Financial Risk Management Instruments for Renewable Energy Projects

Summary document

United Nations Environment Programme
Division of Technology, Industry and Economics

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Foreword

Financial risk management is a key element of any commercial investment in conventional energy and infrastructure projects, yet little attention has been paid to its use in the deployment of renewable energy technologies, particularly in developing countries. Risk management instruments such as contracts, insurance and reinsurance, alternative risk transfer instruments, and credit enhancement products could, if used, transfer certain types of risks away from investors and lenders, reducing the costs of financing renewable energy projects. These and other financial tools are an essential part of well-established markets. But the market for renewable energy technologies is only getting started in many parts of the world and lack of good information hinders its development. Bringing better information to policy makers is one of UNEP's roles.

This report presents an overview of risks specific to the financing of renewable energy projects. It discusses both risk management products currently available in the market, and emerging instruments that could be applied to the sector. New products based on partnerships between private and public sector risk managers are also presented.

The application of risk management instruments to renewable energy projects requires financial innovation and a willingness to test new approaches. This in itself is risky, and the report suggests a learning-by-doing approach in order to gain experience and confidence in these new markets.

By providing concise technical information to risk management specialists and project developers, this report aims to contribute to a better understanding of risk management options for renewable energy projects. It is our hope that better understanding leads to greater deployment of clean energy technologies that meet development needs.

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Acronyms and abbreviations

AfDB	African Development Bank
ASEAN	Association of South East Asian Nations
AsDB	Asian Development Bank
CDM	Clean Development Mechanism
CERES	Coalition for Environmentally Responsible Economies
CLN	Credit Linked Note
CSR	Corporate Social Responsibility
CUP	Cooperative Underwriting Programme (of MIGA)
DFID	Department for International Development (a UK Ministry)
EBITDA	Earnings before interest, tax, depreciation and amortization
EBRD	European Bank for Reconstruction & Development
ECA	Export Credit Agency
ECGD	The Export Credits Guarantee Department (of the UK)
EIA	Environmental Impact Assessment
EIB	European Investment Bank
EU	European Union
FDI	Foreign Direct Investment
GDP	Gross Domestic Product
GEF	Global Environmental Facility
GNI	Gross National Income
GNP	Gross National Product
IADB	Inter-American Development Bank
IBRD	International Bank for Reconstruction & Development
IDA	International Development Agency
IFC	International Finance Corporation
IFI	International Financial Institution (i.e. IMF and World Bank)
ILS	Insurance Linked Security
IMF	International Monetary Fund
IRR	Internal Rate of Return
kWh	Kilowatt Hour
LDC	Least Developed Country
M&A	Mergers & Acquisitions
MDB	Multilateral Development Bank
MFI	Multilateral Financial Institution
MIGA	Multilateral Investment Guarantee Agency
MW	Mega-Watt

NCR	Non-Commercial Risk
NCRI	Non-Commercial Risk Insurance
NEXI	Nippon Export and Investment Insurance (of Japan)
NFFO	Non-Fossil Fuel Obligation
NGOs	Non-Governmental Organizations
NPV	Net Present Value
OBI	Official Bilateral Insurer (for political and non-commercial risk)
OCF	Official Capital Flows (Non-Concessional Funds plus ODA)
ODA	Official Development Assistance
OECD	Organisation for Economic Cooperation and Development
O&M	Operations and Maintenance (contracts or agreements)
OPIC	Overseas Private Investment Corporation (of the USA)
OTC	'Over-the-Counter' (securities)
PCG	Partial Credit Guarantee
PPA	Power Purchase Agreement
PPI	Public Private Interaction
PPP	Public Private Partnership
PRG	Partial Risk Guarantee
PR	Political Risk
PRI	Political Risk Insurance
PSA	Production-Sharing Agreement
PV	Photovoltaic
RDB	Regional Development Bank
RE	Renewable Energy
RET	Renewable Energy Technology
RoA	Return on Assets
RoE	Return on Equity
SME	Small and Medium-sized Enterprise
SEFI	Sustainable Energy Finance Initiative
SPUV	Special Purpose Underwriting Vehicle
STAP	Scientific and Technical Advisory Panel (GEF)
UK	United Kingdom (Great Britain and Northern Ireland)
UN	United Nations
UNCED	United Nations Conference on Environment and Development
UNCTAD	United Nations Conference on Trade & Development
UNDP	United Nations Development Programme
UNEP	United Nations Environment Programme
USD	United States Dollars
WB	World Bank
WBG	World Bank Group (i.e. IBRD, IDA, IFC and MIGA)
WHO	World Health Organization
WTO	World Trade Organization
XOL	Excess of Loss (Reinsurance contract)

Glossary of terms

Accession Countries: Countries in the process for accession to the European Union.

Appetite for Risk: A measure of the propensity for Risk Taking or Risk Aversion.

ART (Alternative Risk Transfer): Generic phrase used to denote various non-traditional forms of re/insurance and techniques where risk is transferred to the capital markets. More broadly, it refers to the convergence of re/insurance, banking and capital markets.

Asset-backed Securities: Debt securities which depend on a pool of underlying receivables. In ART these refer to insurance-linked securities.

Blended Cover: Typically a combination of traditional re/insurance product lines with other risk management products in a single aggregated policy. These are commonly arranged on a multi-year basis.

Bond: Capital instrument issued by government or private corporation. Redemption may be linked to an event (e.g. CAT bond).

Call Option: Gives buyer the right to buy, seller is obliged to sell.

Capacity: Amount of reinsurance that can be underwritten by an entity or market.

Captive: The term for an insurance company that is owned by the company it insures. It is a Risk Financing strategy to lower the cost of insuring Risk and is usually established in a 'low-tax' environment.

CAT: Common term for a catastrophe.

CAT Bonds: Securitized insurance receivables—an example of an ART structure.

Cedant: An insurance company buying reinsurance cover.

Collaterallized Debt Obligations (CDOs): Securitization of loans/bonds etc.

Commercial Risk: Risk from a company's commercial activities as distinct from insurable risk.

Contingent Credit: Credit made available related to specific events and limits.

Credit Derivatives: Securities that offer protection against credit/default risk of bonds or loans.

Deductible: First part of loss borne by policyholder.

Degree Day: Term created to better forecast demand for energy. Number of degree days is calculated from the difference between actual temperature and a previously set level (usually 65 degrees). Expressed in Cooling Degree Days or Heating Degree Days.

Derivative: A financial contract whose value is derived from another (underlying) asset, such as an equity, bond or commodity.

Excess of Loss Reinsurance: Reinsurance which pays on the basis of the excess of claims over and above a predetermined retention limit.

Experience Account: Reserve fund set up to hold the premiums for finite reinsurance from a single insured party. Earns interest over the fixed term, and through an agreed profit commission formula returns to the insured whatever principal and interest is not paid out as losses and net of a risk premium that will be charged by the reinsurer for assuming the timing/investment risk due to a loss frequency or severity that was not anticipated.

Financial Risk Management (FRM): A method of mitigating risk in various financial transactions.

Financial Risk Management Instrument: Includes both insurance and non-insurance instruments.

Finite Risk: Re/insurance policy with an ultimate and aggregate limit of indemnity often with direct link between premium and claim amounts.

Forward Contract: Commits user to buying or selling an asset at a specific price on a specific date in the future.

Global Environment Facility (GEF): The GEF is the financial mechanism of the Convention on Biological Diversity (CBD) and the United Nations Framework Convention on Climate Change (UNFCCC).

G20 Countries: The G20 countries account for 86.7 per cent of the world's GDP and for 65.4 per cent of the total global population. The full membership includes Argentina, Australia, Brazil, Canada, China, France, Germany, India, Indonesia, Italy, Japan, Korea, Mexico, Russia, Saudi Arabia, South Africa, Turkey, UK, USA and the EU presidency.

Hedging: A financial markets term for undertaking risk management activities; usually involves taking a position (to purchase or sell financial instruments) that is counter to the original transaction.

Hot Dry Rocks (HDR): HDR technology involves developing an underground heat exchanger in buried hot granites (250–300 degrees C) through opening up existing joints by hydraulic pressure.

Index Based Contracts: Options contracts based on an index. The value of the derivative is derived from the index. Variation between actual losses and those derived from the index creates basis risk.

Insurance Guarantee Funds: Funds set up to meet in full or part the cost of claims from insolvent insurance companies.

Insured: One who transfers a risk to another party. The person named in the agreement of indemnity from an insurance company (or person) affording them indemnity from risks set out therein. Interchangeable with 'Assured'.

Insurer: The insurance company who has agreed to accept the risk and to pay monies by way of an indemnity to an insured in the event of loss. The amount paid can be an agreed amount or actual loss sustained.

Interest Rate Swap: An exchange of financial instruments to give each party their preferred position.

Investment Grade: In the context of bond ratings, the rating level above which institutional investors have been authorized to invest.

Least Developed Countries (LDCs): LDCs are generally characterized by low levels of economic activity and poor quality of life. There are 48 countries on the UN list.

Leverage: Also known as 'gearing', leverage generally refers to a high level of debt financing relative to equity. It can also imply trading on margin—particularly derivatives.

Legal Liability: The responsibility imposed under law upon one person by another, whether by negligence (common law), statute or contract.

Liability Insurance: Provides protection for the insured against loss arising out of his legal liability resulting from injuries to other persons or damage to their property.

Loss or Damage: Loss is technically distinguished from damage in fire insurance when all or any portion of the property insured is consumed. 'Loss' designates that portion which is entirely consumed, while 'damage' designates that part of the property which is not consumed, but remains in a damaged condition after a fire.

Mutual Insurance Company: Organization in which members or policyholders share risks, and premiums go into a pool from which claims and expenses are met.

Option: A contract which gives the buyer the right, but not the obligation to buy or sell a particular asset at a particular price.

Over-the-Counter (OTC): A derivative that is not traded on an exchange but purchased from an investment bank.

Policy: The actual insurance contract with all its details.

Property Insurance: Provides financial protection against loss or damage to the insured's property caused by 'all risks' of physical loss or damage unless otherwise excluded, or on a 'named perils' basis to include such risks as fire, smoke, windstorm, hail, explosion, aircraft, motor vehicles, vandalism, rioting, civil commotion, etc.

Project Finance: Often known as off-balance sheet or non-recourse finance since the financiers rely mostly on the certainty of project cash flows to pay back the loan, not the creditworthiness of the project's owners.

Proportional Treaty: A reinsurance contract which takes a defined pro rata share of all risks within treaty limits.

Put Option: Gives seller the right to sell—the buyer is obliged to buy.

Quota Share: Reinsurance on a percentage basis of a fixed share of all risks.

Reinsurance Pool: Pooling of reinsurance risks within fixed limits of a group of reinsurers.

Retention: The strategy of retaining some of the cost of risk in the insurance contract. 100 per cent retention is known as Self-Insurance.

Risk-Based Capital: System of calculating insurance capital required for a specific risk or 'package' of risks with reference to different elements of risk.

Risk Exposure: An exposure to loss (property, liability etc.).

Risk Financing: Methods of funding the cost of risk (e.g. insurance, credit and financial reserves).

Risk Linked Securities: Generic name for securities such as CAT Bonds.

Risk Management: Identification, evaluation and control of risk.

Securitization: Securing the cash flows associated with insurance risk. Securitized insurance risk enables entities, which may not be insurance companies, to participate in these cash flows.

Self-Insurance: Funded from an organisation's own financial resources.

Strike Price: Price at which future or option contract operates.

Swap: Two companies exchange cash flow linked to a liability or asset.

Timing Risk: Risk that claims may become payable earlier than expected.

Tradable Green Certificates: TGCs are generated by the certification of RE production. Certificates are tradable and consumers are required to prove that they have reached renewable energy production quotas by purchasing certificates.

Tranche: Term to describe a specific class of bonds within an offering. Usually, each tranche offers varying degrees of risk to the investor and is priced accordingly.

Transfer of Risk: The transfer of the financial consequences of a risk to another by legal contract and/or insurance.

Value-At-Risk: Often abbreviated as VAR, these are a class of models used by financial institutions to measure the risk in complex derivative portfolio positions.

Weather Hedge: Product which allows buyer to partially or fully offset climate-related risks.

World Bank Group: Includes the following sub-groups: IBRD, IDA, IFC and MIGA.

Executive summary

This study was funded by UNEP's Sustainable Energy Finance Initiative (SEFI) and conducted by a consortium of consultants and advisors led by Marsh Ltd with the objective of providing an overview of the barriers and/or risks affecting investment in Renewable Energy (RE) projects, 'financial risk management' instruments currently supporting RE projects and those that could be developed to reduce uncertainty and facilitate more efficient and effective financing of such projects.

The study was undertaken under the premise that current approaches to financing renewable energy are inadequate to realize the potential of these technologies to meet expanding energy needs while helping to mitigate climate change and other adverse environmental impacts[1]. Public interventions are therefore needed to help accelerate RE development, commercialization, and financing.

The full study on which this Executive Summary is based (hereafter referred to as 'the main document') is available online at www.uneptie.org/energy/act/fin/index.htm.

Key messages of the report include:

Traditional insurance products are gradually becoming more widely available to the RE sector. However, 'institutional inertia' is preventing any significant progress with regard to product development. The tendency in the insurance industry is to readapt existing products rather than create new ones. Substantially more engineering tests must be carried out on RE technologies for the purposes of actuarial studies: there is an important role for the public sector in the sponsorship of this work.

Capital allocation within insurance companies is dependent on senior management being convinced that the business case for underwriting a certain class of risk meets their minimum criteria. Most small projects have a high opportunity cost and rarely exceed the internal hurdle rates required by management. There is currently an impasse in RE market development in part due to restrictive thinking. Fresh approaches and financial innovation are required. Based on the responses to this study, the hypothetical provider of such innovation in the insurance markets is likely to be a small- to medium-sized specialist risk transfer/finance operation with dedicated capital and low overheads. Such an enterprise could facilitate and attract additional capital by providing industry leadership. However, few such operations currently exist.

[1] Adapted from the G8 Renewable Energy Task Force

This study proposes that there is a gap between the developers, their advisors and institutional investors. On one side are the boutiques and consulting firms that really interact with the majority of renewable energy (RE) project developers. On the other side are the major financial institutions who interact at a high level with policy makers but, despite good intentions, are usually too large/inflexible to operate usefully in the RE space at this time. There is a useful role for the public sector to act as a 'mezzanine player' or bridge between the expertise, creativity and nimbleness of boutiques and the distribution networks, balance sheet and market influence of major financial institutions.

New financial risk management approaches and instruments are evolving and can be adapted to meet the needs of the RE sector. These include; risk finance approaches, alternative risk transfer products, specialist underwriting vehicles, credit enhancement instruments and indexed derivatives. Insurance collaterallized debt obligations may be one method of directing capacity at particular insurers and lines of business. There is an ongoing role for risk mitigation and especially credit enhancement products provided by Multilateral Financial Institutions (MFIs), Official Bilateral Insurers (OBIs) and Export Credit Agencies (ECAs).

A key objective of this study is to accelerate plans to develop product blueprints for actual application in the market. **A learning-by-doing approach to developing new and commercially acceptable RE financing and risk management products could be usefully adopted through focused interactions between the public sector, specialist financial boutiques/insurers and global financial intermediaries.** This can be accomplished through joint ventures that combine the perceived support and credit rating of public sector entities with the creative vision of specialist private boutiques and the distribution networks of large financial services companies.

A number of programmes are suggested in section 6. **The main suggestion is to develop Special Purpose Underwriting Vehicles (SPUVs) with dedicated capacity for the RE sector.** An example of a risk management start-up operation from the forestry sector demonstrates the possibility for specialist Lloyd's syndicates to provide cover to commercially viable RE projects. There are a variety of SPUV structures which could be developed. The nature of the cover to be provided determines the level of public support required. An insurance company providing standard fire and wind storm protection for forestry requires nominal public support unless/until it takes on broader environmental agendas. However, the **technology** and **operational** risks inherent in RE projects mean that providing standard insurance cover is actually quite complex because of the data requirements. **Public sector support is required for engineering as well as project risk rating studies for most Renewable Energy Technologies (RETs) that have limited operational experience.**

1. Renewable Energy Technology assessment

Table 1 provides an overview of renewable energy technology (RET) characteristics, maturity and resource potential. In short, renewable energy source is abundant and there are many promising options for converting it into useful energy. The relative merits of renewable energy vary greatly depending on the scale, capacity, and status of individual technologies, natural resource availability and characteristics, location and a number of other factors. But it is generally true that renewable energy resource is infinitely available in all regions of the world, and that the conversion efficiencies for harnessing it and the costs involved have improved considerably, and continue to do so. Furthermore, RE technologies also represent a paradigm shift in innovation compared with conventional energy-supply systems.

Table 1: Renewable energy potentials

Resource	Technical potential (TWh/year)	Energy conversion options
Direct solar	In relation to energy demands, virtually unlimited.	Photovoltaics. Solar thermal power generation. Solar water heaters.
Wind	Very large in relation to world's electricity demands, especially offshore resources.	Large-scale power generation. Small-scale power generation.
Wave	Not fully assessed but large.	Numerous designs.
Tidal	Not fully assessed but large.	Barrage. Tidal stream.
Geothermal	Several orders larger than the amount currently used. As with other technologies, use depends on costs not the quantity of resource technically available, which is huge.	Hot dry rock, hydrothermal, geopressed, magma, shallow geothermal systems (only hydrothermal and shallow geothermal systems currently viable).
Biomass	Potential varies greatly between countries, but can complement agriculture and protect watersheds and biodiversity.	Combustion, gasification, pyrolysis, digestion, for bio-fuels, heat and electricity.

Source: Imperial College Centre for Energy Policy and Technology (2002)

2. The role of financial risk management instruments

Investors and lenders are naturally averse to risks that can give rise to unexpected negative fluctuations in a project's cash flows or value. To attract financing, there is a fundamental requirement to manage risk in a way that minimizes the probability of an occurrence that could give rise to a negative financial impact on the project.

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This study focuses on some financial risk instruments that can help transfer specific risks away from project sponsors and lenders to insurers and other parties better able to underwrite or manage them. A diverse range of risk management approaches are considered, including: insurance/reinsurance; alternative risk transfer; risk finance; contingent capital; and credit enhancement products.

When considering a project, a financier will usually prepare a risk/return analysis to assess each major risk and the means to mitigate its potential impact on the project. Assessing the returns involves verifying the potential 'downside' cost ('what might go wrong') and 'upside' revenue projections ('what might go right'), and then comparing the financials of the project with the cost of financing to be used. This practice of risk allocation and due diligence is necessary but often expensive and is carried out to provide the financial community with a better understanding of applicable technologies, relevant markets and any new approaches to managing risks. Unfamiliar technologies, developers and jurisdictions require proactive sponsorship at senior management level. Without sufficient commercial incentive, this is difficult to attain.

As a result, most small-scale RE projects, and even large deals in potentially risky jurisdictions, are simply not considered by commercial financiers. When these projects find private financing beyond the developer's equity, it is often as a result of an eclectic support group that may comprise: specialist/boutique consulting and financial advisory firms; high-net worth individuals seeking tax shelters; community and local finance schemes; equipment leasing arrangements; and, occasionally, corporate sponsorship by a utility. Attempts to 'bundle' small projects together to achieve critical mass for financing purposes have, to date, been unsuccessful. However, 'roll-out' deals comprising multiple small installations of the same technology have been completed. Table 2 gives consideration to the various forms of finance available and their relative merits in the context of RE projects.

Typically, small RE projects or deals using new or adapted technologies (where limited operational hours can be demonstrated for actuarial purposes) require equity sponsorship of at least 25 per cent and often 50 per cent of the total value of the project. As the real or perceived risk associated with a RE project increases (say, due to host country political risk), lenders require a larger equity component to finance the project. Equity investors take a greater share of the burden of capital investment and this is onerous for small-scale developers.

Table 2: Forms of finance

Type of finance	Merits in RE context
Private Finance from personal savings or bank loans secured by private assets.	Can often be the only available finance for small-scale projects.
Grants from the public sector are often designed to help a project developer share the costs of early stage development.	Key to moving certain RETs such as wind/wave/tidal forward to commercialization.
Risk Capital is equity investment that comes from venture capitalists, private equity funds or strategic investors (e.g. equipment manufacturers).	Besides the developer's own equity and other private finance, risk capital is often the only financing option for RE projects.
Mezzanine Finance groups together a variety of structures positioned in the financing package somewhere between the high risk/high upside equity position and the lower risk/fixed returns debt position.	Good scope for public/private funding. A number of RE mezzanine funds are now being targeted in developing countries.
Corporate Finance, debt provided by banks to companies that have a proven track record, using 'on-balance sheet' assets as collateral. Corporate sponsor required to accept risk and potential reward of a project in its entirety.	Mainly available to mature companies with strong asset base, debt capacity and internal cash flows. Structured finance in conjunction with the public sector offers scope for development. IFC deals offer some examples.
Project Finance, debt provided by banks to distinct, single-purpose companies, whose revenues are guaranteed by credit worthy off-take agreements. For renewable energy projects these are typically structured as Power Purchase Agreements (PPAs).	Long-term off-take agreements enable non-recourse finance for reasonable tenors. PPAs tend to be deeply discounted which reduces value to developers. Sometimes regulatory risk is excluded which reduces lender appetite for such non-recourse debt. Limited scope for off-grid RE projects.
Participation Finance, similar to project finance but the 'lender' is a grouping of investors, for example a cooperative wind fund, that often benefit from tax and fiscal incentives.	May be prepared to provide principal finance, which does not require long-term PPAs particularly when risks can be proactively managed and hedged.
Risk Finance/Insurance Structures are used to transfer or manage specific risks through commercial insurers and other parties better able to underwrite the risk exposures and 'smooth' revenue flows.	Promising scope for developing new RE financing approaches in countries with functioning insurance markets.
Consumer Finance is often required for rural clients as a means of making modern energy services affordable. Once client creditworthiness is proven, the portfolio can be considered an asset and used as collateral for financing.	Various types of micro-credit schemes are now being deployed in the solar home system market, for example, which often involve risk-sharing at the local and institutional levels.
Third-party Finance, where an independent party finances many individual energy systems. This can include hire-purchase, fee-for-service and leasing schemes, as well as various types of consumer finance.	Asset backed finance offers some flexibility over traditional project finance structures and there may be some tax benefits.

Many RE projects do not get beyond the planning stage as a result. There is a need for innovative structures that can fill the funding gap between the equity and debt available to a project.

In developing countries, the financing of rural energy programmes is usually addressed through government subsidies, donor programmes and private cash sales of small systems adapted to local conditions. Quasi-equity or mezzanine finance has had some limited application in developing country situations. The 'burden of proof' requirements[2] for off-balance sheet project finance are usually too onerous for RE projects in these locations because of real and perceived credit risks. Some major transaction costs are fixed and so economies of scale are favoured.

Investor confidence is critical to attracting financing. As a result, the type of financing available to renewable energy projects is largely dependent upon the risk management approaches adopted by the project's management and the instruments available to mitigate real and perceived risks.

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The most significant risk allocation tools are the contracts[3] governing each project participant's responsibilities. Ultimately the investors and lenders attempt to strike a deal that allocates risks cost-effectively and provides adequate transparency as well as monetary safeguards to protect themselves.

Where risks are insurable[4], commercially available insurance can play an essential part in ensuring that a successful project finance structure is achieved by transferring risks considered unacceptable away from investors/lenders and to the insurance markets.

Generally, revenue exposure (as a result of project delays, damage/losses during fabrication, transport, installation, construction and operational stages) is of prime concern for financiers. Lenders require insurance due diligence to be undertaken to review the risks and the adequacy of the proposed insurance arrangements. These can be an integral part of developing contracts, clauses in credit and other agreements, and insurance-related conditions before reaching financial closure.

[2] Typical project finance requirements include: firm long-term fuel supply from, and power purchase agreements with creditworthy parties; fixed price, turnkey design and build contracts placed with experienced contractors; guarantees, warranties or bonds for completion and performance provided by sponsors and contractors; all contracts and insurance polices assigned to the bank, so that the lender can take over the project in the event of non-performance by the project company.

[3] Including offtake agreements concerning resource availability and supply, power and tradable environmental permits.

[4] Insurable risks generally are those that can be accurately quantified according to the likelihood and severity of losses from insured events and which meet certain legal, economic and social criteria.

3. Overview of risks and barriers

The study has identified, qualified and explored a number of key risks and barriers that can threaten investment in RE projects and thus prevent more rapid uptake of desirable technologies. The research methodology consisted of questionnaires, telephone interviews and literature reviews which captured a diverse range of expertise and insight to provide a holistic view of high level barriers categorized in a top down approach[5].

At the broadest macro-economic level, barriers associated with investment in RE projects were categorized according to distinct but interrelated themes including:

- Cognitive barriers, which relate to the low level of awareness, understanding and attention afforded to RE financing and risk management instruments.
- Political barriers, associated with regulatory and policy issues and governmental leadership.
- Analytical barriers, relating to the quality and availability of information necessary for prudent underwriting, developing quantitative analytical methodologies for risk management instruments and creating useful pricing models for environmental markets such as carbon emissions permits.
- Market barriers, associated with lack of financial, legal and institutional frameworks to support the uptake of RE projects in different jurisdictions.

Just as there are gaps in the financing continuum relating to the different sources of capital needed to take a RE project forward to implementation, financial risk management instruments also suffer from barriers to implementation. These barriers are more prevalent in less developed countries because the financial, legal and institutional frameworks necessary for stable financial markets[6] are not present.

The financing problem for the renewable energy sector as a whole relates to the way the resource is priced in the market compared with energy generated by conventional fossil fuels. Conventional market pricing models do not accurately

[5] Research was carried out through telephone interviews, meetings and correspondence between 29 October 2003 and 15 February 2004 involving various stakeholders including (re) insurance and financial institutions; project developers, NGOs, policy makers; and multilateral financial institutions.

[6] Consideration of the surrounding economic environment is of paramount importance in understanding the gaps in the financing continuum and the opportunities for adapting existing, and developing new, financial risk management instruments for RET applications.

reflect environmental externalities including CO_2 emissions produced from the generation of energy from fossil fuels. Similarly, environmental and wider sustainable development benefits associated with RE projects are not accurately reflected in the pricing of renewable energy sold to consumers.

At a macroeconomic level, it is evident that stable policy support measures are needed to mitigate the real and perceived risks for investors in renewable energy projects and technologies. Only **long-term** policies can change the familiar pattern of commercial investment away from conventional energy sources in favour of large-scale investment in clean technologies. Respondents to questionnaires frequently cited lack of confidence in regulatory policies because of changing national and international prerogatives.

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At the project level various risks and barriers were explored, many of which contribute towards the difficult commercial conditions for the sector. Some persistent challenges such as the often-small scale of projects, technology efficacy risk, resource availability and supply risk[7], relate particularly to the RE sector. Other barriers are generally applicable to utility projects (especially in developing countries) such as long lead times, high up-front costs, credit risk, construction delays, business interruption and physical damage issues.

From an investment perspective these various risks and barriers may have differing levels of financial significance depending on the management of the project, host country and the other investors in the deal. The presence in a deal of, say, an official bilateral insurer or the IFC can dramatically reduce the perceived credit risk to lenders. Credit enhancement has proven effective in attracting foreign capital to many developing country investment projects.

Leaving aside the issues of 'small scale' and project location for the time being, the financial sector requires a better understanding of RE-specific **resource, technology and operational risks**. In general, a lack of data and institutional inertia are preventing the development of new/better risk management products.

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Table 3 highlights some of the key risk issues affecting different RE technologies. Technology and operational risks are the principal deterrents to attracting appropriate commercial insurance cover.

Insurers and financiers penalize new or poorly understood processes and technologies with prohibitive premiums and terms. 'Institutional memory' amongst some insurers lingers on from the 1980s when new wind turbine technologies led to damaging losses in the onshore insurance markets and resulted in a significant decline in available capacity. Institutional memory was one of the leading reasons that insurers were unwilling to underwrite onshore

[7] Either in terms of assessing the resource or contracting the supply.

Table 3: Key risks/barriers associated with RE projects

RET type	Key risk issues	Risk management considerations
Geothermal	• Drilling expense and associated risk (e.g. blow out). • Exploration risk[8] (e.g. unexpected temperature and flow rate). • Critical component failures such as pump breakdowns. • Long lead times (e.g. planning permission).	Limited experience of operators and certain aspects of technology in different locations. Limited resource measurement data. Planning approvals can be difficult. 'Stimulation technology'[9] is still unproven but can reduce exploration risk.
Large PV	• Component breakdowns (e.g. short-circuits). • Weather damage. • Theft/vandalism.	Performance guarantee available (e.g. up to 25 years). Standard components, with easy substitution. Maintenance can be neglected (especially in developing countries).
Solarthermal	• Prototypical/technology risks as project size increases and combines with other RETs e.g. solar towers.	Good operating history and loss record (since 1984). Maintenance can be neglected (especially in developing countries).
Small hydropower	• Flooding. • Seasonal/annual resource variability. • Prolonged breakdowns due to offsite monitoring (long response time) and lack of spare parts.	Long-term proven technology with low operational risks and maintenance expenses.
Wind power	• Long lead times and up-front costs (e.g. planning permission and construction costs). • Critical component failures (e.g. gear train/ box, bearings, blades etc). • Wind resource variability. • Offshore cable laying.	Make and model of turbines. Manufacturing warranties from component suppliers. Good wind resource data. Loss control e.g. fire fighting can be difficult offshore due to height/location. Development of best practice procedures.
Biomass power	• Fuel supply availability/variability. • Resource price variability. • Environmental liabilities associated with fuel handling and storage.	Long-term contracts can solve the resource problems. Fuel handling costs. Emission controls.
Biogas power	• Resource risk (e.g. reduction of gas quantity and quality due to changes in organic feedstock). • Planning opposition associated with odour problems.	Strict safety procedures are needed as are loss controls such as fire fighting equipment and services. High rate of wear and tear.
Tidal/wave power	• Survivability in harsh marine environments (mooring systems etc). • Various designs and concepts but with no clear winner at present. • Prototypical/technology risks. • Small scale and long lead times.	Mostly prototypical and technology demonstration projects. Good resource measurement data.

[8] The probability of success in achieving (economically acceptable) minimum levels in thermal water production (minimum flow rates) and reservoir temperatures.

[9] Stimulation technology attempts to improve natural productivity or to recover lost productivity from geothermal wells through various techniques including chemical and explosive stimulation.

wind energy projects, and this could also account for the slow development of new insurance products for other RE projects. Many insurance practitioners highlight that, with the exception of onshore wind energy, there is a limited understanding of most RE projects and associated risks.

Generally speaking, underwriting processes and mentalities are rigid and inflexible to change and innovation. This 'institutional inertia' is reflected by the tendency in the insurance industry to adapt existing products rather than develop new ones specifically for the RE sector. For example, products that cover the resource supply risk better known as 'exploration risk'[10] associated with drilling for Hot Dry Rocks (HDR) in **geothermal** projects are derived from conventional oil and gas exploration insurance. Resource risk is obviously quite different for each technology and the risks for a failed geothermal well are particularly costly.

Similarly, risks associated with securing long-term sustainable supplies of **biomass** will be of greater concern to financiers than the resource availability and supply issues associated with **wind**, **tidal** or **solar** projects. At the same time, the technology and operational risks associated with wind and **biogas** projects, such as component failure and controlling the fermentation process respectively, are of more concern to financiers than the more mature processes driving geothermal technologies.

There are a number of derivatives and insurance policies evolving to manage resource risk in the RE sector and generally. Some temperature related products are now exchange traded and structured solutions are available worldwide for precipitation and wind risk as long as weather data is available. As satellite-monitoring technologies continue to become less expensive, weather data will be more readily collected and the private sector will continue to improve weather-related RE resource risk management products.

However, the challenges posed by unfamiliar technologies are notoriously difficult to overcome in the commercial insurance market. Public sector support could be usefully extended to sponsor more product testing and pilot projects. The operational results of such publicly funded engineering studies could be made available to the commercial insurance market as long as several firms commit to use the data for actuarial purposes and develop some new products specifically designed for renewable energy technologies.

If commercial insurance policies were available for some RE-specific technology and operational risks then private sector investment in the sector could grow by a factor of four or more.

If commercial insurance policies were available for some RE-specific technology and operational risks then private sector investment in the sector could grow by a factor of four or more[11]. Given the lack of confidence that

[10] See footnote 8

[11] Combined estimates from commercial sources.

survey respondents had with regard to maintaining stable policy regimes, publicly-funded engineering studies may be a relatively inexpensive and uncontroversial approach to increasing the flow of funds into the RE sector.

Indeed, one of the most critical and fundamental concerns highlighted by investors and project developers alike relates to the fact that any investment made under a policy regime is exposed to the numerous reviews and potential changes which may take place between the time the investment is made and the time at which invested capital is fully repaid from project cash flows. Such regulatory risk is common to many infrastructure deals and particularly affects utilities. However, many fickle subsidy and price support regimes are RE-specific as governments find their way with energy policy and security issues.

At the same time, some types of price support mechanisms,[12] along with associated financial risk management instruments that can provide certainty around future RE obligations, will be needed to underpin the future value of any traded renewable energy or 'green' certificates. These will provide comfort about future cash flows and enable financiers to back projects on reasonable terms. In developing countries, PPAs often require official government guarantees. Sovereign guarantees are also discussed further in section 5.

The main document explores a number of commercial and non-commercial risk issues affecting developing countries. Empirical evidence demonstrates that private lenders are particularly sensitive to credit risk when considering instruments that could help to mobilize debt finance for renewable energy projects. Several lenders suggested that wider application of credit enhancement for local debt issues in developing markets would be quite useful. The role of the IFC and other institutional actors is being examined and the credit enhancement products they currently offer are being reviewed.

This study also gives consideration to the indirect barriers inhibiting the development of new risk transfer products. The research made clear that the most effective role for commercial insurance in supporting RE projects is technology dependent and conditioned by legal, political, social and economic factors which will vary from one country to another. Insurance industry practitioners emphasize that decisions to insure a particular risk are not taken on theoretical grounds, but in the light of practical experience and commercial considerations. These are the areas that policy makers should target when designing measures to increase investment flows to the RE sector.

[12] Price support mechanisms include feed in tariffs, investment subsidies, quota obligations (e.g. Renewables Obligation), fiscal incentives (e.g. tax credits), tendering systems (e.g. NFFO)

4. Existing insurance products for RE projects

The role of insurance

Insurance has an important role in supporting investment in RE projects by giving financial protection from delays or damage during the fabrication, transport, construction, and operational stages of a RE project—whether for technical reasons, human error or the forces of nature. Cover for loss of income can be a critical issue from a lender's perspective, as it not only affects a project's ability to pay its construction loan, but also affects the balance sheet of the entire project.

The industry is familiar with assessing many of the wide-ranging risks associated with different stages of conventional energy and infrastructure projects. Currently there are many more examples of existing risk transfer instruments developed by the insurance industry (see Table 4) and applied to RE projects than compared with other non-insurance financial instruments which are at a more evolutionary stage of application (see section 5). The 'traditional' products which insurers respond to include: contractors risks; property damage; machinery breakdown; delays in start up/business interruption; errors and omissions; as well as legal liability, political risks and some financial risks such as currency convertibility and default.

Insurance can lower a corporation's cost of capital and increase liquidity by reducing the financial impact of risk events.

Some of the specialist underwriting practices and principles associated with the energy industry will be similar for RE projects and their associated risks. It is important to tap this specialist expertise where crossover exists, especially for those risks associated with fabrication, transportation and installation of marine structures (e.g. offshore wind farms, wave and tidal facilities) and onshore drilling (e.g. geothermal).

Insurance can lower a corporation's cost of capital and increase liquidity by reducing the financial impact of risk events. In order to bear risk in return for a premium an insurer must have sufficient information to be able to estimate with a sufficient degree of accuracy the likelihood and severity of losses from the insured events. Although pricing structures for wind projects are now standardized through rating programmes, most RE projects do not have the required statistical data for measuring probability distributions and correlations between random loss events.

… most RE projects do not have the required statistical data for measuring probability distributions and correlations between random loss events required for insurance cover … Typically insurance for RE projects is arranged on a case-by-case basis and normally entails comparatively higher prices and restrictive terms and conditions.

Notably, research suggests that for RE projects, with the exception of some products (namely property damage and liability insurance) for wind projects, most standard products have underwriting restrictions. Typically insurance is arranged on a case-by-case basis and normally entails comparatively higher prices and restrictive terms

and conditions. Projects of less than USD15 million (excluding small wind projects) have difficulty finding insurance cover, and as a result, financing.

Insurance capital allocation

Capital allocation within insurance companies is dependent on financial management being convinced that the business case for underwriting a certain class of risk meets their minimum underwriting criteria. Included within such an assessment is a charge for the risk capital employed, a risk premium and an administrative cost. Business acquisition, underwriting due diligence and account servicing costs are the same for a small project as for a large one. For medium- to large-size insurance companies, central cost allocation manifested through the administration costs are a significant barrier to entry. Consequently most small projects have a high opportunity cost and rarely exceed the internal hurdle rates required by management.

This would suggest that at this stage of the renewable energy market's development, where financial innovation is required to support the development of small- to medium-size enterprises and projects, a specialist and focused risk transfer/finance operation with dedicated capital and low overheads will be a prerequisite to provide efficiently priced risk management solutions for small-scale developers. This capacity will need to be supported by a strong technical/engineering evaluation capability that can adequately assess the technology risk. Financial support and investment from the public sector is often required to overcome political and regulatory risk concerns. Perhaps some of these funds could be more usefully deployed sponsoring engineering tests and pilot projects for commercial actuarial studies and subsequent product development.

Existing availability of insurance for RE projects

This section focuses on 'traditional' products that are available or have been transacted for RE projects. Wind energy projects are the most commercially viable RE technology, and the technology with which the insurance industry has most experience and capacity to respond at present. Table 4 provides an overview of the various 'traditional' insurance products, and Figure 1 provides generic insurance cover available for RE projects.

Wind energy projects

Until recently, much of the insurance for commercial **wind energy** projects, owned and developed by larger parent companies in the power sector, has been provided under the main property insurance 'package' covering the parent companies' power assets worldwide. Although providing much needed early capacity for wind energy projects, the use of (unspecialized) parent company packages did not provide adequate cover to the unique risk profile of the wind sector (especially for offshore wind projects).

Following an early period of underwriting losses the insurance market for construction and operation of onshore wind projects has expanded somewhat

Table 4: Overview of traditional insurance products available for RE projects

Risk transfer product	Basic triggering mechanisms	Scope of insurance/risks addressed	Coverage issues/underwriting concerns
Construction All Risks (CAR)/ Erection All Risks	Physical loss of and/or physical damage during the construction phase of a project.	All risks of physical loss or damage and third party liabilities including all contractor's work[13].	Losses associated with cable laying such as snagging can be significant for offshore wind projects[14]. Quality control provisions for contractors.
Delay in Start Up (DSU)/Advance Loss of Profit (ALOP)	Physical loss of and/or physical damage during the construction phase of a project causing a delay to project handover.	Loss of revenue as a result of the delay triggered by perils insured under the CAR policy.	Cable laying risk. Loss of transformer. Lead times for replacement of major items. Offshore wind weather windows and availability of vessels.
Operating All Risks/ Physical Damage	Sudden and unforeseen physical loss or physical damage to the plant / assets during the operational phase of a project.	'All risks' package.	Explosion/fire concerns for biogas, geothermal. Increase in fire losses for wind. Lightning. Quality control and maintenance procedures.
Machinery Breakdown (MB)	Sudden and accidental mechanical and electrical breakdown necessitating repair or replacement.	Defects in material, design construction, erection or assembly.	Concern over errors in design, defective materials or workmanship for all RETs. Turbine technology risk. Scope and period of equipment warranties. Wear and tear (excluded from MB).
Business Interruption	Sudden and unforeseen physical loss or physical damage to the plant/assets during the operational phase of a project causing an interruption.	Loss of revenue as a result of an interruption in business caused by perils insured under the Operating All Risks policy.	Cable/transformer losses represent large potential BI scenarios. Lead times for replacement of major items. Offshore wind weather windows and availability of vessels. Supplier/customer exposure (e.g. biomass resource supply).
Operators Extra Expense[15] (Geothermal)	Sudden, accidental uncontrolled and continuous flow from the well which can not be controlled.	All expenses associated with controlling the well, redrilling/ seepage and pollution.	Some geothermal projects require relatively large loss limits. Exploration risk excluded. Well depths, competencies of drilling contractors.
General/Third-Party Liability	Liability imposed by law, and/or Express Contractual Liability, for Bodily Injury or Property Damage.	Includes coverage for hull and machinery, charters liability, cargo etc.	Concern over third-party liabilities issues associated with toxic and fire/explosive perils.

[13] Scope of activities for insurance cover includes, but is not limited to: procurement; construction; fabrication; loading/unloading; transportation by land, sea or air (including call(s) at port(s) or place(s) as may be required); pile driving; installation; burying; hook-up, connection and/or tie-in operations; testing and commissioning; existence; initial operations and maintenance; project studies; engineering; design; project management; testing; trials; cable-laying; trenching; and commissioning.

[14] Cables for wind projects represent a high concentration of value for relatively horizontal risk exposure.

[15] Often forms part of a Package Policy including sections for Property Damage and Liabilities.

over the past three years as the technology has matured and the size and number of projects has increased. A competitive insurance marketplace now exists for onshore-operating wind energy projects with a selection of many leading (re) insurers providing physical damage coverage with typical premium rates of approximately 0.3–0.4 per cent of total insured property value.[16]

In the offshore market, as projects experience a greater number of successful operating hours, and as underwriters' technical understanding and evaluation of the risks improve, increased capacity should become available. Although, still only forming a very small proportion of underwriters overall portfolios, insured limits of up to EUR300 million have been placed for offshore projects. There should be sufficient capacity in the market place to cover higher insured values and limits as projects grow, while the loss records of existing projects will have a bearing on the attractiveness of these classes of insurance.

Delays or damage during fabrication, transport, installation, testing and commissioning can affect the revenue profile of a project; consequently, the construction stage of a wind farm is the key area of concern for investors. During the construction stage of onshore wind energy projects there are a variety of policies available that provide comprehensive and wide coverage for all risks of physical loss or property damage, delay in start-up and third-party legal liabilities.

Restrictions on insurance cover exist for certain offshore construction projects because the offshore construction process presents a higher risk than onshore and demands a stage-by-stage rating approach, which is reflected by higher premiums and deductibles. Typically for an offshore wind energy construction project premium rates would be approximately 2 per cent of the estimated project cost compared with premium rates for onshore construction of 0.4–0.6 per cent.

Once each turbine has reached an operational state, a new operational 'all risks' policy takes affect and design features and collision risk issues become more significant. Increasingly, insurers require projects to demonstrate what loss control measures are in place to minimise losses from high wind, freak wave conditions, fire and lightning and vessel collision.

Similarly, rigid restrictions apply to the design and technology risks associated with wind turbines. For example some restriction clauses require specification of component replacement after 5 years' operation or 40,000 operating hours with certain cover available for consequential losses arising from faulty design and workmanship. The faulty part itself is excluded. Insurers currently do not provide broad design cover for many new and prototypical turbines. Project developers therefore have to rely on the warranties provided by turbine manufacturers as a means of managing the risk of defective turbines. However, the creditworthiness of the turbine manufacturer then needs to be considered.

[16] Premium rates vary depending on the risk profile and experience of the project and its operator.

As projects with new, larger turbines emerge, e.g. 5 MW prototypes currently being tested, it will become increasingly difficult to secure appropriate insurance cover for 'defective parts' and any consequential losses.

A possible solution may lie in the contractual arrangements that are used in parts of Europe for wind energy projects. Some of the large turbine manufacturers now offer Contractual Service Agreements (CSAs) which guarantee the technical availability of the system over the term of the financing agreement. Manufacturers receive payment per kilowatt hour generated, in return for which they guarantee to cover all maintenance and repair costs, including possible replacement of expensive components such as rotor blades, gearboxes or generators. This type of service agreement can provide greater confidence to underwriters that the technology and operating and maintenance risks associated with wind energy projects are being better managed, which could assist in creating greater capacity and broader coverage with reduced premiums.

A further concern for underwriters relates to the potential of business interruption losses for offshore wind projects. Loss of a single turbine would lead to an insignificant business interruption claim for the wind farm, while any loss to the export cable or transformer could lead to a significant interruption to the overall electricity output of the farm. The premium rates for offshore business interruption will therefore vary significantly depending on the design of the project. For any **Delay in Start Up** insurance required during the construction period of an offshore wind project, approximate premium rates in the range of 2–3 per cent of annual gross revenue could be expected. Furthermore, this may become an increasing problem as the numbers of offshore installations increase, which might put a strain on the supply and availability of marine infrastructure (e.g. appropriate vessels) to service sites and repair and replace damaged items.

Geothermal energy

Geothermal projects face significant upfront capital investment for exploration, drilling wells and the installation of plant and equipment, and often employ some degree of public assistance. Due to the fact that the geothermal environment is quite different from the petroleum environment, especially in terms of higher temperature, more corrosive fluids, and generally harder rocks, drilling can be inherently expensive and risky, and the costs can vary between EUR1 and 5 million depending on the geological nature of the reservoirs, the depth of the wells to be drilled, the local authorities and available service industries involved. Generally speaking, the risks associated with drilling wells are well understood and financiers and insurers are more concerned with the application of petroleum industry expertise in a very different geothermal environment, unproven stimulation technology[17] and the technical elements for integration of geothermal electricity.

[17] Stimulation technology attempts to improve natural productivity or to recover lost productivity from geothermal wells through various techniques including chemical and explosive stimulation.

Due to the significant upfront capital outlay for geothermal projects and the potentially lengthy period before revenue generation, financiers are particularly concerned with any risks and/or expenses that may delay or prevent the project from meeting its debt obligations.

Operators Extra Expense insurance is adapted from the oil industry and is often required by lenders for geothermal projects as it is designed to protect the policy holder from any extraordinary expenses or risks associated with drilling exploration wells and operating production platforms. The main expenses that trigger the policy include costs associated with controlling a well or blow-out,[18] the costs of redrilling or restoring a well, and the costs of remedial measures associated with seepage and pollution. Although seepage and pollution pose less of a risk to geothermal projects compared to oil and gas projects, the expenses associated with hiring specialist personnel to control blow outs, and the potential for casualties is still of major concern to financiers. Insurance cover for standard physical damage and operators' extra expense is becoming more widely available and cost-effective.

Exploration risk—the risk of not successfully achieving (economically acceptable) minimum levels of thermal water production (minimum flow rates) and reservoir temperatures—represents one of the key barriers to investment in geothermal projects. Traditionally, the public sector has had to cover this risk but recently a public/private initiative has been developed by Rödl & Partner with a private sector insurer. The insurance cover provides protection against the flow rate not achieving an economically acceptable level and has significant scope for large-scale applications.

Protection against breakdown in key components such as water pumps is also of concern to lenders as this can delay or interrupt the successful functioning and revenue generation of the project. Typically the lack of operating experience for such projects (operators and components) can restrict the cover available.

Biomass/biogas

Biomass/biogas projects suffer significantly from resource supply risk and small scale. One issue that comes up repeatedly when seeking finance for biomass/biogas and cogeneration projects is security of fuel supply and fuel price volatility. Marsh Ltd are involved in the development stages of several large biomass/waste-fuelled power generation facilities, all of which have a fuel/waste supply exposure, which is preventing the projects from reaching financial close.

Crop yield insurance may be a solution where energy crops are involved but traditionally this cover been difficult to come by for reasons of scale and non-standard crops. A form of business interruption cover is required as well as

[18] Blow outs are the sudden, accidental, uncontrolled and continuous flow from the well of the drilling fluid, oil, gas or water, above the surface of the ground or water bottom, which cannot easily be stopped, or which is declared by the appropriate regulating authority to be out of control.

instruments to secure long-term fuel supply contracts. However, no such products are available yet. Even standard business interruption cover can be difficult to purchase because of the length of the reinstatement period for biomass plants which are dependent upon continuity of fuel supply.

Machinery Breakdown and **Business Interruption** insurance is widely available for biogas plants that use tried and tested machinery. For waste to energy plants the technology risk is not considered an issue by many insurers as most of the technology involved is now mature, although manufacturing warranties are still a prerequisite. For biogas plants involving fermentation processes, technology and operational risks are a concern for underwriters as are health risks associated with noxious gases. Without strict safety procedures and operational experience for the technology and operators involved in controlling the fermentation process there are difficulties in obtaining wide coverage.

Wave/tidal/ocean current

The **wave/tidal/ocean current** sector is rapidly developing with many devices showing commercial potential. Whilst it will be a long time before underwriters are comfortable enough with the technology involved to start underwriting technology-based risks, some marine insurers are willing to provide cover for the construction, delay in start-up and liability risks associated with small demonstration projects. Typically for **Third-Party Liability** coverage for small scale wave projects with low limits of liability of around GBP25 million (in accordance with current Crown Estates Lease requirements if in UK waters) underwriters require minimum premiums of approximately GBP125,000 and high deductibles, which can be prohibitively expensive for small demonstration projects.

Machinery Breakdown cover has been provided for the world's first commercial scale floating wave energy converter, the Pelamis. This was only possible through independent verification by leading offshore engineers of the prototype design specifications and further verification of the whole system to give the project a high safety factor in a hundred-year storm. Typically, the survivability of the device in hostile marine environments and its location in relation to collision risks cause most concern for underwriters.

Solar PV

Solar PV often tends to be a small-scale, consumer product and so does not usually attract the attention of commercial insurers. For larger installations, where insurance is required and available, underwriters often cite the need for regular maintenance procedures to be in place as frequent breakdowns and wear and tear can cause attrition losses.

The commercial appetite for providing cover for this sector will improve as the size and value of installations increase. A good example of this is the proposed AUD800 million, 1 km-high solar tower to be developed in Australia for which

Marsh Ltd has started placing construction and operational insurance. However, the remoteness of these applications and the availability of service industries to repair, replace and maintain these facilities will be of concern to insurers who write machinery breakdown and business interruption insurance.

Small hydro

Various liability covers for **small hydro** (generally up to 10 MW) are becoming more widely available. Large scale hydro is a well developed, long-term proven technology with low maintenance expenses and few operational risks or barriers. From a financing and risk management perspective, small-scale hydro installations benefit from a general understanding of the technology. Civil engineering works (weirs, channels) last for many years with suitable maintenance and the mechanical and electrical lifetime of a hydro power plant can be up to 50 years. In an increasing number of remote/rural parts of the world, small-scale 'run of river' and smaller storage reservoir systems are the leading source of renewable energy.

Figure 1: Generic RET risk transfer heat map, existing insurance products

Risk Categories	*Construction All Risks*	*Resource Supply / Exploration*	*Property Damage*	*Machinery Breakdown*	*Business Interruption*	*Delay in Start Up / Advanced Loss of Profits*	*Defective Part / Technology Risk*	Contractors Overall Risk	General / Third-Party Liabilities
Wind (onshore)									
Wind (offshore)									
Solar PV				n/a					
Wave / tidal									
Geothermal									
Biogass									
Small hydro				n/a					
Biomass									

Availability of cover

- Increasingly comprehensive and competitive cover—rates going down, cover being extended
- Broad cover—leading markets available, standard rating available, possible high premiums / deductibles
- Partial cover—growing market interest, some gaps in cover, limited capacity, high premiums / deductibles
- Very limited cover—few markets, restrictive terms and conditions, many exclusions
- No cover available from traditional insurance markets

5. Evolving financial risk management instruments that can support RE projects

Financial risk management instruments are evolving and can be adapted to meet the needs of the renewable energy sector.

The role of emerging risk management instruments

This section focuses on financial risk management instruments that are evolving or can be adapted to meet the needs of the renewable energy (RE) sector. These include alternative risk transfer (ART) products, specialist underwriting vehicles, weather derivatives, credit derivatives, and political risk insurance. This section also hosts a brief discussion on the potential role of the risk mitigation and credit enhancement products provided by Multilateral Financial Institutions (MFIs), Export Credit Agencies (ECAs) and Official Bilateral Insurers (OBIs).

Table 5 lists a number of the instruments reviewed. Some have already been transacted in RE projects/deals and others have the potential to be redefined or modified for use in the RE sector. The table identifies, for each instrument, some of the key issues which can prevent the successful application of that instrument under different economic conditions.

Of the products discussed below, weather insurance and derivatives are the most widely used in the RE sector. Some temperature products are traded on exchange markets. Reinsurers provide insurance-based precipitation indices amongst others. Derivatives market-makers can produce wind power indices that are well correlated with wind at both onshore and offshore sites. As with any insurance or derivative product, the critical factor in developing a new weather derivative/insurance contract is the availability of data.

Some instruments, such as **Partial Credit Guarantees** (PCGs) are generalist tools but their popularity with investors is indicative of the wider role that credit enhancement can play in transacting RE deals.. Preliminary research indicates that a specific project grant could be usefully aimed at developing blueprints for RE-specific risk management products that can be commercially deployed by the private sector. Some of the instruments such a study would seek to readapt are discussed in Table 5.

Weather derivatives for RE projects

Renewable energy projects have a natural weather position and, directly or indirectly, this is often the most significant source of day-to-day financial uncertainty. **Weather Derivatives** are used to protect RE project revenue streams against the financial uncertainty associated with wind, precipitation and temperature variability. **Volumetric** risk associated with adverse weather conditions can be hedged using a wide variety of Over-the-Counter (OTC)

Table 5: Emerging financial risk management instruments for RE projects

Risk mitigation product	Nature	Basic mechanism	Risks addressed	Key RET application issues
*Weather insurance/ weather derivatives	Hybrid of re-insurance and indexed derivatives	Contracts and traded/ OTC derivatives including weather-linked financing (e.g. temperature, wind, and precipitation). Risks transferred from project owners/sponsors to insurance and capital markets.	Volumetric resource risks that adversely affect earnings.	Requires accurate and robust data streams from satellites etc.
*Double-trigger products (integrated risk management)	Alternative Risk Transfer (ART)	Contracts or structures provided by re-insurers covering, for example, business interruption risks caused by a first trigger such as unforeseen operational problems that create a contingent event (e.g. a spike in electricity price).	Clearly defined contingent risks which adversely impact revenues.	Complex and relationship-intensive. Requires accurate and robust trigger definition.
*Contingent Capital	Risk finance (synthetic debt and equity)	Insurance policy that can take the form of hybrid securities, debt or preference shares provided by (re) insurer to support and/or replace capital that the insured would otherwise be forced to obtain in the open market at punitive rates.	Any contingent event that suddenly damages the capital structure of a project or enterprise.	Complex and relationship-intensive. Can be used in SPUV development.
*Finite Structure	Risk finance	Multi-year, limited liability contracts with premium calculated on likelihood of loss and impact. Smoothes out volatility of events that adversely impact earnings/cash flows. Potential to spread high cash-flow impact losses over time.	'Timing risk' that losses occur faster than expected.	Complex and relationship-intensive. Often relies on strong credit profile.
*Alternative Securitization Structures	Various types of asset-backed securities ('synthetic reinsurance')	Securitized risk finance instruments including Insurance Linked Securities (CAT Bonds)/Collateralized Debt Obligations issued with several 'tranches' of credit/risk exposure. Creates a risk transfer and financing conduit based on credit differentials.	Bundling of credit default, liability, trade credit risk together. CAT bonds address risks associated with natural catastrophes.	Pooling of energy, weather related or emerging market and resource supply risks. SPUV potential.
Captives or other pooling/ mutualization structures	Risk finance or ART	Self-insurance programme whereby a firm sets up its own insurance company to manage its retained risks at a more efficient cost than transfer to a 3rd party. Pooling through 'mutual' or 'Protected Cell' structures can further diversify risks amongst similar enterprises.	Property/casualty insurance. Can be adapted to include financial risks.	Mutualization/pooling mechanisms often require homogeneous risk. Initial capitalization requirements.
TGC or emissions reduction delivery guarantees	Insurance	Products provided by insurers and re-insurers to guarantee future delivery of 'credits' or, money to purchase credits in spot markets to fulfil contractual requirements. Risks transferred from project owner/investors to insurers.	Risks associated with delivery of TGCs or emissions reductions, including performance related and political risks.	Sound legal/regulatory framework required. Long-term policy support mechanism for RE needed.
GEF Contingent Finance Mechanisms	Grant, loan, guarantee	Contingent grant, performance grant, contingent/ concessional loans, partial credit guarantees, investment funds and reserve funds provided by GEF in conjunction with Implementing Agencies. Transfers some financial project risk.	Desirable but high-risk projects benefit from soft funding.	Process delivery is slow and appears complex. Limited resources.
Guarantee funds	Guarantee (credit enhancement)	Professionally managed funds that use donor capital to leverage commercial lending. Examples include the Emerging Africa Infrastructure Fund and (as yet unlaunched) GuarantCo.	Political and credit risks in emerging markets.	Designed for large infrastructure projects but have wider applications.
Guarantees from MFIs	Guarantee (credit enhancement)	Partial Risk Guarantee (covers creditor/ equity investors) and Partial Credit Guarantee (covers creditors) by World Bank Group and the Regional Development Banks. Flexible structures that do not require sovereign counter-guarantees are preferred.	Specific political risks (e.g. sovereign risks arising from a government default on contractual obligations) and credit default.	There are ad hoc applications of PCGs for RE project finance. Credit enhancements in any form help transact RE deals.
Export Credit Guarantees	Guarantee, export credit, insurance	Guarantees, export credits, insurance provided by bilateral Export Credit Agencies (ECGD etc.) and Official Bilateral Insurers (OPIC etc.).	Commercial and political risks involved in private sector trade/investment abroad.	Most ECAs/OBIs have limited RET experience. Need more data for underwriting.

* Asterisk denotes the instruments that require fundamental need for sound financial, legal and institutional frameworks which generally limits the application of those instruments in least developed countries.

structures and several exchange-traded products. Temperature is still the most commonly traded weather product but other risks are gaining prominence. Wind power indices (WPIs) are available to wind farm developers in areas where there is sufficient data to create an index that is highly correlated to the wind flow into the turbine. Similarly, precipitation indices are available. Weather derivatives are increasingly offered as part of structured finance packages or 'quanto' hedges that may also include power and currency derivatives. As a general guide (to *all* derivatives), the more transparent the product, the cheaper it will be to use. The quality and robustness of available data is a barrier to the development of weather products for many regions but cheaper satellite monitoring systems are evolving to reduce this information deficit.

Adaptable credit products

Credit derivatives are useful for hedging certain types of credit risk, and aggregated credit structures could potentially be useful to the RE sector. These instruments allow brokers to repackage small and illiquid credits into tradable securities that can be distributed to a variety of investors. There are many specific corporate and some project-related credit products in OECD countries but credit derivatives in emerging markets are generally linked to sovereign debt. Products based on government bonds are of no use to RE projects but currently account for 80 per cent of the volume in emerging markets. Conversely, products that can aggregate ('bundle') poorly understood/small/illiquid credits and then attract capital from institutional investors could be quite useful to the RE sector and should be investigated further. **Credit Linked Notes** (CLNs) are currently estimated to account for about 10 per cent of emerging markets credit exposure. The interest and principal payments of CLNs are linked to the credit risk performance of 'reference assets'—a single company, a portfolio of companies, sub-sovereign debt or other assets such as a pool of RE projects. **(Synthetic) Collateralized Debt Obligation** (CDOs) first entered the emerging markets about five years ago. These CDOs combine securitization and credit derivatives to 'tranche' a pool of underlying default swaps into different classes of credit risk. The different tranches usually carry ratings ranging from triple-A to single-B. A final equity tranche is unrated and represents the 'first loss' in exchange for the highest return. A default swap, made with an external counterparty, represents the senior tranche and covers a certain percentage of the reference portfolio. The proceeds of the notes are invested in a pool of highly rated government securities. Principal and interest is paid to the highest rated notes first, while any losses are borne by the more junior tranches. This structure is popular with investors but expensive to put together without a template. There is ongoing convergence between the capital and insurance markets, and securitization structures are often hybrids that can fall into the categories of instruments called Alternative Risk Transfer (ART) set out below.

Risk finance vs. risk transfer

The main document describes at some length the process of risk management in terms of **risk retention** versus **risk transfer**. The retention decision is both a risk management and capital structure decision. An 'unfunded retention' is the retained risk of a project for which any losses are not financed until they have occurred, while a 'funded retention' means that specific funds are allocated to carry particular losses. A funded retention (also known as preloss financing) can either be 'paid-in' or 'contingent' capital. These various distinctions are important to make. Since few new technologies and applications are insurable, **risk finance**—effectively professional management of retained risk—can offer some revenue-protection solutions for RE projects that may be acceptable to financiers and thus help facilitate more transactions.

Evolving/adaptable risk management and 'new capacity' structures

Alternative Risk Transfer (ART) instruments (including captives for convenience) offer potential for innovation and extending the limits of insurability. ART products are organized as 'contracts, structures and solutions' and often include combinations of both risk finance mechanisms (captives/finite products) and risk transfer (Integrated Risk Management). For example, risk finance structures using **finite insurance** can be applied to smooth revenues for RE projects. The ability to make instalment payments into a reserve or 'experience' account over a period of years spreads out any losses over time and thus eliminates any sudden impacts on project operating revenues.

A **captive** insurance or reinsurance company is a type of organized self-insurance programme in which a firm sets up its own insurance company (usually in conjunction with a re/insurer[19]) to fund and manage its retained risks. Companies operating captives can provide insurance for some of their operating risks at wholesale cost. Most multinational corporations maintain their own captive re/insurer. Some large wind turbine manufacturers and a number of utilities already use captives but typically these are structured as part of a larger parent company self-insurance programme covering the companies' assets worldwide.

The captive arrangement can be quite useful for asset protection. A captive is legally able to accrue reserves against contingencies. The underlying business may take tax deductions for premiums paid, but the captive itself defers taxation, to the extent that it is able to accrue reserves. **Multi-parent** captives facilitate some sort of risk diversification across different firms. **Group** captives are often set up by industry trade associations. When each member is too small to justify having its own captive then this structure can make sense but the self-insured risks need to be similar to work.

[19] The (re)insurer provides certification of coverage, reinsurance, loss control and mitigation advice, claims reserving, adjustment, risk management, underwriting, regulatory work, etc. in return for an annual fee.

Protected Cell Companies and **Rent-a-Captive** structures may offer a potential solution for 'bundling' some smaller RE developers seeking pre-loss financing of retained risks. In general, there is some real potential for captives, captive-like structures and other risk finance vehicles to fill gaps in the RE risk management product base. Where no conventional insurance is available, specialist underwriting vehicles may be the only method of obtaining cover sufficient to attract finance. Indirectly, some RE projects, particularly those that are exposed to natural catastrophes such as windstorms, may form part of a wider portfolio of risk that is taken on by (re) insurers.

ART securitization structures such as **Insurance CDOs** are emerging as a new source of capital for smaller insurers in the USA. There have been five separate offerings in the USA over the past year that raised $1.5 billion in new capital. The ratings agency Fitch expects the development of insurance CDOs to significantly affect the US insurance market in the coming year.[20] Several different small companies can pool debt together in one CDO to reduce underwriting costs and legal fees while increasing the issue's critical mass. Individually, small and mid-size insurance companies do not have easy access to capital markets, and so obtaining bank loans or raising equity capital is costlier as well as difficult to transact. Lack of risk capital during the recent hard insurance cycle has meant that smaller insurers have been unable to deviate from core lines of business. Access to the capital markets via insurance trust preferred CDOs will lower smaller insurers' cost of capital. It is the smaller insurers who are likely to start providing cover to the increasing number of community financed renewable energy schemes. Additionally, boutique insurers are not hindered by institutional inertia and are likely to become important sources of risk management expertise and new product development in the RE sector. The arrival of the insurance CDO market in the USA is a positive trend and the public sector should give some thought to guiding some potential European and emerging market Insurance CDO structures. With appropriate public sector guidance, locally-sensitive insurance capacity can be directed toward small-scale insurable (i.e. wind, biomass) RE projects.

Insurance Linked Securities (ILS also known as Risk Linked Securities) have a pay-off profile that depends in some part on the outcome of the reinsurance offered by the SPV issuing the notes. There are a growing number of examples of risks that can be insured using a securitization platform. The best known example is the **Catastrophe Bond** or 'CAT' Bond. These ILS usually follow a structure that is similar to a CDO and payments are linked to a portfolio of premiums and losses arising from natural disasters such as earthquakes, ice storms, tropical cyclones, tornadoes and other varied risks. There is scope for securitization structures to evolve to include a variety of RE-related risks as part of a portfolio of diversified energy, weather-related or emerging market risks.

[20] International Securitization & Structured Finance Report, 15 November 2003.

Initial support by multilateral or bilateral financial institutions (say, to provide credit enhancements to the senior tranche of an issue) would greatly assist the development of a market for such an instrument. Some RE-specific alternative securitization structures have already been undertaken; one notable transaction involved a large power utility company and its entire wind portfolio.

In the past five years, some debt issuers have started using commercial **Political Risk Insurance** (PRI) to achieve an investment grade rating, even when the foreign currency rating of the issuer's nation is sub-investment grade (or marginal). Although PRI can cover a number of risks, the ratings agencies usually only require currency inconvertibility and exchange transfer cover. This coverage protects investors against the inability of the borrower to convert interest and principal payments from local currency to hard currency (generally USD). Recently a number of such deals have been transacted and, conceptually, it would be straightforward to issue a PRI-enhanced debt issue to finance a large RE project. Indeed, emerging market project bonds have proven quite attractive to investors over the past year despite the generally poor condition of the high-grade fixed-income market.

Public sector instruments

The **Official Bilateral Insurers** (OBIs—including the Export Credit Agencies or ECAs) including OPIC, NEXI, HERMES, Coface and the ECGD provide by far the largest proportion of investment insurance against the three basic political risks: expropriation, war/civil war, and currency convertibility/transfer as well as other non-commercial risk insurance. To date, OBIs have had little experience with RE support. However, OBIs take on project risks that private and MFI insurers will not, particularly in emerging markets where there are significant opportunities for technology exports. One example of an OBI-led RE deal is a novel repayment guarantee structure supporting the financing of a new wave power plant in Spain. A deal relying on an OBI credit enhancement to help market an issue of corporate bonds/notes has already been done in the telecommunications sector in Uganda and similar deals can be done in other sectors/countries. There is a large role for these bilateral insurers to play in future public-private interactions designed to bolster investment into the RE sector.

With clear direction from their governments and shareholders, ECAs could develop new products and approaches to address the specific requirements of RE projects. Some of these could be developed directly by the individual ECAs; others would require the respective ECA guardian authorities to collectively change relevant international agreements, including the OECD Arrangement on export credit finance.

Investors respond well to various types of **credit enhancement**. Guarantees offered by the development banks (MFIs) such as the IFC are especially

Table 6: Examples of MFI Partial Credit Guarantees	
Sovereign guarantee required	Sovereign guarantee unnecessary
IBRD Partial Credit Guarantee	IFC Partial Credit Guarantee
Asian Dev. Bank PCG (Public Sector)	IADB Credit Guarantee (Private Sector)
African Dev. Bank (Public Sector)	Asian Dev. Bank PCG (Private Sector)
ICIEC Bank Master Insurance	African Dev. Bank Enclave Projects

attractive to lenders in emerging markets. The partial (political) risk guarantee[21] (PRG) and partial credit guarantee[22] (PCG) are designed to mitigate the risks of sovereign contractual obligations[23] or long-maturity loans that private lenders will not bear and/or are not equipped to evaluate in developing countries.

An increasing number of PCG deals are done to facilitate local currency financing, which is an effective means of managing currency risk as well as raising funds. However, with the exception of the IFC (and MIGA), most MFIs have maintained a reactive approach to implementing the available guarantee instruments[24]. Although not RE-specific, wider application of MFI credit enhancement products to facilitate transactions could only be helpful.

A distinction needs to be drawn between the various guarantees offered based on whether or not the issuing MFI requires a s**overeign counter-guarantee** for the loan (or bond). MFI products that require a sovereign counter-guarantee are of little practical use to most RE project developers. Table 6 lists some PCGs which require sovereign guarantees and some that do not.

Small-scale and flexible partial credit guarantees have proven very effective in mobilizing finance for a variety of transactions. The IFC is an active sponsor of PCGs for financial sector deals in transition economies. There is certainly potential for these instruments to facilitate a greater number of bankable renewable energy projects.

[21] Partial (political) risk guarantees covers creditors for specified sovereign risks arising from a government's default on contractual obligations, or the occurrence of certain *force majeure* events of a 'political' nature.

[22] A partial credit guarantee covers creditors irrespective of the cause of default up to an agreed capped amount—for example, 40 per cent of the initial principal, or one year of debt service.

[23] Sovereign contractual obligations typically include: maintaining an agreed regulatory framework, including tariff formulas; delivering inputs, such as fuel, to a private power company; paying for outputs, such as power or water purchased by a government utility; compensating for project delays caused by political actions or events.

[24] For instance, guarantees only account for about 1 per cent of the World Bank Group's total loan exposure and this seems quite low given the products' usefulness.

Whilst not strictly financial risk management instruments there are a number of wider credit enhancement and **contingent financing** mechanisms offered by the **GEF** including contingent grants, performance grants, contingent or concessional loans, partial credit guarantees, investment funds and reserve funds. GEF contingent finance instruments are useful when there is substantial uncertainty about the existence and extent of incremental costs, characteristics not unusual in RE projects. The presence of GEF funds in a deal provides comfort to other lenders and thus leverages additional commercial finance.

GEF resources are limited and the institution has a broad mandate. The interests of GEF as an institution are best served by introducing programmes that are taken up and commercialized by the private sector. As a result, it is proposed that a budget be devoted to developing new risk management products and supporting new insurance capacity as discussed in section 6. The intended results of such pilot programmes would be replicable financial risk management templates that could be applied more cost efficiently across the RE sector. This barrier removal activity is consistent with GEF's charter and could prove effective at attracting private sector investment over the long term.

6. Scope for developing new financial risk management instruments for the RE sector

Scope for new product development

The objective of this study is to accelerate plans to develop product blueprints for actual application in the market and to move forward the current institutional operating framework that is hindering progress in RET uptake. However, given the limited financial resources available from the public sector to assist this process, it is necessary to qualify and quantify the objectives. How and where can this study direct limited public resources to the greatest advantage for the RE sector?

Least developed countries

It is important to recognize the differences in markets for RET in least developed countries compared with the developed world. Roughly 400 million households in the world's poorest countries do not currently have access to electricity. Historically, affordability of rural energy has been addressed through government subsidies, donor programmes and private cash sales or small systems. However, donations without any cost recovery destroy markets as consumers come to expect donor aid and will wait rather than pay market prices. Donors continue to undermine LDC market development with capital cost subsidies and donated equipment.

Scale is a particular problem in least developed countries, because the economies are so small, and wealth levels are low. The needs of local communities are often mismatched with the relatively high level of technology inherent in Western RETs. For example the evolution of wind turbine technology means that current monopiles are too large for many local infrastructures to manage, and small-scale installations are not economic projects for international financiers. Considerable amounts of capacity-building are needed as well as a much more local/regional approach for RET that differs from the broader objectives of this scoping study.

Carbon finance

The World Bank Prototype Carbon Fund's experience has shown that carbon finance[25] can materially improve the return on climate-friendly investments including certain RE projects. Methane capture from landfills and combustion to generate energy offer the greatest returns and opportunities for carbon financing. At prices currently paid by the PCF, carbon revenues from a typical landfill gas to energy project, for example, can contribute about USD15 per

[25] Carbon finance is a means of leveraging new private and public investment into projects that reduce greenhouse gas emissions, thereby mitigating climate change and promoting sustainable development.

megawatt hour, potentially increasing project internal rates of return by five percentage points or more.

To date, however, too few projects have attracted carbon finance for it to be of wide commercial interest. The difficulties of obtaining carbon finance and determining the forward price of traded permits predicate the difficulties in developing risk management instruments that will, for example, guarantee a future value of emissions reductions. The regulatory and other issues that have thus far inhibited the wider development of the carbon finance market are too complex to be usefully addressed here. However, Marsh and other leading players are ready to offer insurance products relating to permit delivery when the legal and policy frameworks are better established.

Commercial instruments in developed (and some transition) economies
As a result of the above considerations, and due to the particular expertise of the consultants involved, this scoping study focuses on some specific instruments that can be designed and applied in a commercial context in the current operating environment. Empirical evidence from both the RE community and financiers suggests that it is typically boutique companies (whether consulting or corporate finance, etc.) that interact with smaller-scale developers and, to some extent, with the RE sector in general. These boutiques are useful sources of certain types of expertise but are too small and too poorly capitalized to influence broader investment trends. A number of large financial institutions with the potential to help shape policy are engaging with governments on emissions reductions, energy security and development issues. However, because of their size, these same institutions are not able to respond properly to the current needs of the RE sector.

There is a gap in the private sector renewable energy 'financing spectrum' in developed markets. While small-scale RE developers and undercapitalized boutiques tend to interact at one end of the spectrum, large financial institutions with good intentions for RE projects but little practical room to manoeuvre commercially are interacting with policy makers at the other end of the same spectrum. This is especially evident in London, arguably the world's premier financial centre. As a result, a large amount of RE-related business of all types simply does not get done. There is a useful potential role for the public sector to act as a 'mezzanine player' or bridge between the expertise, creativity and nimbleness of boutiques and the distribution networks, balance sheet and market influence of major financial institutions.

As a result of this study, the authors believe that material improvements in the current picture for renewable energy finance can be best addressed by tripartite approaches that draw upon the strengths of both boutique players and large institutions assisted by the public sector. Some product development suggestions below reflect this view.

Demand issues

There is no shortage of demand for solutions to underlying LDC risks but no new risk management products will resolve their social, economic and infrastructure challenges. Likewise, there is great demand for any product that can offer certainty in the realm of carbon finance but obviously there is no supply of such products because of the associated regulatory risk. So, given limited public resources, where is the greatest addressable demand for new products? And what potentially useful new products can be most efficiently created using the tripartite approach introduced above?

New approaches in Europe

With the advent of the new EU legislation on emissions trading, energy efficiency and wider environmental issues (as well as soaring crude oil prices), there is probably greater interest in Europe than elsewhere in as yet uninsurable RE technologies. Barrier removal that will increase the uptake of desirable technologies is an EU objective. The interest in new technologies can be translated into demand by stimulating the insurance community to create new products that can be used by the banking community as a platform for finance. One way of moving forward could be to operate a typical EU-style tender where entrants can compete for sponsored engineering studies to test their currently uninsurable but promising renewable energy technologies. The resulting data could be disseminated to underwriting and lending 'teams' that combine the creativity and speed of boutiques with the distribution networks and balance sheets of the larger players. A combination of carrot (potential new business) and stick (environmental fines and penalties) policy instruments along with the availability of indemnity cover for attractive technologies would create demand.

Expertise and markets

Strong natural demand exists for standard insurance cover but providing it can be complicated. Some of the instruments described in this text are years away from application in developing countries. For better or worse, most trend-setting financial products and approaches tend to be introduced in the City of London or on Wall Street, where relationships with the MFIs are fairly weak, and where the RE sector in general is poorly understood. That said, there is a willingness in the financial community to push forward 'good' (in appearance or substance) projects and so it is a reasonably auspicious time for new joint-venture product development initiatives.

Current demand for expensive ART solutions is negligible in the context of individual RE projects. Conversely, there is interesting potential for these more complex structures to aggregate smaller projects for risk finance/transfer purposes. Additionally, instruments such as Insurance CDOs can introduce fresh capacity to niche markets. Boutique operators are often better able/more willing to serve the existing addressable demand for SME-type risk management services to the RE sector than the major players in finance and insurance. In

time, and as economies of scale improve, some of these very companies are likely to be absorbed by the major players and their expertise/experience then delivered to a wider commercial field. In general terms, demand for RE-specific risk management products appears inelastic and should continue to grow as capacity becomes available.

A learning-by-doing approach to new product development

A learning-by-doing approach to developing new and commercially acceptable RE financing and risk management products should be adopted through focused interactions between the public sector, specialist financial boutiques and insurers, and several multinational financial intermediaries.

A **learning-by-doing** approach to developing new and commercially acceptable RE financing and risk management products should be adopted through focused interactions between the public sector, specialist financial boutiques and insurers, and several multinational financial intermediaries. Rather than financing individual projects, the goal of these exercises would be to design and then scale up the size of RE-related financing and risk management instruments. This can be accomplished through partnerships that combine the support, balance sheet and credit rating of public sector entities with the creative vision of specialist private boutiques and distribution networks of large companies.

The objective of this approach is to send creativity and responsiveness up the RE financing spectrum in major financial centres, while sending capacity, credit strength and distribution networks back down. The public sector assistance would function as a 'mezzanine facilitator' between the two. In this way, existing demand for smaller-scale risk management structures can be satisfied, while concurrently building critical mass for later-stage, large scale commercial deployment of RET. The deliverable result of the initial exercise should be product blueprints with an action plan for implementing a pilot programme.

The success of any resultant prototype RE-specific financing and risk management vehicles may be initially dependent upon credit enhancement or other support from multi- or bi-lateral agencies. The main risks to manage are technological and political risks. Naturally, the objective of any pilot programme would be to transit the current asset class of RE projects into the mainstream.

Initial studies of product architecture and the organization of some pilot programmes could be coordinated and managed by a public organization. Deal origination, credit enhancement and distribution will require the additional sponsorship of a regulated entity with a substantial balance sheet. As discussed above, such joint ventures ideally need three parties; a regulated boutique mandated to supply creative vision and develop product and service strategies, a public sector agent as mediator and sponsor, and additionally a large private bank, broker or (re)insurer with a solid distribution network. While these shareholder-driven institutions will not want to shoulder initial research and development costs for RE-targeted products, some would be willing to participate in marketing and distribution of investments and insurance products that have already been developed in conjunction with niche operators and assisted by relevant public support.

Special Purpose Underwriting Vehicles

'Special Purpose Underwriting Vehicles' (SPUVs) are discussed in some detail in the main document and could be useful in overcoming some of the more persistent barriers to RET uptake. For instance, even when scale is not an issue, RE project sponsors often find there is simply a lack of available indemnity cover. The sector could benefit from a pilot project that introduces blueprints for new specialist underwriting facilities that can provide needed insurance cover to RE projects. As a first step, it is proposed that a study be launched into the potential of risk finance vehicles, ART mechanisms and specialist Lloyd's syndicates in the creation of fresh platforms/SPUVs for managing the risks associated with constructing and operating RE projects.

There are a number of structures of varying complexity that can create a standard excess of loss (XOL) platform using a limited amount of public sector support—perhaps in the form of a contingent capital/credit line. As such structures develop loss histories, the resultant data will become a critical asset for actuarial modelling. This data would be the foundation for the subsequent commercialization of similar deals that could ideally be done without any further public sector support. Where practical, it makes sense to adapt existing products and structures that are already serving other sectors.

One useful example of a planned SPUV comes from the forestry sector. The London start-up ForestRe (FRe) is setting up as a specialist Lloyd's syndicate and will immediately benefit from Lloyd's investment grade credit rating (A-) and 65 worldwide operating licenses. The core business will be providing global fire/wind cover to small/medium sized forestry operations that are not currently served by the market. FRe will reward operations with sustainable management practices by reducing premiums. Once sufficient capacity has been reached, a good portfolio spread achieved and profitable operating history established, the firm intends to develop specialist lines for environmental markets that may include energy crop yield cover and carbon sink guarantees. FRe intends to pursue public-private interactions as part of its longer-term business development plan. If successful, FRe can offer a model to the RE sector.

Providing simple forestry fire/wind cover does not generally require public assistance. However, technology issues mean that providing RE project cover is comparatively complex and expensive. There may be scope to set up a viable wind power syndicate with an objective of serving smaller accounts and developing markets (indeed, the only mono-line syndicate currently operating on the Lloyd's market specializes in nuclear power). Depending on the commercial viability of the underlying RE technology, public sector support for specialist SPUVs can be limited to the payment of certain professional fees or other market development activities rather than the extension of risk capital. However, any RE technologies that are currently 'uninsurable' will still require extensive further engineering studies before a SPUV solution is considered. **It is**

proposed that some work be devoted to examining the potential of SPUVs in greater detail and that potential product blueprints with associated business development plans be the resultant deliverables.

Other programmes

This study identified a number of research areas, initiatives, and market practices that can further the uptake of renewable energy technologies into the broader commercial realm. Some of these include:

1. **A study of the boundaries of insurability with respect to RET.** The delimitations of prototypical and resource risk need to be further explored to facilitate the development of new risk finance/transfer products as suggested in the study.
2. **A (transparent and publicly funded) study of current RE project risk rating methodologies with the objective of disseminating information to create some initial rating templates for use in the RE sector.** The market needs reproducible and relatively transparent techniques to assess the risk/return profiles of proposed new investments and transactions, and thus to help set the pricing and terms and conditions of insurance cover. With generic tools supplied by public sector studies, underwriters could accelerate their implementation of a commercial rating methodology to set appropriate terms and conditions and enable a rational and stable pricing structure to emerge for RE projects. The initial study could focus on biomass as this is a technology area where substantial rationalization of ratings is possible.
3. **A study of existing Public—Private Sector interactions focusing on how any relevant arrangements can be adapted to the benefit of the RE sector.**
4. **A review of potential tripartite joint venture groups (boutiques + public sector agents + large financial sector groups) for product development pilot programmes as suggested in this study.**
5. **A review of the potential role of public-private partnerships with Official Bilateral Insurers** (OBIs—typically Export Credit Agencies). The mandates of many OBIs are coming under strain because their governments forbid them to provide NCRI cover where private insurers are willing to take the risk. Hence, OBIs suffer poor results as 'insurers of last resort' but are asked to break even at the same time. This situation is unsustainable. If OBIs are to remain solvent they will need a balanced spread of risk in their portfolios and could benefit from the introduction of new products to promote the RE sector that are designed in conjunction with the private sector.
6. **A detailed review of current and potential credit enhancement instruments that can be adapted for use in the RE sector.**
7 **Product development studies that focus on 'bundling' small projects using existing re/insurance, ART and capital markets products.**
8. **Adoption of more holistic valuation methodologies for RE projects and technologies.** Most of the value inherent in RET is difficult to quantify

because forecasts often depend on particularly uncertain variables. Real Option Analysis improves upon standard valuation techniques for RE projects by better quantifying the potential upside investment value of RE-associated revenue streams.

Barrier removal priorities

Several barrier removal priorities need ongoing consideration.

1. Small scale of RE projects versus high transaction costs is a fundamental barrier to the commercial development of the sector. RE projects could benefit from cheaper and simpler risk management templates that are portable and replicable and can be adapted to individual parameters.
2. Uncertainty around policy has been identified by most financiers as the key barrier to commercial development of RET in countries where specific policy support measures are in place. Whilst it is necessary to have some official support measures for renewable energy (acknowledging that no one approach will be equally relevant in all regulatory environments) the critical issue for investors is the need to demonstrate long-term support and stability of approach. Rational and long-term policy interventions are needed to provide a more enabling environment for financing desirable new technologies.
3. The existing rigid, fragmented and inflexible underwriting methodologies within the private and public sector insurance markets inhibit the financing of RE projects. New underwriting approaches and methodologies are called for. Where it is practical, existing energy-related insurance lines that cover similar operations or similar risks faced by RE projects can be adapted and extended. The ongoing convergence of the insurance and capital markets is opening up some new conceptual possibilities for raising capital and managing risk in the RE sector. Initial sponsorship/co-financing from the public sector will probably be required to 'test-drive' and publicize new products in the open market.
4. At present, the market does not have sufficient information to appropriately determine the performance, delivery and asset quality risks associated with RE projects. The lack of actuarial data and the inability to accurately quantify RET risks demands the commercial integration of new risk modelling and assessment techniques that can function with limited data points.
5. A more structured and systematic 'implementation' framework is required to help advance product development for renewable energy finance. The main document discusses the resources available to GEF implementing agencies such as UNEP and considers how these can be well targeted to various RET applications[26]. However, several key underlying institutional operating constraints need to be overcome to improve the commercialization of products and market acceptance of public sector engagement.

[26] The GEF is currently in the 'GEF-3' period (FY03-06) and the total resources available during this period are USD3 billion. The main document discusses the resources available for projects.

Concluding summary

This report is intended for use as a scoping study to identify promising areas for future research, and also as an initial outline for possible product development strategies. The ***learning-by-doing*** approach is identified as an efficient means of making forward progress. Such an approach requires both strategic vision and low overheads to be successful. In the financial sector, it is argued that institutional inertia currently precludes the development of meaningful new risk management or financing products designed to leverage private capital flows to the RE sector.

Innovation in many market sectors is spawned by niche operators and small businesses that are later absorbed by larger players and thus new ideas are moved into the mainstream. However, financial sector participants require substantial amounts of capital to meet regulatory requirements, let alone acquire an investment grade credit rating that will be attractive to prospective institutional investors. Acquiring this capital is expensive and returns must be justified by quarterly performance reports to the shareholders.

Both niche operators and large institutions are needed to break the current product development impasse in the RE sector. There is a role for the public sector as a catalyst and third partner to mentor/mediate any team initiatives and provide assistance as appropriate.

In this sensitive operating environment there is little incentive to finance and insure projects that are perceived as high-risk and low-margin. At the same time, it is the large financial institutions that set investment trends by widely distributing products and ideas. These institutions also negotiate with governments, NGOs and other corporations and, for better or worse, help determine policy. Both niche operators and large institutions are needed to break the current product development impasse in the RE sector. There is a role for the public sector as a catalyst and third partner to mentor/mediate any team initiatives and provide assistance as appropriate.

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About the UNEP Division of Technology, Industry and Economics

The mission of the UNEP Division of Technology, Industry and Economics is to help decision makers in government, local authorities, and industry develop and adopt policies and practices that:

- are cleaner and safer;
- make efficient use of natural resources;
- ensure adequate management of chemicals;
- incorporate environmental costs; and
- reduce pollution and risks for humans and the environment.

The UNEP Division of Technology, Industry and Economics (UNEP DTIE), with the Division Office in Paris, is composed of one centre and five branches:

- **The International Environmental Technology Centre (Osaka)**, which promotes the adoption and use of environmentally sound technologies with a focus on the environmental management of cities and freshwater basins, in developing countries and countries in transition.
- **Production and Consumption (Paris)**, which fosters the development of cleaner and safer production and consumption patterns that lead to increased efficiency in the use of natural resources and reductions in pollution.
- **Chemicals (Geneva)**, which promotes sustainable development by catalysing global actions and building national capacities for the sound management of chemicals and the improvement of chemical safety worldwide, with a priority on Persistent Organic Pollutants (POPs) and Prior Informed Consent (PIC, jointly with FAO).
- **Energy and OzonAction (Paris)**, which supports the phase out of ozone depleting substances in developing countries and countries with economies in transition, and promotes good management practices and use of energy, with a focus on atmospheric impacts. The UNEP/RISØ Collaborating Centre on Energy and Environment supports the work of the Unit.
- **Economics and Trade (Geneva)**, which promotes the use and application of assessment and incentive tools for environmental policy and helps improve the understanding of linkages between trade and environment and the role of financial institutions in promoting sustainable development.
- **Coordination of Regional Activities Branch**, which coordinates regional delivery of UNEP DTIE's activities and ensures coordination of DTIE's activities funded by the Global Environment Facility (GEF).

UNEP DTIE activities focus on raising awareness, improving the transfer of information, building capacity, fostering technology cooperation, partnerships and transfer, improving understanding of environmental impacts of trade issues, promoting integration of environmental considerations into economic policies, and catalysing global chemical safety.

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