the expected loss.

Pricing mechanisms	Price = Expected Claims + Admin Costs + Risk Premium. Expected Claims Payment are the payments the insurer must potentially make to the insured party under the contract. Administrative Costs cover all the administrative, distribution and other costs the insurer bears in order to provide the policy protection. Risk Premium covers the capital and interest costs.

Underwriting guidelines and policies define the underlying operational execution principles for risk underwriting:

Underwriting guidelines include the following elements:

- Underwriting Data Requirements for Risk Assessment / Risk Rating.
- Interests Insured and Insurance Options.
- Coverage (Limits, Deductibles), Terms & Conditions, Exclusions.
- Capacity, Pricing, Processes and Acceptance.
- Accumulation Controls, Natural Catastrophe (Nat Cat) Exposure.

Underwriting Data Requirements for Risk Assessment / Risk Rating	Standard insurance forms are used to collect information from project developers which will help assess the risk exposure of the project. The different risk appraisal steps are: 1. Risk engineering: Understanding the mechanics of the risk to be insured. This is normally done by experts and relies on available exposure and loss information. 2. Risk assessment: Identifying, describing, estimating and evaluating the various risk factors that are relevant in the context of the technology, environment and other risk factors. 3. Risk rating: Based on the risk assessment, a rating provides a rough guideline of how good or bad a risk is. The three generic ratings for RET are “prototype,” “unproven,” and “proven” technology. Different ratings might imply underwriting decisions. It can be difficult to find insurance for technologies that are rated as “prototype”.

Interests Insured and Insurance Offering	The insured has an interest in a property that is subject to insurance. Damage, destruction, or value reduction of that property would cause the insured to incur financial loss. This must be demonstrated when a policy is issued and must always exist at the time of loss (with the exception of life insurance). For RET the most common interests insured are property values (such as machinery, turbines, platforms, installations, warehouses, and buildings), the business value generated from the property (revenue, rent, profit), liability values (third-party) and specific interests (construction phase). Insurance offerings consist of the products that indemnify, or hedge, the risks identified with regards to the insured objects. In today’s markets for most common risks, standardized insurance products are offered. For complex and new risks, new technologies, lack of expertise and loss experience, or large capacities, customized policies are issued. This applies for RET projects in many cases. Customized policies are normally more expensive than standard products.

Coverage (Limits, Deductibles), Terms & Conditions, Exclusions	Once the risk has been assessed, reported and decided upon then the appropriate coverage, the terms and conditions that apply as well as the exclusions in the coverage can be developed. Coverage includes setting the limits and deductibles in order to come up with an attractive insurance offering. For RET, most terms and conditions are derived from the ones used in property, engineering and energy insurance policies. Exclusions are a critical factor to be considered in the contract stage. Some standard exclusions apply for risks such as war, terrorism, natural catastrophe (nat cat), etc. Also some specific exclusions are applied case by case.

Capacity, Pricing, Processes and Acceptance	Once the details of coverage, terms and conditions have been agreed upon, an insurance capacity is suggested, and the premium (pricing) as well as the acceptance are set.

Accumulation Controls, Nat Cat Exposure	In parallel to the pricing and capacity setting, accumulation control of a risk in an existing pool of risks must be strictly governed. Also specific risk exposure information must be analyzed with regards to Nat Cat events and the exposure to these perils.

2 Basic Insurance Product Offerings for RET

Traditional and already available classes of insurance are relevant in conjunction with RET projects and operations. As of today, RET coverage is a combination of traditional insurance products. However insurance companies that are active in the renewable energy arena have set up specific underwriting teams for renewable energy or alternative energy.

Type of Insurance	Scope	Relevance for RET
Property	Property insurance covers the damage and loss to property. Physical Damage / Operating All Risks applies to losses from all accidental and unforeseen causes with the exception of perils that are specifically excluded from the policy.	Physical Damage / Operating All Risks for a company's property value, including properties where RETs are installed.
Engineering	Engineering insurance is specifically used to protect construction works, as well as erection and operation of machinery. Non-renewable coverage is used for projects under construction and/or erection. Renewable coverage is used for installations, equipment and machinery once they are ready for commercial operations.	Non-renewable and renewable coverage for RET installations (construction and operations phase).
Marine	Marine insurance provides coverage for hull and cargo. Hull covers all types of vessels that float. Cargo provides coverage for anything that is loaded in any type of vehicle or vessel for the purpose of being transported.	Marine coverage for transport to and from RET sites.
Energy	Energy insurance is traditionally for oil platforms. It provides coverage for platforms and equipment in offshore oil operations and exploration as well as for all supply vessels serving the offshore oil fields and offshore pipelines. Nuclear coverage is often considered as a separate class of insurance due to its very specific risk characteristics.	RET might establish a new class of insurance in energy underwriting.
Liability: General / Third Party	General Liability offers personal and commercial coverage for the financial	Liability coverage in conjunction with construction and operation of RET

	consequences of damages claimed by third parties that are not included in property, employers, motor and marine liability. Third Party Liability (TPL) considers the impact of construction and operation work on third parties (visitors, neighbors) or employees that incur bodily or physical property damage.	installations.
Crime, Fidelity, E&O, D&O	Crime, Fidelity, Errors & Omissions (E&O) as well as Directors & Officers (D&O) covers are additional special lines of insurance considered to be relevant for some RET projects, especially when there are many project stakeholders, complex ownership (owners, employers, developers) and new emerging technologies involved.	These covers are relevant for specific issues with regards to project ownership (D&O) and emerging technologies (E&O).
Credit Risks	Credit Insurance and Credit Delivery Guarantees offer protection for the payment risk resulting from the delivery of goods or services. This is caused by the counterparty being unable to pay as a result of protracted default, insolvency or bankruptcy.	Credit coverage in conjunction with counter-party exposure in RET projects.
Political Risks	Political Risk insurance offers protection against political conditions that result in a loss. These can be political violence, governmental actions (expropriation, confiscation, repudiation of assets) or other issues such as currency inconvertibility or inability to repatriate funds.	Political risk coverage in conjunction with political exposure in RET projects.
Weather Risks	Weather derivatives are instruments used to hedge against the risk of weather-related losses. The underlying assets are measurable weather events and patterns such as rain, temperature or snow.	To hedge dependency on weather patterns for wind and solar installations, as well as other RETs.
Emission Reductions	Certified Emissions Reductions (CER) Futures offer protection against unwanted price developments in the CER market. A put option with a defined price (strike) gives the buyer of this option the right to perform a CER sale at this price up to a certain date (strike period/ strike date).	To hedge uncertainty of CER price movements for all RET projects generating CER.

With regards to constructing, erecting and operating an RET installation, the main insurance offerings are property and engineering products:[1]

Physical Damage / Operating All Risks	Renewable policy to protect against losses / damage to property that has been erected and is operational.
Construction All Risks (CAR)	Non-renewable coverage to protect against losses in the construction phase.
Erection All Risks (EAR)	Non-renewable coverage to protect against losses in the erection phase.
Advance Loss of Profit (ALOP) / Delay in Start-Up (DSU)	Non-renewable coverage in conjunction with CAR and/or EAR. To protect against loss of income or profit during the construction or erection phase.
Contractors Plant and Equipment (CPE)	Renewable policy to protect against losses on a plant and equipment independent of the location or project.
Machinery Breakdown (MB)	Renewable policy to protect against losses to machinery that has been erected and is operational.
Business Interruption (BI)	Renewable policy to protect against loss of income or profit if operations are interrupted because of loss.

Physical Damage / Operating All Risks

Definition	Physical Damage / Operating All Risks covers all physical damages to tangible property and plant assets that have been erected and are operational.
Coverage	Sudden and unforeseen physical loss or physical damage to the plant / assets during the operational phase of a project subject to exclusions.
Insured Parties	Owner of the plant.
Sum Insured	New replacement value of the insured plant assets that can be defined as the cost of replacing by a new one of the same capacity. This includes transport and erection costs, as well as taxes and customs. If total loss occurs the indemnification might be restricted to the actual cash value.
Main Hazards	Fire and explosion, theft, burglary, collapse, earthquake, seaquake, landslides, storms and flood. Perils might vary from location to location.
Exclusions	Standard exclusions are war, other political perils, seepage and pollution, contamination, nuclear energy risks. Further exclusions apply case-by-case.

CAR – Construction All Risks

[1] For further information see the Swiss Re publication “Engineering insurance and reinsurance”, 1997.

Definition	CAR insurance covers all types of building and civil engineering construction and offers protection against hazards that may threaten the work under construction.
Coverage	All Risks basis for physical loss damage to the insured property subject to the damage being unforeseen and accidental, and subject to exclusions to the policy.
Insured Parties	Insured parties are project owners, principals and contractors.
Sum Insured	Total contract value e.g. the anticipated value of the completed works including materials, salaries, transport, custom duties, taxes and the value of any material or labor supplied by the principal.
Main Hazards	Fire and explosion, theft, burglary, collapse, earthquake, seaquake, landslides, storms and flood. Perils may vary from location to location.
Exclusions	General exclusions are liquidated damages or penalties for delay or detention, or in connection with guarantees of performance and efficiency, willful acts or omissions or gross negligence of any director, manager or responsible party on site, nuclear risks and political risks. Further exclusions apply to normal upkeep, consequential loss of any kind, or loss of use, wear and tear, corrosion, erosion, or deterioration due to lack of use and other reasons.

EAR – Erection All Risks

Definition	EAR insurance covers the erection of individual machines such as lifts or complete systems such as power stations.
Coverage	All risks basis including coverage for testing and commissioning of erected machines, subject to the damage being unforeseen and accidental, and subject to exclusions to the policy.
Insured Parties	Same as CAR. In addition the machinery manufacturer might be included as an insured party if performing a function on the erection site.
Sum Insured	Anticipated value of the completed works. Might be adjusted during the course of erection. Final total investment is declared upon completion of the project.
Main Hazards	Main hazard is fire and explosion, and machinery breakdown during testing and commissioning. Further hazards depend on the type of works and location – for instance if indoors, forces of nature are less relevant than in CAR.
Exclusions	Exclusions are the same as for CAR.

ALOP / DSU – Advance Loss of Profit / Delay in Start-Up

Definition	Business income protection to cover for losses of the gross profit resulting from a delay in completion of a construction and / or erection work. Underlying CAR and/or EAR must be in force.
Coverage	Actual loss of gross profit sustained from a delay in the completion of the project. Loss must be covered in the respective CAR and/or EAR.
Insured Parties	Principal or owner of project to be constructed or erected as defined in the underlying CAR and/or EAR.
Sum Insured	Expected annual gross profit, revenue, rent, or fixed costs – to be defined case by case.
Main Hazards	Loss events as defined for CAR / EAR.
Exclusions	General exclusions are the same as for CAR / EAR. Further exclusions apply to restrictions imposed by public authorities, alterations to the insured works after the occurrence of the material damage accident, and delays caused by further reasons– also some specific nat cat perils such as earthquake, volcanic eruption, tsunami and hurricane if not agreed to in writing.

CPE - Contractors Plant and Equipment

Definition	Renewable cover for plant and equipment used by contractors at different locations.
Coverage	All risks basis for unforeseen and accidental physical loss or damage due to external causes.
Insured Parties	Owner of the insured plant and equipment.
Sum Insured	New replacement value of all plant and equipment insured under the policy including freight costs, customs and erection costs.
Main Hazards	Working accidents, fire, burglary, theft, faulty operation, natural perils such as earthquake, storm and flood, collision and overturning.
Exclusions	Excludes mechanical and electrical breakdown. Normal wear and tear, lack of oil or coolant, deposits of rusts, exchangeable tools and parts and further reasons are excluded.

MB – Machinery Breakdown

Definition	Renewable coverage which offers protection against sudden and unforeseen physical loss or damage to machinery that has been erected and is operational or at rest.
Coverage	Policy pays for all repair costs, or in case of total loss or repair costs exceeding the actual value of the machinery, the actual value is

	indemnified.
Insured Parties	Owner of the machinery.
Sum Insured	New replacement value of the insured machinery that can be defined as the cost of replacing by a new one of the same capacity includes transport and erection costs, taxes and customs.
Main Hazards	Working accidents, centrifugal force tearing a machine apart, short circuits, defects or faults in design, material or manufacturing, incorrect operation.
Exclusions	Corrosion, erosion, wear and tear, overloading, and further specific exclusions might apply.

BI – Business Interruption

Definition	Business income protection to cover losses of the gross profit resulting from a disruption in the operational performance of a company because of property loss.
Coverage	Policy pays for actual loss of gross profit sustained resulting from a disruption in operational performance. The insurance protects during the time period it takes to achieve commercial operational readiness again. An indemnity period (mostly with maximum of 12 months) and a time deductible are agreed.
Insured Parties	Owner of the operations / company.
Sum Insured	Expected annual gross profit, revenue rent or fixed costs – to be defined case by case.
Main Hazards	Loss events as defined for Physical Damage / Operating All Risks.
Exclusions	General exclusions are war, other political perils, seepage and pollution, contamination, nuclear energy risks. Further exclusions apply case-by-case.

3 Basic Underwriting Processes and Guidelines

The following underwriting guidelines are valid for all underwriting affairs and cover the setup of a standard underwriting form and standard underwriting clauses.

A standard underwriting form for RET business (generic form) consists of following information:

Elements	Description
Contracting Parties	Name and address of carrier and insured. Full legal names of the carrier and insured corporate entity with complete address. Also name of broker if applicable.
Occupancy or Project	Occupancy must be listed. In case of coverage limited to part of the corporate activity this must also be specified.
Scope of Coverage / Coverage	General description of the scope of coverage such as CAR / EAR, Operating All Risks, etc.
Geographical Scope	Description of the geographical scope if not worldwide. Either use name of existing states, territories with settled political boundaries, or regions (not for Political Risk policies).
Period	Renewable Covers: Inception and Expiration date for coverage. Non-renewable covers: Inception date.
Structure of Contract	▪ Total Insured Value (TIV). ▪ Limits and Capacity provided by insurer or reinsurer [based on limit, ALP (anticipated loss potential), MPL (maximum possible loss) or other base] plus deductibles. ▪ Premium (100%) and Deductions.
Exposure and Risk Quality	Location set inclusive top location. MPL per location. Exposure risk quality / Rating if applicable.
Exclusions	Specifically excluded perils.
Specific Perils	Sub-limits and deductibles per specifically included perils.
Nat Cat	Sub-limits and deductibles per natural catastrophe peril if applicable.
Loss History	Add loss history information if applicable (Year, Loss Description, Total loss).
Choice of Law	Applicable law must be agreed upon before coverage commences. Law must be acceptable pursuant to the contract preferences of parties involved. Must refer to the substantive law of a particular state or country.
Claims provisions	Specific claims-related provisions related to the claims settlement process must be listed. Claims control clauses as applicable.

Standard underwriting guidelines set up the clauses which cover a list of required elements in order to issue an insurance contract. Here is a list of typical principles:

Guideline	Description
Basic requirements	Insurance follows the principle of indemnity.
Indemnity or Insuring Clause	Policy should make clear what the scope of the coverage is, for example, for which liability, loss, damage, injury or expense the policy will pay or indemnify. Terms like “permanent damage,” “accidental,” “sudden,” and “unforeseeable” should be clearly defined with regards to what is excluded.
Disclaimers of legal duty for disclosure	Contractual waivers of insurer’s rights and remedies at law arising from pre-contractual non-disclosure or misrepresentation of material facts are subject to approval in each situation. Insurers prefer to retain all rights and remedies available at law.
Accumulation control	Systematic tracking of the accumulated risk exposures regarding capacity controls, natural catastrophe scenario exposures, terrorism covers and Contingent Business Interruption (CBI) covers.
Nat Cat clause	Nat cat perils have to be specifically enumerated. Capacities are locally allocated.
Contingent Business Interruption	There are specific considerations for Contingent Business Interruption coverage for unnamed suppliers and customers. Insurers might set a maximum limit of liability for this kind of BI coverage (as a percent of sum insured, as loss limit, and as absolute amount). Similar limits apply in case of public utilities and denial of access where an additional time deductible might apply.
Reinsurance Proceeds Clauses	In cases of reinsurance, a list of specific clauses is explicitly considered such as cut-through clauses, loss-payee clauses, and arrangements. Typically they are avoided or restrictively handled.
Definition Occurrence / Events	Definition of property occurrence must aggregate all loss or losses arising from one common cause, event, or catastrophe during the period of insurance. If an “hour’s clause” is applicable, the covered time period is limited to a certain length, typically 72 hours.
Definition Values Reported	Value basis (Real or Actual Cash value, BI values, etc) must be defined and reviewed.
Fronting arrangements	Fronting arrangements are granted in specific constellations.
Multiyear Coverage	Renewable covers normally are based on one-year coverage. In some cases, multiyear covers are also granted. Non-renewable covers for engineering projects might easily achieve multiyear status.
Claims considerations	Claims cooperation clauses cover the duties of the insured to provide to the insurer all information relevant to a covered loss.

	Claims notification clauses describe the specified time and further considerations such as “prompt”, “immediate,” or “as soon as reasonably practicable.”
Extensions	Extensions of coverage vary depending on the type of insurance and coverage. They typically cover extra costs and expenses borne from the loss, debris removal, expediting costs, and extensions with regards to liability and manufacturer’s risk.
Exclusions	Exclusion clauses typically consider following risks: ▪ Excluded Countries – Insurers maintain lists of excluded countries where they do not write any business. This includes relationships with public or private clients, acceptances and risks located in these countries. ▪ Political Risks typically are not written by property, energy or engineering insurers. They are covered by credit insurers. ▪ Reputational risks are considered in case of publicly-controversial environmental, social, ethical and political issues. Insurers do adhere to strong internal compliance rules with regards to ethical principles in writing sensitive business risks. ▪ Terrorism clauses might be added for very large and exposed risks. ▪ War and civil war clauses typically are not written by property, energy or engineering insurers.

Risks and Barriers in RET Underwriting

Frequencies and severities of losses associated with renewable energy projects are not fully known. Technology innovation happens quickly. RETs evolve quickly which often lead to a general lack of underwriting experience due to lack of data and expertise on the new technologies.

Risks and Barriers	Description
Technology efficacy	For insurance companies, a new RET product is a significant bet on technology with regards to reliability, quality and costs. Efficacy of the technology is still in doubt with regards to operational reliability. Technologies that are considered to be at an early stage such as certain RET do lack the operating history and provide a limited amount of loss information for loss projections and pricing. Underwriting multiple insured using the same, yet not fully proven, technology might generate many losses.
Technology risk profile diversification	The risk profile of existing mature technology is different from new technologies. A portfolio of risks in a new technology can be strongly non-diversified.
Technical perils	Certain RETs present concerns during construction, testing and commission phases. Often high risk and complex engineering processes, procedures and contracts / equipment are involved. Which create perils with regards to handling, erecting, testing and commissioning a new installation.
Technology replacement cycle	Technology innovation might lead to the replacement of a relatively new technology by an even newer technology. This is true for areas where new designs are introduced in short cycles and no single design becomes dominant.
Local economic conditions	The same technologies are deployed in different localities and countries. Mere knowledge about the failure behavior of a new technology is not sufficient. Environmental factors such as local maintenance practices, supply channels, and operating conditions might also have a severe impact on the loss exposure.
Regulatory environment	Government actions, regulations, and taxes typically favor some specific RETs. In some emerging markets and developing countries, restrictions towards market access of foreign players are in place which means that a certain proportion of the risk is reinsured by local insurers.
Natural catastrophe hazards	Impact of natural hazards on engineering insurance is partially understood. Increasing frequencies in extreme atmospheric events such as floods, storms and heat waves have been observed. This leads to an acceleration of secondary effects (losses). Currently, the percentage of losses in engineering insurance triggered by natural events is between 10% (Europe) and 75% (Taiwan).
Accumulation control and vulnerabilities	Individual structures and systems on a property may have very different vulnerabilities with regards to nat cat events. Some mobile machinery and

	equipment have variable exposure during events depending on their exact location at the time of the event. Problems with business interruption coverage often arise due to the inability to account for the whereabouts of mobile plants and equipment. EAR / CAR coverage is faced with changing values during the erection period. At the end of the erection period, the value at risk (VAR) is typically at its maximum and poses a much higher vulnerability. A loss caused by natural hazards can result in ALOP or DSU coverage at any time during construction.
Credit and counter-party risks	For each RET project, an actual or perceived credit risk posed by the project's host country or developer exists. The smaller and less experienced the suppliers and consumer groups are, the more difficult it becomes to overcome the perceived credit risk. Credit enhancements provided by public funds are considered a very effective tool in order to support private financing of RET projects.
Market conditions	Generally for RET and other new technology risks, a small group of insurers and reinsurers are positioned as leaders. They have a reputation for technical expertise and can dictate the terms and conditions of the policy. They will be supported by a group of companies who are prepared to "follow" the leaders' terms and conditions. Over time, more leaders are established and businesses will be underwritten jointly with different terms and conditions.
Availability of data	An extensive and long-term database of empirical claims, losses, damages occurrence rates etc, is one of the most useful tools for underwriting. Improved actuarial data is a key facilitator for product development and underwriting in RETs.
Availability of experts	If historical loss and exposure data is not available, experts must be able to identify the risk exposure profile of a new technology. This includes educated predictions of potential failures, and the possible frequencies and severities of losses.
Infrastructure and local markets	Adequate financial, legal and service infrastructure is a key enabler for RET in developing countries.
Local insurance markets	In some emerging and developing economies, national insurance regulations tend to protect insurers or reinsurers by restricting access to local markets.

A comprehensive risk analysis is a key step to completely understand the challenges, pitfalls and necessary insurance needs of a RET project. Below is an example of considerations commonly applied in the insurance process for a large-scale wind project following the typical project stages of project development, construction, testing and commissioning, and operating.

Risk analysis example for a large-scale wind project		
Risk	**Project Stage**	**Details**
Permitting /	Project	Risk of delay due to inability to obtain building permit /

Planning Delays	Development	planning or other regulatory consent.
Contract bankability	Project Development	Risk of being unable to secure bankable offtaker / fuel supply contract.
CER bankability	Certified Emission Reduction	Risk of Certified Emissions Reductions (CERs) not being recognized as bankable revenue streams.
Contractor non-performance	Construction, Testing and Commissioning	Risk of EPC (Engineering, Procurement, Construction) and turnkey contractors being unable to deliver to specification and to budget on time.
Engineering risk	Construction, Testing and Commissioning	Risk of physical loss or damage to property caused by technical / engineering hazards (e.g. defective design, faulty parts and/or workmanship).
Physical hazard (caused by man or nature)	Construction, Testing and Commissioning	Risk of physical loss or damage to property caused by human and/or natural hazards / catastrophes (e.g. fire, lighting, explosion, earthquake, flood, windstorm).
Offtaker contract failure	Construction, Testing and Commissioning	Risk that power offtakers withdraw from contract subsequent to financial closure.
Catastrophic design failure	Construction, Testing and Commissioning	Risk of complete mechanical or control failure during testing and commissioning due to defective design.
Process Interruption	Operating	Risk of complete plant shut down (total process interruption) at any time due to unscheduled maintenance.
Natural hazards	Operating	Risk of physical loss and/or damage to the plant and/or machinery breakdown caused by natural hazards / catastrophes (e.g. fire, lighting, explosion, windstorm, flooding).
Design / Engineering Risk	Operating	Risk of physical loss and/or damage to the plant and/or machinery breakdown caused by design / engineering perils (e.g. defective design, faulty parts and workmanship, all occurring outside the scope of any warranty protection).
Physical hazard (caused by third party)	Operating	Risk of physical loss and/or damage to the plant caused by human hazards external to the project (e.g. strikes, riots, civil commotion, war).
Wind volatility	Operating	Risk that average wind speeds falls below required thresholds to generate economically efficient power outputs / electricity.
Offtaker default	Operating	Risk of the electricity offtaker defaulting on contractual obligations under PPA (Power Purchase Agreement).
Warranty non-performance	Operating	Risk of the warranty provider failing to meet contractual obligations.

Legal liability	Operating	Risk of the legal liability caused by bodily injury or property damage to third parties.
CER-Specific Risks	Certified Emission Reduction	Risk of CER delivery shortfall or failure due to Kyoto regulatory risk (e.g. changes to baseline methodology, monitoring procedures, additional rules or other eligibility criteria), host country political action (e.g. expropriation, nationalization, confiscation and prohibitions in connection with the sale of CERs), lower than expected plant performance, or insolvency of project proponents. Risk of limited marketability of emission reductions post 2012.

5 . Specific Considerations for Wind

Repetition from Module 2: Refer to Module 2 – Section 2

Characteristics	Description
Overall attractiveness	Significant growth potential.
Current situation	Trend to off-shore wind farms.
Ideal operating conditions	Specific window of wind speed (between 10 and 25 m/s) required.
Insurance maturity and loss experience	Early phase of large underwriting losses. With latest increase of projects there is more underwriting and loss experience available.
Major known loss factors	Design and material, lightning, storm, short circuit, fire.
Insurance offerings	Used to be part of main property insurance package. With growing project sizes and numbers, specific policies are becoming available. Insured limits of up to USD 500 million have been placed. Construction phase: CAR, DSU, TPL available. Operational phase: Operating All Risks, MB, BI

Key Risks	Risk Management Drivers / Measures
Long lead times and up-front costs.	Make and model of turbines.
Critical component failures.	Manufacturing warranties.
Wind resource variability.	Loss control.
Offshore cable laying.	Best practice procedures.

Traditionally, commercial wind energy projects have been owned and developed by large power companies. Insurance has been provided under the main property package covering all parent power assets worldwide. However this unspecialized policy did not provide adequate coverage to the unique risks profile of the wind sector – especially in case of off-shore wind projects.

Wind underwriting has gone through an early phase of losses but has achieved a good level of maturity. In comparison to other RET covers, there is already a competitive insurance marketplace for on-shore wind energy projects. Premium rates for physical damage coverage are in the range of 0.3 to 0.4% of total insured property values. Off-shore projects have a more risky profile and underwriting experience is not as advanced. Insured limits placed on the market have been up to USD 500 million. It is expected that more capacity will be made available with growing expertise, more projects and operating hours, more policies placed, and more loss data available.

Delays or damages during fabrication, transport, installation, or testing and commissioning are key concerns during the construction process. Risks in the off-shore area are significantly larger than with on-shore projects. Off-shore DSU and ALOP policies are more expensive and have more restrictions and deductibles than on-shore policies. DSU premiums for off-shore projects are in the range of 2 – 3% of annual gross revenue to be expected. Future growth of DSU coverage is limited by the availability of marine infrastructure (vessels) to service sites and repair or replace damaged items.

Once operating, Operating All Risks policies are available. Insurers might want to verify the loss control measures against perils such as high wind, freak wave conditions, fire and lightning and vessel collision.

With regards to design and technology risks, some restrictions also apply. Insurers do not provide a broad design coverage for new and prototypical turbines. Clauses regarding component replacement (after 5 years or 40'000 operating hours) also apply. Project owners and developers might have to rely solely on warranties provided by the turbine manufacturers. This again creates credit risks with regards to the manufacturer's creditworthiness.

Today's new projects emerge with new, larger turbines (5 MW and more). Appropriate insurance for defective parts and consequential losses (BI) is very difficult to attain. Therefore so-called Contractual Service Agreements (CSA) are directly offered by large turbine manufactures which guarantee the technical operation of the system over the term of the financing agreement.

Generally, business interruption coverage is a major concern. Loss of a single turbine does not affect substantially large scale wind projects' operations; however the loss of export cables or transformer should lead to the interruption of the overall electricity output. For off-shore wind, a BI cover is very much dependant on the design and location of the project.

Insurance Characteristics for Wind

Characteristics	Description
Main challenges	Construction phase: ▪ The construction phase is a key area of concern for the investor and subject to many issues regarding to new technology and prototypes. ▪ Delay in Start Up coverage is limited by issues regarding the availability of marine infrastructure to quickly service sites in order to repair and replace damaged items. Operational phase: ▪ Offshore technology is still not yet fully proven in challenges such as cabling, weather, and repair lead times. ▪ Space and landscape requirements challenge on-shore parks. ▪ Power distribution and volatility of power generation requires back-up power installations. ▪ Business Interruption is difficult to obtain because of the potential for cable or transformer loss in offshore wind parks.
Main exclusions or restrictions	Offshore construction projects present higher risk, therefore higher premiums (2% of project cost) and higher deductibles apply. Design and technology risks associated with wind turbines result in no coverage for design of new and prototypical turbines.
Loss control measures required	Control measures should be in place to protect against high winds, freak waves, fire and lightning and vessel collision. Mitigation of design risk with a Contractual Service Agreement (CSA) provided by wind turbine manufacturer, covering maintenance and repair costs, can provide greater confidence to the underwriter.

Exemplified Insurance Application Form for Wind Power Installations

(This application form is shortened and exemplified for educational purposes)

The Insured has the obligation to respond to the hereafter indicated questions as accurately and truly as possible. If the reply does not correspond to the real installed equipment and installations the Insurer could, possibly, invoke cancellation of the policy after a one month period. In case of intentional omission of material information and/or gross negligence, the Insurer could cancel “ab initio”. The Insurer’s withdrawal of the right of coverage is normally excluded, except in case of intentional omission of material information, even if the noted omission would have resulted in the Insurer taking on the risk with different terms and conditions.

1-Insured:			
2-Country:	County/Province:	Location:	Zip Code:

Insurance Period From:

3-Machinery Breakdown Insurance		
Insured value machinery, new values basis*, include. Freight, civil works and peripheral equipment such as transformer, yard switchgear in $/EUR: *New value basis: indicate in – or excluding VAT		
Manufacturer:	Type:	
Year of construction:	Name plate capacity:	KW:
Height of nacelle (in m):	Tower construction: steel tube - / mast tower	
Cable length (in m):	Propeller manufacturer:	
Rotor diameter (in m):		
Gearbox manufacturer:	Type/construction:	Serial number:
Switchyard installed (yes/no):	To be insured (yes/no):	
Manufacturer Capacity:	MVA (Market Value Added) Value (in $/EUR):	
Hoist installation costs of 5,000 Euro are insured on first loss basis.		
Increase of first loss basis to (maximal 20,000 Euro)		
Deductible (in $/Euro):		

4-Machinery Breakdown Business Interruption		
Calculate KWh: Plate capacity (KW) x peak load operating hours p.a. (please provide wind study pattern)		
Calculate Value in EUR: KWh (projected annual energy production) x production delivery price according the Power Purchase Agreement (provide copy) in EUR/KWh		
This insured Business Insured value (in $/EUR):		
Delivery period(s) (in days/weeks)		
Gearbox:	Generator:	Propeller:
Period of Indemnity: 6 months	Deductible:	

5-Risk description	
Is the insured owner of the installation (Yes/No):	If no who is Owner:
Are all components tested and serial produced, i.e., there are no prototype or “one of a kind” installation (Yes/No):	
Has a commissioning test run been adequately executed with reaching name plate capacity (Yes/No): (add copy test acceptance protocol)	
Has a manufacturer’s maintenance programme been contracted (Yes/No): (add copy)	
Does a manufacturer’s warranty contract exist (Yes/No): (add copy)	
Does a service contract incl. a manufacturer’s availability guaranty for the installation exist (Yes/No): (add copy)	
Has the Wind Energy Installation been fitted with a Condition Monitoring System (CMS) (Yes/No)	
If Yes, manufacturer:	Type
Has the CMS been certified by an acknowledged testing organisation (Yes/No)	
If yes by whom: (add copy manufacturer’s declaration, that certified criteria have been complied with)	
Has the Wind Energy Installation been fitted with a “State of the Art” lightning protection system (Yes/No)	
Has the Wind Energy Installation been fitted with a fire detection system and/or automatic fire suppression extinguishing system (Yes/No):	
If yes, indicate manufacturer:	
After the occurrence of a loss can restrictive measures be expected from local authorities (Yes/No):	

If yes, indicate which ones are likely:

6-Special Agreements
7-Existing coverage
Does there exist insurance coverage (Yes/No):
What type of cover does exist:
Who is the insurer
Coverage cancelled by insured/Insurer:
8-Loss History
9-Signatures

The undersigned parties warrant that the information supplied in this questionnaire is truthful and applies correctly to the installed Wind Energy Installation(s). Non-intentional omission of information will not jeopardise insurance coverage; however gross negligence in omitting material risk information, which unduly and unknowingly increases the risk for the underwriter, may trigger nullity of the contractual insurance terms “ab initio”.

6 . Specific Considerations for Hydro

Repetition from Module 2: Refer to Module 2 – Section 2

Characteristics	Description
Overall attractiveness	Large-scale is already established and has proven attractive.
	Small-scale installations in developing countries and rural or remote areas are a leading source of renewable energy.
Current situation	Small hydro has significant potential and competitive generation costs.
Operating conditions	Storage reservoir systems require large space.
	Run-of-river systems require sufficient river flow.
Insurance maturity and loss experience	Large-scale hydro has well a developed, long-term, proven technology with low maintenance expenses and few operational risks.
	Small-scale hydro installations have a lifetime of up to 50 years.
Major known loss factors	Flooding, seasonal / annual resource variability.
Insurance offerings	Large Hydro: All insurance packages available.
	Small Hydro: Only few insurance offerings. Liability covers are becoming more widely available. Small hydro might benefit from large hydro's experience base and risk management understanding.

Key Risks	Risk Management Drivers / Measures
▪ Flooding ▪ Seasonal / annual resource variability also caused by natural perils such as flood or drought. ▪ Prolonged breakdowns due to offsite monitoring and lack of spare parts.	Long-term proven technology with low operational risks and maintenance expenses.

Large-scale hydro is a very well developed long-term proven technology with low maintenance expenses and few operational risks and barriers. Typically small-scale hydro has the capacity to generate less than 10 MW of energy. From a financing and risk perspective, small-scale hydro relies on the same technology and operating foundations and can benefit from the experience base of large-scale hydro. Lifetime of a hydro power plant is up to 50 years, due to the long-term infrastructure, mechanical and electrical lifetime of the installations. Small-scale run-of-river and reservoir storage systems are a leading renewable energy source in many remote and rural parts of the world.

Some emerging countries have started to promote small hydro. For instance, in India, a potential of more than 15'000 MW in small hydro installations has been verified with more than 4000 potential sites identified. However, small hydro projects do not always meet the critical size for commercial insurance and are not considered for underwriting. With an average size of less than 1 MW, small hydro installations typically produce less than 3 GWh per year on average. This corresponds to less than EUR 300'000 potential revenues assuming feed-in price of 10 Eurocents per kWh.

In the future, more standard insurance offerings for small-scale hydro may be developed in conjunction with large-scale installations in emerging and alpine countries. For small-scale hydro liability coverage is already becoming much more available.

The following are critical elements to consider with regards to hydro installations:

- Power plant type and turbine types. Typical for small hydro are run-of-river or diversion-type water supply plants. The potential energy to be absorbed depends on the vertical difference of the water fall (head) and the amount of cubic meters of water per second. The higher the head, the lower must be the required volume per second.
- Hydro plants are situated in widely varied locations. Run-of-river plants are normally easier to access than large dams. However, many run-of-river plants in emerging countries are located in very remote or alpine areas with difficult access.
- Critical perils to consider are damages to turbine buckets and blades, or to the entire runner as a result of fatigue, cavitations or erosion. Fire exposure due to lubricant equipment, generators and exciters must also be taken into account. Diligent fire protection measures are therefore a key element.
- Loss prevention with regards to machinery breakdown focuses on detailed planned maintenance programmes. Also, extensive safety and monitoring equipment is required.

Insurance Characteristics for Hydro

Characteristics	Description
Main challenges	Typically the construction and operating site is in a rural, remote, and/or alpine location.
	Few challenges in the area of technology and loss experience in the area of large hydro. It is a long-term proven technology with low operational risks and maintenance expenses.
Main exclusions or restrictions	No specific exclusions applied.
	Underwriting follows traditional property and engineering terms and conditions.
Loss control measures required	Control measures should be in place regarding offsite monitoring and spare parts supply, as well as fire prevention and a detailed safely and maintenance plan.

Exemplified Insurance Application Form for Hydro Power Installations

(This application form is shortened and exemplified for education purposes)

The Insured has the obligation to respond to the hereafter indicated questions as accurately and truly as possible. If the reply does not correspond to the real installed equipment and installations the Insurer could, possibly, invoke cancellation of the policy after a one month period. In case of intentional omission of material information and/or gross negligence the Insurer could cancel “ab initio”. The Insurer’s withdrawal of the right of coverage is normally excluded, except in case of intentional omission of material information, even if the noted omission would have resulted in the Insurer taking on the risk with different terms and conditions.

1-Insured:			
2-Country:	County/Province:	Location:	Zip Code:

Insurance Period From:

3-Site Information
General configuration / construction of hydro facility (barrage, penstock)
Head distance (vertical distance between the inlet and the turbine)
Spill ways or overflow facilities
If dam construction provide dam details (type of dam, height, length, width at base, width at crest, capacity or reservoir, internal drainage, other)
Protection of generator and switchgear during synchronisation - method

4-Machinery, Plant & Equipment
Provide plant and machinery information e.g. turbines, gearboxes, generators, transformers, engines, and other works → Make, Model, Year, Output, Details of overhauls
Provide buildings and civils information e.g. turbine house, machinery foundation, dam, weir, spillway, tailrace, canal, penstock, pipeline → Company, Year, Details of re-construction and improvement works since initially constructed

4-Business Interruption / ALOP
Estimated Annual Revenue turnover from the sale of power (in currency, in power units) also indicated own use annual consumption
Required indemnity period in months
Time exclusion required (normally a minimum applies)

5-Maintenance, Repair
Warranties / or comprehensive maintenance contracts in force
Maintenance plan in force
Maintenance work by in-house staff / qualifications of staff / contractors
Obsolete spares / suppliers available

6-Risk Protections
Automatic fire detection and prevention
Remote monitoring and alarm systems
Physical security systems
Total loss prevention: Physical separation of buildings, open and exposed to natural elements:
Distance to nearest operational fire station
History of flooding of buildings and electrical equipment
Inspections (interval, inspecting body)
Access to facilities in case of repair/rebuilding of insured property
Devices and mechanisms installed to be insured against lightning damage
For CAR: Responsible person for appraisal and design of site, Details about project manager Contractors and subcontractors Tme plan of project (start, completion of works, testing, commissioning, maintenance cover)

7- Special Agreements
8- Existing coverage Does there exist insurance coverage (Yes/No)
What type of cover does exist:
Who is the insurer
Coverage cancelled by insured/Insurer
9- Loss History
10-- Signatures

The undersigned parties warrant that the information supplied in this questionnaire is truthful and applies correctly to the installed Hydro Installation(s). Non-intentional omission of information will not jeopardise insurance coverage, however gross negligence in omitting material risk information,

which unduly and unknowingly increases the risk for the underwriter, may trigger nullity of the contractual insurance terms “ab initio”.

7 . Specific Considerations for Solar

Repetition from Module 2: Refer to Module 2 – Section 2

Characteristics	Description
Overall attractiveness	Off-grid systems are small-scale consumer products with low attraction for commercial insurance. Grid-connected projects for solar photovoltaic are starting to gain momentum. Some large scale projects are underway.
Current situation	Grid-connected projects are increasing in size and value. Significant subsidies in some countries.
Ideal operating conditions	High local sun irradiance with high amount of W per m^2.
Insurance maturity and loss experience	Not yet mature. Low loss experience.
Major known loss factors	Faulty material, theft (offsite), fire exposure, technology parts (circuits, converters), weather (hail, lightning), leakage (thermal).
Insurance offerings	Very few as of today.

Key Risks - Photovoltaic Power	Risk Management Drivers / Measures
▪ Component breakdowns (e.g. short-circuits).	Performance guarantee available (e.g. up to 25 years).
▪ Weather damage.	Standard components, with easy substitution.
▪ Theft / vandalism.	Maintenance need to be enhanced.
Key Risks – Solar thermal	**Risk Management Drivers / Measures**
▪ Prototypical / technology risks as project size increases an ▪ Other RET risk such as those associate with the erection solar towers.	Good operating history and loss record. Maintenance need to be enhanced.

Generating energy with solar photovoltaic (PV) technology is in many cases a small-scale, consumer process, and is not attractive for commercial insurers. For larger installations, commercial protection is available. Underwriters focus on regular maintenance procedures due to frequent breakdowns and attrition losses due to wear and tear.

Currently the size and value of commercial installations are increasing. Large projects have been developed in Australia, the United States (Nevada, Arizona, California), Spain and Germany with capacities above 10 MW. Construction and operation insurance is already available. However, the applications are very remote. The availability of service industries to repair, replace and maintain these facilities is a concern for machinery breakdown and business interruption underwriting.

Key underwriting considerations for Solar PV are:

- Main risk exposures are workmanship and faulty material as well as theft and equipment handling.
- With regards to the technology, short circuits and converters are critical elements.
- Vulnerability to weather events such as hail and lightning .
- Third party liability (TPL).
- Additional operational risks.

Like solar PV, solar thermal projects are increasing in size and value. The risks for solar thermal installations are the same as for solar PV.

For Solar Thermal, the following additional risks apply:

- Leakage.
- Similar risk factors as applicable for steam turbine power plants.

Overall, the growth rates for solar technologies are expected to be larger than for any other group of RET. Generally the loss and actuarial experience for solar PV and solar thermal is significantly lower than for other RETs such as wind or hydropower.

Insurance Characteristics for Solar

Characteristics	**Description**
Main Challenges	Remoteness of solar installations with reduced availability of services to repair, replace and maintain the facilities.
	Low loss experience with large-scale solar installations.
	Availability of polysilicion feedstock is a critical issue for the growing PV industry.
Main exclusions or restrictions	Design and technology risks associated with new solar installations. No coverage or higher deductibles for new and prototypical emerging solar PV.
Loss control measures required	Control measures should be in place to ensure offsite monitoring and spare parts supply, as well as fire, hail and lightning prevention, and a detailed maintenance plan.

8 Specific Considerations for Biomass

Repetition from Module 2: Refer to Module 2 – Section 2

Characteristics	Description
Overall attractiveness	Biomass technologies are mature however still relatively costly especially in the case of organic ranking. Securing a stable fuel / biomass supply is challenging. In some countries, the production of biofuels using sugar cane and other agricultural waste has already gained significant share of overall fuel production.
Current situation	Biomass generally get less support and subsidies than wind and solar. Mature technologies can be employed at large scale (10 to 100 MW). Biofuels are currently under debate with regards to ethics and crop substitution (crops for food vs. crops for fuel).
Operating conditions	Key criteria are the long-term continuous supply of fuel (biomass, crop). For biogas strict safety conditions apply.
Insurance maturity and loss experience	Despite mature technologies, insurance offerings are still lacking. Relatively low loss experience.
Major known loss factors	Faulty material, fire exposure, TPL due to emissions and pollution, prototypical technology, operational lack of experience.
Insurance Offerings	Very few as of today. For biogas: MB, BI.

Key Risks - Biomass / Biofuels	Risk Management Drivers / Measures
▪ Fuel supply and availability. ▪ Resource price variability. ▪ Environmental liabilities associated with fuel handling and storage.	▪ Long-term contracts can solve the resource problems. ▪ Fuel handling costs. ▪ Emission controls.
Key Risks - Biogas	**Risk Management Drivers / Measures**
▪ Fire / Explosion risks. Resource risks (e.g. reduction of gas quantity and quality due to changes in organic feedstock). ▪ Planning opposition associated with odour and potential health problems.	▪ Strict safety procedures are needed as are loss controls such as fire fighting equipment and services. ▪ High rate of wear and tear.

Biomass and biogas projects encounter significant challenges with regards to resource supply risks. Security of fuel supply and fuel-price volatility is a major concern for the risk and finance management of these projects. In the case of energy crops, crop yield insurance might be a solution but it is difficult to attain. Other financial instruments that secure long-term fuel supply are not yet available. Business Interruption insurance is difficult to purchase because of the length of the reinstatement period for biomass facilities that are dependent upon the continuity of fuel supply.

For biogas installations with tried and tested machinery, MB and BI covers are widely available. Also for waste-to-energy generators, the technology risk is not critical due to its maturity. Manufacturers' warranties are still prerequisites. Biogas facilities that use fermentation processes are still a major concern, due to the health risks posed by the noxious gases. Underwriters require strict safety procedures and operational experience.

Key underwriting considerations for biomass installations are:

- Workmanship and faulty material, which often constitute the main risk exposures.
- Fire exposure.
- TPL for emissions and pollution.
- Technology design risks due to prototypical nature.
- General lack of experience in operations.
- Similar risks as for steam turbine power plants.
- Availability and security of supply fuel.

Insurance Characteristics for Biomass

Characteristics	Description
Main challenges	Small scale projects are risky. Resource supply is risky due to insecurity of fuel supply and volatility of fuel prices. Biogas installations (with fermentation process) pose health risks due to noxious gases.
Main exclusions or restrictions	Biomass installations have higher deductibles for Business Interruption coverage risk because of insecurity in fuel supply. Biogas installations encounter restricted liability coverage due to the potential negative health and pollution risks.
Loss control measures required	Biomass (waste-to-energy) installations still need comprehensive manufacturing warranties prerequisite to insurance. Biogas (fermentation) installations require strict safety procedures and operational experience.

Exemplified Insurance Application Form for Biomass Power Installations

(This application form is shortened and exemplified for educational purposes)

The Insured has the obligation to respond to the hereafter indicated questions as accurately and truly as possible. If the reply does not correspond to the real installed equipment and installations the Insurer could, possibly, invoke cancellation of the policy after a one month period. In case of intentional omission of material information and/or gross negligence the Insurer could cancel “ab initio”. The Insurer’s withdrawal of the right of coverage is normally excluded, except in case of intentional omission of material information, even if the noted omission would have resulted in the Insurer taking on the risk with different terms and conditions.

1-Insured:			
2-Country:	County/Province:	Location:	Zip Code:

Insurance Period From:

3-Machinery Breakdown Insurance		
Type of installation:		
Installation with indemnity according Power Purchase Agreement:		
Power with heat recovery installation:		
Installation fired with crop refuse:		
Power with heat recovery installation using crop refuse:		
Installation company / Designer:		
Installation components	New values (without rebates)	
Components for gas production, gas preparation, mixing tank, Fermentor, refuse holding tank, gas storage, gas drying) (in $/EUR):		
Installation designer:		
Skid mounted boiler plant unit(s) including automatic steering (in $/EUR)		
Number:	Power KWel:	Year of construction
Motor design	Manufacturer:	
Type:	Year of construction:	Operating hours

Storage volume (in m3):	Gas consumption (in m3):	
Transformer including net supply switchgear		
Capacity:	Power KWel:	Year of construction
Manufacturer:	Type:	
Enclosure/building (in $ / EUR)		
Total sums insured (include VAT: YES/NO) (in $ / EUR)		
Projected annual capacity:		
From which material is the Fermentor made:		
Surface protection:		
Is fire damage to be covered (YES/NO):		

4-Machinery Breakdown Business Interruption			
Calculate KWh: Engine/turbine capacity in KW x projected operating hours p.a.			
Calculate Value: KWh x price power purchase contract (provide copy) (in $/EUR/KWh)			
Result: Sum Insured			
Replacement time (in days/weeks):			
Engine / Turbine:	Transformer:	Switchgear:	
Period of Indemnity (3 / 6 months):	Deductible:		
Damage as a result of Fire, Lightning or Explosion: Period of Indemnity 12 months			

5 Risk description
Is the insured owner of the insured premises? (Yes/No)
If not, please indicate owner:
Are the premises also used by others (Yes/No)
If yes, by whom
Is the insured owner of the “ to be insured “ installations? (Yes/No)
If no, please indicate owner of the installations
Is the installation in an existing integrated process? (Yes/No)

If yes, what type of building
Does an increased Fire-or Explosion hazard due to contents, operation or environment in a 30 m radius exist? (Yes/No)
Are all components of know & proven technology and no prototype equipment and not one of a kind installation? (Yes/No)
Has a commissioning test run of 4 weeks been adequately executed with reaching name plate capacity (Yes/No) (If so add copy test acceptance protocol)
Has a manufacturer's maintenance programme been contracted? (Yes/No) (If so add copy)
Does a manufacturer's warranty contract exist? (Yes/No) (If so add copy)
Is the installation build according plans of designer, installer or components supplier? (Yes/No)
If not please add description of deviation.
Is a state of the art gas cleaning installation foreseen, sulphur filter and silica filter? (Yes/No)
If Yes , what system-type
Are the employed engines/ Turbines for the Bio-gas firing in conjunction with the installed gas cleaning installation approved by the designer/ manufacturer? (Yes/No)
If Yes, does a corresponding legal guarantee exist? (Yes/No)
Is a flue gas temperature control, an engine / Turbine revolution measurement, a methane sulphur and silica Bio-gas content measurement, an ambient room air-gas measurement been installed and an does automatic security trip ensues of accepted base values are exceeded? (Yes/No)
If Yes, is data stored for review? (Yes/No)
Are prescribed lubrication oil quality analysis carried out, oil changes executed according manufacturers maintenance prescription, and lubrication quality data adhered to? (Yes/No) (If Yes add last test protocol)
Has the Installation been fitted with a "State of the Art" lighting protection system, (i.e. DIN VDE 0100 part 540/737) or similar acceptable equipment? (Yes/No) If Yes, has it been tested? (Yes/No)
Have technical installation measures (i.e. Carbon absorption filter, gas dryer, gas pipe insulation) been taken to avoid gas being cooled below gas dew point? (Yes/No)
Have all technical & safety standards, regulatory norms, prescriptions, licenses been obtained for the operation of this installation? (Yes/No)
What type of fire detection & protection installation has been installed?
Have the insured still recommendations to comply with? (Yes/No)
If Yes, which one and when to be complied with?
Are authoritative regulations and/or constraints expected in case of a replacement after a loss? (Yes/No)

If Yes, which one
Is sales of heat foreseen? (Yes/No)
If Yes, what is the projected annual sales
Any special conditions?

6- Special Agreements
7- Existing coverage
Does there exist insurance coverage (Yes/No)
Who is the insurer? Place Insured
Coverage cancelled by insured/Insurer
8- Loss History
Review of claims history precondition of coverage
Cancelled by whom? Insurer? Insured?
Last 5 years claims history?
No (claims for which not yet insurance existed are to be indicated)
Yes (Nature, number, date and indemnity are to be indicated)
9- Signatures

The undersigned parties warrant that the information supplied in this questionnaire is truthful and applies correctly to the installed Biomass Installation(s). Non-intentional omission of information will not jeopardise insurance coverage, however gross negligence in omitting material risk information, which unduly and unknowingly increases the risk for the underwriter, may trigger nullity of the contractual insurance terms “ab initio”.

Key Terms

Term	Definition
Insurance Cycle	The insurance cycle refers to the periodic oscillation of the market between “soft” and “hard” phases. The soft market is characterized by decreasing premiums, less capital and weakening of competition. The hard market exhibits growing premiums, new capital influx in the market and more stringent underwriting guidelines. A hard market can be triggered by a large loss event such as “9/11” or Hurricane Andrew. A soft market follows the hard market once market has become saturated, competition has accelerated and premiums start to decline.
Insurance Pricing	The pricing process determines insurance premium by estimating losses and expenses as well as making provisions for uncertainty and profit factors. Price (or insurance premium) = Expected Claims + Admin Costs + Risk Premium. Expected Claims Payment are the payments the insurer must potentially make to the insured party under the contract. Administrative Costs cover all the administrative, distribution and other costs the insurer bears in order to provide the policy protection. Risk Premium covers the capital and interest costs.
Risk	Risks have a probability of occurring and an impact (if the event were to occur). The term has two different meanings in the context of insurance and financial markets: 1. Risk referred to an insured object: Risk is a general term that can refer to an insured property or person, or else to the insured perils against which an insured property or person is covered. In this sense, "risk" includes the concepts insured peril and insured person. 2. Risk referred to occurrence of uncertain event: Risk is the possibility of the occurrence of an uncertain, random, and unforeseen event resulting in loss, injury or damage. This event, if it occurred, could threaten achievement of some part of project objectives (e.g. construction or operation related).
Underwriting	Process of examining, classifying and pricing insurance risks, including the conclusion of the contract for those risks which are accepted. Also includes the rejection of risks.
Technology efficacy	Technology efficacy refers to operational reliability, quality and costs of a newly introduced technology. Technologies that are considered to be at an early stage such as certain RET do lack the operating history and provide a limited amount of loss information for loss projections and pricing.

Lesson Review

Section 1 – Basic Underwriting Principles

Insurance indemnifies against loss events covered in an insurance policy. Loss events are either caused by physical, human or natural perils. Insurance can help to lower the overall cost of capital for an economic undertaking by reducing the uncertainty of the negative financial impact of the insured risk events. Insurers are in the business of taking the risks they underwrite. This requires a diligent underwriting philosophy. The main factors of the underwriting philosophy are the sustainable balancing of risk appetite and risk tolerance, the effective management of the insurance cycle, and the appropriate pricing of insurance policies. The execution of the underwriting philosophy is supported by appropriate underwriting principles. These cover the data requirements for risk assessment and risk rating, the interests insured and policies offered, the coverage, terms and conditions, as well as the capacity, pricing, nat cat and accumulation control, and acceptance processes.

Section 2 – Basic Insurance Product Offerings for RET

The basic insurance offerings available for RET are property, engineering, marine, energy and liability products. Furthermore special lines such as crime, E&O, D&O, credit, political, weather risks and emission reduction insurance are available. The main property and engineering products are related to the construction and operation phase of RET installations.

Section 3 – Basic Underwriting Processes and Guidelines

Basic underwriting processes and guidelines are applied for RET underwriting. Standard underwriting forms cover all the required underwriting information such as the parties, occupancy, scope of coverage, geographical scope, period of insurance, structure of contract, exposure and risk quality assessment, exclusions, additional perils, natural catastrophe information, loss history, and provisions regarding law and claims management.

Underwriting guidelines are drawn from the main clauses that are considered in the policy terms. The exact definition of occurrence, events and values can be critical in case of a major loss event. Each insurance company defines their extensions and exclusions for their offered type of insurance. Specific considerations also apply for accumulation control, Nat Cat perils and contingent business interruptions. Especially in the case of emerging and developing countries, where fronting arrangements, reinsurance proceeds clauses, and claims considerations are taken into account.

Section 4 – Risks and Barriers in RET Underwriting

Underwriting Renewable Energy Technologies is not trivial. There are still many risks and barriers to overcome. The most important barriers are the missing expertise with regards to new technologies and the relatively low loss and actuarial experience with RET. Furthermore, underwriters must consider the regulatory, economic and market environment, the credit and counter-party risks, and the influence of potential natural catastrophes. An example of a risk analysis for an off-shore wind project provides insight to the variety of risks during the planning, construction, testing, commissioning and operating phases.

Sections 5 through 8 – Specific Considerations for Wind, Hydro, Solar and Biomass

The last four sections provide an overview of the specific underwriting considerations for four classes of RET: wind, hydro, solar and biomass. There is already a firm knowledge base available for all of these technologies; however the actuarial experience still varies. More established and proven technologies are on-shore wind and hydro. New applications with less actuarial data are solar, off-shore wind and biomass. A smaller experience base requires a more sophisticated underwriting process and results in a tighter capacity, with more restrictive conditions and a higher price.

Further Readings and Related Links

Reading	Link
UN Publications	
UNEP	http://www.unep.fr
Assessment of Financial Risk Management Instruments for Renewable Energy Projects, UNEP Working Group 1 Study Report, published by Marsh Ltd and UNEP Division of Technology, Industry and Economics (DTIE), 2007.	
Scoping Study on Financial Risk Management – Instruments for Renewable Energy Projects, Reference Document, Marsh together with UNEP Division of Technology, Industry and Economics (DTIE) and SEFI, 2004.	
Survey of Insurance Availability for Renewable Energy Projects, Marsh Marine and Energy Practice, together with UNEP, 2006.	

Further Publications	Link
A solar grand plan, Society and Policy, Scientific American, December, 2007. (Authors: K. Zweibel, J. Mason, V. Fthenakis)	http://www.sciam.com/article.cfm?id=a-solar-grand-plan
Emerging Technologies: Insuring what has not been insured before, IMIA Working Group Paper 52/07, 2007.	http://www.imia.com
Engineering Insurance of Offshore Wind Turbines, IMIA Working Group Paper 46/06, 2006.	http://www.imia.com
Environmental Policy: Renewable Energy Sources in figures – national and international development, Federal Ministry for the Environment, Nature Conversation and Nuclear Safety, Berlin 2004.	http://www.bmu.de
From Risk to Opportunity: 2007, Insurers Responses to Climate Change, CERES, 2007. (Author E. Mills)	http://insurance.lbl.gov
Impact of increasing Natural Hazards on Engineering Insurance, IMIA Working Group Paper 38/04, 2004.	http://www.imia.com
Insuring Projects and Contract Work, IF'S Risk Management Journal, Part 1 2/2004, Part 2 1/2005. (Author: A.Lindberg)	http://www.imia.com/downloads/external_papers/EP31_2008.pdf and…/EP32_2008.pdf
International Energy Agency (IEA), Implications of climate change for energy industries, especially World Energy Outlook series.	http://www.iea.org
Renewable Energy Projects Handbook, World Energy Council, 2004.	http://www.worldenergy.org/publications/322.asp

Renewable Energies, Innovations for the future, Federal Ministry for the Environment, Nature Conversation and Nuclear Safety, Berlin 2006.	http://www.bmu.de
Renewables 2007, Global Status Report, Renewable Energy Policy Network REN21, 2008.	http://www.ren21.net
Schadenspiegel, Special Feature Issue, Risk factor of Earth, 2007., Risk factor of Fire, 2006., Risk factor of Water, 2005.	http://www.munichre.com
Annual review of catastrophe losses, yearly report.	http://www.munichre.com
Engineering insurance and reinsurance, An introduction, 1997.	http://www.swissre.com
Insurance Instruments for GHG Projects: Private Sector Options, UNECE Ad Hoc Group of Experts on Coal Mine Methane, Presentation by W. Diogo of Marsh Ltd in Geneva, April 2007.	http://www.marsh.com
Survey of Insurance Availability for Renewable Energy Projects, Marsh Marine and Energy Practice, together with UNEP, 2006.	http://www.marsh.com

Test

Question 1

What is the potential consequence of a non-diversified portfolio of RE technology?

Answers:

Losses from the insurance policies in this portfolio are positively correlated. For example if the design of a newly introduced wind turbine is poor, it is to be expected that large losses occur simultaneously in a relatively short time period.	☐ Check if Correct
Losses from the insurance policies in this portfolio are positively correlated. For example if the design of a newly introduced wind turbine is poor, it is to be expected that many losses occur simultaneously in a relatively short time period.	☑ Check if Correct
Losses from the insurance policies in this portfolio are negatively correlated. For example if the design of a newly introduced wind turbine is poor, it is to be expected that large losses occur simultaneously in a relatively short time period.	☐ Check if Correct
Losses from the insurance policies in this portfolio are negatively correlated. For example if the design of a newly introduced wind turbine is poor, it is to be expected that many losses occur simultaneously in a relatively short time period.	☐ Check if Correct

Question 2

Wind: What are the key risks for wind energy installations?

Answers:

Long lead times and up-front costs, critical component failures, resource price variability.	☐ Check if Correct
Critical component failures, wind resource variability, flooding.	☐ Check if Correct
Long lead times and up-front costs, critical component failures, wind resource variability.	☑ Check if Correct
Long lead times and up-front costs, theft and vandalism, wind resource variability.	☐ Check if Correct

Question 3

Hydro: Which statement is true?	
Answers:	
Typically small hydro has a capacity of less than 1 MW and relies on the same technology and operating foundations than large scale hydro.	☐ Check if Correct
Typically small hydro has a capacity of less than 10 MW and relies on the same technology and operating foundations than large scale hydro.	☑ Check if Correct
Typically small hydro has a capacity of less than 1 MW but relies on a different technology and operating foundations than large scale hydro.	☐ Check if Correct
Typically small hydro has a capacity of less than 10 MW but relies on a different technology and operating foundations than large scale hydro.	☐ Check if Correct

Question 4

When underwriting Solar Photovoltaic installations which of the following considerations are most relevant?	
Answers:	
Workmanship and faulty material, Short circuits and converters.	☐ Check if Correct
Vulnerability to hail and lightning, Vulnerability to theft and vandalism.	☐ Check if Correct
Component breakdowns and weather damage.	☐ Check if Correct
All of the above.	☑ Check if Correct

Question 5

Biomass: Which of the following statements is wrong?	
Answers:	
Security of fuel supply and fuel-price volatility is a major concern for the risk and finance management of a biomass project.	☐ Check if Correct
Waste-to-energy generators are considered to be mature technologies.	☐ Check if Correct
Biogas projects must consider planning opposition due to potential health and odour problems.	☐ Check if Correct
Biomass technologies are mature and also relatively inexpensive especially in case of organic ranking cycle (ORC) process.	☑ Check if Correct