Co-location, Co-location, Co-location.

Underwriting the future of flexible clean power

June 2026 Report

TOKIO MARINE GX

Foreword

Fraser McLachlan, Chairman, Tokio Marine GX

In the early days of renewable energy development, it really was just like 'Selling Sunset' - all about Location, Location, Location. Pick the windiest or sunniest spot you could find, as close as possible to a grid connection and as far away as possible from somebody who might object to the sight of a wind turbine spinning in their backyard.

Of course, it was never quite that simple, but the concerns of those early pioneers still pale in comparison to the sheer complexity faced by the developers, utilities, investors and Independent Power Producers (IPPs) building and operating portfolios today.

This is because, in a highly volatile market landscape dominated by rapidly rising energy demand, geopolitical turbulence, and grid stability concerns, we are seeing a fundamental change in the product that the renewable energy market provides.

Clean energy generation in itself is no longer enough; increasingly critical are considerations of how renewable energy projects can improve grid stability, overcome the limitations of intermittent generation, and enhance operational flexibility to unlock new revenue opportunities.

At Tokio Marine GX (TMGX), we've been closely following how this new focus on 'firm power' and 'flexibility' is driving the evolution of our renewable energy clients' business models worldwide.

In the US, portfolio owners are racing to build multi-technology portfolios encompassing battery energy storage and hybrid assets, including on-site behind-the-meter systems that aim to fulfil 24/7 power demands from energy intensive data centres.

In Europe, faced with rising energy security concerns, price cannibalisation, and high-profile grid issues, we are seeing the rise of 'next-generation' IPPs and utilities retrofitting their portfolios with on-site BESS, while pioneering more innovative 'Power-to-X' schemes.

In the Middle East, developers are working on some of the most ambitious clean 'megaprojects' the world has ever seen, coupling gigawatt-scale 'round-the-clock' generation and storage with data centres and other infrastructure, and forming industrial clusters that create a new paradigm for the way energy demand is managed and fulfilled.

Today, it seems the words on everybody's lips are Co-location, Co-location, Co-location. The closer and more integrated our energy systems become, the greater the value that can be unlocked for portfolio owners, the grid, consumers, and the planet.

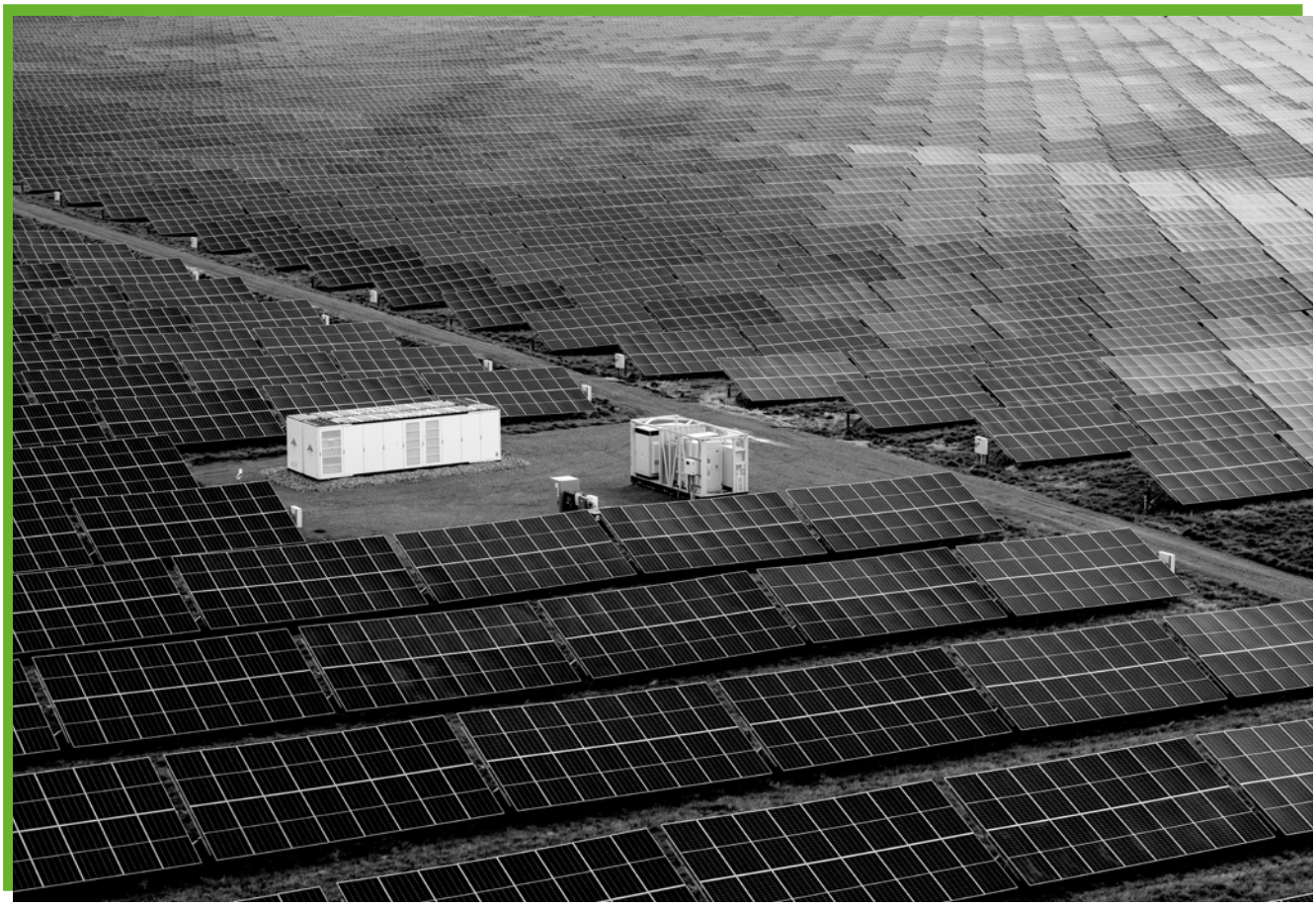
But what of your humble underwriters? How do they adapt to the rise in technological and commercial complexity that co-located, hybrid projects bring? And how can the insurance market and asset owners better collaborate to understand and manage risks for the next generation of renewables and clean infrastructure? These are the questions that I have posed to the market at numerous events I have spoken at over the last few months.

TMGX has been founded on a commitment to provide robust and stable insurance coverage across multiple green transition sectors. For our clean energy client base, this means stepping up to the plate to support their evolution as they pursue more ambitious and innovative projects.

In this report, we draw on perspectives from our underwriting and claims teams, alongside expert contributions from risk managers at pioneering hybrid projects, to provide our assessment on the unique risks and opportunities presented by co-location.

Enjoy the report and do get in touch if you would like to discuss any of the topics and issues covered.

Fraser



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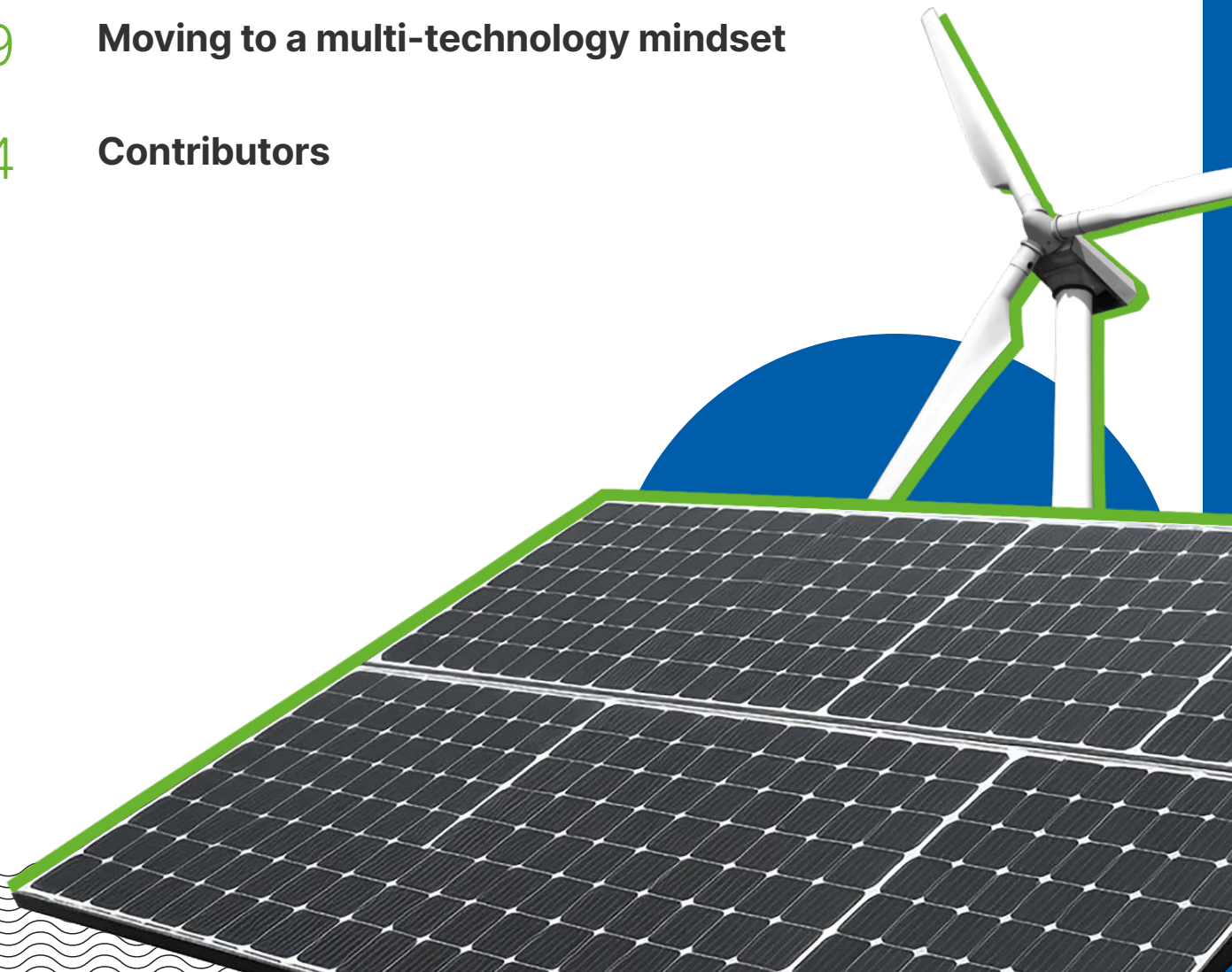
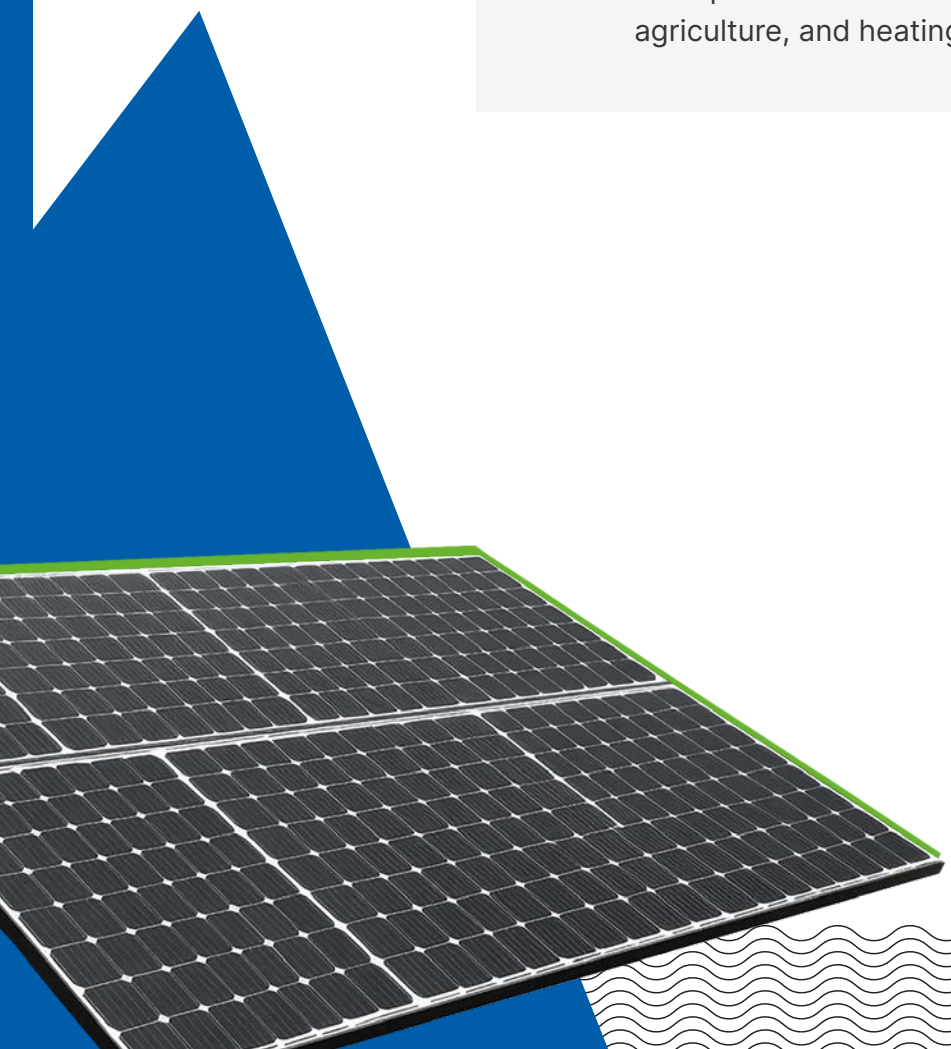


The Future of Co-Location – what is "Power-to-X"?

Today, adding BESS to renewable assets is by far the most popular co-location strategy, but we are also seeing the emergence of pioneering 'Power-to-X' projects. By 'Power-to-X' we mean:

- Projects that transform green electrons into usable outputs (such as e-fuels or chemicals) that can be stored, transported, or consumed to sustainably power hard-to-abate industrial processes
    - Examples of outputs: green hydrogen, green ammonia, and e-methanol
- Projects that create flexibility out of variable renewable electricity for end uses that require a stable supply of high-energy density molecules
    - Examples of sector end-uses: Industry, mobility, energy, agriculture, and heating



1. Underwriting the future of flexible clean power

The type and variety of services offered by green transition projects are changing. With the commercialisation of technologies that can store renewable energy, such as batteries, developers are gradually shifting away from building and operating standalone solar or wind farms towards creating 'flexibility' through hybrid generation and storage systems.

In the future, we anticipate further growth of 'Power-to-X' projects that combine technologies to convert renewable electricity into various energy carriers such as green molecules or fuels (see sidebar for a fuller definition).

Between 2024 and 2025, projects with co-located storage capacity grew at a much faster rate than standalone storage projects, according to Solar Power Portal reporting[1]. Developers who have invested the time and resources to secure a location with a grid connection want to optimise its use.

Along with the benefits of flexibility and grid stabilisation, the co-location model brings new operational complexity. For underwriters, this warrants attention and further understanding of emerging risks to make sure that these systems are appropriately designed, built, and operated.

1 Solar Power Portal, 'Creating a high-quality storage project in the mature UK market', October 2025

But why is the co-location model becoming a key part of the energy transition strategy? How do risk profiles change at co-located sites; and in what ways can the industry adapt to derisk these projects for long-term growth?

Co-location as a new growth model

Co-location has risen to become a preferred model for growth in the renewable energy market around the world and, increasingly, it is being recognised as a crucial part of the energy transition strategy. There are a number of reasons for this.

Demand for 24/7, reliable power is rapidly growing, driven largely by the expanding operations of data centres, which need a quick-to-install, continuous power supply. This, combined with increased energy security concerns amid a turbulent geopolitical landscape, is at the heart of the race amongst renewable energy operators to reinvent themselves.

Increasingly, energy companies, including utilities, IPPs and funds, are targeting a role as multi-faceted energy service providers who not only generate power but can manage exactly how it is delivered to their customers, and when. By balancing generation portfolios with storage and Power-to-X, **businesses that were previously single technology generators are becoming multi-technology operators offering 'firm' power and flexible delivery.**

The primary value of co-location is the solution it offers to the intermittent generation of renewable energy. In doing so, it supports grid resilience, tackles negative pricing and curtailment issues, and potentially enhances revenue streams. The co-location of renewables with battery storage has enabled operators to discharge clean energy during peak demand windows at more competitive prices.

At the same time, **returns on newly built generation projects are currently compressing**. Although 91% of new renewable energy projects commissioned between 2024 and 2025 were cheaper than fossil fuel alternatives, short-term challenges are contributing to higher costs[2]. These challenges are both economic, due to inflationary pressure and high interest rates, and structural, due to grid connection queues, permitting delays, and supply chain strain.

In an industry facing cost pressures, opportunities to maximise project efficiency and profitability by integrating multiple technologies are highly sought after. This, alongside rapidly falling BESS costs year-on-year, has increased the appetite for co-located sites[3].

2 International Renewable Energy Agency (IRENA), '91% of New Renewable Projects Now Cheaper Than Fossil Fuel Alternatives', July 2025

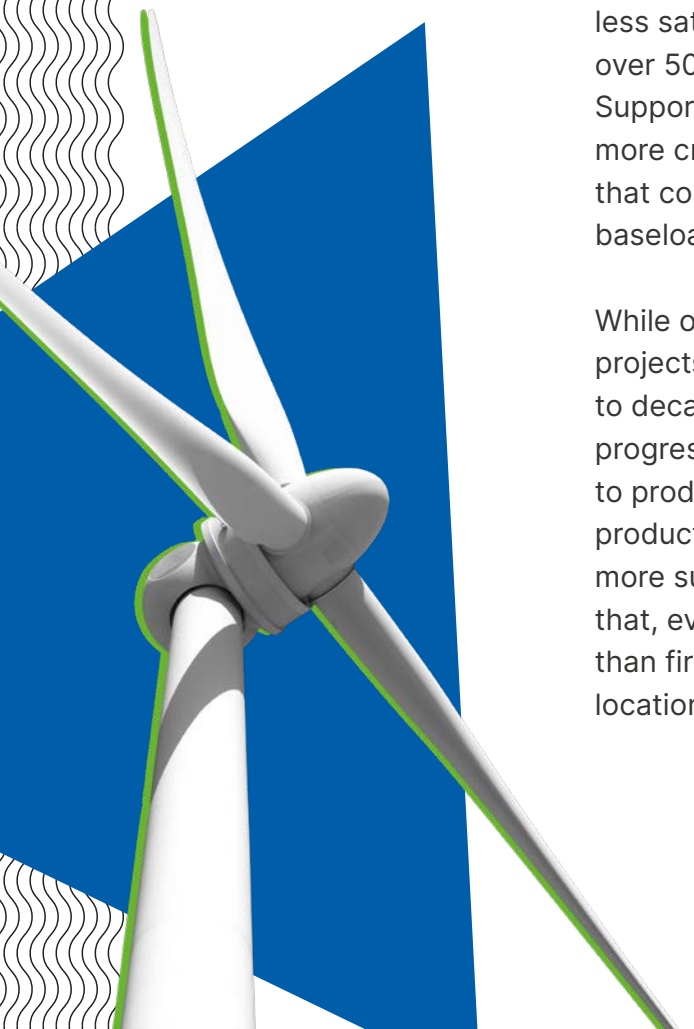
3 BloombergNEF, 'Battery Storage Costs Hit Record Lows as Cost of Other Clean Power Technologies Increased', February 2026

Regional factors play an important role in this new growth model too:

UK and EU: Where network capacity and available land for development are constrained and competition is fierce, developers who have succeeded in procuring land for renewables sites are incentivised to create new project configurations that maximise the revenue from the energy they deliver to the grid.

US: Daily 'price cliffs' have been a persistent challenge for a number of years in states such as Texas and California, where high renewables penetration has led to the Electric Reliability Council of Texas (ERCOT) and the California Independent System Operator (CAISO) forcing producers to stop generating. Co-location has naturally risen as a solution to fix variable prices and improve grid efficiency. Furthermore, the US data centre boom has seen 24/7 power demand grow.

Middle East: Land availability is less constrained, the grid is less saturated with renewable energy, and 'megaprojects' over 500MW are financially de-risked by government offtake. Support for and investment in renewables gives developers more creative space to design pioneering large-scale projects that combine multiple assets at great scale to supply clean baseload grid power 24 hours a day.



While other forms of co-location, such as Power-to-X projects or industrial clusters that use renewable energy to decarbonise hard-to-abate industrial processes, have progressed at a slower rate, there remains a firm appetite to produce green molecules. The imperative to consume products like aviation fuel, shipping fuel, fertiliser, and steel more sustainably (especially in the UK and Europe) means that, even if the timeline for this transition is taking longer than first anticipated, we will see new types of industrial co-location soon.

Risk profiles are changing

On the face of it, the risk profiles of co-located projects do not pose many fresh challenges to underwriters. Solar, wind, and, more recently, BESS assets are technologies with which the market is familiar and increasingly comfortable.

The grid connection and size of both standalone and renewables + BESS projects are currently similar. Likewise, the usual risks that standalone projects face, such as escalating extreme weather or strained supply chains, equally apply to co-located assets. Moreover, average loss and possible maximum loss scenarios at renewables projects do not differ greatly when adding BESS. This, in addition to our track record of successfully underwriting renewables + BESS projects, gives TMGX a strong grasp on the risks of today's co-located projects.

Even so, the integration of different technologies into systems with more varied business operations comes with unknowns and is gradually changing the risk landscape in the renewable energy sector. As insurers, we need to continually tap into our experience and dialogue with key industry stakeholders to ensure our knowledge grows in line with an evolving risk profile. Here are some key risk areas that require industry focus as more co-located projects come online.

1. Unplanned downtime and business interruption

Most renewables + BESS projects, by their nature, have inherent revenue contingency in the event of a breakdown affecting one (but not both) of the technologies on site. However, these projects are more seriously disrupted than standalone projects by events that cause a systemwide pause on operations.

One reason for this is that renewables + BESS projects are active and generating revenues throughout the day and night, meaning they are more adversely affected by extended periods of downtime.

However, the most significant reason is the diversity of revenue streams at risk for many co-located projects. Some projects use batteries simply to charge and discharge according to PPA requirements, following a revenue model that is production-based and very similar to standalone renewables projects. Other projects use batteries to enter ancillary markets such as arbitrage or spot market pricing, following a multi-layered revenue model that differs from standalone renewable projects.

For projects with multiple revenue structures, greater transparency is needed between insureds and insurers **to test and model the risk profile, prepare for business downtime events, and calculate more complicated business interruption (BI) losses**.

1.1 Fulfilling data centre requirements

Since most BESS systems currently have durations of around 4 hours, and longer-duration systems are still in development, we have not yet reached the point where co-located projects can provide baseload power for data centres. As such, most behind-the-meter projects supporting data centres use fossil fuels. Nonetheless, tech giants are signing renewable energy PPA deals in record-breaking volumes to help fulfil the 24/7 power requirements of data centres.

As the market intensifies, co-located projects with data centre offtakers or connected directly to data centres behind the meter are even more acutely impacted by operational downtime that prevents export. Any events that interrupt power supply make it difficult for projects to either meet the terms of their PPA agreement or, if co-located off grid, to secure the power needed for the data centre to generate revenue.

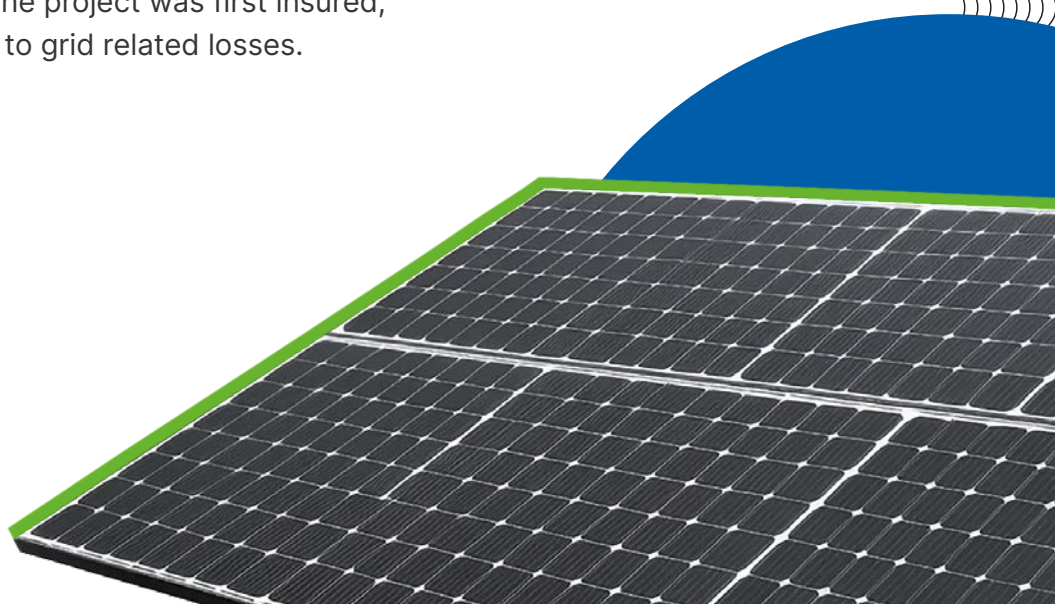
In the event of key equipment failing or breaking down during operation, existing market challenges around the shortage of experienced contractors and long lead times for replacement parts may exacerbate BI losses.

Separately, the urgency of building new capacity to serve the data centre boom in the US will put further strain on the supply chain and may make projects more vulnerable to construction risks and contractor error.

1.2 Single point of failure at the grid connection point

Integrating renewables and BESS increases the profitable use of a project's grid connection and widens available revenue streams but it also increases financial exposure to any issues affecting that grid connection point. This can become a critical bottleneck and a single point of failure that leads to unplanned business downtime. Establishing a shared understanding between insureds and insurers about how the grid connection point works is crucial for a project's insurability.

Across the UK and Europe, we have seen an uptick in contingent business interruption (CBI) claims, stemming from events outside of a project owner's control, such as grid-owned or third party-owned infrastructure faults. In the UK, hybridisation of existing renewable energy projects is increasingly common and may add £15M-£20M in extra revenue compared to when the project was first insured, creating additional exposure to grid related losses.



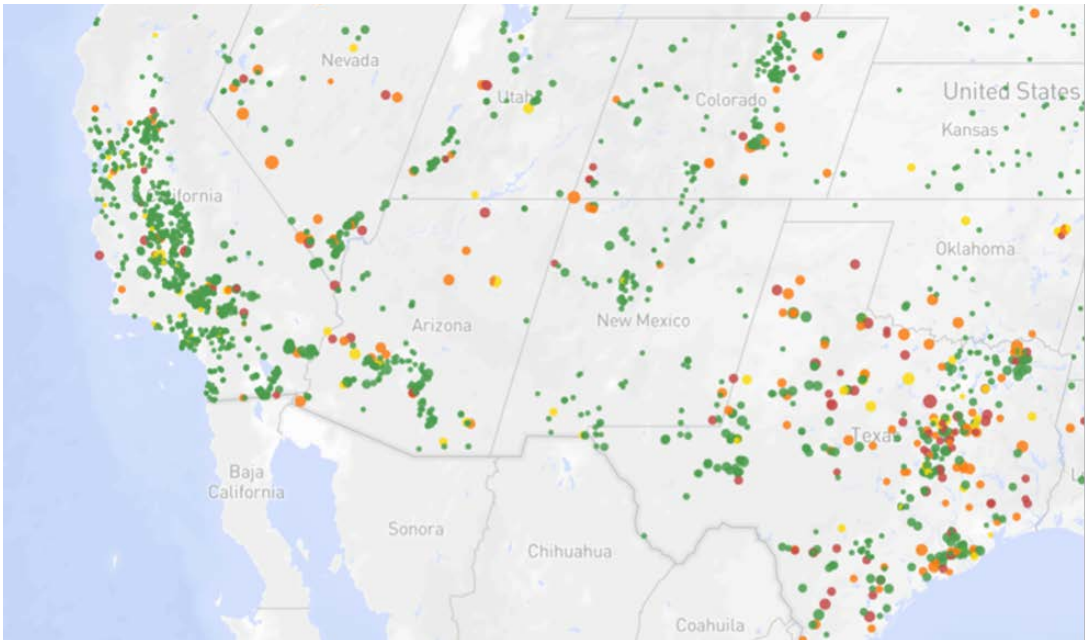


Figure 1: Solar projects in operation and construction.
Source: Global Energy Monitor - Global Solar Tracker

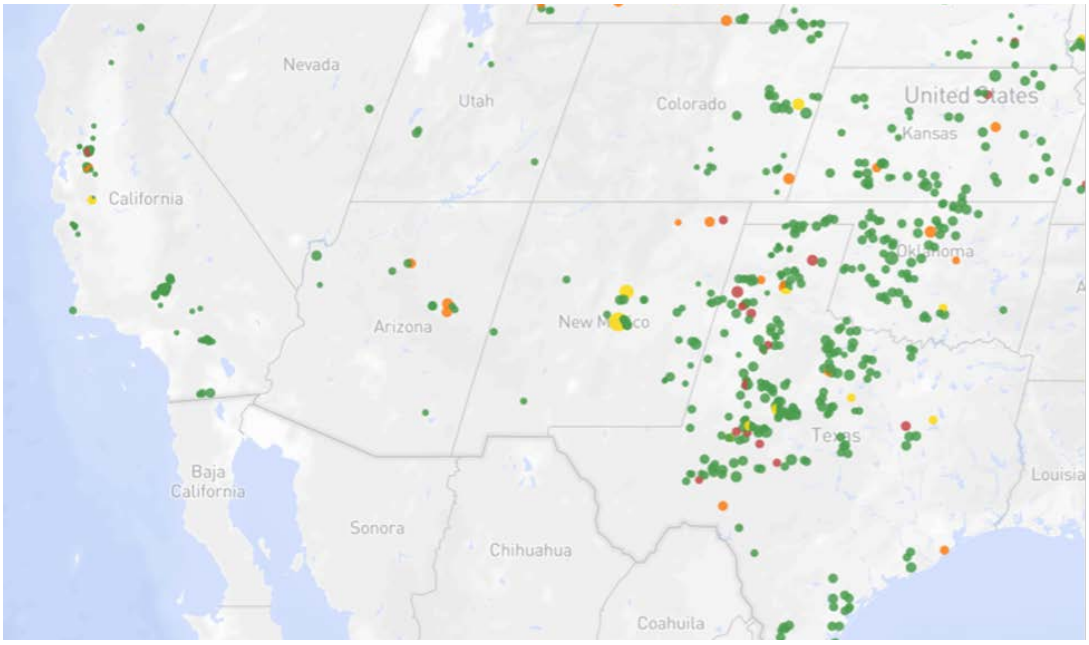


Figure 2: Wind projects in operation or construction.
Source: Global Energy Monitor - Global Wind Power Tracker

In the US, CBI risk and substation pressure are also mounting in key markets where renewables projects are clustered (Figures 1 and 2 show the high concentration of solar projects in California, southern Arizona, and Texas, and the high concentration of wind projects in Texas). Some of these key markets are also more frequently and severely prone to climate risks that can cause unplanned business downtime. Examples in the US include wildfires that spread across California, hailstorms in Texas, and high-frequency Tornadoes covering parts of Oklahoma, Kansas, and Nebraska – as well as parts of Indiana and Illinois at the start of 2026.

When there is damage to interconnection infrastructure in areas with high renewables penetration, multiple projects may become unable to export power.

2. Technology interdependence

Another feature of co-located projects that carries potential risk is the interdependence of technologies. The variety of emerging project types means that there is no clear controls standard for renewables + BESS projects to manage the interface of multiple technologies.

The way BESS assets are operated affects the performance and degradation of co-located generation assets, and vice versa, which in turn affects the whole project's output. Relatively few EPC contractors or OEMs are specialists across all technologies, so it requires a dedicated interface management strategy to unify different strands of specialist knowledge and ensure technologies operate harmoniously.

For projects relying on storage to discharge against the terms of their PPA, can they continue to meet obligations if there is a fault in the storage element of the project? Similarly, can the storage assets perform other services if there is a fault with the generation assets? Certainty on these questions from the outset of a project is important for mitigating the risks brought by interdependence.

In addition to these questions, developers, especially those retrofitting existing projects, must consider physical interdependence risks on site. For example, retrofitting batteries on sites that are 5 or even 10 years old, when batteries may not have been thought of in the original plans, requires creative, non-standard project designs to get the assets fitted. Safe spacing rules between containers are stringent and this is one of the key risk mitigation factors insurers ask for to reduce the risk of thermal runaway events, but this is a challenge when extra space on site is at a premium.

3. Larger-scale renewables + BESS projects

For purpose-built projects, and particularly megaprojects relying on massive deployments, one of the biggest risks is the supply chain. In the US, the sector is attempting to onshore the supply chain for solar and batteries, but this is not yet mature enough to provide for new projects. In the Middle East, where solar panels and battery components are largely imported from China, project construction and inventories of spare parts are often reliant on single sources of supply.

Where there is space and appetite to build co-located 'megaprojects', there is often increased exposure to external perils, particularly in the US and the Middle East. As our 'Known Unknowns' report in 2025 demonstrated, both markets have sustained heavy extreme weather-related losses in recent years.

4. Technological standardisation and degradation

The deployment of new, and relatively untested, technologies is a consistent area of focus for underwriters of co-located projects.

4.1 BESS

Since 2019, BESS enclosure specifications have constantly changed and, in the last three years, almost tripled in size. This has made them more profitable partners in co-located projects but, from an underwriter's perspective, the lack of operational track record for each new model is an evergreen concern.

Evolution of BESS Enclosures

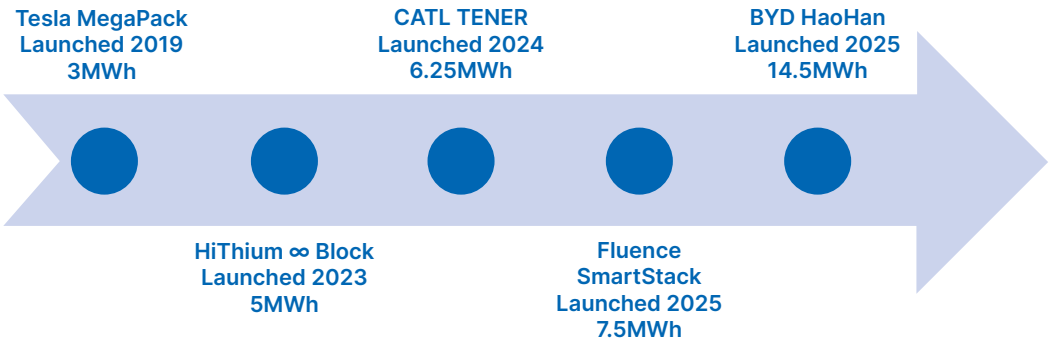


Figure 3: Evolution of BESS enclosures

One of the main unknowns about co-located projects is the degradation rate and lifecycle of BESS assets for which there is a lack of historical data. In our 2024 'Batteries Not Excluded' report, we found that 58% of BESS failures occurred within two years of operation. Since then, this figure has decreased to 49% (51 out of 105), but 35% of failures in the last two years (7 out of 20) have occurred between two and four years of operation compared to just 5% within the first two years (see Figure 4). Of these recent failures, only one occurred at a site with a sub-50MWh capacity.

This suggests that, while the sector is improving reliability in the initial phase of a project, larger projects are now most likely to encounter performance issues once they have reached two years of operation. This emerging trend requires attention to understand common possible causes and highlights the performance challenges that the nascent BESS market continues to encounter.

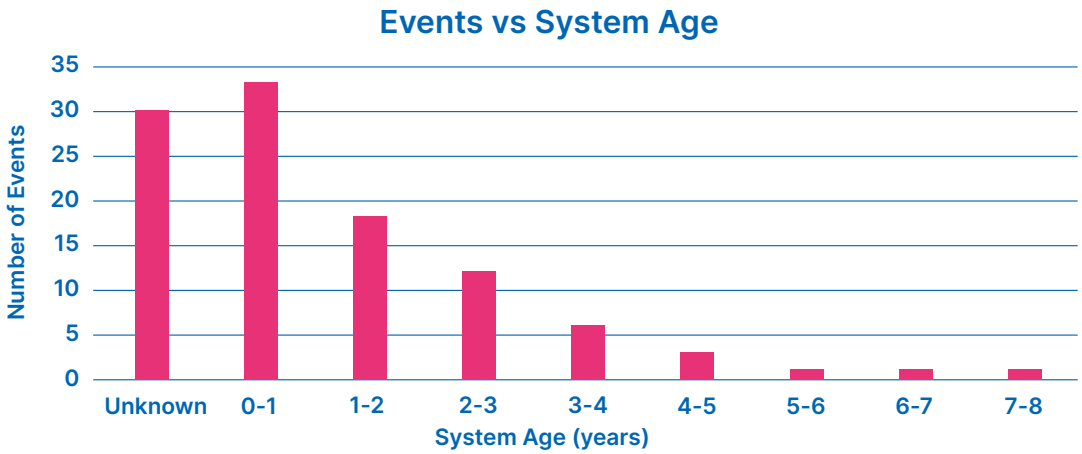


Figure 4: Number of failure events by system year, Source: **BESS Failure Incident Database**

As such, **it cannot be taken for granted that co-located technologies will be online at maximum performance for the entirety of a project's lifespan.** This also puts pressure on the interdependence of installed assets.

4.2 Power-to-X

For the most part, the insurance market is confident with the risk carried by renewables + BESS configurations, which make up the majority of co-located projects today. However, the future of co-location, with the construction of large-scale Power-to-X projects and industrial clusters, will bring less familiar and more complex technology risks.

Insurers have less data and fewer operational track records for electrolysers and other technologies that are core to Power-to-X projects, which means that underwriting decisions today are inherently less informed. With limited data in sectors like green hydrogen, some insurers mistakenly perceive the risk profile to be similar to grey hydrogen (just with a renewable input) and write it off on this basis.

Maximal loss scenarios for green hydrogen projects are not well known and the focus on low frequency, high severity risks has been a hindrance to understanding the smaller, more typical risks that these projects face. For instance, underwriter knowledge around what can go wrong with the water feedstock, technology faults, common mechanical issues, or the lead time on replacement parts is limited.

To move beyond the legacy of grey hydrogen risk profiles, which erroneously ramp up the perception of risk in green hydrogen and build a more accurate picture of green hydrogen project risk, insurers need greater transparency and detailed engineering and performance data.

While underwriters and claims teams are adapting effectively to the subtle, but consequential, evolution of risk that co-located projects now face, it is imperative that the industry continues to stay connected and maintain transparent lines of dialogue as the next generation of more complex green infrastructure emerges.

Clearing the path for co-location

Co-locating multiple technologies at renewable energy sites is already becoming the new standard as the energy transition accelerates. To support and prepare for the more widespread uptake and emerging configurations of this development model, the industry must collectively agree on strategies to manage complexity, address emerging risks, and equitably share exposure.

These are our key recommendations:

a) Improving operational transparency

Data-sharing between insureds and insurers is crucial for improving familiarity with the performance standards of new asset combinations and preparing for possible faults.

Despite their advancement and cost reduction, from an insurer's perspective, BESS assets are still relatively immature, and technology combinations incorporating BESS even more so. Insureds and insurers must be aligned on how the technologies are paired onsite and their dependence on one another to generate revenue.

For even newer technologies, like those used for Power-to-X projects, collecting and sharing operational data and risk engineer reports will play a significant role in raising the confidence and appetite of the insurance market. Early movers in the insurance market need other players to follow to ensure sustainable allocation of larger risks. Understanding the smaller losses that these projects typically encounter is an important first step insurers must take to create useful insurance products.

The market would also benefit from more dialogue between insureds and grid technology owners. Now that renewables projects are increasingly configured with flexibility to support grid load and stability, visibility over grid assets has risen in importance. Co-located projects interact with grid infrastructure in various ways beyond energy dispatch, so having more transparency on these interactions can support more informed concentration risk management.

b) Simplifying project profiles

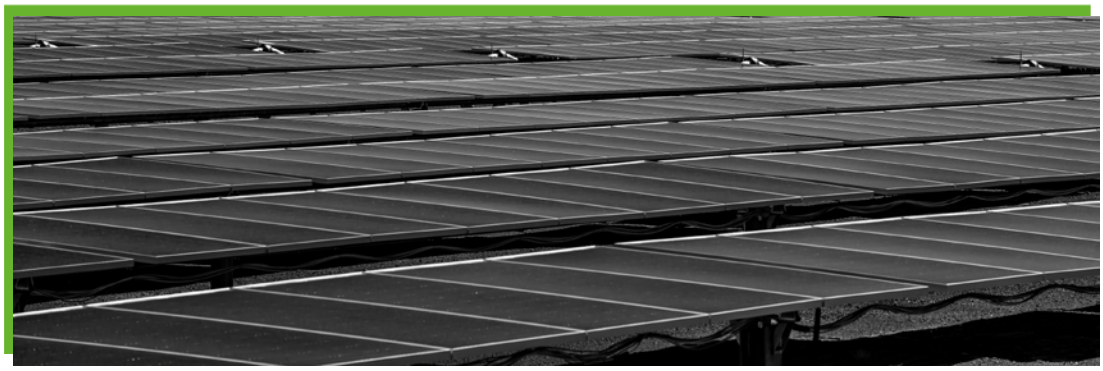
In the short-term, a practical step that developers can take to simplify project risk is to build more separation into different layers of their projects. Separation can be built into the operations, integration, and grid connection of the technologies to protect independent revenue streams from partial faults or losses onsite.

Separation can also be built into the construction process so that different EPC contractors and suppliers are responsible for different parts of the project. Although interdependence is a fundamental part of how co-located renewables projects operate commercially and the project interface needs dedicated management, separating out different strands of value wherever possible makes risk mitigation more manageable and increases overall resilience as insurers get comfortable with more complex projects.

c) Building familiarity with new complexity

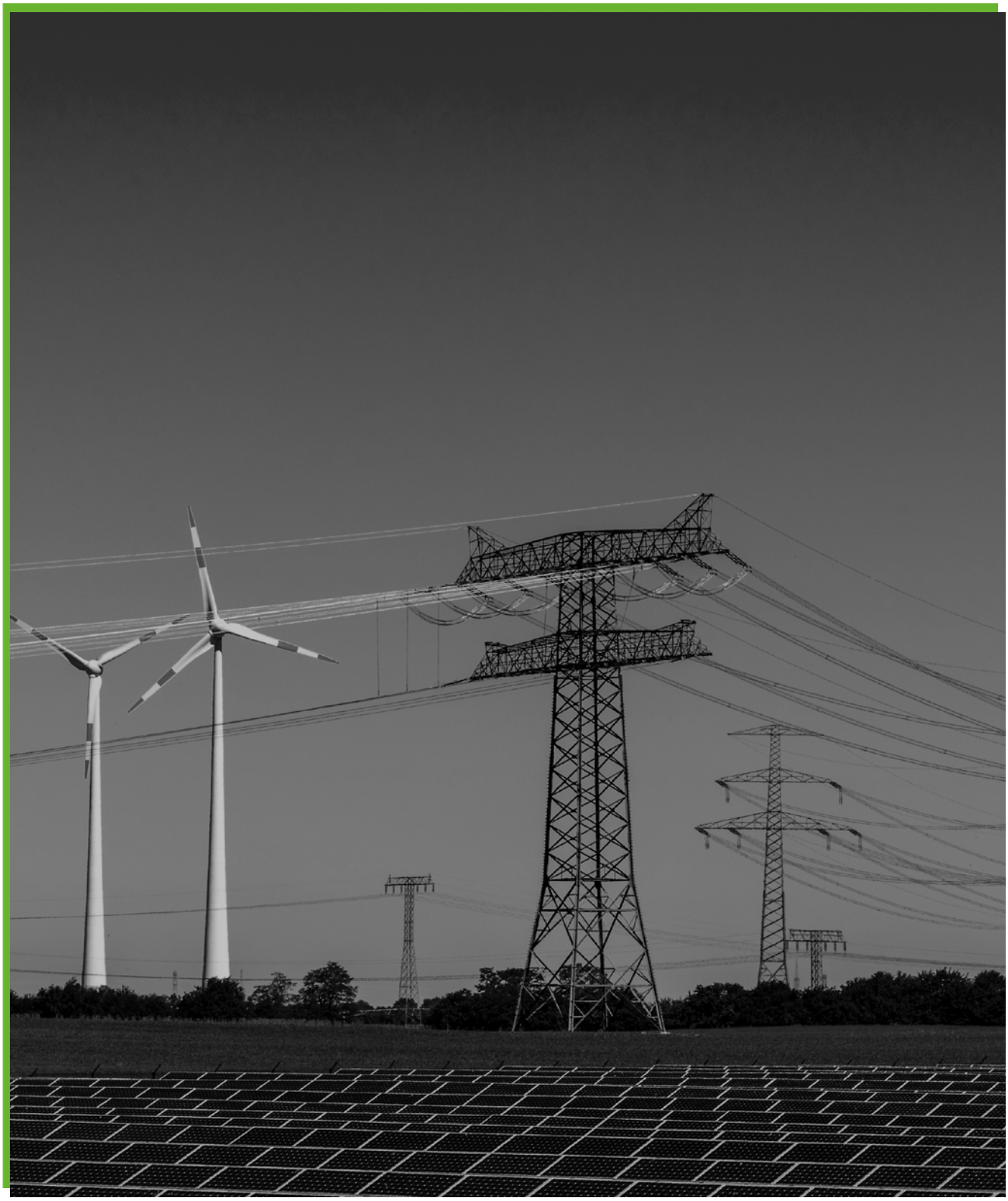
Traditional renewables coverage terms do an effective job in supporting many of today's co-location projects, but the insurance market will have to adapt its offering to support new, more intricate models in the future.

For underwriters, the rapid rollout of BESS assets has led to tailored policy wording that has attempted to more effectively cover instances of storage revenue losses. There now needs to be more innovation in policy wording to reflect the diverse revenue streams that renewables + BESS projects pursue and to properly address the flexibility between generation and storage that these projects possess.



Developers are moving beyond single-asset thinking with the encouragement of lenders. For now, most projects are straightforward configurations of established asset types that insurers understand well. However, these combinations are becoming more elaborate and untested in Power-to-X projects and green industrial clusters. The challenge for the insurance market is to adapt to more systemic development approaches so that co-located projects deliver against their clear potential.

While increasingly sophisticated insurance products are being developed to respond to more technologically complex renewables projects, underwriters ultimately favour simplicity and clear-cut allocation of risks. In the case studies that follow we look at how two pioneering large-scale co-located projects have approached risk management to 'keep it simple' for insurers.



2. ‘Round-the-clock’: Managing co-location risks at a MENA megaproject

Sreenivasulu Narayanakatta (Business Development – Bids to Financial Closure, Masdar) discusses the new standards of excellence that the 1GW ‘Round-the-clock’ UAE project, developed by Masdar and Emirates Water and Electricity Company, is driving both in delivering clean baseload power at scale and in managing the risks attached to co-located megaprojects.

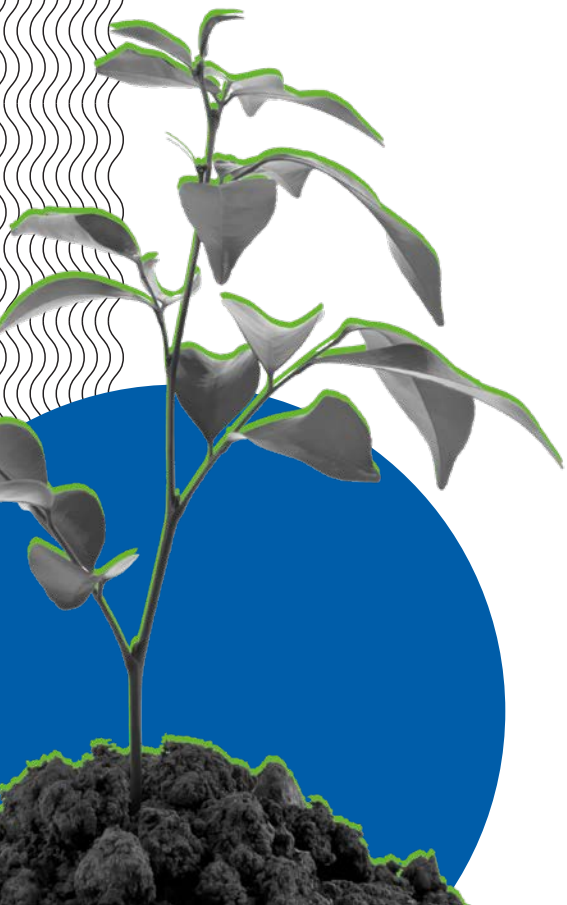
Project background

In recent years, the challenge set before Masdar by the leadership team has been to provide a clean energy solution that can meet growing power demand while overcoming the limitations of intermittent renewable energy generating assets to provide stable, grid-friendly baseload supply. The goal of making renewable energy firm and dispatchable to address intermittency and expand revenue streams is common amongst renewable energy companies around the world and this has given rise to development strategies that co-locate technologies to generate and store clean power. The ‘Round-the-clock’ project is an answer to this challenge and delivers the co-location model on a much larger scale.

Masdar and Emirates Water and Electricity Company's 'Round-the-clock' project will be the world's first gigascale 24/7 clean energy project when it becomes operational in 2027. Located across two closely positioned sites in Abu Dhabi, the world-first project integrates 5.2GW of solar PV with a 19GWh battery energy storage system, which will itself be the largest and most technologically advanced system of its kind in the world.

Beyond 24/7 power, the large project capacity also means that stakeholders can purchase the energy output exceeding 1GW at a different price, generating additional benefit and eliminating the potential cost of building another solar project in the region.

The next step for this project is for both sites to pass financial close in the first half of 2026. What is most exciting about the project, though, is that it lays the blueprint for future 'Round-the-clock' projects in other markets.



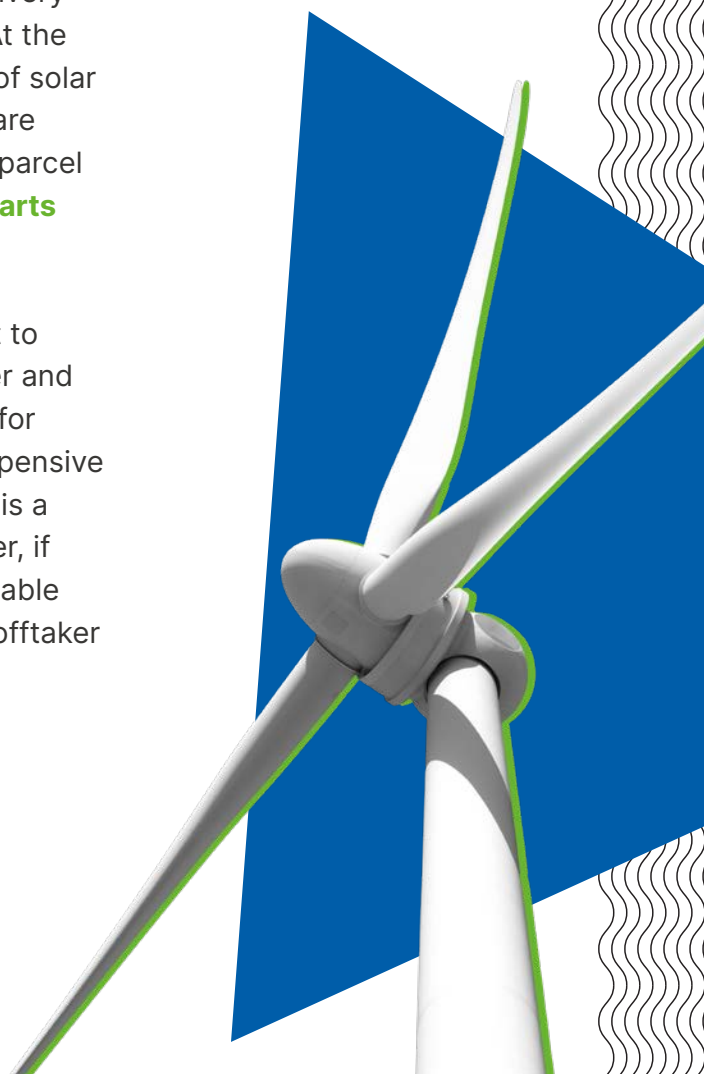
Challenges

The biggest challenge for first-of-a-kind projects like this is **earning the trust of banks, investors, and insurers** to make the project viable. In the pre-construction phase, this trust is established both through diligent months of study with contractors and consultants and through the development of a strong business case.

Initially, the project plan was to combine solar, wind, and BESS, the idea being that this diversity would create operational flexibility and use a wider supply chain. However, the low potential wind resource in the UAE meant that this profile did not make economic sense.

Without wind turbines, the project had to adapt and opted to **oversize the storage capacity** by roughly 30% to cover the 14 non-solar hours of the daily cycle during the summertime. This is the scale required to cater for the minimum delivery obligation of 1GW of baseload power to the offtaker. At the same time, the plan involved such a vast deployment of solar panels that the land requirements (roughly 60-70 square kilometres) were impossible to find in one continuous parcel in the UAE. The project is therefore **split across two parts that are independently connected to the grid.**

Looking ahead, one potential challenge that is difficult to predict is **change to the grid system** in terms of power and demand. The Power Purchase Agreement (PPA) price for 1GW of baseload power is almost three times more expensive than a standard solar tariff. In the current market, this is a comfortable price point for the energy output. However, if demand fluctuates, or if advances in optimising renewable energy generating assets alter this balance, then the offtaker may ask to limit the power output to the requirement.



We have already seen the solar tariff come down by about 30% since the switch to bifacial solar capture. This rate of price reduction is crucial to the growth of renewables in emerging markets such as the Middle East. The challenge for developers of large-scale projects is to deliver a value proposition that will be competitive for offtakers not just now, but ten years from now.

Managing the risk profile

In all aspects, this project was designed to **set a new standard** rather than follow existing standards. This is the case in the safety precautions taken to manage the project's risk profile. The project's prestige means that there is more than financial loss at stake and there are additional incentives to ensure the project is a commercial success.

The co-location of BESS and solar at this scale is unprecedented and the number of different assets is one of the key concerns from a risk management perspective. One of the most important questions insurers ask us relates to the

spacing of BESS units, recommending a distance between containers of up to 3 metres, and between containers and the MV station of 5 metres. We have gone above and beyond with distances of 5 metres between containers and 15 metres between containers and the MV station.

There are further examples of the project **exceeding the risk management guidance** from specialist consultants. The project has C4 level corrosion protection where C3 suffices, the project is prepared to withstand more than 54 metre per second wind speed where 45-48 metre per second wind speed is the standard, and the project's solar trackers have 100% concrete foundations even though 30% is deemed acceptable.

The decision to spread the project across two sites was necessary due to land constraints and adds complexity in terms of the risk management scope. However, this configuration actually improves risk-sharing across the project. **Both sides of the project have their own contractors and suppliers**, which helped to ensure effective delivery and avoid heavy dependencies on these project vendors. So, even though the formula is the same, the concentration of risk attached to individual stakeholders is reduced.

This design also limits the risk exposure of the $6B project. Both sides are **independently connected to the grid system**, addressing potential aggregation risks and the vulnerability of a megaproject having a single point of failure. This independence eliminates contingency risk, too. Furthermore, from a construction perspective, this **separation reduces execution risk**. Running the facility as two independent projects that are simpler to manage has been crucial in raising the comfort level of underwriters.

Getting underwriters familiar with the nature of these projects is important. Should underwriters look at this project in a different way compared to standalone solar or BESS? This is a key question, especially when you consider that

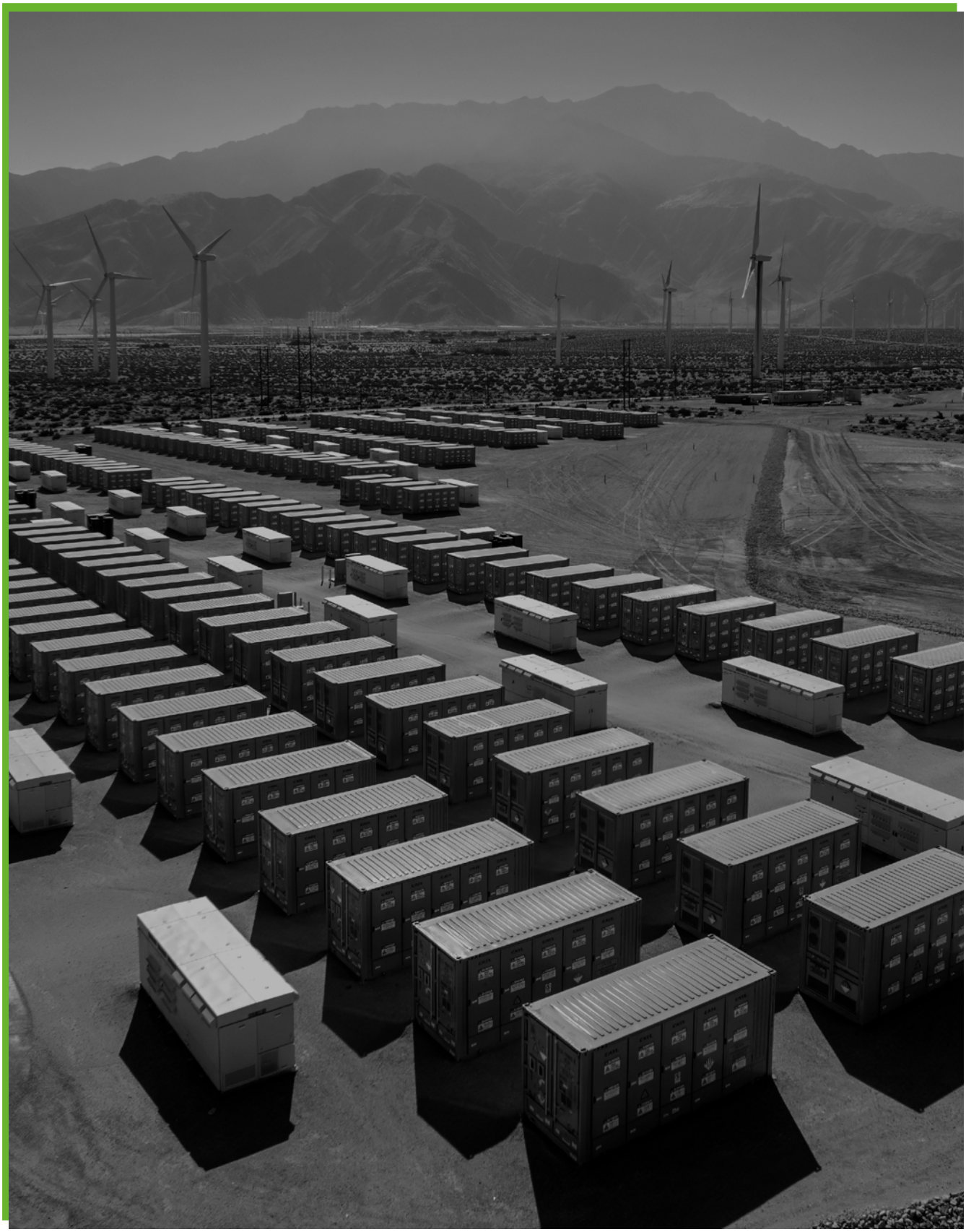
developers and operators treat the solar energy generated at a co-located project differently compared to standalone solar energy because the revenue is so much higher. Many principles are the same, and the technology is not new, but the combination at co-located sites is a point of difference and, as a result, there is a different risk profile at co-located projects for the industry to understand and manage.

Market outlook

The co-location model is increasingly popular today as a means of providing clean, reliable power, and improved economics mean that it will only get more popular in the future. BESS market development over the past couple of years has also shifted the landscape for large-scale energy project developers. For the 'Round-the-clock' project, we found that dispatchable solar doesn't just break even with the combined- and open-cycle gas turbines that we operate in the region; it is actually more viable to build.

In future, we will see more megaprojects with co-located renewables and BESS assets across several markets and these projects will produce and sell energy more competitively than nuclear or gas facilities. For example, this project offers a blueprint for further Masdar projects in the Middle East and Central Asia. **I expect the next milestone (2GW round-the-clock baseload power) to be reached in the next five years in the Middle East**.

For growth to be successful and sustainable, it is important that these enormous projects are prepared to cope with potential faults and proactively protect against losses. The 2024 storms and flooding in the region are a reminder of escalating climate risks, for instance, and the co-location of unprecedented numbers of assets means that increasingly large values of equipment are exposed. The 'Round-the-clock' project doesn't just set a new standard for baseload clean energy; but it also sets a new standard for co-located project risk management.



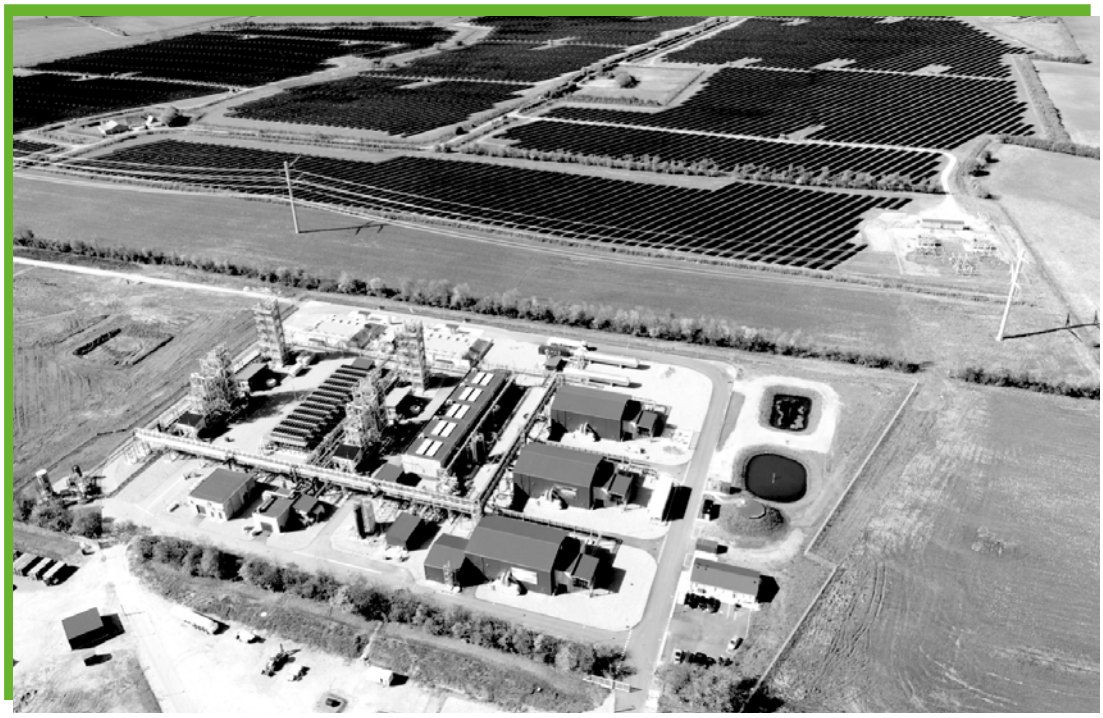
3. Kassø: De-risking a pioneering Power-to-X project

Ole Nyborg Thomsen (Vice President and Head of Group Risk Management & Insurance, European Energy) details Project Kassø's journey from a pioneering ambition to a commercially operating e-methanol facility, highlighting the key risks that had to be addressed to reach this point, and sharing lessons that the wider industry can learn from to support the deployment of future Power-to-X projects.

Project background

Going back more than three years, interest in Power-to-X projects, and specifically the production of e-methanol, was at an all-time high among European developers as a potential solution for hard-to-abate industrial processes and energy security in the region. The Kassø facility is one of the few projects so far that has successfully turned ambition into reality.

The Kassø e-methanol facility uses electricity from the 304MW Kassø Solar Park in southern Denmark, the biggest solar farm in Northern Europe, to power three electrolysers (52.5MW). These produce hydrogen that is then combined with biogenic CO2 to make e-methanol. The facility officially opened in May 2025, delivering the product to three offtakers - A.P. Moller - Maersk, the LEGO Group, and Novo Nordisk - with capacity to produce 42,000 tonnes of e-methanol annually.



The initial plan for the solar park didn't specifically include the construction of the world's first large-scale e-methanol facility, but its proximity to the harbour area in Denmark and the growing demand for green fuels to decarbonise shipping in line with ReFuelEU regulation made this a timely and attractive proposition to pursue.

European Energy's aim is to be a frontrunner in this emerging market, committing significant investment to Kassø's progress to date and for the future. Part of the strategic value of this first-of-its-kind project lies in creating a model that can be reproduced elsewhere for the global development plan, but also to show lenders, insurers, investors, and offtakers that it works.

The market for this product is growing and the delivery of Kassø was a key milestone in terms of learning and establishing best practice across the industry for developing and operating e-methanol plants at a commercial scale.

Challenges

Delivering on the promise of Power-to-X has proved to be very difficult, largely due to costs. At this early stage for the sector, there are a lot of unknowns to face and the **cost of building the facilities and installing assets such as electrolysers is high**, making it more attractive to early movers with long-term strategies.

In the case of project Kassø, building a first-of-its-kind facility came with the type of **engineering, construction, and planning hurdles** you might expect. For example, the product storage and delivery solutions we had in place to begin with, which involved underground storage and building pipelines from the park to the harbour, proved to be unworkable and had to be changed to a truck transport model. Identifying challenges like these and learning from them is a crucial experience for executing future e-methanol projects, but it also added **delays to the construction process**.

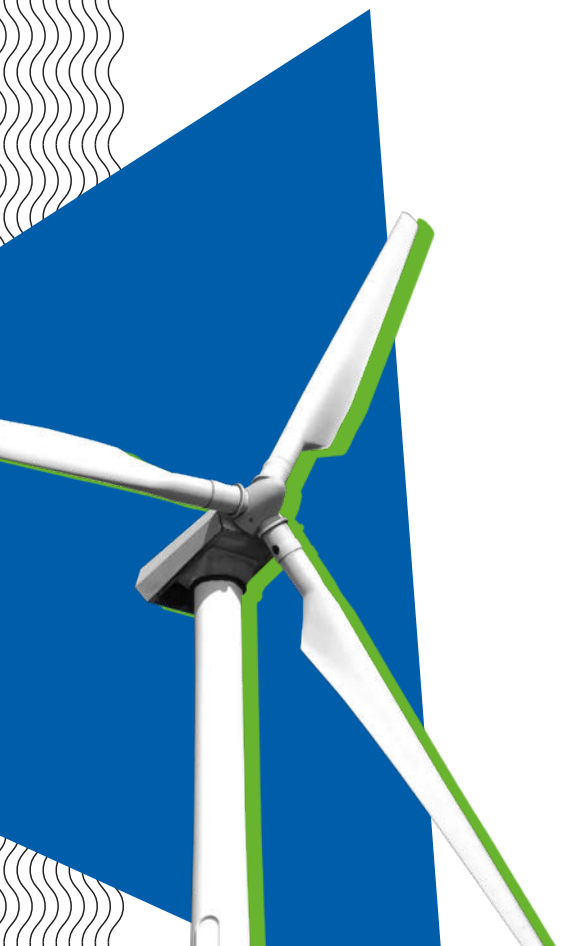
Another challenge for a market-first project like this is the **immaturity of the supply chain**. If we need to replace important components or if we want to build up an inventory of spare parts, the market has not yet reached the stage where these parts are readily available. Some of the components are new to suppliers and are highly bespoke, which is why the development of components for Kassø has been a collaborative process with trusted OEMs in Denmark.

On the other hand, one of the market's biggest challenges is something that this project was able to overcome even before the first piece of earth had been dug up on site. **Securing offtake agreements** has been a stumbling block for project deployment due to the "green premium" of Power-to-X products. For Kassø, the offtake contracts were signed before construction, providing certainty and creating the new, but not unwelcome, challenge of managing the project to meet the agreed delivery deadline. Confirming offtake agreements with prominent Danish companies from the outset was a key driver in Kassø's viability.

Managing the risk profile

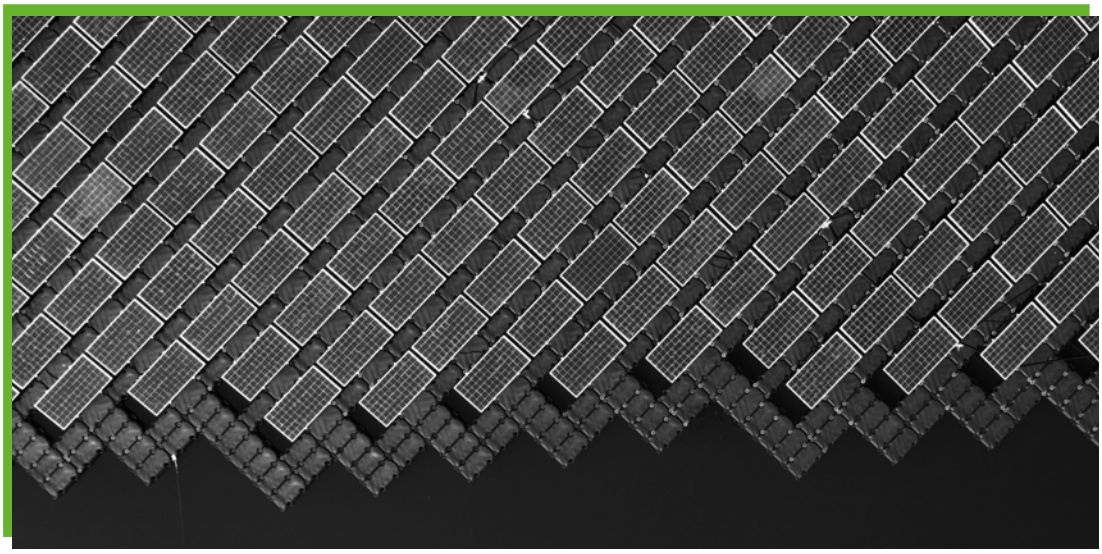
The appetite in this project from offtakers, investors, and underwriters is healthy and that is thanks in part to the **thorough risk management approach** we have taken at the site. This is especially important for a large-scale project in this sector because the risk profile of green hydrogen production and e-methanol production facilities is much less familiar than for a large solar park.

A key question to address is what happens to the whole facility if one of the co-located technologies should experience a fault that means it cannot operate. The configuration of the grid connection at Kassø allows solar power to be sold straight to the grid and, inversely, power to be bought from the grid. This flexibility means that if the e-methanol facility should go offline, the solar park can simply trade in the traditional way for standalone solar, and if the solar park should go offline, the e-methanol facility can still access the power it needs to continue operations.



This **separation in design significantly reduces the business interruption complexity** common at such projects while **alleviating exposure to aggregation risk** by featuring more than one single point of project failure. Aggregation risk is also important to the Danish and European authorities with whom European Energy worked to establish best practice for the project's security and public safety. Through this process, we were able to **proactively identify risks around storage and transport** and modify our strategy for sustainable product delivery.

European Energy risk managers built up a strong level of comfort about the site due to the lessons learned in the design and construction processes. This has also been the case for insurance carriers in the construction and operation phase who have helped share project risk and elevate standards in reducing exposure.



However, future Power-to-X projects would benefit hugely from **risk managers and insurers collaborating as early as possible**. For one thing, the earlier insurers can be brought into the risk management strategy, the better it is for a project's lifecycle. For another, the **wide range in pricing** we have seen to insure the plant, both in construction and in operation, suggests that the insurance market is yet to fully understand the unique risk profile of Power-to-X projects.

Pricing for these projects can't simply be modelled on pricing for a traditional gas station or standalone renewables project. The variable coverage premiums available in the market show that closer coordination is needed to accurately price these facilities and enable market growth.

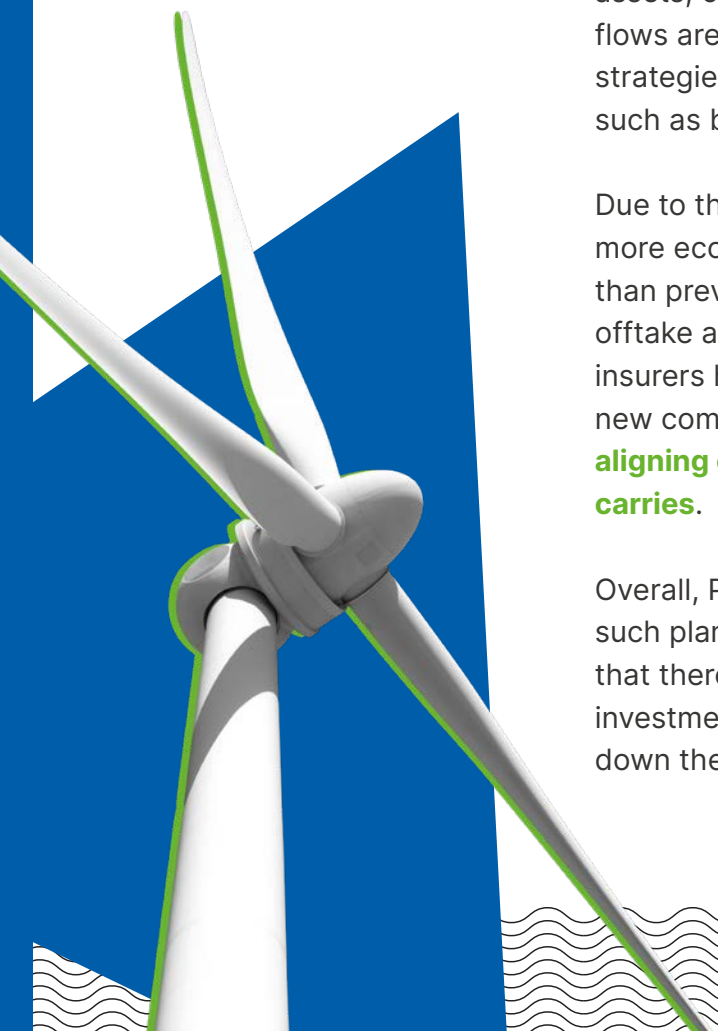
Market outlook

For European Energy, Kassø paves the way for the future build out of e-methanol facilities in other locations, both by setting a standard to emulate and by providing valuable lessons learned through the challenges the project has faced. We also have the ambition to expand the site to twice the size it is today, which will require more investment, but speaks to growing offtaker interest.

More generally, the Power-to-X market is not easy to develop in today due to the huge amounts of investment needed to push projects through to completion. However, combining assets, opening up new revenue streams, and extending cash flows are all front of mind for developers with co-location strategies, who are benefitting from the cost of technologies, such as batteries, coming down rapidly.

Due to this, I expect Power-to-X projects to gradually become more economical to build and operate, albeit more slowly than previously predicted, as the technology advances and offtake appetite increases. To support this development, insurers have an important role to play in understanding the new combinations of technologies they are underwriting and **aligning on terms that accurately price the risk a project carries**.

Overall, Project Kassø was designed to be the first of many such plants, not a unique outlier. This project demonstrates that there is a path forward for Power-to-X but it will require investment and wider support across the industry to bring it down the cost curve towards standard commercial adoption.



4. Moving to a multi-technology mindset

Olly Litterick, Head of Renewables, TMGX

Underwriting emerging clean energy technologies has never been simple, but insurers have always risen to the challenge of handling the new complexity they bring. Over time, underwriting conditions for technologies like offshore wind, onshore wind, solar, and BESS have gradually eased as insureds and insurers have increased familiarity with asset lifecycles and risk profiles, the most common causes of faults, and renewables market dynamics.

However, as this report demonstrates, the rise of co-location and the gradual emergence of first-of-a-kind green industrial projects mean that insurers are encountering more complexity than ever before, and this is likely to increase in the future.

Today, insurers are getting up to speed with new revenue models and technological integration at renewables-plus-storage sites; tomorrow, the lessons learned will need to be carried over to projects incorporating less mature technologies for the production of green molecules like green hydrogen.

As green projects evolve into more elaborate systems with increasingly diverse functions, it will be crucial for the industry to simplify and standardise as it goes.

Both of our case study contributors and the TMGX underwriting team have underlined the benefits of separating out different parts of co-located projects. While insurers get more comfortable with these projects, splitting them into more manageable pieces simplifies the underwriting challenge and helps to develop experience at these sites.

For emerging hybrid project types that combine less mature technologies, sustainable market growth requires green insurers to follow early movers with a wider range of products.

In the meantime, getting the market more comfortable with emerging risks is a top priority. Besides making a case for improved terms over time, direct exposure to projects and their management as early as possible plays a crucial role in the development of insurance products that actually make a difference to project viability.

In last year's report, 'It's Not Easy Writing Green', we highlighted that the next phase of growth in the green transition requires insurers to focus on three core pillars: **data & analytics, greater industry collaboration** and **insurance product innovation**. These same areas will be critical for insurers following the lead of renewable energy businesses moving to a multi-technology mindset.

1. Data & Analytics: Connecting insurers and risk engineers

When projects combine multiple technologies, the volume and diversity of data generated is multiplied, too. For co-located projects, the number of datapoints to make sense of has massively increased. **Without greater transparency of performance data and risk analysis, insurers' knowledge gaps will widen**.

Similarly, given the unique profile of new projects coming to market, it is imperative that insurers, investors, lenders, and risk engineers engage as early as possible. From an insurance perspective, the earlier the dialogue begins the better.

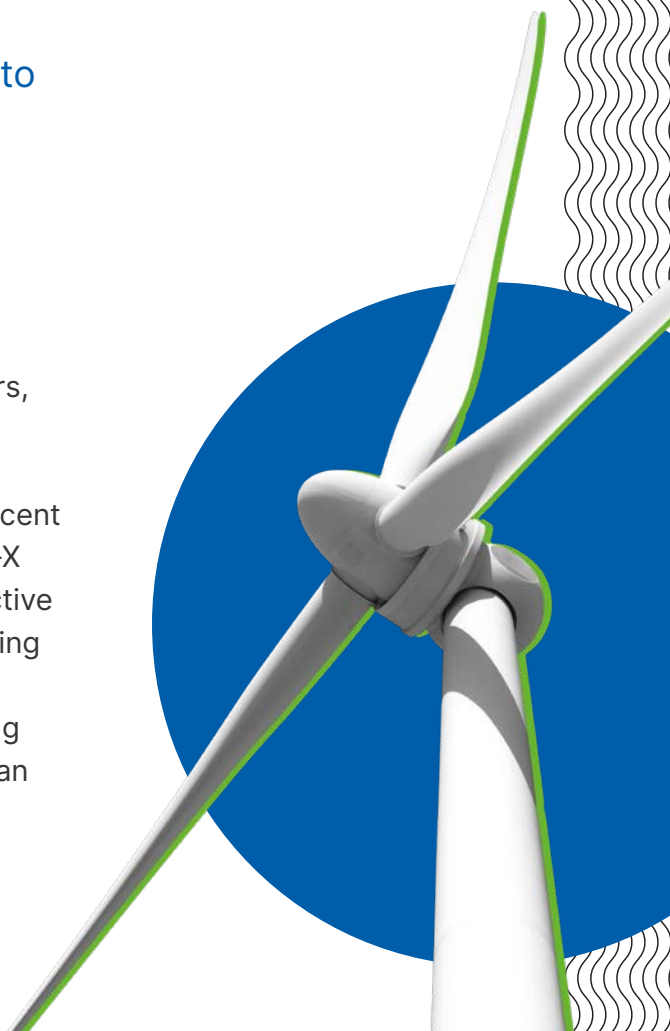
Open dialogue from the very start of a project build is a constructive way for insurers to establish familiarity with the project's exposure and the risk management strategies in place, improving the support on offer for developers. After all, it is the developer transferring the risk from their balance sheet to the insurance company's balance sheet, so the sooner and more transparent the communication can be, the more likely it is that a project will be a success for all parties involved.

More than traditional projects, today's co-located strategies break down when different project workstreams are siloed. Both case studies emphasise the value of complete project integration, even where separation has been built in for more simple risk management.

2. Industry collaboration: Working together to tackle complexity

More broadly, **the sector must take opportunities for collective discussion and problem-solving**. TMGX's expertise as a pioneering green transition insurer is born of its commitment to sharing insights for the industry's education and hosting forums that bring together insurers, investors, lenders, and developers.

To keep pace with growing complexity in the sector in recent years, TMGX has been an active participant in Power-to-X working groups alongside industry leaders involved in active projects and is also part of a steering committee organising the first specialist renewable energy claims conference this year. These gatherings help inform our understanding of emerging risks and our confidence to lead on new clean technologies.



3. Product innovation: Closing coverage gaps

With more data and closer alignment in project development, the insurance market can create more impactful products to enable market growth. **The reinvention of renewable energy businesses as multi-technology flexibility providers calls for a reinvention of the insurance coverage deployed to protect new revenue streams**. Innovation opportunities for insurers are growing as co-location increases in popularity.

For instance, in green hydrogen, there are gaps in coverage for key aspects that improve project bankability, such as warranty, technology degradation, and fully wrapped EPC solutions. There is also room for creative offerings along financial lines in credit, or surety or offtake security that insureds may not be aware they can benefit from.

Likewise, even relatively simple co-located projects perform a varied range of services today and would benefit from more tailored insurance support. Combinations of renewable energy generating assets with BESS that provide energy arbitrage, ancillary services, or capacity payments, for example, are operating with specific revenue models that would be better supported by bespoke BI policies that address the full scope of their commercial activity.

In the first half of the decade, renewable energy development strategies focused on deploying capacity at scale and speed for an 84% increase in global renewables capacity from 2,799GW to 5,149GW[4]. The second half of the decade will be defined by a focus on operational flexibility.

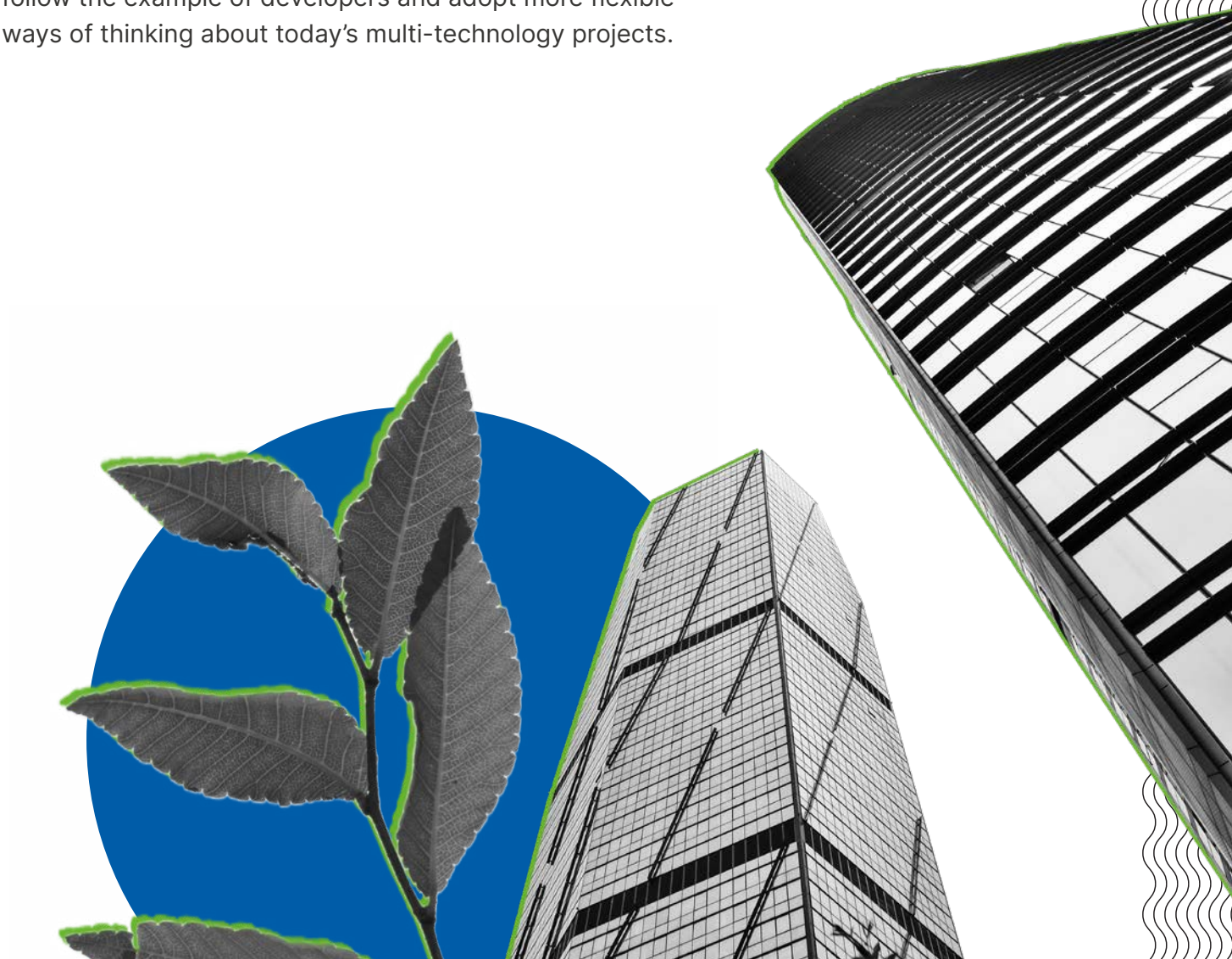
As renewable energy companies aspire to be more than solely clean power generators, co-location, co-location, co-location has started to take prominence over location, location, location, heralding a new era of portfolio sophistication and complexity.

4 International Renewable Energy Agency, 'Renewable Capacity Highlights', March 2021; 'Renewable Capacity Highlights', March 2026

The result is that, not for the first time, green insurers are encountering a fresh uptick of unknowns in the sector. This report has sought to address some of these unknowns.

In the short-term, the industry needs to find ways to reduce complexity at projects where it is possible to do so to ease the insurance market's adaptation to new development strategies. In the long-term, insurers need to get up to speed with new strategies and revenue models to improve their level of comfort with increased complexity. Greater data transparency, more focused industry collaboration, and the innovation of new insurance products tailored to hybrid projects all have a decisive part to play in delivering the next phase of sustainable market growth.

To match the pace of change and play their role in supporting this key area of the global green transition, insurers must follow the example of developers and adopt more flexible ways of thinking about today's multi-technology projects.



5. Contributors

Foreword

Fraser McLachlan
TMGX Chairman

Moving to a multi-technology mindset

Olly Litterick
TMGX Head of Renewables

'Round-the-clock': Managing co-location risks at a MENA megaproject

Sreenivasulu Narayanakatta
Masdar Business Development – Bids to Financial Closure

Kassø: De-risking a pioneering Power-to-X project

Ole Nyborg Thomsen
European Energy Vice President and Head of Group Risk Management & Insurance

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About Tokio Marine GX

Founded upon GCube's decades of experience in renewable energy underwriting and claims, and with expertise drawn from across Tokio Marine's global operations, Tokio Marine GX provides a single point of access to a suite of products and services, for partners and clients committed to more sustainable practices. Tokio Marine GX is part of Tokio Marine Group. Tokio Marine Group is one of the world's largest global insurance and risk players with a market capitalization of approx. $81 billion as of June 30, 2025, a network encompassing Japan and 46 countries and regions worldwide, and over 43,000 employees. Tokio Marine Group has the capabilities to drive genuine positive change through a business model grounded in a sense of purpose and social responsibility, built on 145 years of history and an enduring culture that fosters innovation and expertise.

Composed of a diverse range of insurance and solutions businesses across the world, that bring a depth and breadth of capabilities to address and mitigate the ever-evolving risks we face, we provide our clients and communities with the security they need to move forward, while working to create more resilient societies and a better tomorrow.

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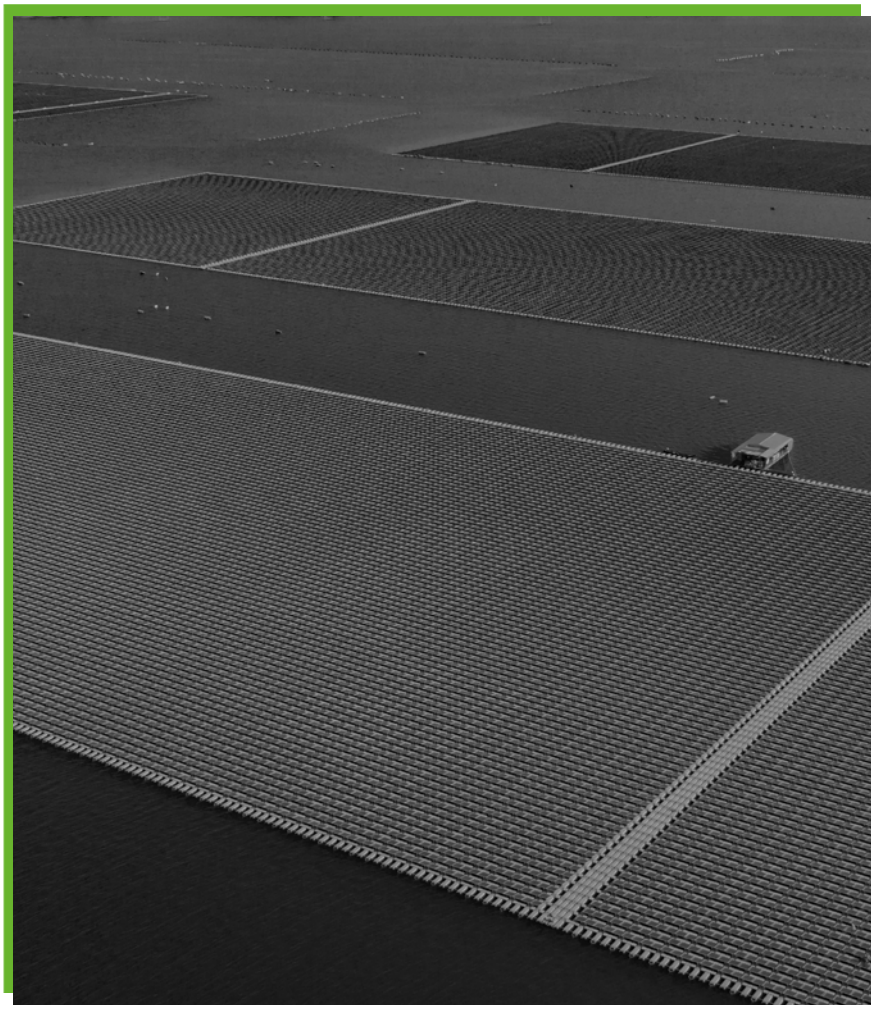

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