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Centre for Active Resilience and Security (CARS)

Resilience, Renewable Society Summit
Track 2 Leveraging Insurance to Enable and Finance Resilient Energy Systems Discussion Note

Introduction

Imperial College London and the International Energy Agency (IEA) convened the workshop on 17 September 2026 to examine how insurance and financial mechanisms can support investment in resilient energy systems. The workshop followed a joint workshop held in October 2025 in Paris[1]. It focused on three linked issues: priority resilience risks, the economic and financial value of resilience measures, and the role of insurance and finance in supporting resilient electricity infrastructure.

This workshop was part of The Resilient, Renewable Society (RRS) Summit - a two-day conference organised by Imperial College Centre for Active Resilience and Security (CARS) and their partners that brings together leaders from academia, NGOs, government, policy, and the private sector to learn from recent crises, stress-test future scenarios, and shape resilience strategies together[2].

Part 1: Understanding the Challenge and Identifying Solutions

Climate-related disruptions are placing growing pressure on energy systems, with power grids particularly exposed. Figures presented indicated that power grids account for approximately 85% of tracked disruptions and that outages affected more than 200 million households in 2023 (IEA, 2025). Storms, floods, and extreme temperatures remain major causes of disruption. However, cyber-attacks, malicious physical attacks, and other security threats also form part of the same risk landscape. The relative scale and interaction of these risks remain insufficiently understood, which makes investment priorities harder to define.

Resilience therefore needs to be considered not only as an engineering or operational issue, but also in terms of the economic and financial value of avoided losses. One utility example showed how organisations can allocate different layers of risk. High-probability, low-impact risks can remain within operational budgets and maintenance costs. Medium-probability, medium-impact risks can be retained through captive insurance arrangements. Low-probability, high-impact risks can then be transferred to commercial insurance markets. Captives can also reduce exposure to volatile insurance pricing and show that asset owners retain a meaningful share of their own risk.

Technical solutions are only part of the challenge. Affordability and finance capability can also limit resilience investment. In the United States, figures presented during the workshop indicated that investor-owned utilities expect to undertake around $1.4 trillion in capital expenditure on power

[1] The role of insurance for energy resilience has been discussed at a technical workshop on the 1st of October 2025 organised by the IEA, in collaboration with Imperial College London and the Coalition for Disaster Resilient Infrastructure (CDRI), convened as a side event to the IEA High-Level Roundtable on Strengthening Energy Infrastructure Resilience. https://www.iea.org/events/strengthening-energy-infrastructure-resilience

[2] https://www.imperial.ac.uk/resilience-centre/resilient-and-renewable-society-rrs-summit/

infrastructure over five years for the broader capital expenditure programmes. This scale of investment would require substantial additional revenues under existing financing arrangements. Large increases in customer bills were described as politically and socially difficult to sustain. Wildfire liability creates a related problem because large and uncertain losses can reduce the investability of utilities. This has increased interest in mutual insurance and risk-pooling structures that combine clearer liability rules, risk assessment, and collective loss sharing.

The energy transition also changes both the sources of risk and the options for managing them. Cyber exposure, vulnerable above-ground infrastructure, gas-supply risk, and force majeure provisions can increase the impact of disruption. At the same time, system design can create new resilience options. Examples include distributed energy resources and vehicle-to-grid storage to support essential demand during transmission faults, demand differentiation to protect critical services, and closer integration of heat and power systems. These examples show why decarbonisation and resilience should be assessed together in a systemic way rather than as separate objectives.

Together, these pressures raise a practical financing question. Organisations first need to identify and reduce risk where this is economically feasible without impacting consumer affordability. They then need to decide how to retain, pool, or transfer the remaining risk. This question leads directly to the role of insurance.

Part 2: Financing Resilience – The Role of Insurance

Insurance has an important role in addressing a large and uneven protection gap. Swiss Re figures presented indicated that global insured natural-catastrophe losses reached approximately $107 billion in 2025, while total economic losses exceeded $200 billion. The United States accounted for a large share of insured losses, including around $40 billion from wildfires in California. By contrast, insurance penetration in some lower-income markets, like Nepal remains below 2%. In these markets, most economic losses remain uninsured. The key issue is therefore not only how insurance pays for losses, but also how it can support risk reduction and investment.

Risk reduction remains the starting point for effective insurance. A recent report mentioned a case study concerning a long transmission line exposed to wildfire risk (IFC 2026). Under a high-emission scenario, wildfire could erode around 30% of net asset value by 2050. Fire breaks costing roughly 3% of net asset value were estimated to protect around 23% of net asset value and reduce outages significantly. The estimated benefit-cost ratio was about $8.6 per dollar invested. This example shows why insurance pricing should recognise effective resilience measures where evidence supports the link. Fortified construction standards, risk-engineering recommendations, and sustainability-linked insurance products can create such incentives, but they require credible standards, reliable data, and coordination across the market.

After risk reduction, different instruments can address different layers of residual risk. Captive insurance can retain medium-probability risks and reduce dependence on volatile commercial markets. Commercial insurance remains important for low-probability, high-impact events. Parametric insurance can provide rapid payouts when objective hazard thresholds are met, although basis risk and limited demand restrict its use. Catastrophe bonds and other capital-market instruments can transfer tail risk beyond the traditional insurance sector. Risk pools can

also diversify losses across a wider base. No single instrument is sufficient, and poor design can weaken incentives for risk reduction or create pricing distortions.

The UK is among the more active countries at the international level on the energy resilience agenda. Responding to the regulator OFGEM, the report from Imperial College London "From Risk to Resilience" finds that extreme weather, electrification, and an aging infrastructure demand greater incentivisation of network operators to invest in a more resilient electricity grid (Imperial 2026). The National Energy System Operator (NESO) early competition model is a mechanism to design, build, operation and maintenance of new, separable onshore transmission assets, that are needed to achieve a net zero resilient energy system.

Another challenge comes from the mismatch between the time horizon of insurance and that of infrastructure finance. Banks and infrastructure investors often need long-term certainty to support credit decisions. Insurers usually reprice risk annually because hazards, claims experience, and market capacity can change quickly. Long-term insurance agreements therefore tend to cover only a few years and usually include repricing or exit provisions. Insurance can support project bankability, but it cannot replace long-term debt, equity, or public funding.

Supply chain and operational risks are becoming a major challenge. Long replacement times add another layer of risk. Waiting times for critical grid components such as transformers and cables have doubled in the past three years (IEA 2025). Similar constraints affect gas turbines and other critical components. A damaged asset may therefore remain out of service long after the initial physical loss, which can make business-interruption losses much larger. Concentrated supply chains also create geopolitical and single-source dependencies. Risk assessment therefore needs to combine historical loss data with forward-looking analysis of climate, technology, and supply-chain exposure.

More broadly, some transition-focused stress tests may understate physical risk. Better climate-risk scenarios and clearer resilience metrics would help investors identify projects that can remain robust under future physical conditions.

These limits become more significant in emerging and developing countries with weaker insurance markets, tighter public finances, and lower institutional capacity. The final thematic session therefore focused on how emerging and developing economies can finance resilience under these conditions.

Part 3: Financing Energy Resilience in Emerging and Developing Economies

In emerging and developing economies, many of the same constraints are more pronounced. Analysis suggested that the vast majority of existing and planned hydro and solar PV generation capacity in India and Southeast Asia faces high or critical climate risk by 2030, compared to less than half for renewable generation capacity in Europe(Zurich 2026). The protection gap is therefore not simply a shortage of insurance. It also reflects weak data, limited modelling capability, regulatory constraints, affordability issues and limited fiscal space. These factors affect both the price of protection and the ability to invest in resilience.

A layered risk-bearing architecture can help address these constraints. Domestic insurance markets remain important, but many lack sufficient capital, reserves, catastrophe-modelling

capability, underwriting capacity, or access to reinsurance. Some risks can stay within domestic markets. Regional pools can diversify other risks. Larger exposures may need international reinsurance or capital-market support. Multilateral development banks and development finance institutions can strengthen this structure by financing resilient infrastructure, improving data availability and regulation, and providing guarantees, concessional finance, and risk-transfer instruments. Governments also need to account for disaster-related contingent liabilities in fiscal risk management.

The gap between construction and operation also deserves particular attention. Development-bank projects often carry insurance during construction, but this cover may not continue once the asset enters service. One regional initiative is exploring whether development loans can include insurance premiums for longer-tenure operational cover. The approach would also involve risk engineers from project design through implementation and operation. This would connect financing, engineering, and insurance from the start rather than adding insurance after key technical decisions have already been made. A sovereign parametric payout after Hurricane Melissa in Jamaica in 2025 showed a similar principle at national level: rapid liquidity can support recovery, but it cannot replace stronger assets or sound recovery planning.

Insurers can also contribute as long-term investors. One insurer highlighted a transition finance framework targeting around $6 billion in portfolio investments by 2030, particularly in emerging and developing economies, across areas such as renewable energy, energy access, adaptation, and related investments in emerging and developing countries. Further investment is constrained by perceived risk and difficulties in identifying credible projects that meet fiduciary return requirements. Additional barriers may include high foreign-exchange hedging costs arising from mismatches between hard-currency equipment or foreign-currency debt and local-currency tariffs, as well as limited visibility of physical climate exposure in some remote areas.

At the same time, emerging and developing economies differ significantly and should not be treated as a single category. In some lower-income markets, weak utility balance sheets and limited fiscal space make even basic resilience investment difficult to finance. In other markets, the main constraints lie in market design, data quality, risk allocation, or the depth of domestic insurance and capital markets. The financing mix must therefore reflect local conditions. Across these contexts, insurance and finance can narrow the protection gap only when they support wider risk reduction, stronger institutions, better data, and regulatory reform.

Summary and Future Work

Looking ahead, stronger evidence and a systemic approach including transition and resilience will be central to the next stage of work. Resilient energy investment needs more comprehensive data, risk intelligence, and economic and financial methods for valuing avoided losses and resilience benefits. Utilities and project developers also need stronger loss-control measures, including physical adaptation, cyber resilience, supply-chain management, and risk engineering. Governments and public finance will remain necessary where risks are uninsurable, markets are incomplete, or affordability limits private solutions.

The IEA will continue to expand on its work in energy system resilience, through tracking disruptions, analysing vulnerabilities, and assessing mitigation measures. It is also working on a new project on Investing in Energy Security, including a framework to help countries assess value

at risk and the costs of resilience interventions. A single global estimate of value at risk would be difficult to produce and may hide important differences between countries and assets. Country-level and asset-level case studies can provide a more practical evidence base. A call to action for insurers was discussed (see appendix).

Project development would also benefit from earlier involvement of insurance advisory and risk engineering. This can help assets remain insurable throughout their lifecycle. Investors and policymakers also need clearer evidence on how resilience measures affect premiums, deductibles, coverage terms, financing costs, and recovery outcomes. Follow-up work should therefore combine sector-specific case studies with better data and closer collaboration between utilities, manufacturers/OEMS, insurers, commercial banks, other institutional investors, governments, energy and financial regulators, and development-finance institutions. Closer alignment at the project development stage, between engineering, finance, and insurance can then support both risk reduction and investment in more resilient energy systems.

The UK could build on its finance, industry and academic expertise to lead this agenda. Recent OFGEM ED3 consultation, NESO's new role and systemic approach and the Department for Energy Security and Net Zero (DESNZ) upcoming Energy Resilience Strategy can drive action domestically. Taking the presidency of the G20 in 2027 represents an opportunity for the country to lead this agenda at the international level.

Imperial CARS can support this agenda by providing multidisciplinary research and taking a systems approach to risks and threats in the energy sector. Capacity building and lifelong learning represent a further area for future work. CARS is exploring the development of a Global Resilience Mentoring Programme (GRMP) to strengthen the cross-disciplinary skills and knowledge needed to address interconnected cross-domain risks. Participants in this workshop could contribute relevant expertise, particularly in defining the capabilities needed to integrate insurance, finance, risk engineering, and resilience considerations into energy investment and project development.

Appendix

Call to action for insurers

Insurance can play a more strategic role in enabling investments in resilient energy systems:

- **Providing data and risk intelligence for policymakers and developers**
  - Insurers have unparallelled access to risk data, modelling capabilities
  - Improved publicly available data can help policymakers to understand where the emerging risks are and where the protection gaps are
- **Advising on loss control and risk mitigation/resilience measures**
  - Insurers must be integrated earlier into the project development process to provide expertise on risk and resilience engineering
    - Improve site design and project engineering and Improve operations
  - Better alignment between OEMs, EPCs, developers, lenders, and governments on prioritized resilience measures
- **Translating risk into capital allocation decisions for resilient infrastructure**
  - Enabling developers and lenders to develop cost-benefit analyses for investments in resilience
- **Investing in resilient infrastructure as a capital provider/asset manager**

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