Building resilient, flexible grids for the renewable era

Laura Fleming, Country Managing Director at Hitachi Energy UK & IE, explains how energy security, grid resilience and digital innovation are shaping wind power integration in the UK and Ireland, and why collaboration across the sector is critical to meeting future energy challenges.

PES: Welcome back to PES Wind, Laura. Grid resilience and energy security have become more central. How have these priorities shifted within Hitachi Energy's strategy, especially in relation to wind integration?

Laura Fleming: Energy security has become increasingly prominent in the thinking of governments and regulators since the disruption to energy supplies following the invasion of Ukraine. The situation in the Middle East has unfortunately heightened these concerns again.

At Hitachi Energy, our solutions have always strengthened energy security by integrating secure, local sources of electricity generation into reliable and resilient grids. The increased focus on security has not changed the solutions we provide, but it has shifted the perceived hierarchy of their benefits in the minds of our stakeholders. Our secure solutions also deliver resilience, enable low-cost renewable generation and support sustainability.

Grid resilience and reliability, particularly voltage and frequency stability, often referred to as power quality, have always been a central element of our solutions.

The focus on them, however, has increased as people become more aware of their importance in today's world. We are now in a time of great instability, both in energy security and also through risk, for example with extreme weather affecting energy output.

Our technologies and solutions not only connect wind to the grid but also actively strengthen the system as renewable penetration escalates.

We're increasingly designing solutions that provide stability and services through innovative digital technologies, enabling better maintenance, security, system strength and controllability, alongside increased capacity and technologies that enhance sustainability and decarbonisation. Today, wind integration is as much about maintaining a secure, flexible and resilient system as it is about reducing carbon emissions.

Our strategy is to work collaboratively with partners and customers to modernise the grid. Early involvement helps network companies and developers create certainty around equipment and service needs, enabling the supply chain to plan effectively and meet project requirements.

The sooner this planning begins, the greater the likelihood of successfully delivering on project goals

PES: As conventional synchronous generation declines, how are grid operators addressing inertia, frequency stability and voltage control challenges?

LF: In Great Britain, National Grid ESO (now NESO) has introduced new stability services and products, such as Dynamic Containment, Dynamic Moderation and Dynamic Regulation, that procure sub-second fast frequency response, mainly from battery storage, to manage frequency with much lower synchronous inertia.

NESO also runs the Stability Pathfinder programme, contracting 'carbon-free inertia' from synchronous condensers, repurposed gas plants and grid-forming converters to provide inertia, short circuit strength and voltage support without burning fuel.

Examples include large synchronous condensers at sites like Eye and Pembroke, plus inertia contracts in Scotland that together provide the equivalent stability of several coal stations. NESO has also rolled out real-time inertia metering and forecasting, so it can monitor effective inertia regionally and schedule these new assets and services to maintain system stability as renewables grow

PES: With grids becoming more decentralised, how important is system flexibility and which technologies are proving most effective?

LF: Flexibility is absolutely fundamental. As renewable output becomes more variable and less predictable, the ability of the system to respond quickly and flexibly is what determines resilience.

We see the most effective solutions coming from a mix of grid-scale power electronics, storage, flexible interconnection and digital control systems. HVDC links, for example, are powerful tools for managing congestion, balancing regions and stabilising frequency across wider areas. Our enhanced STATCOMs provide a range of stability and inertia services.

PES: What are the key bottlenecks in UK and Irish grid infrastructure that could slow wind deployment?

LF: The biggest bottlenecks are no longer technical; they are structural. Transmission capacity constraints, lengthy planning processes and connection queue management are all slowing deployment.

There is a large backlog of generation projects waiting to connect, delaying many wind farms and storage projects and pushing connection dates further out. Power cannot be transported to the main demand centres to take offshore wind resources without upgrades to the grid. This leads to curtailment, which means wasted clean energy and higher costs.

In both the UK and Ireland, the pace of grid build-out has not yet caught up with the ambition of wind development. Addressing this requires anticipatory investment, streamlined consenting and regulatory frameworks that reward long-term system value rather than incremental reinforcement.

It's essential for grid modernisation and digitisation, and this takes time. We need an energy system capable of managing unprecedented levels of variable generation, flexible resources and storage.

In Ireland, rapid growth in electricity demand from data centres, for example, is straining grid capacity and requires structural changes.

PES: How are digital monitoring and optimisation changing the way grid operators manage risk and reliability?

LF: Digitalisation is transforming grid resilience from a reactive to a predictive discipline. Advanced monitoring, analytics and asset management tools allow operators to understand real-time system behaviour, anticipate failures and optimise performance over the full asset life cycle.

This is increasingly critical as assets are pushed harder and used in more complex ways. Digital tools help extend asset life, reduce unplanned outages and improve confidence in operating closer to system limits.

PES: What lessons from long-term HVDC operation on the East West Interconnector apply more broadly to UK and Irish grids?

LF: The East-West Interconnector shows that HVDC can deliver exceptional long-term reliability while providing strategic flexibility to the system. One key lesson is that interconnectors are not just energy trading assets; they are stability assets.

Operational experience also highlights the importance of long-term service partnerships, robust control strategies and continuous optimisation. These lessons are directly applicable as the UK and Ireland deploy more HVDC for offshore wind and internal reinforcement.

PES: Where is the bigger misalignment behind grid connection delays: technology, regulation or planning and queue management?

LF: The biggest misalignment isn't technology, it's capacity. Connections reform is already tackling the queue, but the truth is we started expanding the grid far too late, and there simply isn't enough network capacity to plug in the volume of low carbon projects coming forward. Regulation and planning processes haven't kept pace either, which slows down the buildout we need. Queue management improvements help, but they can't fix the fundamental issue: the grid itself needs to be bigger, faster.

PES: How is Hitachi positioning itself to help countries build secure grid systems less exposed to geopolitical and supply chain shocks?

LF: Energy security increasingly depends on resilient supply chains, regional manufacturing capability and long-term partnerships. We are investing heavily in production capacity, standardisation and service capability to ensure grids can be built and maintained reliably.

At the same time, we're supporting customers with solutions that reduce dependence on imported fuels by enabling higher renewable penetration and stronger interconnection between systems.

PES: How do sustainability commitments align with resilience and reliability when planners are prioritising investment?

LF: Sustainability, resilience and reliability are increasingly aligned rather than competing priorities. Eco efficient designs, lower losses, longer asset lifetimes and reduced maintenance requirements all contribute directly to system resilience.

From a planner's perspective, the most sustainable solution is often the one that delivers stable performance over decades with minimal intervention, and that's where technology choice becomes critical.

For us at Hitachi Energy, the priority is to plan for the long term and act accordingly. This involves investing in and collaborating with

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customers to provide the grid technologies required to integrate renewable energy and other power sources at scale.

It also includes making forward-thinking commitments to skills development to help meet rising demand. We are already seeing first-hand what can be achieved through these partnerships.

PES: What grid technologies or design approaches are uniquely needed for offshore wind in the UK and Ireland?

LF: Offshore wind in the UK and Ireland needs HVDC transmission, offshore voltage/reactive power support, strong onshore connection

points and advanced control systems to manage variability.

Grid design must plan for future expansion, including multigigawatt offshore zones, not single projects. Interoperability and regulatory reform are essential to enable coordinated, meshed HVDC networks at sea.

PES: As offshore wind projects scale to multi-gigawatt levels, what new integration challenges are emerging?

LF: As offshore wind scales up to multigigawatt projects, we're connecting far larger volumes of power through offshore grids based on power converters, often using HVDC technology. That creates new technical challenges in keeping the grid stable during faults and rapid ramps caused by weather changes. It demands much closer coordination between offshore controls and the onshore transmission network.

Onshore, bringing several gigawatts into a handful of coastal connection points means we need major reinforcements, smarter grid control and more flexible resources to manage congestion, voltage and frequency.

From a Hitachi Energy UK perspective, this is exactly why we are investing in advanced HVDC, grid-forming converter solutions and digital tools that help National Grid and developers plan, monitor and operate these large offshore hubs securely and efficiently.

For us, these challenges align directly with the need for next generation HVDC systems, advanced offshore platforms and coordinated control solutions.

Technologies such as multiterminal and vendor interoperable HVDC, grid-forming converters, and digital twins for holistic system studies are becoming essential to maintain stability, controllability and resilience as offshore capacity grows.

PES: How critical is collaboration across developers, TSOs, technology providers and regulators?

LF: Whole system delivery is impossible without close collaboration. No single stakeholder can solve these challenges in isolation.

Early engagement, shared system modelling and aligned incentives are critical to delivering resilient, secure and cost-effective grids. The most successful projects are those where collaboration happens from the concept stage, not after problems emerge.

Suppliers and customers can work differently to meet the scale of the challenge and deepen collaboration by developing multi-year roadmaps, so projects are planned as part of a broader system rather than in isolation.

Long-term planning frameworks, including programme based procurement and earlier engagement with suppliers, help provide predictability.

Coordinating larger, longer-term orders gives manufacturers the confidence to invest in capacity and skills, while working together to harmonise or rationalise equipment types increases flexibility between projects and reduces design complexity and delivery risk.

Taken together, these approaches create greater certainty across the supply chain and improve outcomes for customers and consumers alike.

For network planners and transmission operators, planning can shift from reactive, project-by-project connections to integrated, anticipatory design that minimizes bottlenecks and reduces overall system costs.

PES: How do distributed energy resources and storage interact with centralised grid infrastructure in future energy security strategies?

LF: Distributed resources and storage complement rather than replace centralised infrastructure. Large transmission assets remain essential for moving bulk renewable power, while DERs and storage provide local flexibility and resilience.

The challenge and opportunity lie in orchestrating both through digital platforms so the system can respond intelligently at all levels.

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