Profiling the risks in solar and wind

A case for new risk management approaches in the renewable energy sector
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As the renewable energy sector continues to grow, so will its demand for risk management services. By the end of this decade, a 50% increase in renewable energy investment is likely to produce more than a doubling of insurance spending in six of the world’s leading renewable energy markets alone. Depending on the scenario, annual expenditure on risk management services could reach between USD 1.5 billion to 2.8 billion by 2020.
Traditional fossil fuels – oil, coal and gas – have powered the world economy over the past century, but this has come at a price and is not without risk. Ensuring a sufficient supply of fossil fuels from energy-rich but often politically unstable regions is a challenge that requires significant efforts, and greenhouse gases accelerate and intensify the risks of climate change.

Improving energy efficiency and deploying renewable technologies are critical to reduce the emission intensity of power production while at the same time securing future power supplies for a growing and developing world. But the share of renewable energy in the global energy mix will expand slowly. Enormous investment is required for new infrastructure, and new investors and sources of financing are needed to deploy these relative immature technologies on a larger scale.

Sound risk management is vital to attract the necessary capital, and well developed financial risk transfer solutions will play an important role in complementing other risk management measures. Insurance has the capability to mitigate some of the risks specific to renewable energy assets, such as production risk linked to the impact of unfavourable weather conditions. Fostering risk management expertise and making new, cost-effective insurance products available will facilitate the investment decisions essential to growth and innovation in the renewable energy sector.

Swiss Re and Bloomberg New Energy Finance have undertaken this study to better understand the risks and opportunities inherent in renewable energy markets. We share the view that a sustainable energy mix can be achieved in a more cost-effective and intelligent way when a more informed approach to risk management is employed. The six markets selected for this study – Australia, China, France, Germany, the UK and the US – are not only leading markets for new energy investment but will also have the largest operational fleets of wind turbines and solar panels installed over the next decade.

As a provider of risk solutions for the energy industry, Swiss Re Corporate Solutions can present a risk management framework for renewable energy projects that allows investors to become comfortable with investing in such projects.

As the world’s leading research firm on renewable energy and low carbon technologies, Bloomberg New Energy Finance understands the risks taken by investors, policy makers, and energy companies every day in the world’s rapidly transforming energy industry. By bringing information and clarity to strategic decisions, we can help mitigate these risks.

Guy Turner  Juerg Trueb  
Chief Economist  Managing Director  
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Introduction

As the renewable energy sector continues to grow, so will its demand for insurance and risk transfer solutions. By 2020, an anticipated 50% increase in investment in renewables is likely to produce more than a doubling of spending on risk management services in the sector. Depending on the scenario, expenditure on third party risk management services – including conventional insurance, derivatives and structured products – could reach anywhere between USD 1.5 billion and USD 2.8 billion by 2020 in six of the world’s leading renewable energy markets.

There are three key reasons for this trend. First, the sheer growth in investment needs for renewable energy projects will require new sources of capital, including institutional investors such as pension funds and insurers. These investors require long-term, stable yields, and their risk appetite differs from utilities and private equity investors. Institutional investors commonly allocate only 5% of their assets for so-called alternative investments, a class encompassing renewable energy projects, while typically reserving about 40% for bonds. To attract capital from institutional investors on a greater scale, it therefore becomes important to bring the risk/return profile of renewable energy investments closer to bond-type investments. This can be achieved by de-risking the cash flow volatility of renewable energy assets.

Second, the rising market share of offshore wind, particularly in Europe, will increase construction risk. Delays and downtimes in offshore wind projects – for example resulting from high waves interrupting offshore construction – are not uncommon and can materially reduce the expected returns on investment. Currently, these risks are mostly taken into account as part of negotiated contracts amongst investors, developers, construction companies and manufacturers. Yet they are often neither explicitly assessed nor are their financial costs sufficiently managed. Better evaluation and insurance against these risks would improve project returns.

The third driver of demand for risk transfer solutions comes from everyone who has been impacted by the increasing presence of renewable power generation in the energy market. Renewables will increasingly have a disruptive effect on power markets, as they bring a variability risk which calls for new means of mitigation. Traders and grid operators face low and sometimes even negative power prices, as well as high production volatility and grid balancing issues. In markets with fixed feed-in tariffs, the burden of low power prices and the need to provide back-up capacity fall on incumbent power generators, which negatively affects their profitability. Here too, more sophisticated approaches to managing these risks can reduce the costs of dealing with intermittent output in areas of high renewable energy deployment.

The purpose of this report is to assess the underlying trends in the renewable energy sector and consider how new risk management and insurance products can contribute to the sector’s growth and long-term sustainability.
Drivers of investment in renewable energy

According to projections by Bloomberg New Energy Finance (BNEF), some 70% of the new power capacity built between 2013 and 2030 worldwide will be in the renewable sectors (including large hydro), which equates to more than USD 2 trillion in investment over this period. Of this renewable capacity, 75% (900GW) will be in the solar and wind sectors, both onshore and offshore.

This report focuses on six countries: Australia, China, France, Germany, the United Kingdom and the United States. Together, these six markets account for over half of the projected capacity additions and investment in solar, onshore and offshore wind to 2020.

Figure 1 and Figure 2 show the growth forecast for installed capacity in wind and solar power for each country between 2012 and 2020. In 2012, the US and China have broadly similar wind capacities. But on the basis of current projections, China will have roughly double the US’ capacity by 2020. Across all six countries, the total installed base of wind and solar assets will triple between 2012 and 2020, increasing from 220GW in 2012 to about 660GW in 2020.

Figure 3 and Figure 4 show the annual investment and capacity additions in the six countries. The pronounced spike in solar investment in 2011 was attributable to the solar boom in Germany – and to a lesser extent in the UK – as a result of generous subsidies. These subsidies were then adjusted, causing headline investment to drop in the next year. The overall growth trend continues despite less government support, partly because the boom itself contributed to reductions in equipment and installation costs.

Data on pipeline investment and future economic trends indicate that there will be steady year-on-year growth in capacity additions of solar and offshore wind from 2013 onwards, with annual build of onshore wind remaining roughly stable. From 2018 we project that offshore wind will see the biggest annual investment, resulting from the planned capacity installations and high unit costs for this technology.

1 Global Renewable Energy Market Outlook, Bloomberg New Energy Finance (http://about.bnef.com/gremo/)
A cross-comparison with the projected capacity installations shows a healthy level of growth in the sector with about 60GW year-on-year additions from 2016 onwards. Capacity additions of solar photovoltaic (PV) even rose in 2012 despite far lower investment than 2011, due to a rapid drop in the price of solar modules. In Germany, feed-in tariffs have fallen below retail electricity prices in some areas, but the costs of both modules and installations have fallen to levels that still allow solar to be built. Capital costs for wind are decreasing more slowly than for solar due to fewer opportunities for manufacturing efficiencies and technology improvements. Nevertheless, in the long run, the cost of renewable energy technologies should continue to decrease more rapidly than conventional energy technologies as the renewable sector matures. Economics, rather than policy, will therefore become the main driver of growth in renewable capacity, particularly after 2020.

Policy

From today’s standpoint, policy incentives have been the key driver for investment in renewable technologies around the world. Governments have supported the sector through a range of measures including capital subsidies, feed-in tariffs, tax credits, feed-in premiums, and tradable green electricity certificates.

Policies, such as the EU’s target to provide 20% of its own final energy consumption from renewable sources by 2020, currently look on track. In spite of an investment slowdown in countries such as Spain and Germany, many member states are likely to exceed their projected renewable capacity additions. The German policy decision to decommission all nuclear power plants by 2022 will provide a further boost to renewables, as a large chunk of lost capacity will be replaced with capacity from renewable technologies. France, with a smaller installed capacity of both wind and solar generation than Germany, has put in place ambitious targets supported by feed-in tariffs and reverse auctions. The UK also looks on track to achieve its 2020 target through the use of a market-based scheme involving tradable certificates for renewable power generation, although this is expected to evolve towards a fixed-price mechanism involving “contracts for difference.”

Outside Europe there are substantial policy incentives that have driven renewable growth, such as ambitious government targets and cheap credit provision in China, the Production Tax Credit (PTC) in the US and feed-in tariffs in Australia. These and similar policies have successfully attracted investments into the sector. But as the economics of renewable energy become more favourable, the role of policy will become more nuanced, and generators will likely be exposed to greater market risk in the future.

Technology

The final global trend driving greater adoption and investment in renewable energies is the improvement in efficiency and reliability of the technology. As a result, onshore wind farms can now be built in less windy locations. Towards the end of the decade, existing wind installations will begin to be retrofitted with new turbines, and this ‘repowering’ market will then grow more rapidly after 2020. The cost of solar panels continues to fall and will remain low in the long run, regardless of threatened import tariffs. Solar generation, though currently more expensive than wind on the utility scale, tends to come with less risk, having fewer moving parts. Its more modular nature means that defective parts tend to have less impact on overall revenues and can be replaced cheaply. Solar PV, when mounted on roofs, can be used immediately within the building and therefore competes directly with retail electricity prices, which are about twice those at the wholesale level.

Offshore wind is a different story, as the technology is newer and more capital-intensive. Costs, however, will not decline significantly until later this decade. This is due to bottlenecks in the supply of key pieces of service equipment, notably construction vessels, and also due to installations being pushed further offshore. By 2020, we expect these costs to start coming down, as turbines increase in size and efficiency, foundation designs improve, and the bottlenecks in vessel availability are overcome.

Policy incentives have largely driven investment in renewable energy. But as the cost of renewable technologies continues to fall, economics will replace policy as the main driver of growth in the sector.
Four main trends affecting risk

In addition to the drivers of growth outlined in the previous section, electricity markets themselves are undergoing significant change. We have identified four key trends that will change the risk profile of power generation assets, as the electricity systems evolve and renewable sources take a greater share of the energy mix.

**Increasing market exposure**

Feed-in tariffs are ‘low-exposure’ mechanisms from the point of view of renewable projects, as they provide a fixed price for each unit of power generated, irrespective of the market power price. In the absence of grid-scale energy storage, this shifts the cost of output variability onto the grid operator and fossil fuel generators.

In order to control costs and spread risk more fairly, some governments are moving towards other schemes. In contrast to feed-in tariffs, they provide support to renewables while exposing them to greater market risk. For example, the US Production Tax Credit (PTC) subsidises electricity output but leaves projects open to market competition. Most US projects mitigate their revenue risk by signing power purchase agreements (PPAs). In other countries, projects sell power to a free market but have a supplemental revenue stream. Examples include certificate-based schemes in the UK and parts of the US, where support levels are driven by market demand for certificates. Another is the new feed-in premium in the Netherlands, in which projects receive the wholesale power price plus a small premium.

Auctions have been an important mechanism for meeting capacity targets in China, France, and Australia, as they allow the government to control the pace of renewable build-out and also to provide transparent market rules. In such a process, developers bid into a ‘reverse auction’ in which the lowest bid wins the contract. If successful, the developer receives the price of electricity they bid. This means that the developer needs to have a very good understanding of their expected construction and operating costs, and mistakes can prove very costly.

Market-based mechanisms try to blend the benefits of competitive markets with regulatory certainty. They also help renewable generators learn how to operate in open markets, in anticipation of the eventual removal of subsidies. For these reasons, we believe that regulators will eventually incorporate more market-based aspects to their policies. However, this will take time, and some countries may favour fixed-price regimes in the short term. For example, the UK is due to retire its renewable certificate scheme in 2017 in favour of the “contract for difference” that will offer protection from power price volatility to renewable generators.

The gradual trend towards greater use of market-based principles and the eventual removal of subsidies altogether will expose renewable generators to market risks that had up to now been borne by the subsidy system.

**New sources of capital**

The proportion of debt used for projects in mature markets has been holding fairly steady at 70-80% since 2008 (with the remainder being equity). While the availability of debt has not changed much in that time, European banks have increasingly given way to US and Japanese investors. Companies rarely disclose project gearing ratios, so it is difficult to make definitive statements about trends in the volume of debt financing. In addition, financing trends differ greatly by region.

Despite this lack of transparency for new projects, the rising trend for refinancing of existing projects is clear: Figure 5 shows the combined mergers & acquisitions (M&A) and refinancing volumes worldwide for solar and wind projects. These volumes are typically generated by project owners and developers selling debt and equity stakes in renewable projects in order to free up cash for other purposes. This may include building new renewable projects.

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2 The Renewable Energy Certificates (RECs) support scheme exists in participating US States, and is similar to the Renewable Obligation Certificate (ROC) scheme in the UK. Generators receive RECs for each MWh of renewable energy supplied to the grid in addition to the wholesale price for the power. A regulator requires utilities to ‘retire’ a certain number of RECs each year, which they can do by becoming renewable generators themselves or buying the certificates on a secondary market.
With the expected growth in renewable capacity, new investors and sources of financing will be needed to meet future demand.

Most institutional investors will likely try to limit their total risk exposure and will therefore limit the amount that they are willing to invest in this way. To attract the volume of investment projected in the latter part of this decade, it will be necessary to de-risk individual assets. A range of insurance products that bring the risk/return profile of projects closer to a bond-type level may then open the door to institutional investment in renewable power projects.

The impact of renewables on power prices
All of the focus regions in this report except China set power prices using a market mechanism in which generators bid power volumes into the market in advance. The grid operator forecasts the demand for time intervals throughout each day, and holds rolling auctions some time in advance to decide which generators should provide power when and at what price.

A greater capacity of renewables on the grid reduces the certainty with which demand can be matched with supply in advance. As a result, the intraday price volatility will almost certainly increase. Wholesale power prices can become very high during periods of high demand and low renewable supply, with little wind and overcast skies or fog. At other times, for example on a windy night, low demand and high supply mean that negative prices are possible.

The difference between on-peak and off-peak power prices may therefore increase or decrease, depending on the short-run cost of power plants on the grid and how they affect the shape of the supply curve. In situations where the price spread increases, all forms of power generation that dispatch into the wholesale market will need to find ways to manage the increased uncertainty.

Despite this likely increase in hourly volatility of the power price, it is not immediately clear what effect renewables will have on long-term volatility, week-to-week or month-to-month. Long-term fluctuations may in fact decrease in amplitude, depending on the output of the renewables over time and the rest of the power system’s exposure to commodity prices. For example, during winter in Europe, high demand for electricity and for fuel tends to raise the cost of fossil fuel generation, causing average prices for colder months to be higher, all else being equal. Adding wind farms to the grid is likely to flatten the monthly average power prices over the year, as wind farms tend to supply more power during winter months.

In addition to evaluating the effect of renewables on the underlying power price, some governments are also looking more closely at the cost of managing intermittent sources of generation and who bears this cost. In many countries, these costs are currently borne by the rate payers who fund additional investment in grid networks, back-up capacity, and local distribution systems. However, countries such as Germany, Australia, and China are considering a number of market reforms that would involve renewable projects bearing more of the cost of their own variability. Again, renewable energy operators would be exposed to a greater level of market risk.

Grid investment
In some countries, renewable energy projects are subject to “curtailment risks” where they are unable to sell their power because of congestion in the transmission system. This is a well-known problem in countries such as Germany, where much of the wind power is produced in the northern part of the country and much of the demand is in the south.

New investment in power grids will reduce these curtailment risks for renewable projects by increasing the bandwidth of the grid. However, grid improvements typically have a far longer lead time than the renewable generation projects. Wind farms, for example, can be constructed and operational within three years, whereas it can take decades to approve large transmission projects.

Grid constraint will become an increasing challenge for both onshore and offshore wind projects in the future, as more onshore development occurs in emerging markets and as new offshore projects are built further out at sea. In certain locations, this will increase the market-related risks associated with operating renewable assets, particularly wind farms.
Managing risk in the renewable energy sector

The key trends identified above together with conventional risks in building and operating renewable energy assets create an evolving and complex set of risks that need to be managed. These are summarised in Table 1. The rest of this section describes each of these risks in more detail and lays out options for managing them.

Construction risks
As renewable projects are capital-intensive, damage to assets can have a significant impact on overall costs. The construction phase is the most risky period of a project from this point of view: accidents are more likely to occur as wind turbines are hoisted into position; solar panels may be cracked when being fixed into place.

While risks here can be mitigated by effective project management, due diligence, and careful contracting, project developers generally seek insurance to cover further risks. Cover can also be bought for delay in start-up or advanced loss of profit, which allows developers to claim back lost revenues from construction delays.

In the case of the London Array, a 1GW offshore wind installation in the Thames estuary, cover for accidental damage was critical in keeping the project on time and on budget. A year before the completion of Phase 1, a power cable on the sea bed was damaged by the weight of an installation rig. The repair of the cable took four months, and costs were covered by insurance. As a result the losses due to the accidental damage will not impact the project’s bottom line, and thanks to effective contingency planning the project was completed on time. Without adequate contingency planning, the actual financial loss to the project owner resulting from late completion of the project could have been insured with a delay in start-up cover.

The total value of annual construction insurance is likely to stay in line with the annual capacity new-build. Across the six focus regions in this report, we expect new-build rates to be roughly constant except for offshore wind, which will grow driven by ambitious policy targets.

Table 1: Risks facing renewable energy projects

<table>
<thead>
<tr>
<th>Category</th>
<th>Risk type</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Construction</td>
<td>Loss or damage</td>
<td>Breakage/theft in transit or during installation</td>
</tr>
<tr>
<td>Start-up delays</td>
<td></td>
<td>Revenue losses arising from delays in project construction</td>
</tr>
<tr>
<td>Operation</td>
<td>Loss, damage &amp; failure</td>
<td>Accident, theft, fire, natural catastrophe; equipment performs worse than anticipated; manufacturer unable to honour O&amp;M agreements</td>
</tr>
<tr>
<td>Business interruption</td>
<td>Revenue loss arising from failure, damage or extreme weather</td>
<td></td>
</tr>
<tr>
<td>Market</td>
<td>Weather</td>
<td>Variability in revenue due to variability in output, sometimes incurring additional balancing charges</td>
</tr>
<tr>
<td>Curtailment</td>
<td></td>
<td>Regional grid oversupply where power output cannot be sold</td>
</tr>
<tr>
<td>Power price</td>
<td></td>
<td>Variation in revenue due to wholesale price volatility</td>
</tr>
<tr>
<td>Policy</td>
<td>Retroactive support cuts</td>
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</tr>
</tbody>
</table>

Operational risks

Loss, damage and failure
Following construction and commissioning, there remains a material risk of damage to physical assets as a result of accident, negligence, wear and tear, design flaws, or natural catastrophe during operation. It is fairly common for project owners or developers to buy insurance cover for these risks, so that their project’s internal rate of return (IRR) is not adversely affected by having to replace components that have failed or been damaged. Such insurance products would usually cover replacement parts and may cover labour for installation. To protect against losses from large natural catastrophe events, broad and substantial risk transfer capacity offered by globally diversified insurers is generally required.

Alternatively, project owners may rely on manufacturer warranties (see box on next page), or they may sign operation and maintenance (O&M) contracts that guarantee a certain up-time or ‘availability’. In most cases, however, asset owners will use a combination of the above to transfer the operational risks of renewable energy projects. It is becoming more popular for banks to require project owners to sign long-term O&M contracts. Where the O&M supplier is financially unstable, project owners may have to sign a reserve contract with another supplier.

More efficient wind turbine technology enables projects to be profitable in less windy onshore sites, where components are under less stress. In addition, more diagnostic data on technology performance and damage is available. Because of these and other factors, the cost per megawatt due to component failure is likely to fall in the six focus regions considered here. However, as development expands into areas with consistently high wind speeds and more turbulence, such as Brazil and Namibia, developers may see higher failure rates and therefore higher costs there.

For offshore wind, the cost of replacement equipment is often covered by insurance, but this accounts for less of the overall cost of component failure compared to onshore projects. This is because it is more expensive to access the project and to effect repairs, and because the larger turbines lead to bigger revenue losses. In this sector, therefore, operators are interested in covering the cost of installing replacement parts, as well as for interruption and revenue loss. For solar projects, risk levels are lower overall, as there is less likelihood of component failure compared to wind projects.

The growth in operational insurance of this kind will scale with the installed capacity and the unit cost of components in service. As capacity expands, demand for this type of insurance is likely to grow substantially over the coming decades.
Managing risk in the renewable energy sector

Business interruption
Downtime from equipment failure or natural catastrophe also causes lost revenue. It is, however, possible to insure against these losses when this is not already covered by the terms of O&M contracts. This business interruption cover may be a precondition for project finance, but is less common than cover for physical loss or damage. It does not typically cover lost revenue from other causes, such as the bankruptcy or default of a PPA off-taker or retroactive policy cuts.

For offshore wind, this issue is particularly attractive for owners and investors, as interruptions are costly. The loss of revenue due to component damage or failure can be significantly greater than the cost of replacement parts. Faults in offshore substation transformers can effectively shut down the whole wind farm by preventing it from feeding to the grid. One such case in the North Sea resulted in a four-week outage. For a 100MW wind farm this would translate into about 33GWh-worth of lost revenue (USD 6–7 million). Delays can be mitigated through design, preventive maintenance and by having replacement parts on standby, but the risk will always be present.

These risks are typically covered by manufacturer warranties, and sometimes the manufacturers themselves can insure their warranties with a third party. This would allow the eventual owner of a component to claim for replacement parts even in the eventuality that the manufacturer no longer exists. With the ongoing industry consolidation in the solar sector, this kind of risk transfer is popular, but opinions are divided as to the long-term usefulness of these products. In reality, these warranties do not cover the cost of installing the replacement parts, which has become the major cost as module prices have continued to fall. In the medium term, third party warranties are a helpful marketing tool for developers worried about the financial health of their suppliers.

While the solar sector has seen the most insurance activity, we expect wind developers to take more interest after the cautionary tale of Clipper Windpower, now defunct, and other wind manufacturers experiencing financial difficulties. Earlier this year, BP announced its intention to sell its 1.5GW wind portfolio in the US, but 530MW of these projects use Clipper turbines. As a result, they are likely to be sold for a lower value than they otherwise would, as the turbines’ availability cannot be guaranteed to the same extent without a manufacturer of replacement parts.

Interruptions and lost revenue can also be caused by severe weather, as in the case of a storm at sea preventing access to offshore wind turbines for scheduled maintenance or repair. For offshore wind projects, the large turbines and high capacity factors mean that a failure of an individual turbine or transformer can have a big impact on the project’s top line. Other situations include onshore wind farms in locations subject to high wind speeds, where the turbines may be forced to shut down for safety.

In such cases, project owners and O&M companies can purchase cover to minimise the financial impact of unscheduled down-time. These products are triggered by one or more parameters such as wind speed or wave height, hence their name. Despite improvements in technology, we expect the demand for this kind of product to increase as project owners and investors becomes less tolerant of risk. The majority of this growth will be driven by the offshore wind sector, for which weather-induced delays in accessing equipment can result in substantial losses.

Standard warranties for solar and wind equipment

<table>
<thead>
<tr>
<th>Solar</th>
<th>Wind</th>
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<tbody>
<tr>
<td>Module: up to 20 years, guarantee 80% starting efficiency in final year of warranty.</td>
<td>Turbine, onshore: warranty for 2–5 years, extendable by 5 years or more. Warranties may include availability guarantees; O&amp;M contracts include service, maintenance and replacement of faulty parts.</td>
</tr>
<tr>
<td>Third party module warranties can be bought by manufacturer at point of production.</td>
<td>Turbine, offshore: limited warranties available, but these will not cover costs of replacement. O&amp;M companies are subject to marine delays during periods of extreme weather.</td>
</tr>
<tr>
<td>Inverter: 5–10 years. Components differ according to regional grid requirements. O&amp;M contracts offer uptime guarantees with remote monitoring and replacement. Few insurance providers.</td>
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Source: Expert interviews, Bloomberg New Energy Finance
**Market-related risks**

**Weather**

Wind and solar projects depend on favourable weather conditions for their power outputs and therefore their revenues. The variability of the weather means that the volume of power is subject to variation over short and long timescales. The effect of long-term variability means that revenues of projects can vary year to year by around 15-20% for wind and about 5% for solar projects, depending on the region. An example of this kind of variability is shown in Figure 6, in which one wind farm’s output in 2004 was 18% below its 10-year mean level.

In order to achieve financing under a normal loan, projects need to maintain revenues within a certain multiple of the annual debt payments (minimum debt service coverage ratio). Infringement of this minimum or other debt covenants could mean that the investor calls in the loan.

Many debt-financed projects circumvent this problem through debt sculpting, a mezzanine debt arrangement whereby debt payments are allowed to fluctuate in line with outputs. Such arrangements are good for some project owners as they reduce the risk of defaulting on loans. However, as a mezzanine loan, sculpted debt is more expensive than mortgage-style, fixed-tenor loans. It also places the risk of variability onto the debt finance provider.

Insurance companies have begun to offer products that guarantee minimum revenues from power sales in cases where output drops below a stated threshold. In this way, the project may be relieved of a large part of its volumetric risk while still taking out a large debt safely. Volumetric risk management products effectively translate into cheaper debt or a higher debt-to-equity ratio.

While these risk transfer products face indirect competition from debt sculpting, investors would generally prefer to offer fixed-tenor mortgage loans as these have more predictable tenors and incomes. This is particularly the case for institutional investors that may not have deep technical knowledge of the renewable energy sector.

An income threshold equivalent to two standard deviations below mean power outputs can improve IRR for a wind project by one or two percentage points before premiums. Even after factoring in the cost of an annual premium, the benefit to IRR compared to a mortgage debt scheme with a high debt service coverage ratio may be enough to raise a planned project over a financing hurdle, allowing it to be built where it otherwise would not. As a result we expect this kind of product to gain in popularity over the coming years and decades. Uptake of products to cover this risk will be greatest in onshore wind, due to the larger size of the sector, the higher M&A volumes and the greater inter-year variability of the technology compared to solar and offshore wind.

Variable renewable output can also create imbalances on the grid that require short term balancing by dispatching additional power and transmission services. Different markets apportion the costs of the services differently. For example, solar and wind projects in Germany receive a feed-in tariff, so the costs of balancing are channelled through to fossil fuel generators. In China all generators receive a power price set by a central grid operator. In the UK and the US, most renewable projects are insulated from balancing risk by PPAs and support mechanisms such as feed-in tariffs. These guarantee a certain price for power produced by renewable projects, although the costs of balancing are typically reflected in the lower price offered for the PPA.

Insurance and other market-related risk management services can protect wind and solar projects against income losses when the wind doesn’t blow or the sun doesn’t shine.
Managing risk in the renewable energy sector

It is often the off-takers of renewable power therefore that directly bear the balancing costs. These costs can be mitigated by improving forecasting techniques, by diversifying generation portfolios, by selling reserve capacity on the spot market at other times, or by bidding less power to begin with.

The risk could also be mitigated by having the wind farms spread over a wider region, so that undersupply from one wind farm might coincide with oversupply from another. In such a case, a project would both buy and sell on the balancing market, reducing net balancing costs. As falling capital costs and advances in wind turbine technology allow wind farms to be built in less windy sites, this situation will be more common but the risk of net imbalance will not disappear, as weather systems are often as large as a typical European country.

Risk transfer products could also be used to restrict an individual project’s exposure to balancing charges. Such products would require insurers to have a detailed knowledge of the power markets and would depend on each market’s dynamic behaviour and regulations, but they would decrease the uncertainty in costs and revenue for renewable projects.

Curtailment
When regional demand for power is less than the supply, the output of one or more generating projects may be restricted or curtailed. This is commonly due to grid bottlenecks and results in lost revenue to generators. The occurrence of curtailment rises where grid investment does not keep pace with the increase in local renewable energy capacity.

In Germany, France and Australia, projects operating under feed-in tariffs receive payment for power generated, whether or not that power feeds into the grid. Any additional costs caused are passed to the consumer. In China, by contrast, project owners currently bear the cost of curtailment even though they cannot control when it occurs. This is a serious problem in Northeastern China, where frequent curtailment of the many wind farms in the region results in an average capacity factor of only 21.6%, one of the lowest for onshore wind in the world.

In the UK and US, regional grid operators will compensate the revenues of any curtailed generators. However, if a project is not feeding power to the grid it may not receive renewable energy certificates (RECs/ROCs) for that power. As certificates account for up to 45% of project revenues in some regions, curtailment can have a significant impact on IRR.

As the risks affect different parties depending on the region, so risk transfer products would need to be targeted differently. In the US and UK, for example, insurance companies might substitute some certificate revenue in the event of curtailment. In Germany, the grid operator could be compensated, freeing up funds to invest in grid capacity improvements.

In the longer term, as and when grid infrastructure improves, the need for this kind of insurance would decrease. In the foreseeable future however, wind capacity is likely to continue to expand more rapidly than the grid network; wind farms can be constructed and operational within three years of initial planning, whereas large transmission projects can take decades to plan and build. Grid-related curtailment risks are therefore likely to increase until these network issues are resolved.

As the renewable energy sector evolves, all issues that pose risks to project returns will matter more. A key emerging question is how to best manage the variability of output and variations in cash flow linked to market-related risk. This particularly applies to the wind sector because wind resources can vary significantly year on year.

4 Source: Chinese National Energy Administration. For more information on curtailment in China see Bloomberg New Energy Finance Insight Note https://www.bnef.com/Insight/6784 (subscription article)
Power price
Variable renewables are at a disadvantage in the electricity markets as they cannot control when they generate power, unlike fossil fuel driven plants. An increase in the capacity of renewables on the grid will increase the day-ahead uncertainty of supply. Depending on the existing generators and grid infrastructure, and the timescales being considered, the power price may become more or less volatile as a result of adding renewables to the grid. Note that the resultant revenue uncertainty is different from the risk of incurring high balancing costs described above.

Production-contingent, and therefore weather-contingent, power price hedging can be used to ameliorate volatility risks, but price behaviour will become more complex as the proportion of renewables on the grid increases.

Counterparty
Many projects receive financing on the basis of a long-term PPA with a counterparty who agrees to buy the power at an agreed rate for a certain time – typically 10–20 years. A counterparty is usually subject to thorough due diligence, but should it be unable to fulfil its PPA commitments in the long-term, the renewable project will, at worst, have to sell its power to the grid at the wholesale price. In the best case, the project would sign another PPA with a new counterparty. Either way, its revenues will be less certain and likely lower than previously anticipated.

At present there is little demand for products to cover counterparty default, as developers and owners do not believe it to be likely. Given the popularity of PPAs and the growth of the sector, however, it would seem unwise to discount the risk totally. Products to manage counterparty default risk would be similar to credit risk cover, allowing the project to seek some measure of compensation should the original off-taker be unable or unwilling to keep to the terms of the PPA contract. This issue may become more relevant as renewable markets evolve in developing countries with less transparent and credit-worthy counter-parties for PPAs.

Policy risks
All energy projects are prone to policy risk, for example through losses incurred as a result of changes to energy markets. However, renewable project revenues currently depend on explicit policy support more than fossil fuel projects. Any unscheduled reductions in the level of financial support may impact financing arrangements and jeopardise investor confidence in the sector. For example, in 2013 the Spanish, Greek, Czech and Bulgarian governments imposed retroactive subsidy cuts on solar power, reducing the future income of projects that had been financed and built assuming higher revenue levels. This is equivalent to PPA counterparty default risk above, with a government as off-taker.

Products offering all-inclusive cover typically include cover for policy changes; however, such eventualities are difficult to predict and therefore expensive to insure. In addition, the impact of retroactive cuts is declining as technology costs decline. However, insuring against retroactive or unscheduled policy changes remains a topic of interest to investors seeking highly predictable returns.
Conclusions

As the renewable energy sector evolves, managing risk will become increasingly important to developers, investors and electricity suppliers. At a time when projects are slowly being exposed to more market risks, financing conditions are tightening as subsidies are falling and renewable projects seek loans from more cautious investors. As a result, all issues that pose risks to project returns matter more.

A key emerging area is how to best manage the variability of output. This particularly applies to the wind sector, as wind resources can vary significantly year on year causing variations in cash flow, and large wind farms can create material net-work imbalances resulting in additional charges. Solar projects suffer less from these risks as solar resources are more predictable and the scale of projects smaller.

More traditional areas of risk, such as those in the construction and operational phases of the project, will also grow with greater industry scale. As the renewable sector matures and competition in the sector increases, more attention is likely to be paid to revenue losses incurred as a result of business interruption, either because of component failure or weather conditions, and ways of insuring against such losses.

Reducing all forms of project risk is a prerequisite for attracting investment from new sources of private capital such as pension funds – provided that these funds recognise and trust the guarantees that the projects are given. Reducing risk to developers will allow more project development for a given amount of capital, by unlocking cheaper debt and higher leverage ratios. Reductions in project risk will also help operators by making their costs and revenues more visible.

Insurance market projections

The net effect of the trends described in previous chapters will be to increase the need to manage risk in the renewable energy sector. Figure 7 and Figure 8 below show projections of expenditure on risk management services for renewable energy projects. The projections only cover the six regions profiled in this study – Australia, China, France, Germany, the UK and the US – and the two technologies of wind and solar, but including onshore and offshore wind and utility-scale and residential PV.

The definition of risk management services here includes the suite of third-party services that could be offered to address construction, operational, market and policy risks. This includes conventional insurance products for construction and operational risks as well as derivatives and structured products that can be used to address the more market-based risks. Because of the uncertainty of such projections, two scenarios are shown.

In the Low scenario, total expenditure on these services grows from an estimated USD 850 million today to around USD 1.5 billion in 2020. In this scenario, demand for cover of construction related risks is stable over the period in line with relatively constant construction activity and the assumption that around half of construction activity makes use of this sort of cover. In contrast, the demand for operational risk cover rises as a result of an ever increasing installed base of onshore and offshore wind and solar capacity and a need to maximise the return on investment for new financial owners. This scenario assumes that just under a quarter of solar PV equipment providers take out some form of product warranty cover, but only 10% of turbine suppliers do so. It also assumes that between a quarter and a half of wind and solar project developers insure themselves against losses due to technical failure or natural catastrophe events.

Market-related services include cover for weather, curtailment, power price, counterparty and policy risks (chapter “Managing risk in the renewable energy sector”). Today these services are in their

Figure 7: Expenditure on risk management services in renewable energy (Low scenario)

Figure 8: Expenditure on risk management services in renewable energy (High scenario)

Source: Bloomberg New Energy Finance
Note: Covers wind (onshore and offshore) and solar PV (utility scale and residential) and includes UK, Germany, France, USA, China, Australia.
infancy and account for only around USD 5 million of expenditure. They could, however, become more important over time due to the underlying factors affecting the electricity markets in these six countries. The low scenario assumes demand for these services grows to around USD 300 million of expenditure in 2020. Weather-related services would account for two thirds of this USD 300 million market, on the basis of a 16% penetration in the offshore sector and 23% in the onshore sector. The solar PV sector would have comparatively little need for these services due to the more predictable nature of cash flows.

The High scenario assumes greater use of these services across all categories, creating a market potentially worth USD 2.8 billion by 2020. In this scenario, construction-related cover is assumed to be taken up by 80-85% of new build projects requiring USD 400 million of insurance expenditure by 2020. Demand for operational risks is projected to increase more rapidly to reach USD 1.5 billion in 2020. This assumes a third of solar PV suppliers make use of warranty cover, and 80-85% of solar and wind asset owners take out insurance against technical and natural catastrophe risks during operations.

In the High scenario, the demand for market-related risk cover increases to USD 850 million by 2020. This assumes greater involvement from risk-averse financial institutions in the ownership of both wind and solar assets. This is coupled with a more rapid shift to market-based policies in some countries, creating a new exposure to balancing charges as well as a more volatile underlying wholesale power price. In this scenario, it is assumed that 35% of wind and solar assets engage in some form of hedging or derivative activities with third parties to minimise these risks. This scenario also assumes that grid development continues to lag behind wind and solar build out, worsening grid congestion and curtailment problems for both wind and solar assets. As a result, this scenario assumes that 20% of assets take out some form of curtailment cover.

The extent to which equipment suppliers, asset owners, and market participants make use of third party services to manage risk will depend on the circumstances relevant to each project. But as the renewable sector matures to become part of the mainstream energy industry, it will need to evolve from an innovative sector where risks are taken on the chin, to one where returns are more predictable and there are fewer surprises. This in turn will encourage the development of new financial services to meet this need.

As the renewable sector matures, it will need to evolve from a sector that takes risks on the chin to one where returns become more predictable. This may increase its expenditure on risk management services up to USD 2.8 billion per year by the end of this decade.