Insuring renewable energy projects

Barriers and recommendations for engaging the insurance sector

Compiled by WeESG Group Ltd for The Sunrise Project

September 2022

Executive summary

The United Nations Secretary General recently announced the need for USD 4,4 trillion per year to flow into renewable energy technologies by 2030, to meet the world's 2050 net-zero targets. However, significantly less than that has materialised.

This scoping study provides an overview of the renewable energy sector, highlighting the pressure companies and governments face in decarbonising the global energy system, how unevenly distributed the energy transition is, and how the declining costs of renewable energy is further enabling the growth of the industry. Private and public funding has been deployed to fund renewable energy projects, and further investments will be needed from all sources. Renewable energy projects face a range of risks including commercial, macroeconomic, and political. Insurance plays a fundamental role in transferring and reducing risk to make projects financially viable. Overall, the renewable energy insurance market has seen premiums stabilise in recent years, as traditional insurance strategies continue to be refined and more innovative forms of insurance – such as parametric – help to manage costs.

The report goes on to unpack barriers affecting the underwriting of renewables. While insurance was not found to be a significant hindrance to the growth of renewables, several challenges do need to be overcome. These include changing risk exposures, especially in remote locations, insurers struggling to keep up with rapid technological change, and a shortage of expertise in the renewables sector itself. Adequate data is a perennial challenge.

Despite global pressure and the momentum behind renewables, insurers' incentives still appear to be skewed towards fossil fuels due to its profitability and known risk profiles. Governments have several key roles to play. These include being transparent and making clear commitments, careful use of subsidies, and facilitating access to the energy grid (especially in areas with high potential).

The final section of the report shares some recommendations for areas in which the Sunrise Project could support the insurance sector to deepen the underwriting of renewables. These include leveraging regulator announcements to deepen capacity, celebrating insurers proactive in transitioning their portfolios, and increasing pressure on governments to align commitments on the low-carbon transition. Other opportunities include encouraging greater access to reliable data, supporting the growth of emerging markets and supporting insurers expand their role as risk managers and advisors.

Table of Contents

Background

The United Nations Secretary General recently announced the need for USD 4,4 trillion per year to flow into renewable energy technologies by 2030, in order to meet the world's 2050 net-zero targets (UN, 2021). Full decarbonisation of the global energy sector will require USD 131 trillion by 2050 (IRENA, 2021). According to both IRENA (IRENA world energy transitions outlook 2021, 2021) and the IEA (2021) this investment should preferably be made early on. By 2030, annual investment should reach USD 5 trillion before gradually tapering down to around USD 4 trillion per year. However, over the last five years, an average of just USD 2 trillion per annum has been spent globally on renewable energy projects.

Achieving this flow of capital will require considerable alignment between the energy sector, policymakers, and global finance. Part of the challenge is access to adequate and affordable de-risking solutions. Risk transfer (particularly insurance) is integral – in fact essential – to the successful financing of most renewable energy projects, as it provides the necessary protection and confidence for all stakeholders.

Against this backdrop, and recognising the urgency required to scale the global renewable energy market, The Sunrise Project has commissioned an internal white paper to help inform and shape its support for the renewables sector. Specifically, the scope of this study is to explore:

- the extent to which access to insurance hinders growth of the renewable energy sector;
- existing barriers limiting growth of renewable energy insurance; and
- areas The Sunrise Project can support to encourage further growth in the market.

The renewable energy and insurance sectors

Pressure to decarbonise the global energy markets is growing

Massive changes to the global power network are required for the world to meet its 1.5° targets. This requires coal-powered energy – today accounting for 40% of global energy generation – to decrease by 80% by 2030, while natural gas – currently 25% of today's energy mix – to decrease by 35% (McKinsey, 2020). By 2030, renewable energy output must quadruple, surpassing 10,000 gigawatts (GW) of global capacity. This requires an eight-fold and five-fold increase in solar and wind capacity, respectively (IRENA, 2021).

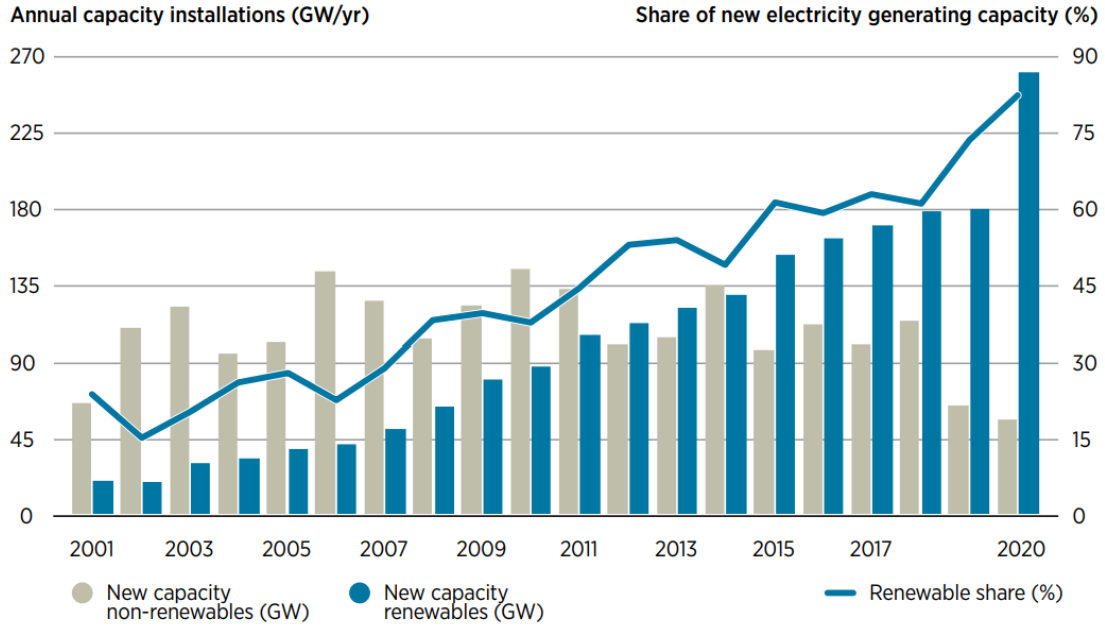
Energy generation must also keep pace with growing global energy demands. McKinsey (2020) estimates that energy demand will triple by 2050. This will be further compounded by the need to unlock further decarbonisation potential across other parts of the economy, such as manufacturing and transportation, which could see the last internal combustion vehicles sold by 2038 (Engineering News, 2022).

By 2050, electricity will be the primary form of energy, increasing from 2018's 21% share of total final energy consumption to 51% in 2050 (IRENA, 2021). The remaining supply of energy would come from modern biomass (18%), direct-use hydrogen and e-fuels (12%), other renewables (4%), and small quantities of fossil fuels (4% from oil, 4% from natural gas and 2% from coal) (IRENA, 2021). Yet full decarbonisation can only be achieved if the baseload energy supply itself is renewable (EEA, 2018).

The energy transition is accelerating but remains unevenly distributed

The growing number of countries with committed net-zero targets is transforming the global energy system. Already, renewable energy dominates the global market for new energy generation capacity and remains the lowest-cost source of electricity in most markets (WEF, 2020). In 2020, a record 260 GW of renewables-based generation capacity was added to the global energy network, four times the capacity from non-renewable sources. For the past seven years, more renewable power was added to the grid annually than fossil fuels and nuclear combined (IRENA, 2021).

Figure 1: New capacity from renewables compared to non-renewables

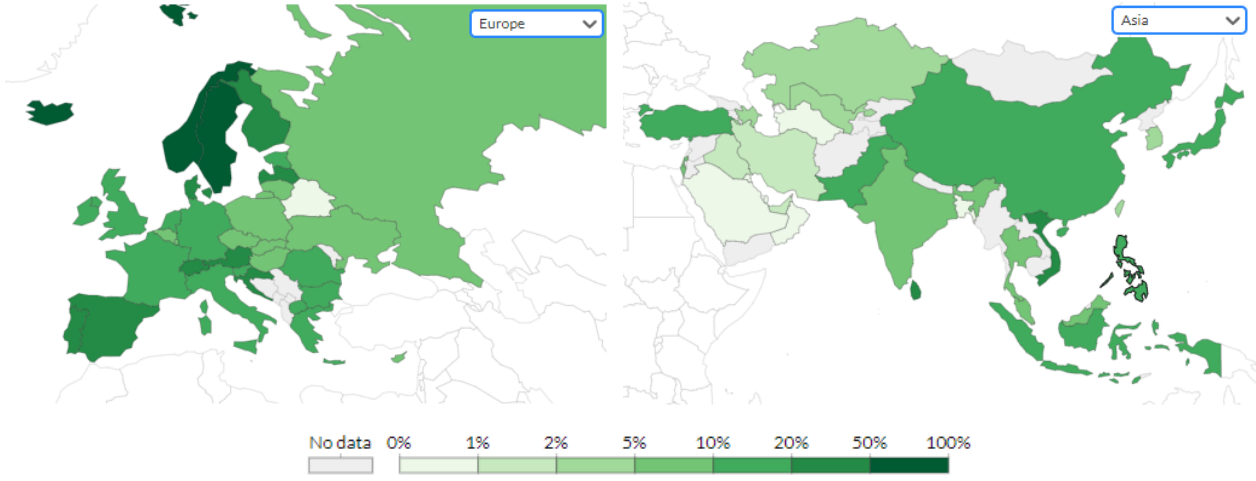


Based on IRENA's renewable energy statistics.

However, while growth in the renewables sector has been significant, it has also proven uneven across geographies and communities. The greatest progress has been made in only a handful of countries and regions. Figure 2 and the

description below highlights the share of primary energy from renewable energy sources[1] for countries in Europe (left) and Asia (right).

Figure 2: Share of primary energy from renewable sources, 2021



Source: Our World in Data based on BP Statistical Review of World Energy (2022) OurWorldInData.org/energy • CC BY
Note: Primary energy is calculated using the 'substitution method' which takes account of the inefficiencies energy production from fossil fuels.

In 2021 this disparity is apparent across Europe. Iceland (87%), Norway (72%) and Sweden (51%) lead in renewables, in contrast to laggards Belarus (<1%) and Cyprus (6%). The disparity is also true in North America where Canada's renewable energy share (30%) is about three times that of the USA (11%) and Mexico (11%). In the USA, after years of limited political backing, the country recently signed into law USD 370 billion in incentives and tax credits to grow its renewable energy capacity, which in 2021 produced only 20% of its total electricity (Grid, 2022; Nature, 2022).

In Asia leaders include Vietnam (23 %) and Sri Lanka (21%) while laggards are Turkmenistan (<0, 01%), and Saudi Arabia (0,02%). China is an outlier as it continues to rapidly increase its renewable energy capacity, aiming to source 33% of its power from renewable sources by 2025, up from 29% in 2020 (Reuters, 2022). Ironically, China is also the world's biggest polluter and is still building coal-fired plants and will only begin reducing coal consumption by 2026 (Reuters, 2022).

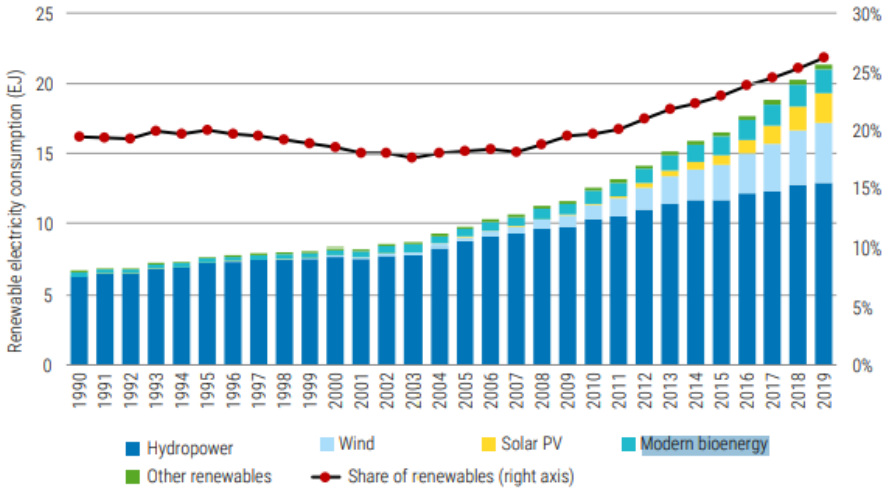
South America also has some strong performers including Uruguay (61%), Paraguay (60%), and Brazil (46%), while countries like Bolivia (9%) and Argentina (11%) are further behind (WB, 2022; Our World in Data, 2021). In 2020, just 9% of the energy produced in Africa was from renewables. North Africa had more installed capacity than the Southern, Eastern and Western parts of the continent combined (WEF, 2022). Energy poverty, particularly in emerging markets, continues to inhibit economic progress and social wellbeing and is a major challenge in delivering a 'just' transition.

Future growth dominated by solar PV and wind energy

Hydropower continues to be the largest source of renewable energy globally, although its market dominance continues to decline. More recent growth in other types of renewables focuses on wind and solar photovoltaics (PV), recording 45% and 35% annual growth respectively between 2018 and 2019 (IEA, 2022). The remaining growth focuses on 'modern bioenergy' (i.e. liquid fuels and gas) while 'other renewables' constitute only a very minor part of the overall renewables mix.

[1]Renewable energy figures include hydropower, solar, wind, geothermal, bioenergy, wave and tidal, and exclude traditional biofuels which can be an important fuel source especially in lower-income regions.

Figure 3: Global renewable energy consumption by technology, 1990-2019



Source: International Energy Agency (IEA, 2021a) and United Nations Statistics Division (UNSD, 2021).

Wind, solar and batteries are becoming more affordable

Significant technological progress has been made in improving the efficiency and effectiveness of renewables. In particular, significant strides have been made in performance and cost improvements across wind energy, solar power, and battery technologies. For example, silicon solar panel efficiency has increased from 15% to 26% over the last four decades, while solar and onshore wind-energy prices have fallen 90% and 70%, respectively, over the last decade (Vox, 2022). The energy density of lithium-ion batteries has tripled over the past decade while the cost of manufacturing has fallen dramatically (by 97%) over the last 30 years (Vox, 2022). 'Direct use' renewable energy technologies – including hydrogen fuel cells and green hydrogen – are also helping to decarbonise traditionally tricky sectors like transportation and industry, and providing green energy to more remote communities (IRENA, 2021).

Overall, this has led to a sharp drop in the overall cost of renewable energy generation, supporting faster growth across the renewables sector than originally expected (WEF, 2020).

Funding of renewable energy projects

In order to meet the global decarbonisation targets of the energy sector, all sources of capital must be deployed. The two primary sources of capital are equity (where a stake in the project is purchased) and debt (via the provision of a loan), both of which can come from private or public sources. The provision of public funds is usually aimed at catalysing or lowering perceived risk in the market. It normally takes the form of low or zero-interest financing, often from local or international government entities such as development banks, or international funds – these are usually specifically for green initiatives.

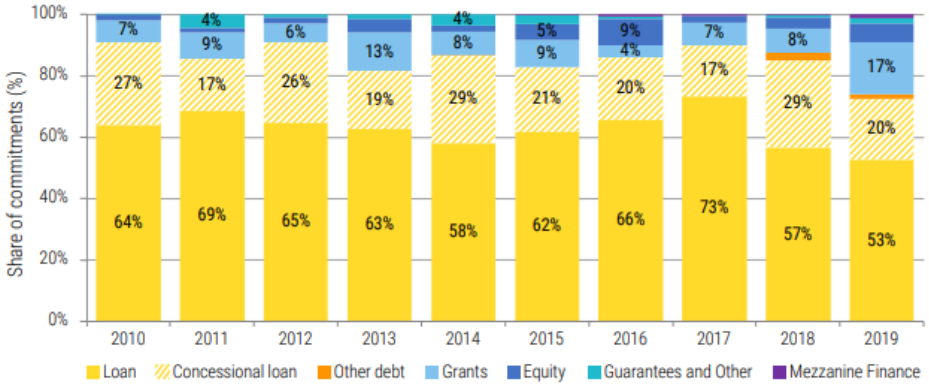
Private funding is usually offered at market-related rates and is provided by commercial actors such as investment firms and commercial banks. It is common for some private funders to be involved during the construction of the project, and then sell their stake to longer-term investors seeking lower risk investments. Longer-term investors or institutional investors tend to avoid riskier investments by investing in projects that are ready to build or already in operation. They obtain lower yields as they avoid most of the development and construction risks.

To ensure local communities also benefit from projects built around them, some countries also require a certain level of community ownership, typically gifted, in projects.

Renewable energy projects follow a similar maturation process as other emerging technologies. This means that while technologies are relatively early-stage, and higher-risk, they tend to attract private equity investors. However, as they mature, they attract lower-cost, longer-term debt that allows for wider adoption and exposure by investors.

Consequently, over time, renewable energy projects should find it increasingly easy to obtain affordable long-term debt financing. This should be in contrast to fossil fuel-based projects that will increasingly be avoided by private financiers and insurers, and therefore forced to fall back on greater levels of equity financing (IEA, 2021).

Figure 4 Shares of annual commitments by financial instrument 2012-2019



Source: IRENA and OECD 2022

To date, most funding for renewable energy projects has come from private venture capitalists seeking exposure to higher risk, higher reward investments, and industrial capital coming from project developers, corporations, and institutional investors. In many instances, public policies and incentives have successfully encouraged flows of private investment into renewable energy through the provision of grants, guarantees, and frequently the offer of concessional loans (i.e. loans offered at better than market rates) (IEA, 2021; IRENA, 2021).

In general, public funding, concessional debt, development finance, and blended finance (i.e. private capital and development funding) remain crucial elements to leveraging sufficient amounts of private capital for many renewable energy projects. This is because the involvement of development finance institutions (DFIs) helps to reduce the actual and perceived risk for third-party investors, therefore helping to lower the overall cost of capital for project developers.

Although there is sufficient finance to fund most renewable energy projects, the projects themselves need to be attractive and bankable in order to attract sufficient investment. Adequate risk transfer, usually via insurance (i.e. not derivatives or catastrophe bonds[2]), is arguably one of the most critical elements in determining whether a project is financeable or not (Interviewee 2, 2022; Interviewee 3, 2022; IRENA, 2018).

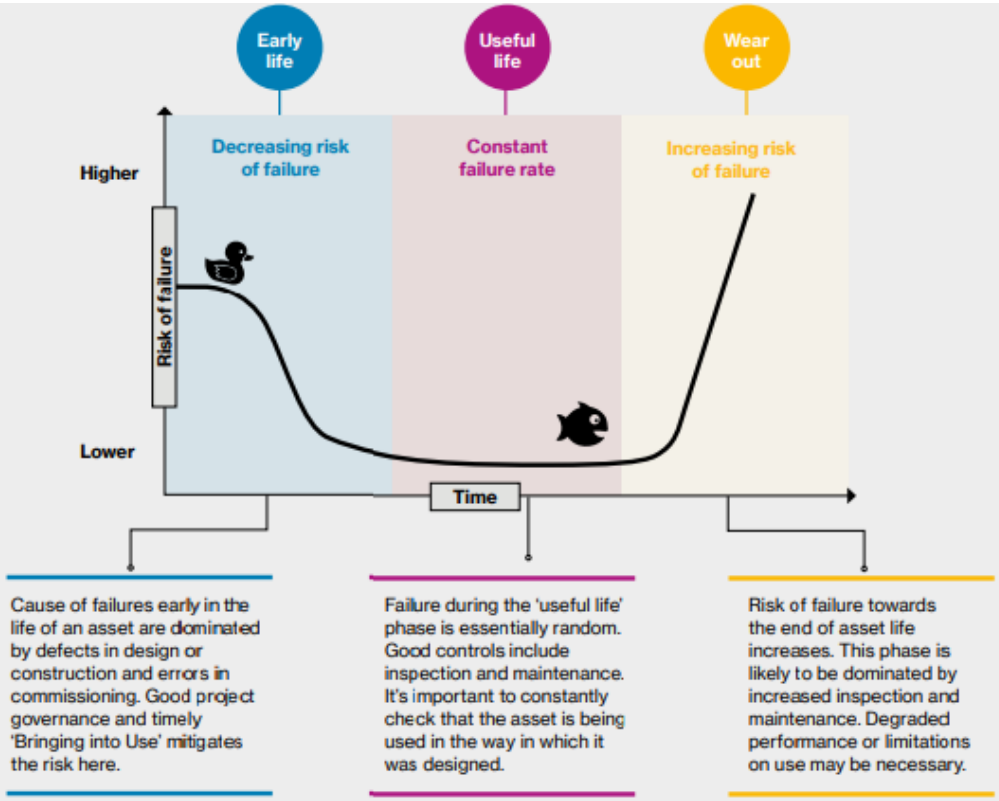
Managing renewable energy project risks

High real or perceived risk exposure (see Figure 5, below) is a frequent stumbling block facing many renewable energy projects. Developers must show that they have effective risk transfer mechanisms in place.

Inevitably, renewable energy projects face numerous and evolving risks over their lifespan. These range from engineering issues during the early stages of project development, supply chain challenges and other delays during the construction phase, through to operational risks once the project goes live.

[2]A catastrophe bond (CAT) is a high-yield debt instrument that is designed to raise money for companies in the insurance industry in the event of a natural disaster. A CAT bond allows the issuer to receive funding from the bond only if specific conditions, such as an earthquake or tornado, occur.

Figure 5: Bathtub curve



Source: Adapted from WTW, 2020

The type and severity of risk exposure changes over time, typically reflecting a spike during the early stages of project development, minimal risk exposure during the operational (i.e. proven) phase of the project, before a steady increase in risk towards the end of the infrastructure's expected lifespan, with the growing likelihood of equipment failure (WTW, 2020).

The typical lifespan of a wind turbine was assumed to be 20 years in the early 2000s, increasing to 25 years by 2015. Now the most recent expectation is 30 years (this can extend up to 40 years) (Renewable Energy World, 2019). Similarly, solar panels commonly have warranties for 20-25 years but as their productive output has declined much slower than expected (approximately 0,5% per year), their lifespan can extend well past the period under warranty (Interviewee 7, 2022; NREL, 2018).Regular maintenance is, however, required for these extended lifetimes to be met. If these are achieved at affordable maintenance costs, there will naturally be a positive impact on the long-term profitability of the project.

Common risks facing renewable energy projects can be grouped into three broad categories: commercial, macroeconomic, and political. Commercial risks are those associated with the specific market in which a project operates and the stakeholders it is exposed to. This includes manufacturers and suppliers, contractors, local communities, local authorities, customers, and environmental impacts. Performance-related risks are also included.

Macroeconomic risks relate to external factors over which project developers have little influence and control. This includes inflation, interest rates, exchange rates and other market forces. Finally, political risks include the elimination of state or tax credits and subsidies, and insufficient regulation around the price and demand for renewable energy. Force majeure (such as wars, social unrest, etc.) also included political risks.

Private insurers are now also partnering with institutional agencies to provide cover against certain political risks which can include non-payment of power purchase agreements, breach of contract, currency inconvertibility, expropriation,

nationalisation, war and civil unrest. Examples of mechanisms that provide this cover include the African Energy Guarantee Facility, a collaboration between Munich Re, the African Trade Insurance Agency, and the European Investment Bank, that could unlock USD 1,4 billion in clean energy investments in Africa (MunichRe, 2018).

Some of the more specific risks, usually transferable via insurance, are described below (Marsh, n.d.).

Figure 1: Summary of risks faced by renewable projects

Risk	Description
Construction	Construction risks include changes in project scope, design, contractor, and engineering issues, supply chain constraints, unfamiliarity with local conditions, and force majeure. These risks can often be compounded by inexperienced contractors, causing further project delays. As equipment and construction costs of a project are substantial, construction risks are a key concern for developers. When a project is approved, the more rapidly a project can be built and go online, the more early a project can begin generating revenue. Thus, delays associated with equipment and construction can be expensive.
Technological	Projects require technological systems to perform at a maximum level of output over long time frames. Design flaws linked to manufacturer and contractor errors or inexperience can present risks. Similarly, manufacturers may lower the quality of their manufacturing to reduce the costs. For example, one of the variables that commonly change on solar panels is the thickness of the glass. Thicker glass is more expensive but able to better withstand larger hailstones. Manufacturers and developers therefore often prefer to use the less expensive option, which might not be fit-for-purpose depending on where the project will be installed (CEA, 2020).
Environmental	Environmental risks are inherent throughout the life cycle of a project. These risks should be identified in the early developmental stages of a renewable energy project. Some of these risks may stem from ground and soil conditions. Site selection is also a potential risk for project owners; many brownfield sites are available for development and may have contaminated ground and soil conditions that need to be considered when planning a project (Interviewee 12). In the US for example, areas of land that are considered too contaminated to be cleaned for other uses attracted solar farms due to their affordability (GreenBiz, 2018).
Regulatory	Project owners can face unexpected costs, fines, or delays that stem from delays in permitting, licensing, approvals, or changes to state or tax credits and subsidies. For example, in an effort to bring the energy sector back under state control, the Mexican president has reversed several energy reforms introduced by his predecessor. This included giving preference to fossil fuel plants, cancelling a public auction for rights to generate solar and wind power (despite previous auctions leading to some of the world's lowest renewable prices) and preventing several privately owned renewable projects that were already built from operating commercially (Americas Quarterly, 2022; NYT, 2022).
Operational	Personnel and equipment, cancellation and standby costs, testing and commissioning, and operation and maintenance, all impact an organisation's operational risks. This includes a project not producing energy to the expected level of output. Also, the operation and maintenance of a facility often carries variable and fixed costs (such as servicing contracts, insurance, and staffing) that can change unexpectedly over time.

Insurance's role in transferring and reducing risk

Insurance can help to transfer many of these risks, and therefore increase the attractiveness of the project to prospective investors. Indeed, in the absence of insurance, most renewable infrastructure projects are unlikely to even be considered for investment. Insurance can also reduce risk by advising clients on best practices and helping to rapidly diffuse such knowledge around the marketplace, as a 'below the radar' risk management service.

Effective de-risking solutions can therefore promote a pipeline of bankable projects and accelerate innovation in renewable energy technologies. De-risking energy transition projects is critical for long-term funding to be made available at affordable rates (IEA, 2021; IRENA, 2021).

Project developers tend to employ multiple ways to diversify, transfer or manage risk exposures. In some instances, capital from government entities such as municipalities and state-owned enterprises can play a role in de-risking infrastructure projects by providing low-cost capital or guarantees that can lower the cost of a project. However, it is insurance that is often used as it can so effectively transfer, for a premium, the financial risks associated with anything from physical property damage and delays in start-up, through to performance and business interruption (BASE, 2020).

Renewables insurance settling in 2022 after a period of fluctuation

Insurance has played a key role in supporting the unprecedented growth in the renewables market that has been driven by the countries and companies racing to net zero (WTW, 2022). Along with the increase in renewable energy capacity, more insurers have joined the long-established specialist renewables insurers in underwriting both offshore and onshore renewable energy projects. This is a positive signal for the renewables industry which needs further growth in the insurance market to support the continued roll-out of installed capacity (Gallagher, 2022).

After facing several natural catastrophe events and associated pricing increases in the last three years, the global renewables insurance market appears to have stabilised, and premium increases for 2022 are likely to be within the single digits. By now, renewables insurers have a good grasp of the types of risks they can expect from different renewable energy technologies, and those from different geographies, so are better positioned to adjust their portfolios according to their risk appetite (Gallagher, 2022; WTW, 2022)

Traditional insurance strategies and models continue to be adjusted and refined, creating opportunities for innovation around new insurance offerings to the pain-points experienced by insurance buyers in recent years (WTW, 2022). One area of difficulty experienced by insurance buyers is finding affordable insurance for a certain level of coverage, but then also having to pay disproportionately more expensive premiums over and above that (Interviewee 10, 2022). One possible solution that has been used, and that holds potential in these and other situations, is parametric insurance, an example of non-traditional insurance (Interviewee 10, 2022).

Insurance is attempting to innovate: Parametric insurance

Parametric insurance is an example of non-traditional insurance. Unlike conventional indemnity insurance which settles claims based on actual damage incurred – and as assessed by loss adjusters – a predefined parametric insurance claim is activated when a certain 'trigger' event occurs. For example, if wind speeds were to exceed a certain threshold, or solar irradiance falls below a certain value, this would result in an automatic pay-out, regardless of the actual losses incurred. Because these metrics can be confirmed quickly from independent sources, pay-outs are often immediate, not requiring the involvement of a loss adjuster to confirm damages. Parametric insurance can therefore help to protect renewable energy projects from income fluctuations due to weather volatility, providing a level of resilience against climate risks (Interviewee 1, 2022; SwissRe, 2021).

Another benefit is enhanced efficiency gains due to the reduced administrative requirement, as well as enhanced customer experience (Interviewee 12, 2022).

In recent years, for example, hail has impacted several industries in the United States, Southern Europe and Australia. Solar projects were affected by physical damage to infrastructure, and following this, traditional insurers reduced availability of coverage. Parametric insurance offers a level of risk transfer that supports the financial viability of solar projects. Accompanying the insurance, specially designed weather stations were installed on-site to improve hail data collection. Parametric solutions are then calculated based on this more accurate data, with pay-outs being linked to hail size. Parametric solutions are therefore flexible, transparent and offer quick pay-outs that support the financials of renewable projects to meet lending needs (Marsh Mclennan, 2021).

New technologies such as green hydrogen, fuel cells and certain battery technologies are typically still considered high-risk by insurers, as they are considered prototype assets. This means that insurance coverage for this technology is quite expensive and only covered on a small scale (Interviewee 10, 2022). Fortunately, private companies are recognising this and responding. For example, Marsh, AIG and Liberty have collaborated to put together a facility that provides up to USD 300 million cover per risk for the construction and/or start-up phases of hydrogen projects, available globally. In addition to providing cover for damage risks during construction and operations, the facility can also provide cover for marine cargo, business interruption, third party liability and delay-in-start-up insurance (Intelligent Insurer, 2022).

Insurance barriers impacting renewables

Both the desktop study and interviews highlighted that access to insurance plays a fundamental role in the financing of renewable energy projects. There are several barriers limiting access to insurance. However, none of these barriers were found to be a material hindrance to the scaling of the renewable energy industry. Indeed, it was generally concluded that access to insurance is not a major inhibitor in the scaling up of renewables and unlikely to be so in the near future.

One instance where insurance cover might be limited is for high concentrations of expensive offshore wind projects in hurricane-prone areas (Interviewee 10, 2022). However, insurers are seeking ways to further de-risk potential investments, even in such high-risk locations.

Another example occurred in Florida where insurers were overwhelmed by a boom in residential rooftop solar installations but lacked data on the associated risks. This included balancing exposure between holes being drilled into roofs versus solar panels helping to hold roofs down and reducing damage during hurricanes. There is also uncertainty around whether solar panels should be covered under homeowners' insurance at all, and whether business insurance (when selling power back to the grid) is more suitable (First Coast News, 2022; Insurance Journal, 2021).

Local regulation also presents additional complexities – when a solar system exceeds a certain capacity, it is required to carry a USD 1 million liability policy to protect the grid, electricians and line workers. Homeowners do not necessarily take all these factors, and the cost of insurance into account when installing a solar system. Insurer responses differ, as some do not offer coverage, others make exclusions, while some offer full cover (First Coast News, 2022; Insurance Journal, 2021).

These examples show that, while there are certain instances where the provision of insurance is under pressure, it is not illustrative of renewable insurance markets as a whole. Indeed, as the industry matures, accurate loss and weather data will assist insurers to assess and price risk accurately. In parallel, legislation is likely to evolve appropriately, technologies will improve, and contractors will learn more.

In recent years, insurers have recorded a growing trend across the renewables sector of weather-related losses that fall outside of traditionally modelled natural catastrophe definitions (previously known as 'secondary perils') (SwissRe, 2019). This includes increasing exposure to more frequent and severe hailstorms, wildfires, and extreme cold events. This has led to extreme weather-related renewable energy losses 300% higher after 2015, than before (GCube, 2021). Part of the reason for these dramatically higher losses is that renewable energy farms take up vastly more space, and are more exposed, especially when compared to fossil fuel-based power stations (Interviewee 10, 2022; Interviewee 12, 2022).

Over the past decade, 70% of solar energy losses have occurred since 2017, linked to increased property damage and business interruption claims (Allianz, 2019; GCube, 2021; Risk & Insurance, 2021; Allianz, 2022). In the United States, most solar installations are located across Texas, California, and Florida. While all regions are well suited to solar generation, California is increasingly prone to wildfires, Texas to hail, and both Texas and Florida to hurricanes. These areas have all experienced significant loss events in recent years, resulting in insurance premiums rising by 400% since 2018 and, in some instances, cover being withdrawn altogether (HBR, 2021).

Compounding the exposure to weather-related losses has been the recent trend for many large renewable projects to be located in more remote areas. On the one hand this is where sufficient and affordable land is available; an inevitability as demand for renewable energy grows and ever larger projects require more space. However, these areas are often more exposed to extreme weather-related events. Furthermore, the remoteness of these locations can also impact maintenance schedules and cause delays to any necessary repairs, further impacting productivity and revenue, and compounding possible insurance claims (Risk & Insurance, 2020).

Underwriting struggling to keep pace with the technological rate of change

Intense competition has led to rapid advancements in the technology, materials, and manufacturing methods offered by renewable manufacturers (Risk & Insurance, 2021; Risk & Insurance, 2020; Allianz, 2019). However, although manufacturers invest heavily in research and development, insurers are only able to accurately assess the real-world performance and durability of these technologies once they have been in use for 'approximately 8,000 hours, at scale, and under different conditions' (Interviewee 5, 2022).

For instance, the next generation of photovoltaic panels offer newer, lighter panels that require just two individuals and a forklift to install over 1 MW of capacity per day. While beneficial from a project delivery perspective, they also introduce unknown risks. The panels are lighter, exposing them to greater hail damage, and installed on new racking systems lower to the ground, potentially increasing their exposure to wind and flood damage (Interviewee 5).

Similarly, as wind turbines increase in size and efficiency, so their exposure to lightning strikes and potential freezing grows. To counteract this, manufacturers have developed lightning protection measures and rotor heating technologies. Yet while these developments allow turbines to operate more efficiently, and in a greater variety of adverse conditions, their increased complexity carries new and unknown risk exposures.

As technologies have matured and the costs of manufacturing declined, the increasing size and technological complexity of renewable energy projects have corresponded with a marked increase in the cost of repairs. In 2019, approximately USD 8.5 billion was spent on unplanned repairs for component failure, representing 57% of all operation and maintenance costs (Risk & Insurance, 2020; Wood Mackenzie, 2019).

New technologies therefore require consistent technical evaluation and underwriting expertise to help benchmark them against previous generations. As the speed of technology accelerates, keeping up with international engineering standards and certifications presents ongoing challenges for risk consultants, engineers and ultimately for underwriters. Yet in some instances the introduction of new technology is directly helping to manage insurance losses. The use of drones allows more frequent remote assessments and improved maintenance schedules, while artificial intelligence allows for more remote monitoring and maintenance forecasting. This forecasting also helps to manage potential bottlenecks in supply chains by pre-empting the need for replacement parts. This is all having a positive impact in reducing potential repair and replacement costs, and business interruption losses.

A shortage of expertise across the insurance and renewable energy sector

Insurers have struggled to build their in-house expertise in line with the broader growth of the renewable energy sector. This has impacted their ability to understand, and confidently underwrite, renewable energy risks. However, while the overall sentiment from interviewees was that this is a valid concern, it was not felt to be an overly material one from an insurance perspective due to the flexibility, and rapid upskilling, of the labour market (Interviewees 1, 2 and 4).

However, a more material shortage of expertise is in the renewable energy space itself. Demand for skilled workers has climbed rapidly in recent years and the best talent is most often secured by the larger developers. This leaves smaller renewable energy developers with less experienced workers. Fierce competition between developers bidding for projects can result in projected margins being too tight, resulting in some developers going out of business, with others forced to 'cut corners' (Interviewee 5, 2022).

Lack of experience and poor-quality workmanship can increase the potential for losses. For example, wind turbine components, like blades, need to be transported in several pieces, due to their size, and installed on site. Not tightening bolts sufficiently is a simple example with costly consequences (Interviewee 5, 2022). Micro-cracking of solar panels, not being stored, transported, or installed in the correct manner, is also a common risk (Risk & Insurance, 2020).

Thus, insurers tend to be more wary of smaller renewable energy projects, especially those in emerging markets, due to perceptions that they carry increased project risk and potentially insured losses. This perceived risk profile is usually

reflected in the risk premium and the conditions offered and could impact efforts to build a more diversified and decentralised renewables network.

A need for more data (weather, technology performance)

It is no surprise that data is critical for supporting more affordable insurance coverage. However, access to data itself, on weather, performance and operational metrics, is a highly sensitive and competitive issue. For example, if an insurer discovers that a certain manufacturer's wind turbine is defective, or fails to perform as expected, that data could be harmful to the manufacturer and would need to be fed back in a way that limits reputational harm.

Ideally, data could be shared in a way that allows all market participants to improve their understanding and confidence in the renewables sector. This is especially true for projects located in more remote, less understood, locations. However, as projects become operational and new sites are identified, data is increasingly being captured and consolidated. Furthermore, live data monitoring is helping to reduce reliance on historical data, by deepening understanding of real-world performance of new technologies. This is a trend that should be supported.

Consequently, while incomplete data may result in premiums and policies needing to change more frequently to keep pace with emerging understandings of risk, insurers should still be able to underwrite most renewable energy projects if they wanted to (Interviewee 2, 2022; Interviewee 3, 2022; Interviewee 4, 2022). In fact, the challenge of insufficient data should be no different to other sectors and it was felt that that large insurers tend to use advancements in technology, and a corresponding lack of data largely as an excuse for being so slow in expanding their own renewable energy portfolios. Several insurers do host risk seminars and risk workshops with clients, and release risk reports to the public, to share some aspects of their data, although most of these tend to be highly redacted. Claims data is often seen as a 'golden egg' for the insurance industry, to improve their premium pricing (Interviewee 12, 2022).

Furthermore, limited weather data in remote areas and especially in some emerging economies means that insurers can also struggle to accurately price risk. Due to extreme losses in some geographies, insurance has either become prohibitively expensive, cover is being heavily curtailed, or no cover is available at all. In situations like these, non-traditional forms of insurance are often being used to provide some risk transfer for renewable energy projects.

Insurer incentives remain skewed towards fossil fuels

Many insurers remain heavily exposed to the fossil fuel sector as it is still a highly profitable market for them and is cited as one of the key reasons behind their slow adoption to underwrite renewables at scale (Interviewee 1, 2022; Interviewee 2, 2022). This is being compounded by perceptions that underwriting margins across the renewable energy sector are 'thin', even though, in contrast, investors regard renewable energy projects as providing stable long-term investments (IRENA, 2018).

Therefore, one of the reasons for a slower shift than hoped for towards renewables is that most insurers lack strategies, expertise, and the correct incentives to do so. In fact, one interviewee claimed that many insurers are only exposed to renewables because of pressure from key stakeholders like shareholders, civil society, and government. They therefore regard a shift towards renewables, more for compliance or reputational, rather than for pure commercial, reasons (Interviewee 2, 2022).

Brokers, in particular, as key stakeholder in the underwriting process, represent another barrier as they play a crucial role in bridging the gap between the insurance needs of a project developer and what an insurer is willing to offer (Interviewee 3, 2022; Interviewee 5, 2022).

Unless a project developer has its own in-house insurance representatives – usually reserved for the largest renewable energy developers – most projects tend to only liaise through brokers and not directly with insurers. However, concerns were raised that brokers are generally incentivised to take a 'rinse and repeat' approach to offering conventional cover for common risks rather than developing unique underwriting solution (i.e., new products) to meet customers' specific needs. Furthermore, it was also felt that when brokers do price new risks, they commonly do so

with just one insurer, therefore failing to drive the competitive tension or the possible syndication of risk necessary to reduce costs. There were concerns that this limits innovation across the industry.

Government commitments still falling short and undermining confidence in renewables

In almost all instances, and largely unsurprisingly, government was highlighted as one of the primary drivers around the growth in renewables. Governments have an intertwined role between the energy pricing entity, the public and private utilities and the setting of regulations influencing numerous aspects of the energy markets. This, in turn, can significantly influence the growth of the sector, and the corresponding insurance market.

First and foremost, governments must make clear and consistent commitments that align with their sustainable energy transition plans and support this by concrete investment and legislative actions. This would provide developers, investors, and insurers with the confidence they need to expand into new markets and projects (Interviewee 1, 2022; Interviewee 2, 2022; Brookings, 2021). Alongside these commitments, supporting legislation is also needed to, for example, allow appropriate renewable energy and associated equipment into the country.

Unsurprisingly, ongoing fossil fuels subsidies continue to hold back demand for, and investment in, renewable energy projects, by artificially lowering fossil fuel prices (Brookings, 2021). Highly targeted subsidies for renewable energy are regarded as appropriate in specific situations, such as supporting innovation in, and de-risking perceptions of new technologies, or opening up new markets (Interviewee 1, 2022; Interviewee 2, 2022; Interviewee 3, 2022). However, this also requires greater transparency as renewable energy projects are highly sensitive to regulatory and legislative changes. For example, the financial viability of many new renewable energy projects is dependent on predetermined energy prices (i.e., Power Purchase Agreements[3]). Yet trust in the long-term commitments to these regulations by government, has been undermined in recent years.

Spain, for example, is facing significant backlash after it pulled the plug on its major renewable energy investment scheme, effectively halting financial support for renewable energy projects. These changes were also applied retroactively. Although the Spanish government has lost 25 of the 50 claims filed by renewable energy developers against these changes, it has severely damaged confidence in the Spanish renewables sector and increased perceptions around project risk (EU Reporter, 2022). Similar instances have occurred in Mexico and the USA when incoming presidents undid the work of previous administrations that tried to progress their nation's low-carbon transitions (Americas Quarterly, 2022; NYT, 2022; NYT, 2020) (NYT, 2022).

Fortunately, the United States has made positive progress recently with the introduction of the United States Inflation Reduction Act which offers almost USD 375 billion in climate incentives. It is expected that this bill will rapidly expedite the transition to renewable energy in the USA. In fact, this particular regulation reflects 'the most spending to fight climate change by any one nation ever in a single push' (PBS, 2022). Inevitably there are concerns over whether future US governments could back-pedal on these commitments.

Another, more practical consideration on the role of government is in facilitating greater, and more affordable, access to the energy grid – a responsibility normally falling to the nation's power utility. This is becoming particularly important as new renewable energy projects are located in ever more remote locations that often lack easy access to the grid infrastructure crucial for the project to remain viable (Interviewee 6, 2022; Interviewee 8, 2022; Interviewee 9, 2022; Risk & Insurance, 2020). For renewable energy to meet the scale and economies required, the national energy grid must have sufficient infrastructure to transfer the volumes of generated electricity.

[3]A Power Purchase Agreement (PPA) is a long-term agreement to purchase clean energy from a specific project at a predetermined price between a renewable developer and a consumer, or between a developer and a supplier who then resells the energy.

Recommendations for engagement

The Sunrise Project has created a niche for itself in the sustainable finance and insurance sector. There are various ways it can help to catalyse the growth of the renewable energy sector. Several suggestions are put forward below. Some include furthering engagements with insurers or working with governments, while there are also collaboration opportunities where both sets of stakeholders are engaged.

Leverage recent regulatory and legislative announcements to deepen needed capacity

The potential impact that the recent USD 370 billion US Inflation Reduction Act (IRA) will have for the renewable energy markets cannot be overlooked. The act puts the US on a firm pathway to reduce emissions by almost 40% by 2030; the single biggest climate investment in US history. Most importantly, USD 30 billion has been earmarked specifically to provide tax credits, aimed at leveraging the financing of clean energy generation and storage, and another USD 30 billion in targeted grants and loans. It specifically targets support for solar PV and wind energy (Forbes, 2022).

As with the progress solar PV technologies have made in the past due to direct support by the German government, the IRA is expected to deliver a huge boost for the US – and ultimately global – renewables sector. This should see record levels of financing flowing into renewable energy solutions and, consequently, presents a huge opportunity for insurers to capitalise on this growing market segment.

However, there remains a significant lack of understanding across the insurance market for the near-future opportunities these legislative changes present. This is particularly true for brokers who may find themselves unprepared for the scaling up in demand expected. This presents an opportunity to provide targeted engagement around scaling up of capacity in preparation for the expected growth in this market. There may be opportunities for collaboration or extending the mandate of various groups that are already working on climate resilience with insurers. Some examples include the Insurance Development Forum, Munich Climate Insurance Initiative and the Geneva Association.

Celebrate insurers actively transitioning their portfolios

There remains reticence across parts of the insurance market to deepen underwriting exposure to renewable energy projects. Some feedback provided was that some insurers were only exposed to the market at all based on stakeholder pressure and expectations. Nonetheless, being seen to be a leader in the renewables space remains attractive to most insurers. Interviewees repeatedly described margins in renewables as 'thin' due to the large physical size of the projects themselves and their exposure to natural catastrophes (Interviewees 11 and 12). Thus while the commercial incentives are not as great as they would be for fossil fuel projects, the pressure to stop underwriting *and* divest, especially from thermal coal, are intense (Insurance Day, 2022; Positive News, 2022; Capital Monitor, 2021).

This would suggest that a transition leader board, similar to Unfriend Coal, but instead celebrating insurers most active in transitioning their underwriting book to renewable energy, might be well received by the market and helpful in encouraging best practice.

Furthermore, insurers that take a strong net zero stance will have no option but to phase out coal, and as that happens, they will seek new opportunities. Naturally, renewable energy will become an opportunity that more underwriting and investment resources could be dedicated to.

While we recognise that The Sunrise Project is not best positioned to lead political campaigns aimed at influencing government policies around renewables, this remains an important area of consideration and need, possibly in partnership.

Encourage greater access to reliable data

Access to reliable and consistent global hazard and claims data on renewable energy projects presents an ongoing challenge as it undermines confidence in the underwriting process. In particular, data shortfalls revolve around technology and site-specific data. This is undoubtedly a challenging area, and one reinforced by ongoing competitive forces. Encouraging closer alignment between technology producers, renewable energy projects, governments, and the finance sector could help to develop more reliable (potentially open source) data that can help de-risk projects further and with greater underwriting consistency. Consortia of data-sharing across hazards (e.g., flood) have been established in the past and additional work can be done to determine if these were effective (Interviewee 12, 2022).

Insurers are natural partners to clients in influencing best behaviour, and benefitting from risks priced accordingly. An example is using sensors in a zero-waste building to extract live data around water leaks, energy consumption, voltage fluctuations etc (Interviewee 2, 2022). Similar thinking can be used by insurers who could support the insured to reduce risk and reduce emissions, thereby benefitting from reduced premiums. Similarly, in the renewable energy space, insurers can assist developers by communicating best practice for reducing risk by implementing certain protocols around infrastructure installation, or having minimum training requirements for contractors etc.

Promote the use of 'blended' insurance

Insurers could also potentially collaborate with development finance institutions (DFI) to encourage more investment into novel green innovations, especially around combining public and private sector objectives. 'Blended insurance' facilities could allow DFIs to take a greater proportion of 'first loss', allowing private insurers to take a smaller proportion of risk. This could also be achieved through a mechanism whereby the government agency subsidises private insurers (Emerald, 2019).

Increase pressure on governments to align

Government (in)action remains one of the biggest challenges facing the growth of the renewable energy sector, through changing policies, subsidies, conflicting local regulations, or access to grid connectivity. While this is a sizable challenge, it is so important to the long-term sustainable growth of the renewables sector, that it cannot be ignored. Governments need to make stronger commitments to the sector, followed up with real actions that grow confidence in legislative changes and financial support.

It is possible that a strong, aligned, and vocal financial services sector can provide governments with the confidence to support the renewables sector more boldly. While government support can help to de-risk project financing, the presence of sufficient and affordable risk transfer mechanisms can conversely help to de-risk perceptions of support for government as well. Work such as this could be done with or through green finance initiatives, such as the Green Finance Institute.

Adjustments to competition law could encourage collaboration

Regulation governing collective action – primarily to limit price fixing – often limits collaboration between insurers. Insurers are particularly cautious as the consequences are sever. A violation in the UK, for example, can result in a 10% penalty of annual revenue, disqualification and/or prosecution (CMA, 2014). Consequently, while insurers can take individual action against undesirable industries like fossil fuels, competition laws restrict insurers from doing the same collaboratively. This opens opportunities to work with governments to make legal frameworks that are clear about exactly when insurers can collaborate, and when it is illegal.

However, the response to the development of the COVID-19 vaccine offers an example of where pharmaceutical competitors worked together, sharing resources and expertise, to rapidly address a pressing and clear threat (EPR, 2021). If climate change were to be regarded in the same way, and greater alignment encouraged, this could have a significant impact on the sector's response.

Nature has an important role in the climate crisis

Once built, renewable energy systems need to be resilient in the face of natural catastrophes, to maximise the financial value invested in them. In certain instances, natural systems can be a cost-effective form of reducing risk. Healthy mangrove and coral systems, also termed 'nature-based solutions' have been proven to effectively reduce the severity of storm and flood damage. By reducing the impact of natural catastrophes, natural systems can act as buffers and reduce damage to property, including renewable energy infrastructure (Anthropocene, 2022).

Another area of importance in the global low-carbon transition is carbon sequestration, which many are hopeful that new innovations in carbon capture and storage will be able to achieve. However, an additional benefit of many natural systems is that they also sequester carbon from the atmosphere, thereby slowing the climate crisis and creating a positive reinforcing cycle of favourable impacts for the global financial sector (WEF, 2021).

Don't forget emerging markets

Growth in renewables remains impressive across developed markets, and recent policy announcements are only helping to further this growth trajectory. However, this does not reflect the fact that future energy demand will be centred on emerging markets, in particular Asia, parts of Africa, and Latin America. Unfortunately, these areas are the least supported by conditions conducive to scaling up of the renewables sector. Furthermore, as they are perceived as high-risk projects, both investors and insurers have been extremely wary of gaining exposure. Efforts must be made to help de-risk renewable energy projects in these regions and ensure that effective, affordable, and reliable risk transfer mechanisms are available. One possible point of contact is the Insurance Development Forum that has a working group exploring how insurance working with development banks can support sustainable infrastructure in emerging markets. Another group of interest is the Coalition for Climate Resilient Investment, a private sector-led initiative that works across vulnerable and advanced economies to support investors and policymakers to understand and manage physical climate risks.

References

Allianz. (2019). *Green energy: Insuring a renewables future*. Retrieved from https://www.agcs.allianz.com/news-and-insights/expert-risk-articles/green-energy-Insuring-a-renewables-future.html

Allianz. (2022). *Allianz risk barometer*. Retrieved from https://www.agcs.allianz.com/news-and-insights/reports/allianz-risk-barometer.html

Americas Quarterly. (2022). Retrieved from https://www.americasquarterly.org/article/mexicos-energy-reform-3-risks-to-investors/

Americas Quarterly. (2022). *Mexico's energy reform: 3 risks to investors* . Retrieved from https://www.americasquarterly.org/article/mexicos-energy-reform-3-risks-to-investors/

Anthropocene. (2022). *How much is a mangrove forest worth? In some places, $850,000 per hectare*. Retrieved from https://www.anthropocenemagazine.org/2022/07/how-much-is-a-mangrove-forest-worth-in-some-places-850000-per-hectare/

BASE. (2020). *Lesson 3: Underwriting Guidelines*. Retrieved from https://energy-base.org/app/uploads/2020/07/Lesson3-UnderwritingGuidelines.pdf

Brookings. (2021). *Accelerating Africa's green economy transition*. Retrieved from https://www.brookings.edu/blog/africa-in-focus/2021/11/04/accelerating-africas-green-economy-transition/

Capital Monitor. (2021). *Gap is narrowing between insurers coal underwriting and investment policies*. Retrieved from https://capitalmonitor.ai/asset-class/alternative-assets/gap-is-narrowing-between-insurers-coal-underwriting-and-investment-policies/

CEA. (2020). *Can your solar project weather a hailstorm*. Retrieved from https://www.cea3.com/cea-blog/can-your-solar-project-weather-a-hailstorm

CMA. (2014). *Quick guide to complying with competition law*. Retrieved from https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/306899/CMA19.pdf

EEA. (2018). *Electric vehicles: a smart choice for the environment*. Retrieved from https://www.eea.europa.eu/articles/electric-vehicles-a-smart

Emerald. (2019). *Development finance, blended finance and insurance*. Retrieved from https://www.emerald.com/insight/content/doi/10.1108/ITPD-12-2019-0011/full/html#sec004

Engineering News. (2022). *Net-zero road transport by 2050 still possible as EVs set to quintuple by 2025*. Retrieved from https://www.engineeringnews.co.za/article/net-zero-road-transport-by-2050-still-possible-as-evs-set-to-quintuple-by-2025-bloombergnef-2022-06-01

EPR. (2021). *The research-based industry response to COVID-19; collaboration and innovation*. Retrieved from https://www.europeanpharmaceuticalreview.com/article/161133/the-research-based-industry-response-to-covid-19-collaboration-and-innovation/

EU Reporter. (2022). *Spain's refusal to settle arbitration in renewables threatens to undermine the EU's Green deal.* Retrieved from https://www.eureporter.co/world/spain/2022/06/09/spains-refusal-to-settle-arbitration-in-renewables-threatens-to-undermine-the-eus-green-deal/

First Coast News. (2022). *Some insurance companies dropping Florida customers if they put solar panels on their homes*. Retrieved from https://www.firstcoastnews.com/article/money/some-insurance-companies-dropping-florida-customers-solar-panels-on-their-homes/77-20929c68-bb37-4ae8-b39c-cdf37bb1e2a5

Forbes. (2022). *Energy provisions in the Inflation Reduction Act*. Retrieved from https://www.forbes.com/sites/rrapier/2022/08/14/energy-provisions-in-the-inflation-reduction-act/?sh=6decd8493422

Gallagher. (2022). *Global energy insurance market update: June 2022*. Retrieved from https://www.ajg.com/us/-/media/files/gallagher/us/news-and-insights/global-energy-insurance-market-update-june-2022.pdf

GCube. (2021). *Unmodelled extreme wather driving rising severity and frequency of renewable insurance claims*. Retrieved from https://www.gcube-insurance.com/news/unmodelled-extreme-weather-driving-rising-severity-and-frequency-of-renewables-insurance-claims/

GreenBiz. (2018). *US Superfund sites offer lessons for the future*. Retrieved from https://www.greenbiz.com/article/us-superfund-sites-offer-lessons-future

Grid. (2022). *China is beating the US in clean energy. Can America catch up? The race in five charts*. Retrieved from https://www.grid.news/story/global/2022/08/17/china-is-beating-the-us-in-clean-energy-can-america-catch-up-the-race-in-five-charts/

HBR. (2021). *How the insurance industry could bring down fossil fuels*. Retrieved from https://hbr.org/2021/05/how-the-insurance-industry-could-bring-down-fossil-fuels

IEA. (2021). Retrieved from https://iea.blob.core.windows.net/assets/4719e321-6d3d-41a2-bd6b-461ad2f850a8/NetZeroby2050-ARoadmapfortheGlobalEnergySector.pdf

Insurance Day. (2022). *Sompo criticised for coal policy 'loophole'*. Retrieved from https://insuranceday.maritimeintelligence.informa.com/ID1140820/Sompo-criticised-for-coal-policy-loophole

Insurance Journal. (2021). Retrieved from https://www.insurancejournal.com/news/southeast/2021/11/01/639969.htm

Intelligent Insurer. (2022). *Marsh, AIG & Liberty bring innovative green hydrogen insurance to market*. Retrieved from https://www.intelligentinsurer.com/news/marsh-aig-liberty-bring-innovative-green-hydrogen-insurance-to-market-30141

Interviewee 1. (2022). Director of global insurer that specialises in parametric insurance.

Interviewee 10. (2022). Head of Energy Property at a global insurance firm with 13 years of experience as an underwriter.

Interviewee 11. (2022). Head of global insurance alliance that aims to create greater collaboration between insurers and a global intergovernmental organisation.

Interviewee 12. (2022). Insurance and risk management expert currently working at disaster protection agency.

Interviewee 13. (2022). Commercial expert in large-scale solar projects in Spain.

Interviewee 2. (2022). Partner at global specialist investment firm that primarily invests in environmental infrastructure markets.

Interviewee 3. (2022). Head of a specialist energy and climate-risk finance company offering risk and insurance services.

Interviewee 4. (2022). Head of an international wind-energy association.

Interviewee 5. (2022). Senior underwriter of an international insurer specialising in renewable energy.

Interviewee 6. (2022). Infrastructure specialist at an African development bank.

Interviewee 7. (2022). Head of an organisation that supports clean energy entrepreneurs with more than 30 years of experience in clean energy.

Interviewee 8. (2022). Commercial professional at African renewable energy developer.

Interviewee 9. (2022). Partner at a firm that provides financial and technical services to developers and investors in energy projects with 17 years of experience working for a renewable energy developer (interview by email correspondence).

IRENA. (2018). *Scaling up renewable energy investments in emerging markets: Challenges, risks and solutions*. Retrieved from https://coalition.irena.org/-/media/Files/IRENA/Coalition-for-Action/Publication/Coalition-for-Action_Scaling-up-RE-Investment_2018.pdf

IRENA. (2021). *IRENA world energy transitions outlook 2021*. Retrieved from https://irena.org/-/media/Files/IRENA/Agency/Publication/2021/Jun/IRENA_World_Energy_Transitions_Outlook_2021.pdf

Marsh Mclennan. (2021). *Risk transfer solutions*. Retrieved from https://www.marshmclennan.com/insights/publications/2021/september/risk-transfer-solutions.html

Marsh. (n.d.). *Renewable energy products risk insurance issues*. Retrieved from https://www.marsh.com/pr/en/industries/energy-and-power/insights/renewable-energy-projects-risk-insurance-issues.html

McKinsey. (2020). Retrieved from https://www.mckinsey.com/business-functions/sustainability/our-insights/climate-math-what-a-1-point-5-degree-pathway-would-take

MunichRe. (2018). *First long-tenor political risk insurance to unlock US$ 1.4bn in clean-energy investment in Africa*. Retrieved from https://www.munichre.com/en/company/media-relations/media-information-and-corporate-news/corporate-news/2018/2018-03-21-first-long-tenor-political-risk-insurance-to-unlock-usd-1-4-bn-in-clean-energy-investment-in-africa.html

Nature. (2022). *How the biggest US energy bill ever could revive Biden's climate agenda*. Retrieved from https://www.nature.com/articles/d41586-022-02119-7

NREL. (2018). *STAT FAQs Part 2: Lifetime of PV Panels*. Retrieved from https://www.nrel.gov/state-local-tribal/blog/posts/stat-faqs-part2-lifetime-of-pv-panels.html

NYT. (2020). *Trump environment rollbacks list*. Retrieved from https://www.nytimes.com/interactive/2020/climate/trump-environment-rollbacks-list.html

NYT. (2022). Retrieved from https://www.nytimes.com/2022/08/17/world/americas/mexico-president-renewable-energy.html

NYT. (2022). *Mexico sees its energy future in fossil fuels, not renewables*. Retrieved from https://www.nytimes.com/2022/08/17/world/americas/mexico-president-renewable-energy.html

Our World in Data. (2021). *Renewable Energy*. Retrieved from https://ourworldindata.org/renewable-energy#citation

PBS. (2022). *Sweeping climate bill will push American energy to go green*. Retrieved from https://www.pbs.org/newshour/politics/sweeping-climate-bill-will-push-american-energy-to-go-green

Positive News. (2022). *What would happen if the insurance industry stopped underwriting fossil fuel projects?* Retrieved from https://www.positive.news/environment/what-would-happen-if-the-insurance-industry-stopped-underwriting-fossil-fuel-projects/

Renewable Energy World. (2019). *New report shows useful life of wind projects has increased to 30 years in most cases*. Retrieved from https://www.renewableenergyworld.com/wind-power/new-report-shows-useful-life-of-wind-projects-has-increased-to-30-years-in-most-cases/#gref

Reuters. (2022). *China says a third of electricity will come from renewables by 2025*. Retrieved from https://www.reuters.com/business/sustainable-business/china-says-third-electricity-will-come-renewables-by-2025-2022-06-01/

Risk & Insurance. (2020). *Three risks holding back renewable energy growth and how one insurer approaches the challenge*. Retrieved from https://riskandinsurance.com/sponsored-3-risks-holding-back-renewable-energy-growth-and-how-one-insurer-approaches-the-challenge/

Risk & Insurance. (2021). *A hardening renewable energy market renews Interest in basic risk management*. Retrieved from https://riskandinsurance.com/a-hardening-renewable-energy-market-renews-interest-in-basic-risk-management/

SwissRe. (2019). Retrieved from https://www.swissre.com/risk-knowledge/mitigating-climate-risk/natcat-2019/secondary-perils-not-so-secondary.html

SwissRe. (2021). *Parametric insurance: Certainty in uncertain times*. Retrieved from https://corporatesolutions.swissre.com/insights/knowledge/parametric-insurance-certainty-in-uncertain-times.html

UN. (2021). *New commitments at UN energy summit a major stride towards affordable and clean energy, but much work ahead to halve energy access gap by 2025*. Retrieved from https://www.un.org/en/hlde-2021/page/new-commitments-un-energy-summit

Vox. (2022). *This is what we need to invent to fight climate change*. Retrieved from https://www.vox.com/23042818/climate-change-ipcc-wind-solar-battery-technology-breakthrough

WB. (2022). *Renewable energy consumption*. Retrieved from https://data.worldbank.org/indicator/EG.FEC.RNEW.ZS?end=2019&most_recent_value_desc=true&start=2019&view=map

WEF. (2020). *Explained: why renewables became so cheap so fast*. Retrieved from https://www.weforum.org/agenda/2020/12/renewables-energy-price-cost-cheap-climate-change-sustainability

WEF. (2021). *Consultation: Nature and net zero*. Retrieved from https://www.mckinsey.com/~/media/mckinsey/business%20functions/sustainability/our%20insights/why%20investing%20in%20nature%20is%20key%20to%20climate%20mitigation/nature-and-net-zero-vf.pdf

WEF. (2022). *This is the state of renewable energy in Africa right now*. Retrieved from https://www.weforum.org/agenda/2022/04/renewable-energy-africa-capabilities

Wood Mackenzie. (2019). *Unplanned wind turbine repairs to cost industry $8 billion in 2019*. Retrieved from https://www.woodmac.com/press-releases/unplanned-wind-turbine-repairs-to-cost-industry-$8-billion-in-2019/

WTW. (2020). *Ageing Infrastructure – More than a bump in the road*. Retrieved from https://www.willistowerswatson.com/-/media/WTW/Insights/2020/02/Ageing-Infrastructure-Jan-2020.pdf

WTW. (2022). *Energy market review 2022*. Retrieved from https://www.wtwco.com/en-US/Insights/2022/04/energy-market-review-2022

Note: the interviewees have been anonymised as most participants, though happy to share, preferred not to have their name or organisation associated with their remarks.